2021 Hong Kong Emission Inventory Report

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Environmental Protection Department

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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 2021 Hong Kong Emission Inventory. It covers:

(i) the emission inventory by source category in 2021 (Chapter 3);
(ii) the emission trends from 2001 to 2021 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 machineries 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, PM_{10} and $PM_{2.5}$. The major emission sources for VOC include paints and associated solvents, consumer products and adhesives & sealants, whereas those for PM_{10} and $PM_{2.5}$ include brake, tyre & road surface wear, 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 1 are presented into two total emission figures, one with hill fires and the other without.

3 2021 EMISSION INVENTORY

3.1. Like other countries, the local activities in 2021 were still being affected by the COVID-19 pandemic. Emissions of five major air pollutants including SO_2, NOx, PM_{10}, $PM_{2.5}$ and CO in 2021 decreased by 1% to 5%, as compared with 2020. VOC, the remaining major air pollutant, showed slight fluctuation between 2020 and 2021. The changes in emissions of various air pollutants between 2020 and 2021 are shown in **Annex 1**. The table below provides a breakdown of air pollutant emissions in 2021 by source category.

Breakdown of 2021 Emission Inventory

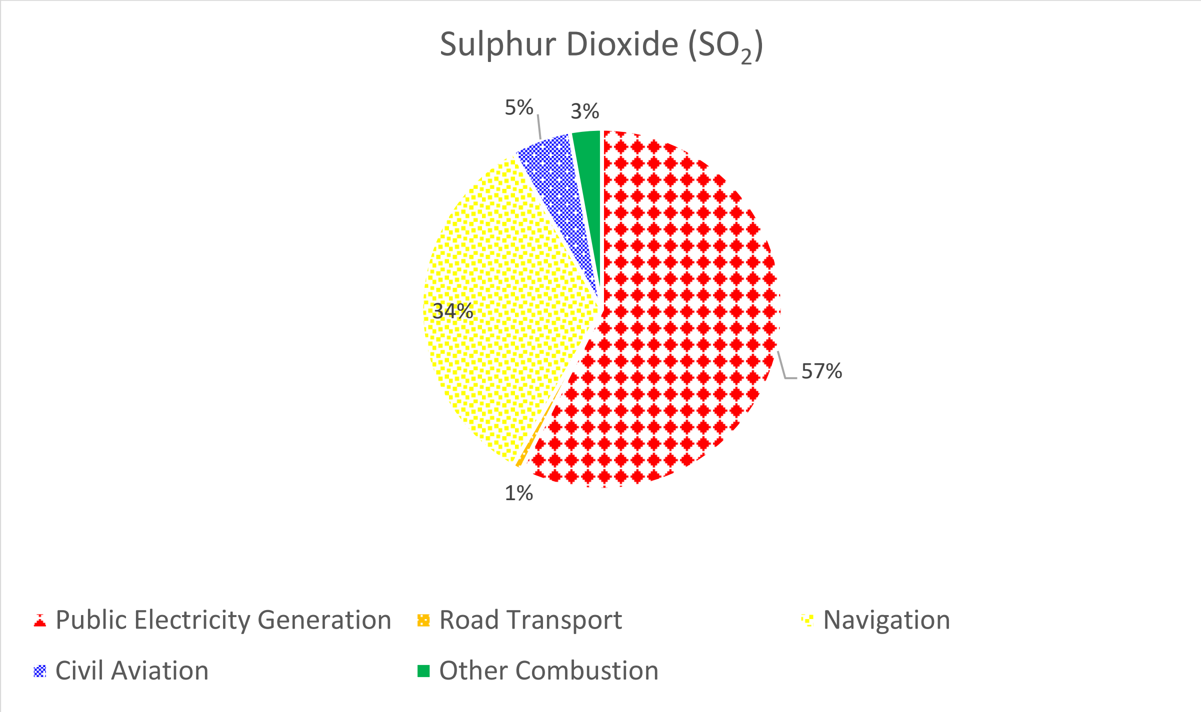
Pollution Sources	Emissions (Tonnes)					
	SO_2	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**
Public Electricity Generation	2,740	14,760	410	260	340	2,760
Road Transport	40	10,300	290	270	5,000	28,000
Navigation	1,600	18,110	720	660	3,270	20,360
Civil Aviation	250	3,450	30	30	230	1,580
Other Combustion	140	7,010	560	530	670	4,700
Non-combustion	N/A	N/A	820	430	12,420	N/A
Total Emissions (without Hill Fires)	4,760	53,620	2,820	2,170	21,950	57,400
Hill Fires	20	120	1,470	1,200	310	3,380
Total Emissions (with Hill Fires)	4,790	53,740	4,290	3,370	22,260	60,780

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.

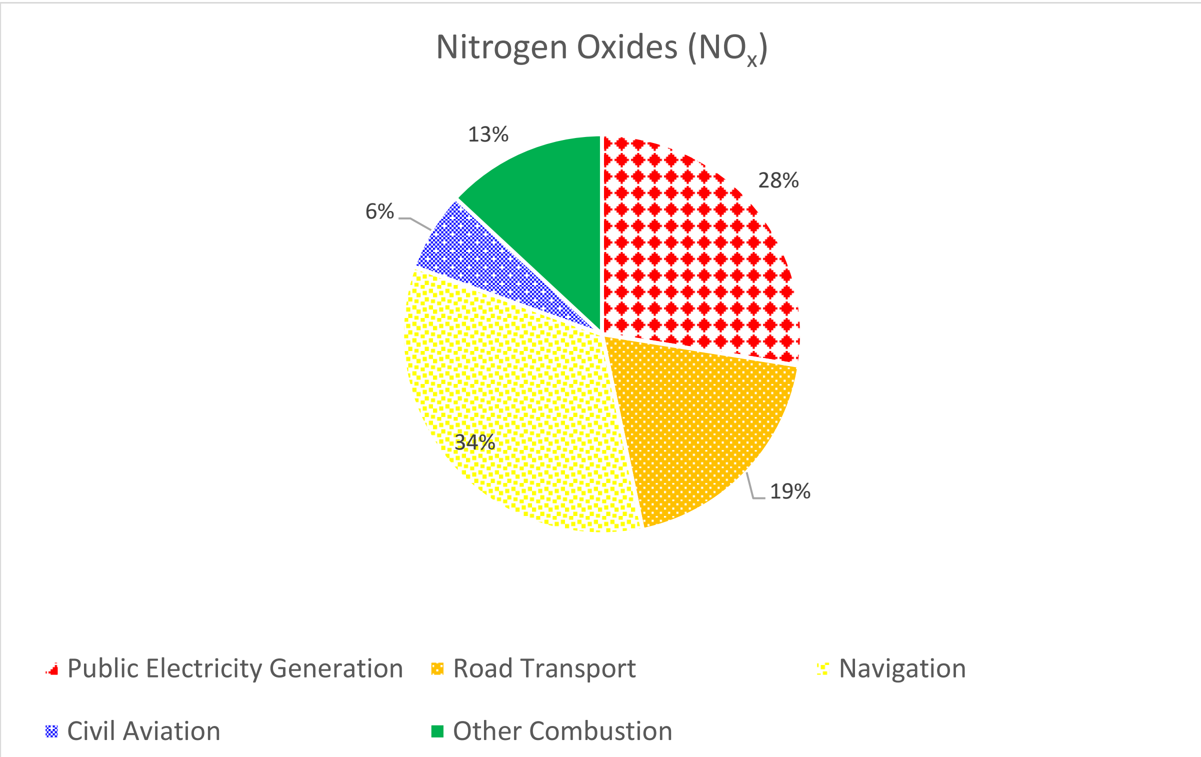
3.2. A summary of updates to the emission inventories is appended at **Annex 2**.

3.3. The following pie charts show the percentage share of emissions by source category (excluding hill fires) for each pollutant in 2021.

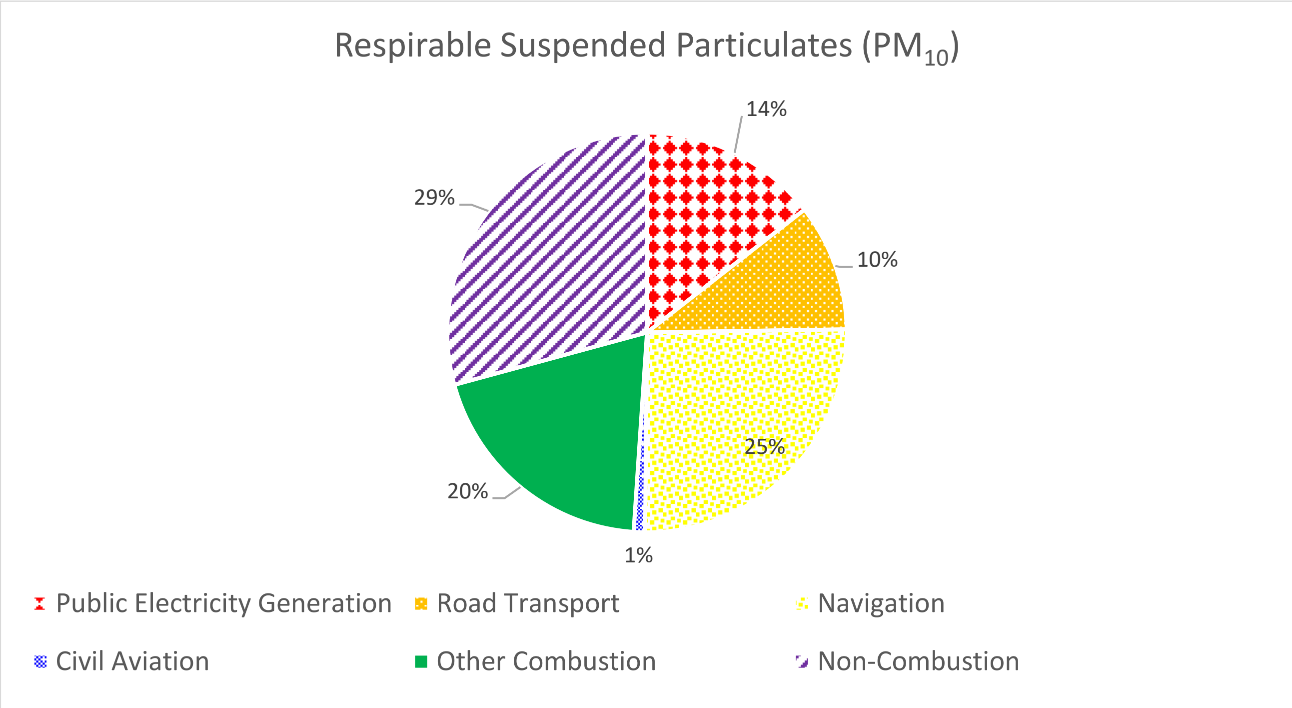
Total SO_2 emissions = 4,760 tonnes



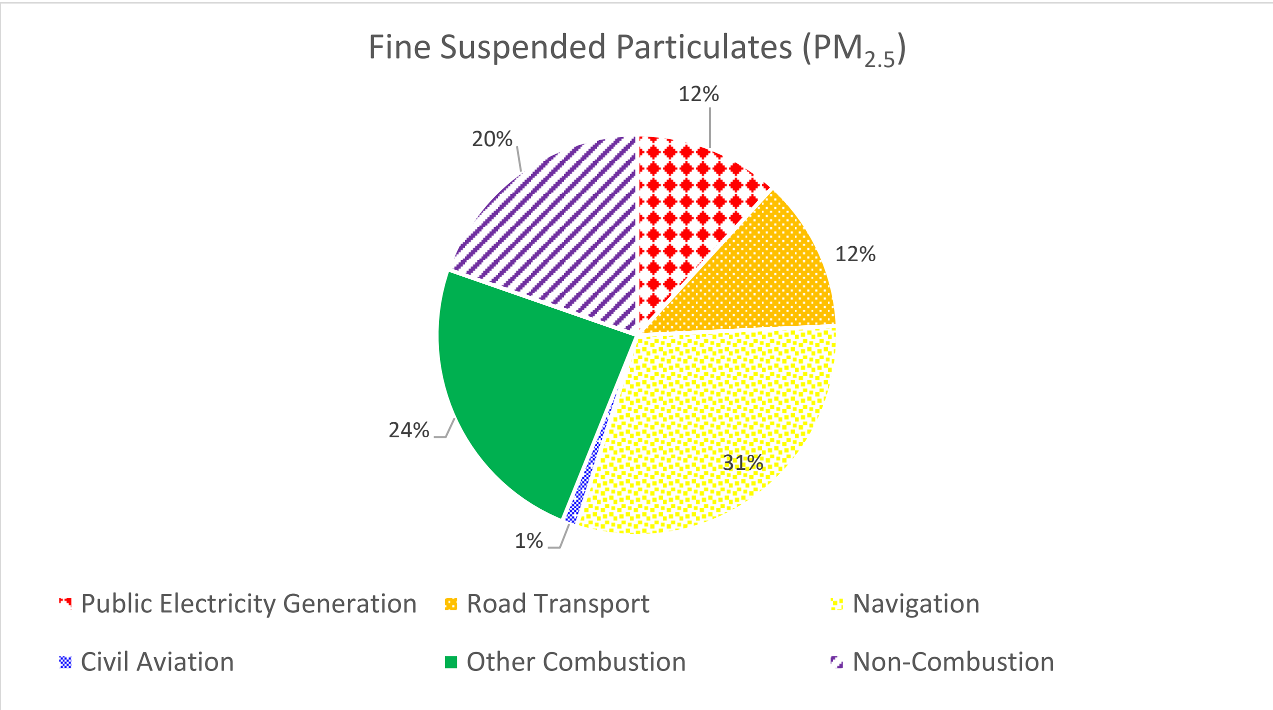
Total NOx emissions = 53,620 tonnes



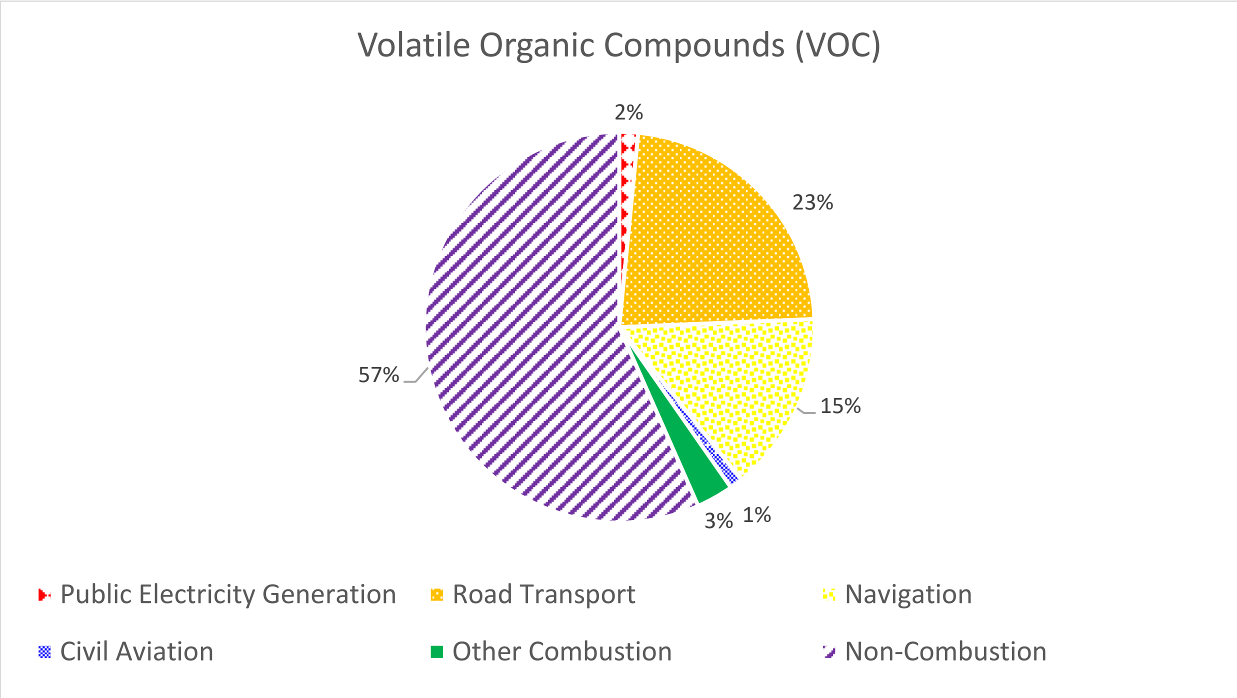
Total PM_{10} emissions = 2,820 tonnes



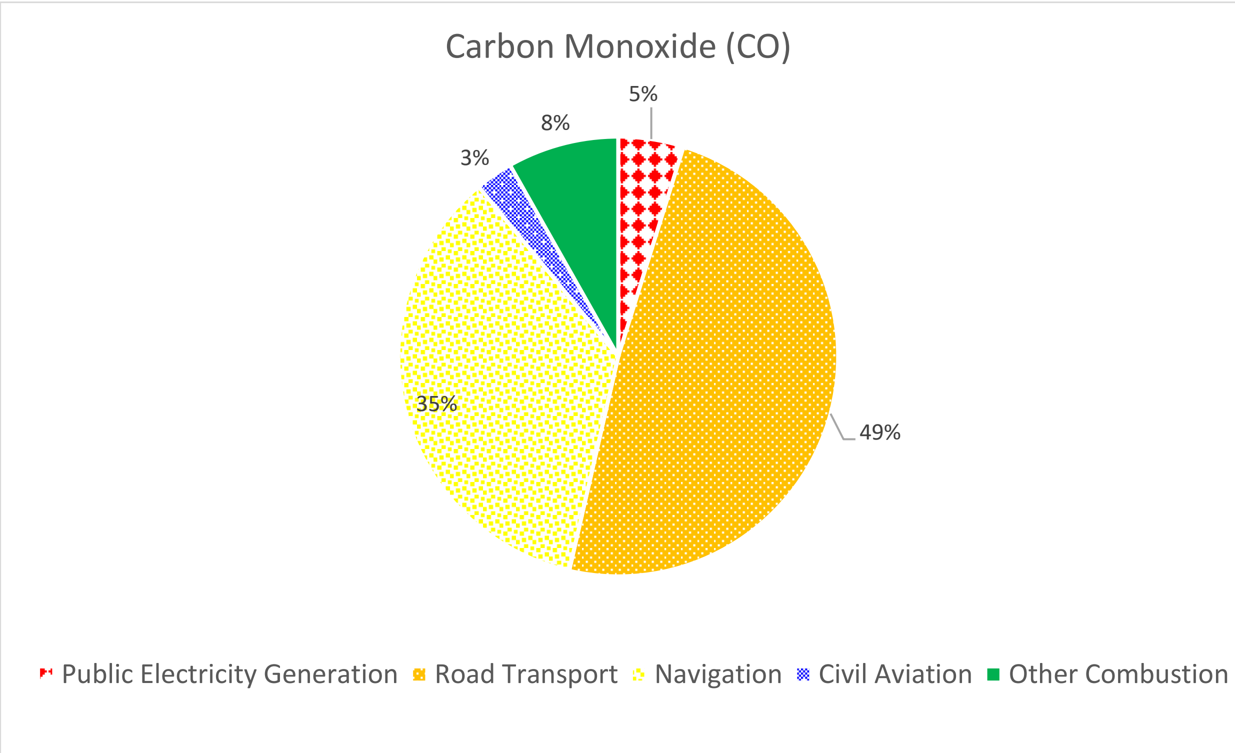
Total $PM_{2.5}$ emissions = 2,170 tonnes



Total VOC emissions = 21,950 tonnes



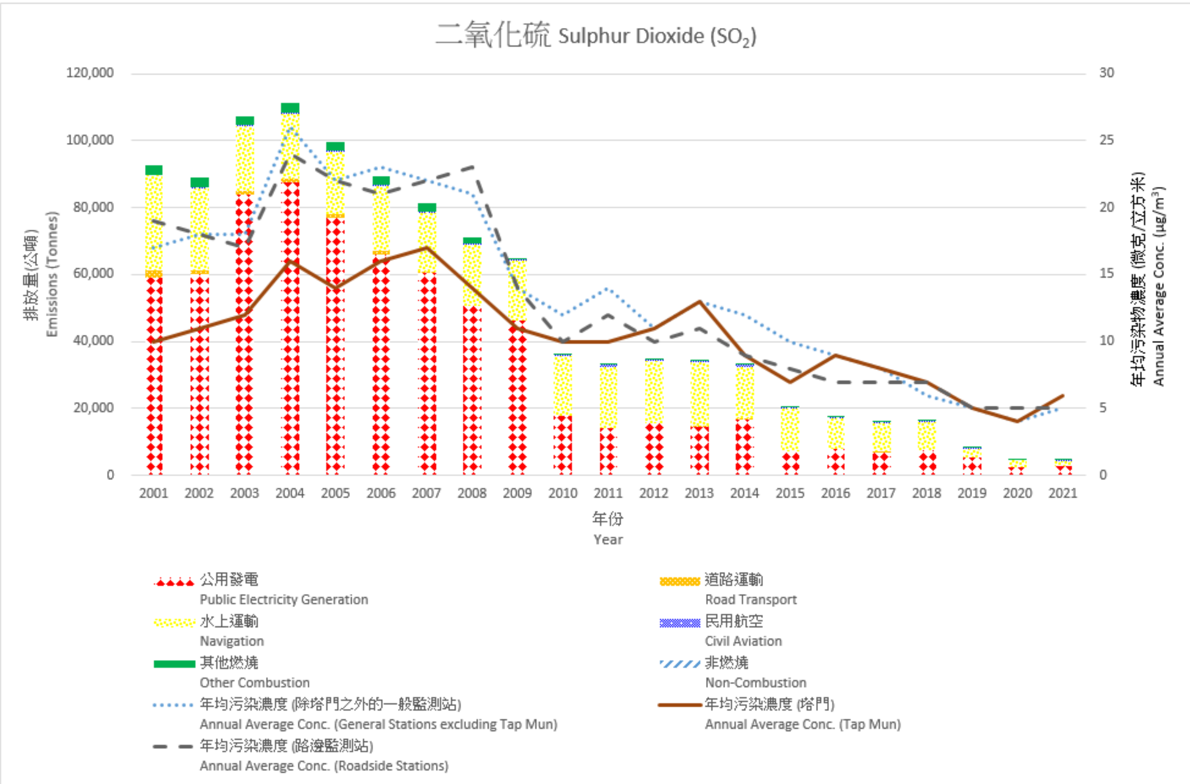
Total CO emissions = 57,400 tonnes



4 EMISSION TRENDS FROM 2001 TO 2021

To illustrate the changes in air quality over the years with respect to pollutant emissions, the annual average concentrations of the respective air pollutants recorded at EPD's air quality monitoring stations were also shown in the charts of emission trends below. 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.

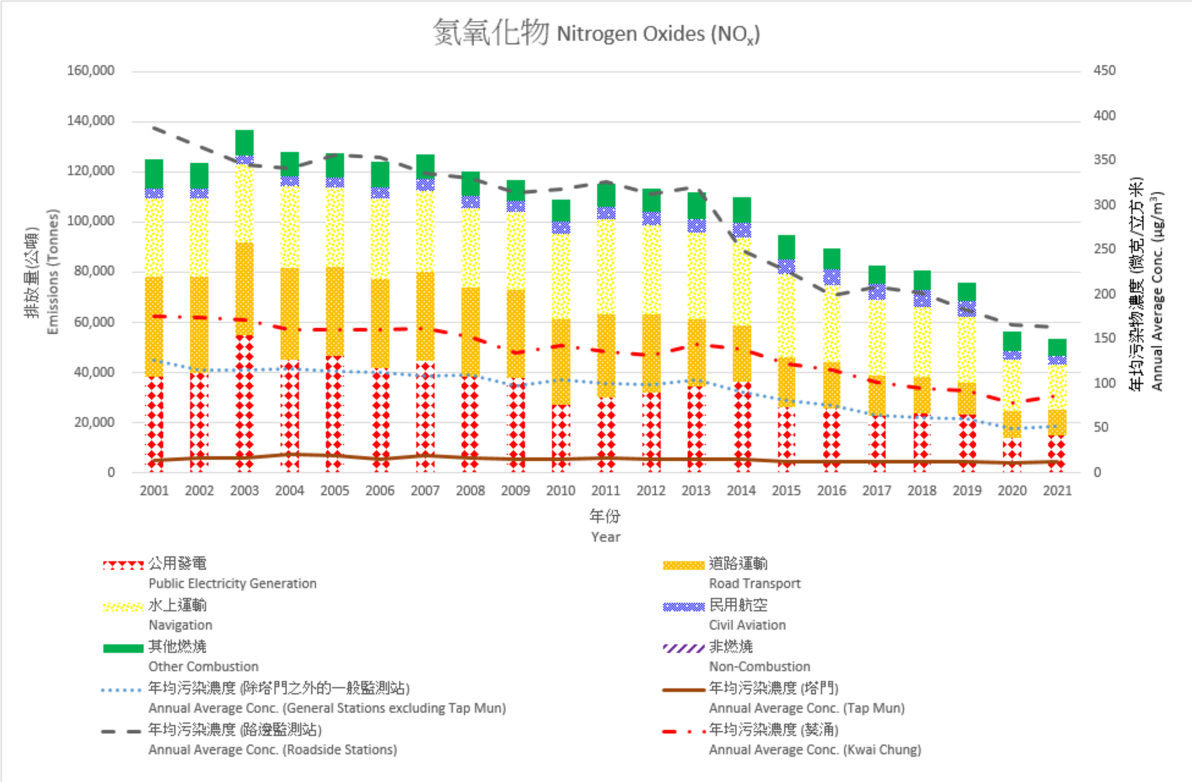
SO_2 Emission and Concentration Trends



4.1. Between 2001 and 2021, SO_2 emissions decreased by 95% mainly due to the significant reductions from the public electricity generation and navigation sectors. Public electricity generation and navigation sectors, however, remained the top two emission sources of SO_2, accounting for 57% and 34% of its total emission in 2021.

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.

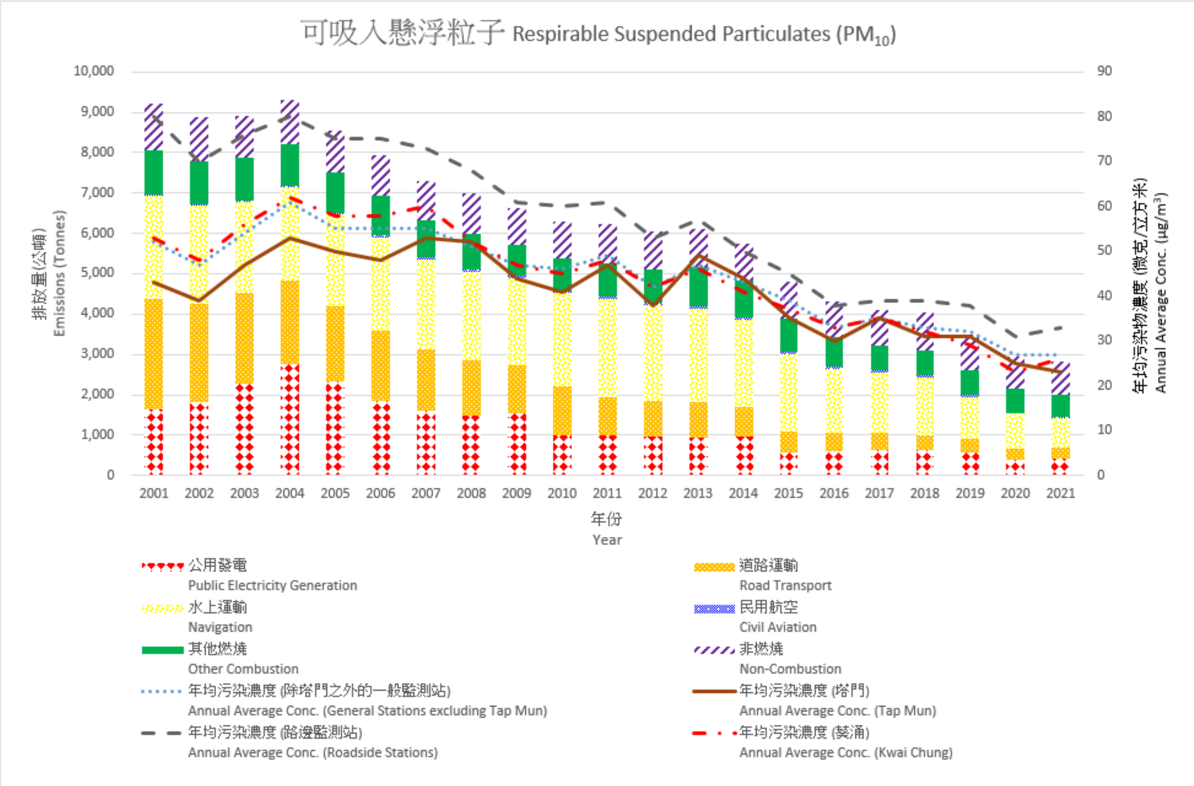
NOx Emission and Concentration Trends



4.3. Between 2001 and 2021, NOx emissions decreased by 57% 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 of NOx, accounting for 34%, 28% and 19% of its total emissions in 2021, respectively.

4.4. The background NO_2 concentration levels measured at the Tap Mun rural air quality monitoring station over the past years have remained very low, indicating that the NOx pollutants in Hong Kong primarily originate from local emission sources. NOx emission recorded in 2020 and 2021 has dropped when compared with the previous years. NO_2 concentration levels measured at the EPD's roadside air quality monitoring stations by and large followed the NOx emission trend. NO_2 concentration levels measured at Kwai Chung air quality monitoring station was in general higher than other general stations, showing the impacts of NOx emissions from ocean-going vessels.

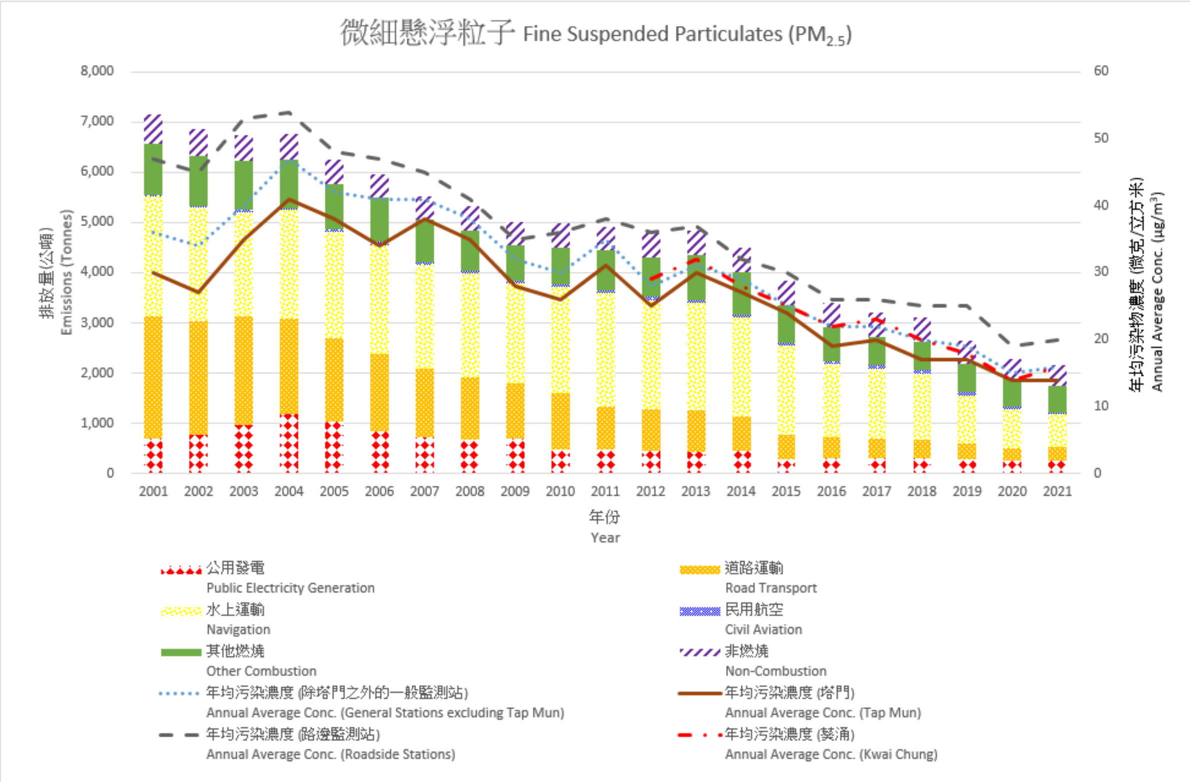
PM₁₀ Emission and Concentration Trends



4.5. Between 2001 and 2021, PM_{10} emissions decreased by 69% mainly due to reductions from road transport and public electricity generation. Non-combustion (mainly "Brake, Tyre and Road Surface Wear"), navigation and other combustion sectors were the top three emission sources of total PM_{10} emissions in 2021, accounting for 29%, 25% and 20% respectively.

4.6. The background PM_{10} 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, indicating that PM_{10} concentration levels in Hong Kong are not only affected by emissions from local sources but also subject to strong regional influence.

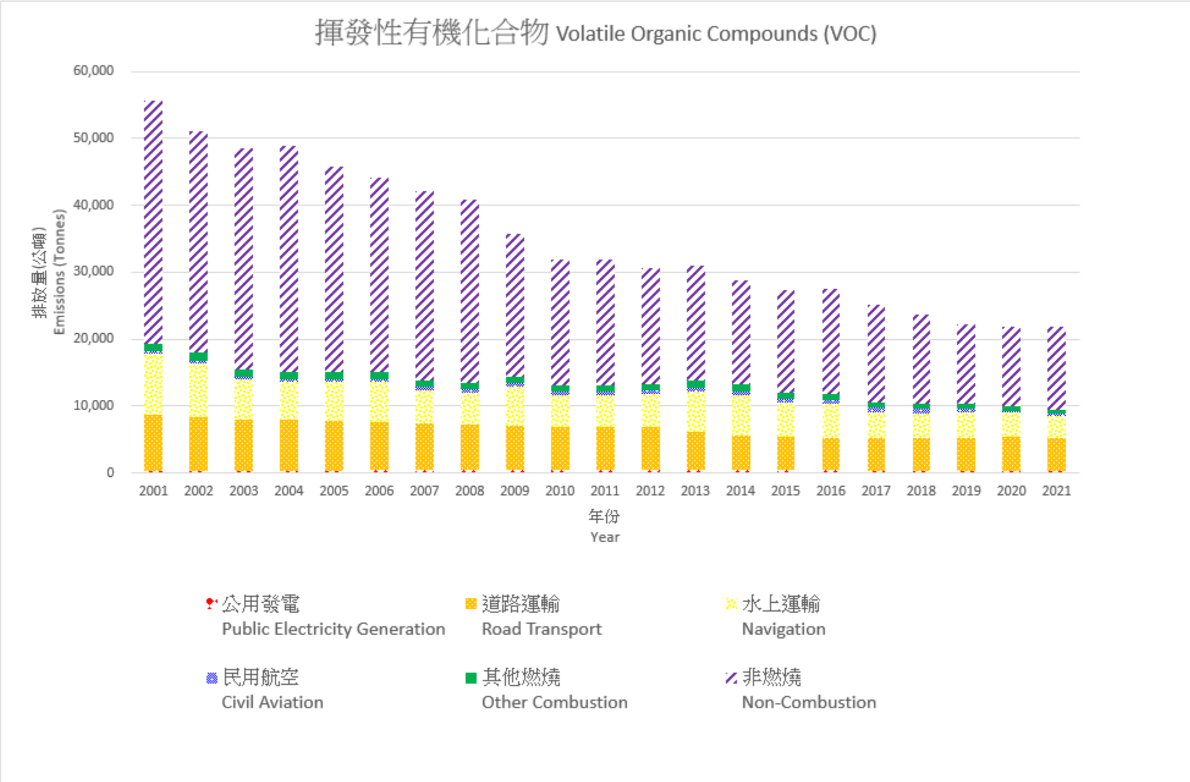
PM2.5 Emission and Concentration Trends



4.7. $PM_{2.5}$ is a fraction of PM_{10} and therefore the emission sources and trends are similar to each other. Between 2001 and 2021, $PM_{2.5}$ emissions decreased by 70%. Navigation, other combustion and non-combustion sectors were the top three emission sources, accounting for 31%, 24% and 20% of total $PM_{2.5}$ emissions in 2021, respectively.

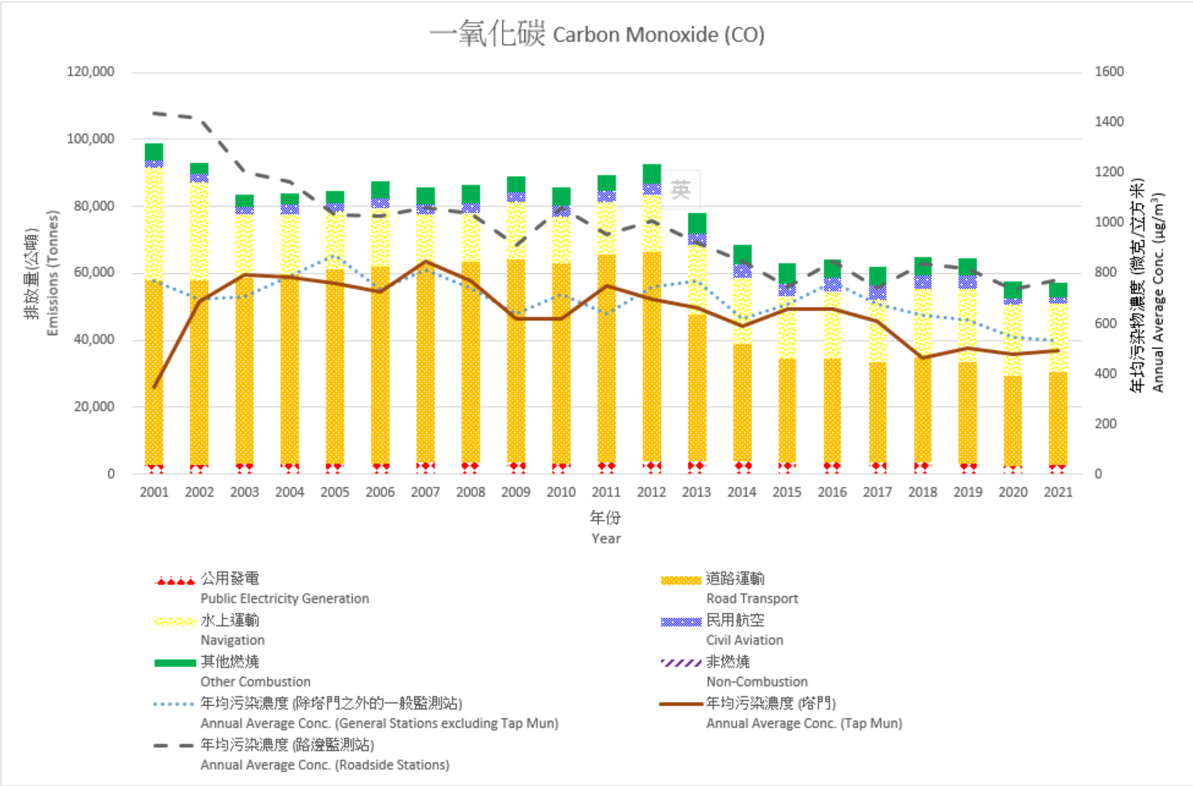
4.8. Similar to PM_{10}, $PM_{2.5}$ concentration levels in Hong Kong are also subject to strong regional influence.

VOC Emissions Trend



4.9. Between 2001 and 2021, VOC emissions decreased by 61% mainly due to reductions from the non-combustion sector. However, the trend has ceased to decline since 2019. Non-combustion, road transport and navigation sectors were the top three emission sources, accounting for 57%, 23% and 15% of total VOC emissions in 2021, respectively.

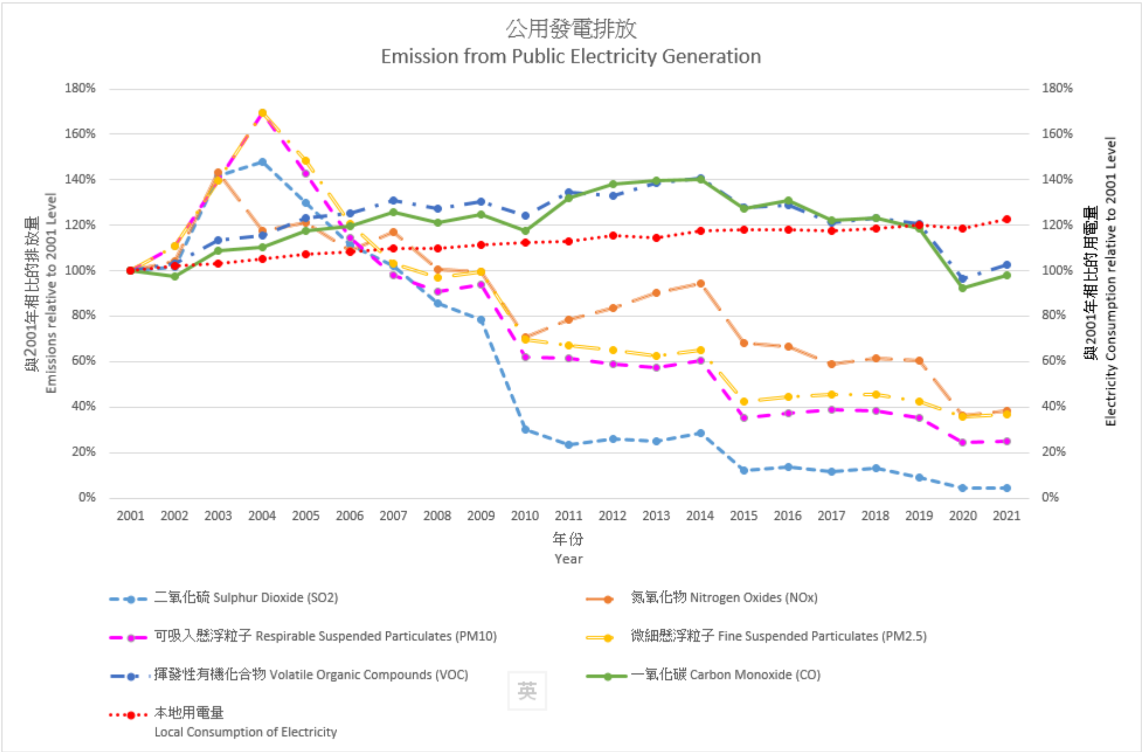
CO Emission and Concentration Trends



4.10. Between 2001 and 2021, CO emissions decreased by 42% mainly due to reductions from the road transport sector. Road transport and navigation sectors were two major emission sources, accounting for 49% and 35% of the total CO emissions in 2021, respectively.

5 SECTORAL ANALYSES

Sectoral analysis for "Public electricity generation"



5.1. Electricity sector has been a major contributor to SO_2, NOx, PM_{10} and $PM_{2.5}$ 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.

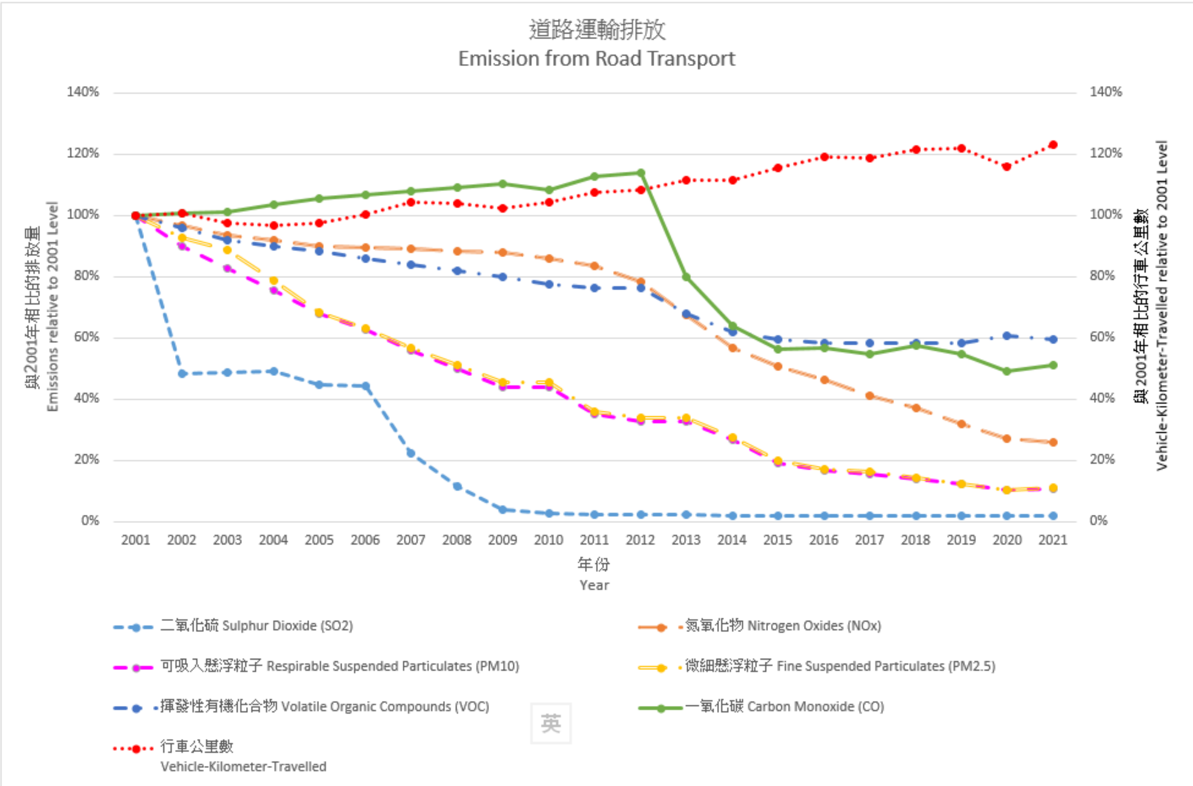
5.2. The Government has progressively tightened the emission caps via the promulgation of new TM and the latest one (i.e. the Ninth TM) was issued in June 2021 to further tighten the emission caps for 2026 and onwards.

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, the emissions of SO_2, NOx, PM_{10} and $PM_{2.5}$ in 2021 reduced substantially by 61 – 95%, despite an increase in electricity consumption of 23%.

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 renewable energy in the generation fuel mix and the supply of zero-carbon energy which are 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 VOC and CO, accounting for 23% and 49% of the total emissions in 2021, respectively. It was once a major contributor of NOx but has decreased to 19% of the total NOx emissions in 2021 after the implementation of a series of reduction measures.

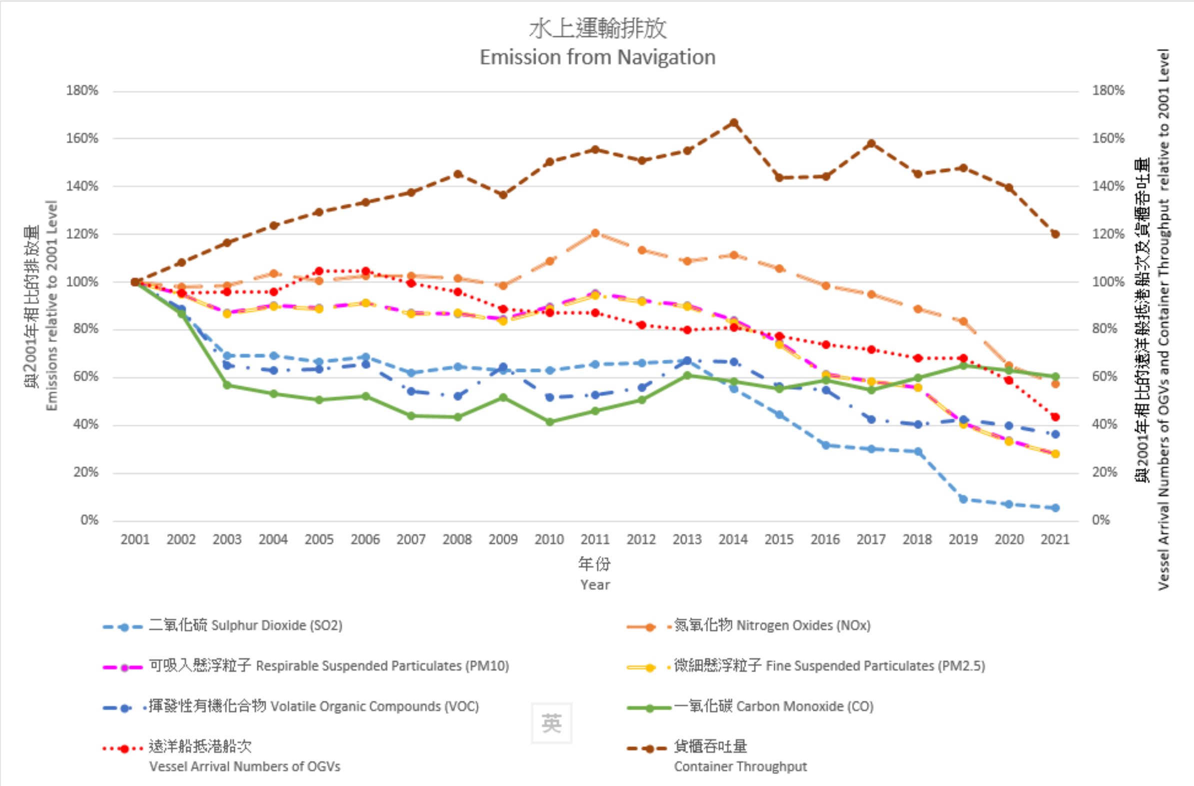
5.6. Overall speaking, the emissions from road transport decreased by 40% to 98% from 2001 to 2021, despite an increase in vehicle-kilometer-travelled of 23% during the same period. The substantial decreases in emissions of different pollutants could be attributed to a series of vehicle emission control programmes, which included strengthening the control of emissions from petrol and liquefied petroleum gas (LPG) vehicles by deploying roadside remote sensing technology 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. With the implementation additional measures, including a further programme launched in October 2020 to progressively phase out about 40,000 Euro IV DCVs by the end of 2027; and tightening of the vehicle emission standards of first registered motorcycles to Euro 4 from 1 October 2020 and the first registered light buses (with design weight exceeding 3.5 tonnes) and buses (with design weight exceeding 9 tonnes) to Euro VI from 1 March 2021, it is anticipated that emissions from the sector of road transport will decrease further.

[2] Except SO_2, emissions of major air pollutants for 2001, 2003, 2005, 2009 and 2010-2021 were calculated based on actual data, while interpolated figures were used for the remaining years. Vehicle-Kilometer-Travelled was provided by the Transport Department.

5.7. Besides, the Government has been promoting the use of electric vehicles (EVs) by offering first registration tax concession arrangements for EVs through the “One-for-One 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 in Hong Kong; installing EV chargers at government car parks; providing gross floor area concessions to car parks of new buildings installed with EV charging-enabling infrastructure; 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 has been staying at a very low level because of the introduction of Euro V diesel in December 2007, which capped the sulphur content at 0.001%.

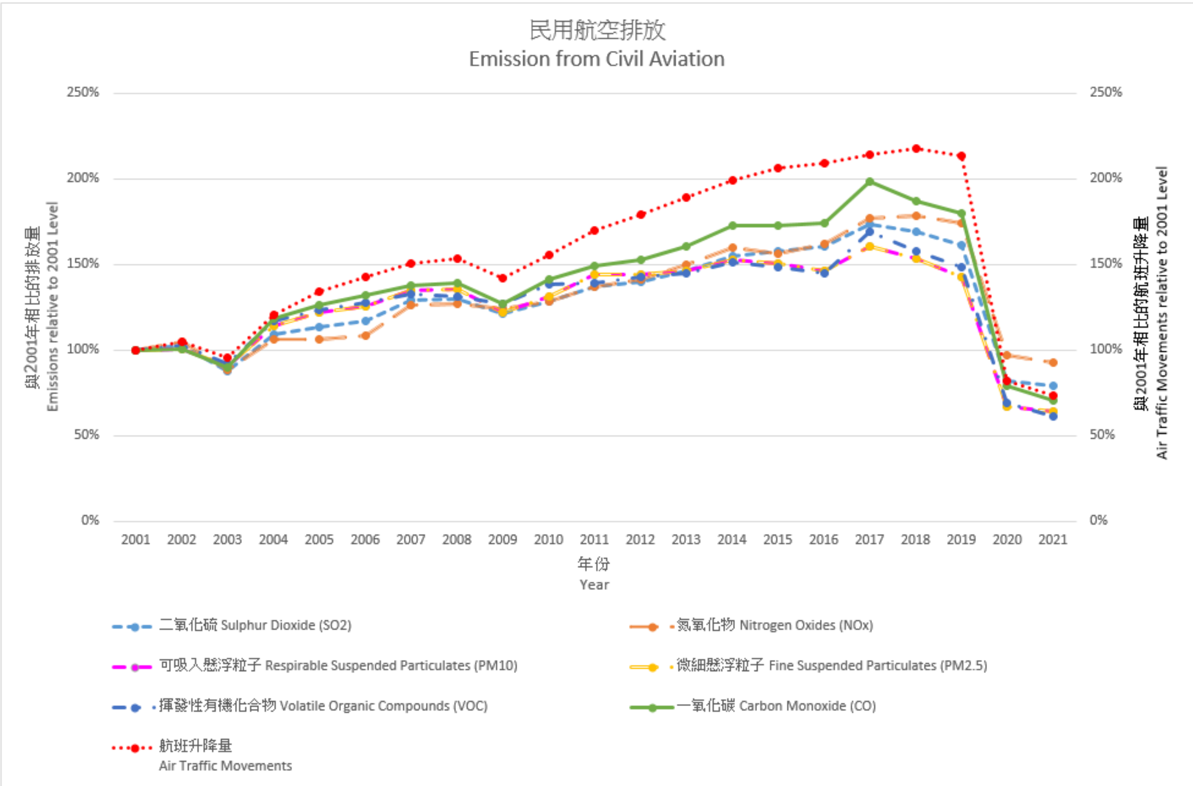
Sectoral analysis for "Navigation"



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, PM_{10} and $PM_{2.5}$ from vessels decreased substantially by 72% to 94% from 2001 to 2021. In 2021, the emissions of SO_2, NOx, PM_{10} and $PM_{2.5}$ from marine vessels accounted for 34%, 34%, 25% and 31% of the total emissions, respectively.

5.10. The SO_2, PM_{10} and $PM_{2.5}$ 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"

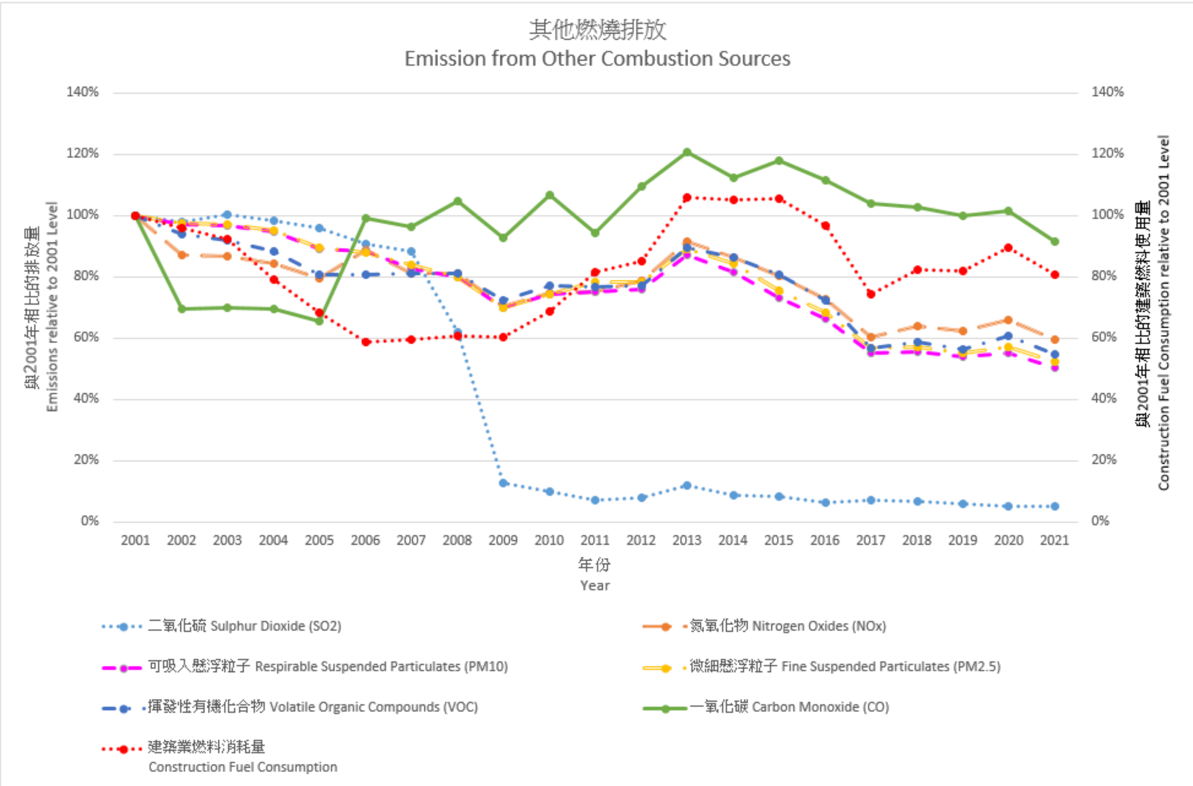


5.11. As the overall air traffic movements in 2021 was still affected by COVID-19 pandemic, emissions from civil aviation dropped further and accounted for less than 6% of the total local emissions of air pollutants in 2021. The emissions of all major pollutants recorded a further decrease by 3% to 11% as compared with 2020, when the air traffic movements dropped by 10%.

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"

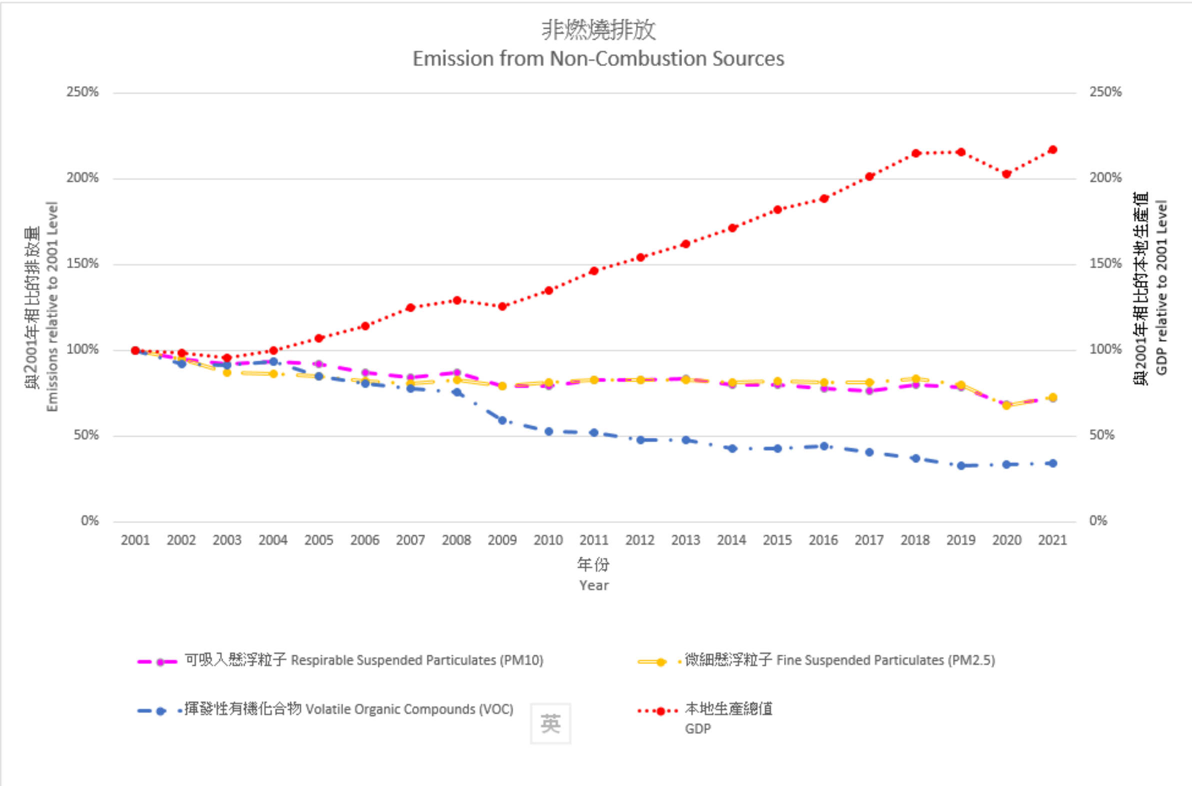


5.14. Other combustion sector is one of the important sources of PM_{10} and $PM_{2.5}$ emissions, accounting for 20% and 24% of total emissions in 2021 respectively. Overall, the emissions of the major air pollutants from other combustion sources decreased by 9% to 95% from 2001 to 2021.

5.15. Major contributing sources in this sector are non-road mobile machinery (NRMMs), especially construction machinery, which accounted for 57%, 57% and 58% of PM_{10}, $PM_{2.5}$ and NOx emissions from other combustion sources respectively in 2021. The emission trends from other combustion sources from 2010 to 2021 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”

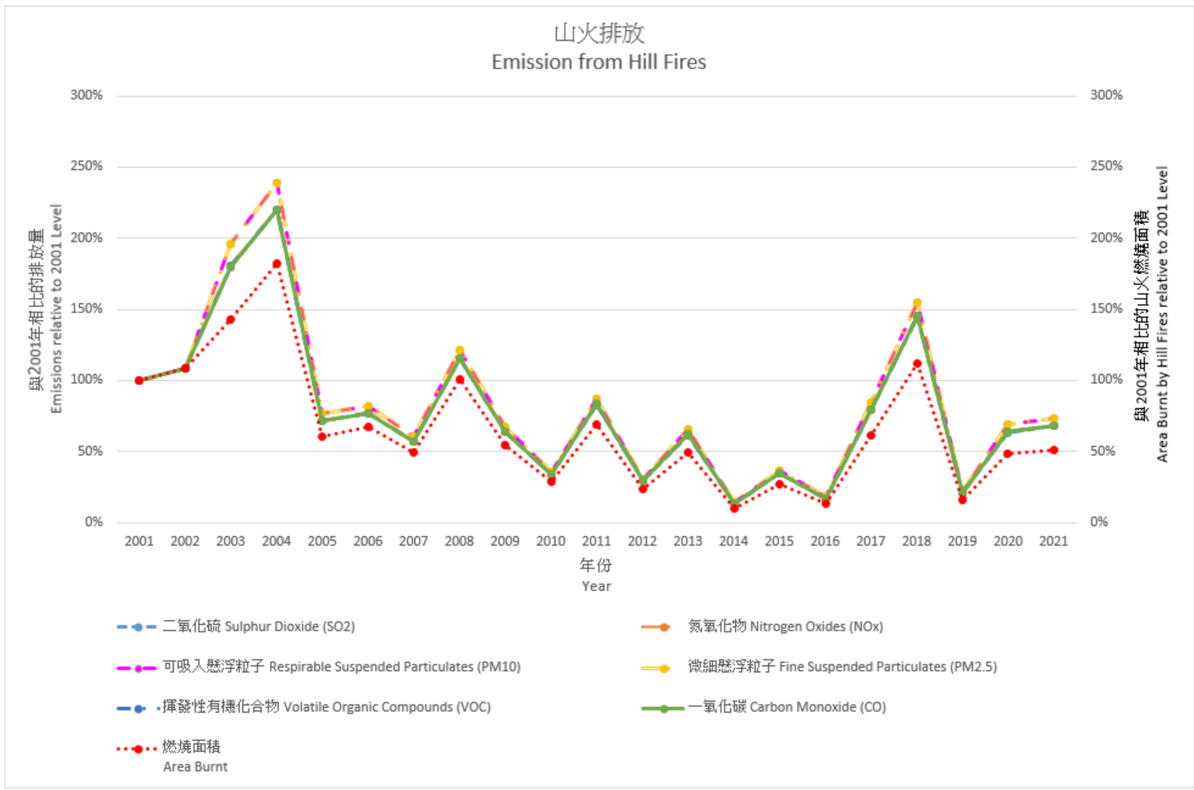


5.17. Non-combustion sources contribute considerably to local VOC emissions, accounting for 57% in 2021, whereas its contributions to local PM_{10} and $PM_{2.5}$ emissions in 2021 were 29% and 20% respectively. Overall, the emissions of the sector decreased by 27% to 66% from 2001 to 2021, despite the growth of Gross Domestic Product by 117%.

5.18. The use of paints, consumer products, adhesive and sealants continued to be the major contributing sources, accounting for 82% of non-combustion sources VOC emissions in 2021. As compared with 2006, the VOC emissions from non-combustion sources decreased by 57% in 2021 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 PM_{10} and $PM_{2.5}$, the major contributing source was “Brake, Tyre & Road Surface Wear”, accounting for 75% and 76% of non-combustion PM_{10} and $PM_{2.5}$ emissions respectively in 2021.

6 EMISSIONS FROM HILL FIRES



6.1. Emissions from hill fires is a major source of PM_{10} and $PM_{2.5}$, accounting for 34% and 36% of total local PM_{10} and $PM_{2.5}$ emissions in 2021, respectively.

Annex 1 – Breakdown of Emission Inventory by Source Category from 2020 to 2021

Pollutant	Source Category	Emissions (Tonnes)	
		2020	**2021**
SO_2	Public Electricity Generation	2,550	2,740
	Road Transport	40	40
	Navigation	1,930	1,600
	Civil Aviation	260	250
	Other Combustion	140	140
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	4,910	4,760
	Hill Fires	20	20
	Total (with Hill Fires)	4,940	4,790
NOx	Public Electricity Generation	13,840	14,760
	Road Transport	10,800	10,300
	Navigation	20,500	18,110
	Civil Aviation	3,610	3,450
	Other Combustion	7,770	7,010
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	56,520	53,620
	Hill Fires	110	120
	Total (with Hill Fires)	56,630	53,740
PM_{10}	Public Electricity Generation	390	410
	Road Transport	280	290
	Navigation	860	720
	Civil Aviation	30	30
	Other Combustion	610	560
	Non-combustion	780	820
	Total (without Hill Fires)	2,950	2,820
	Hill Fires	1,370	1,470
	Total (with Hill Fires)	4,320	4,290
$PM_{2.5}$	Public Electricity Generation	250	260
	Road Transport	250	270
	Navigation	800	660
	Civil Aviation	30	30

Pollutant	Source Category	Emissions (Tonnes)	
		2020	2021
	Other Combustion	570	530
	Non-combustion	400	430
	Total (without Hill Fires)	2,290	2,170
	Hill Fires	1,120	1,200
	Total (with Hill Fires)	3,420	3,370
VOC	Public Electricity Generation	320	340
	Road Transport	5,100	5,000
	Navigation	3,600	3,270
	Civil Aviation	260	230
	Other Combustion	740	670
	Non-combustion	11,920	12,420
	Total (without Hill Fires)	21,940	21,950
	Hill Fires	290	310
	Total (with Hill Fires)	22,230	22,260
CO	Public Electricity Generation	2,600	2,760
	Road Transport	27,000	28,000
	Navigation	21,190	20,360
	Civil Aviation	1,770	1,580
	Other Combustion	5,230	4,700
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	57,790	57,400
	Hill Fires	3,170	3,380
	Total (with Hill Fires)	60,960	60,780

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 2020 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 past emission inventories are summarized in the table below. Based on the latest updates, we have recalculated historical emission inventories from 2001 to 2020. 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.
January 2023	2001-2020	• Adopted Aviation Environmental Design Tool (AEDT) version 3e for estimating emissions from Civil Aviation sector.

Annex 3 – Comparison between the Previous and Recalculated Inventories (without Hill Fires) from 2001 to 2020

Table A3-1. Changes in SO_2 emission inventories from 2001 to 2020

Year	SO_2 (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	92,590	92,640	0%
2002	88,790	88,840	0%
2003	107,430	107,460	0%
2004	111,110	111,140	0%
2005	99,740	99,780	0%
2006	89,230	89,260	0%
2007	81,190	81,240	0%
2008	71,070	71,120	0%
2009	64,970	64,960	0%
2010	36,310	36,310	0%
2011	33,230	33,230	0%
2012	34,930	34,930	0%
2013	34,540	34,540	0%
2014	33,220	33,220	0%
2015	20,590	20,580	0%
2016	17,720	17,710	0%
2017	16,340	16,340	0%
2018	16,690	16,680	0%
2019	8,620	8,610	0%
2020	4,940	4,910	-1%

* Figures are rounded to the nearest ten.

Figure A3-1 **SO_2 emissions trend from 2001 to 2020**

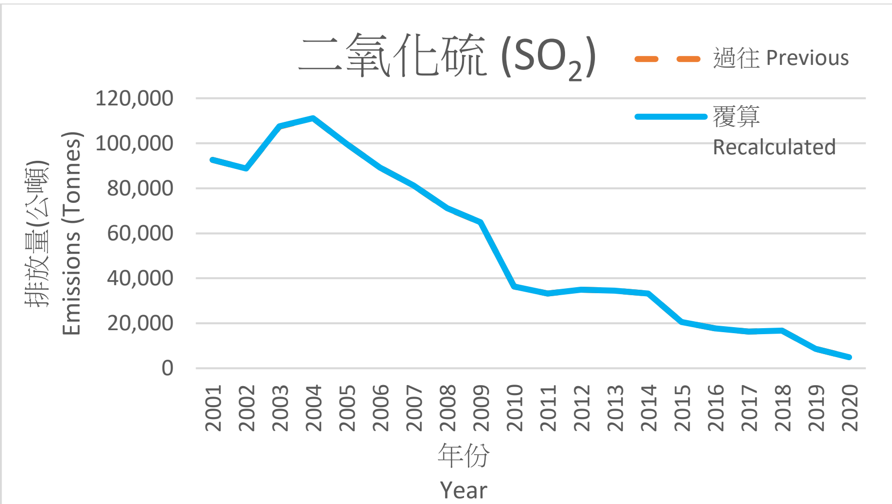


Table A3-2. Changes in NOx emission inventories from 2001 to 2020

Year	**NOx (Tonnes)**		
	Previous*	Recalculated*	% Changes
2001	124,590	125,120	0%
2002	122,940	123,540	0%
2003	136,200	136,570	0%
2004	127,560	127,980	0%
2005	126,890	127,230	0%
2006	123,710	124,100	0%
2007	126,210	126,830	0%
2008	119,330	119,930	1%
2009	116,970	116,920	0%
2010	109,090	109,060	0%
2011	115,220	115,120	0%
2012	113,460	113,460	0%
2013	111,860	112,060	0%
2014	109,820	109,800	0%
2015	94,870	94,680	0%
2016	89,760	89,560	0%
2017	82,800	82,580	0%
2018	80,690	80,490	0%
2019	76,170	75,930	0%
2020	56,680	56,520	0%

* Figures are rounded to the nearest ten.

Figure A3-2 NOx emission trend from 2001 to 2020

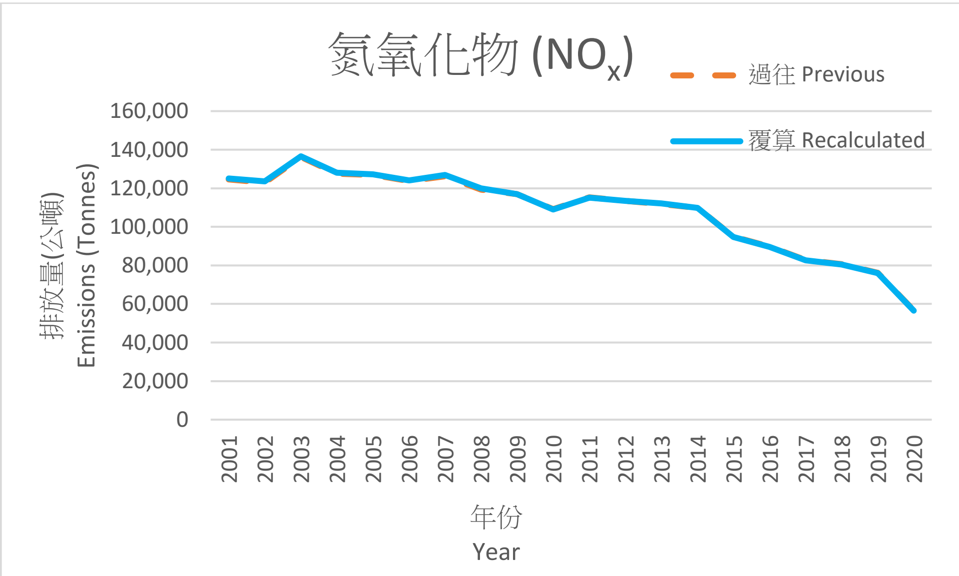


Table A3-3. Changes in PM_{10} emission inventories from 2001 to 2020

Year	PM_{10} (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	9,220	9,200	0%
2002	8,900	8,880	0%
2003	8,940	8,920	0%
2004	9,310	9,290	0%
2005	8,580	8,550	0%
2006	7,950	7,920	0%
2007	7,310	7,280	0%
2008	7,000	6,990	0%
2009	6,640	6,620	0%
2010	6,310	6,290	0%
2011	6,230	6,220	0%
2012	6,060	6,050	0%
2013	6,110	6,110	0%
2014	5,730	5,730	0%
2015	4,790	4,790	0%
2016	4,310	4,300	0%
2017	4,120	4,090	-1%
2018	4,060	4,030	-1%
2019	3,510	3,490	-1%
2020	2,930	2,950	1%

* Figures are rounded to the nearest ten.

Figure A3-3 **PM_{10} emission trend from 2001 to 2020**

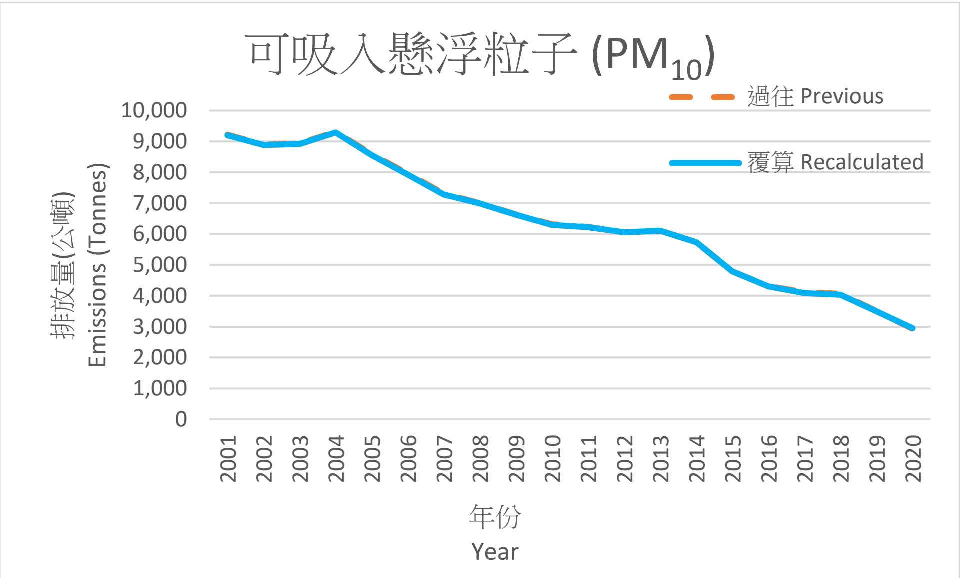


Table A3-4. Changes in $PM_{2.5}$ emission inventories from 2001 to 2020

Year	$PM_{2.5}$ (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	7,170	7,150	0%
2002	6,880	6,870	0%
2003	6,750	6,730	0%
2004	6,770	6,750	0%
2005	6,290	6,260	0%
2006	6,000	5,970	-1%
2007	5,560	5,530	-1%
2008	5,340	5,330	0%
2009	5,030	5,010	0%
2010	5,000	4,980	0%
2011	4,930	4,920	0%
2012	4,800	4,790	0%
2013	4,840	4,840	0%
2014	4,490	4,490	0%
2015	3,830	3,840	0%
2016	3,410	3,400	0%
2017	3,230	3,210	-1%
2018	3,150	3,120	-1%
2019	2,660	2,640	-1%
2020	2,290	2,290	0%

* Figures are rounded to the nearest ten.

Figure A3-4 **$PM_{2.5}$ emission trend from 2001 to 2020**

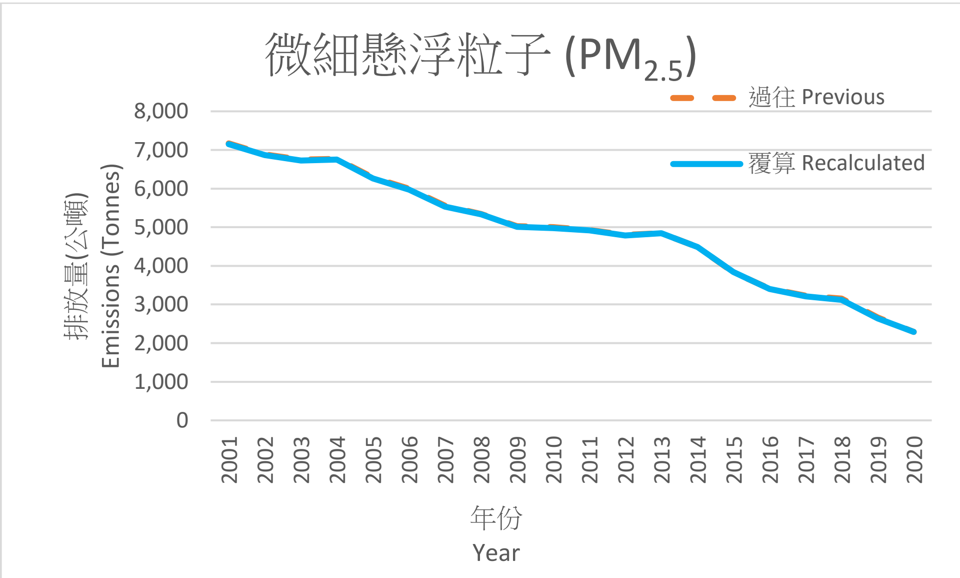


Table A3-5. Changes in VOC emission inventories from 2001 to 2020

Year	VOC (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	55,580	55,650	0%
2002	51,100	51,170	0%
2003	48,430	48,470	0%
2004	48,890	48,940	0%
2005	45,790	45,820	0%
2006	44,100	44,140	0%
2007	42,050	42,100	0%
2008	40,820	40,850	0%
2009	35,660	35,660	0%
2010	32,000	31,990	0%
2011	32,010	31,990	0%
2012	30,720	30,720	0%
2013	31,010	31,000	0%
2014	28,780	28,790	0%
2015	27,430	27,410	0%
2016	27,580	27,560	0%
2017	25,220	25,200	0%
2018	23,760	23,740	0%
2019	22,320	22,300	0%
2020	21,910	21,940	0%

* Figures are rounded to the nearest ten.

Figure A3-5 **VOC emission trend from 2001 to 2020**

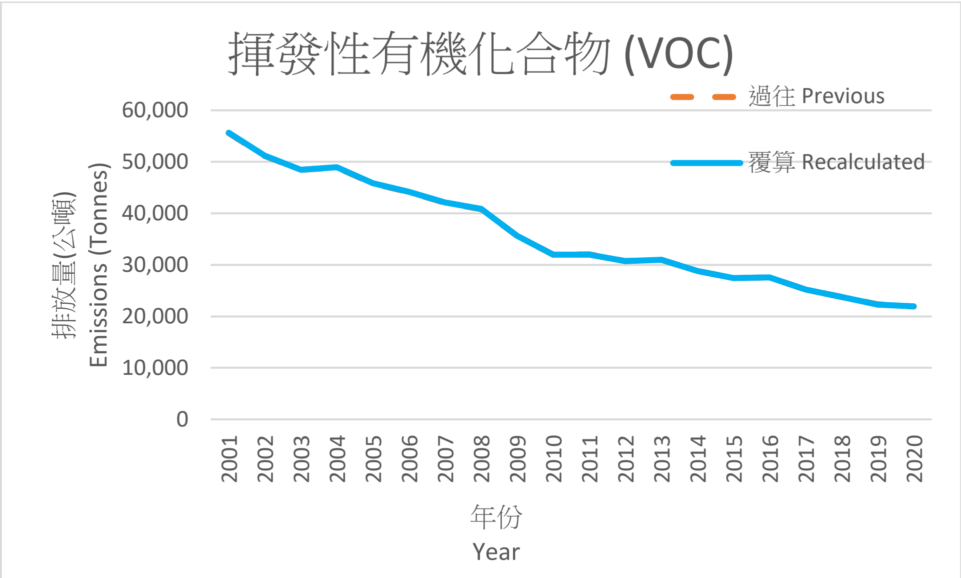


Table A3-6. Changes in CO emission inventories from 2001 to 2020

Year	CO (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	98,560	98,900	0%
2002	92,820	93,170	0%
2003	83,210	83,420	0%
2004	83,770	84,040	0%
2005	84,300	84,530	0%
2006	87,390	87,680	0%
2007	85,290	85,640	0%
2008	86,130	86,450	0%
2009	89,130	89,130	0%
2010	85,600	85,590	0%
2011	89,570	89,510	0%
2012	92,620	92,600	0%
2013	78,250	78,230	0%
2014	68,430	68,440	0%
2015	63,280	63,120	0%
2016	64,440	64,270	0%
2017	61,900	61,820	0%
2018	64,890	64,820	0%
2019	64,670	64,560	0%
2020	57,810	57,790	0%

* Figures are rounded to the nearest ten.

Figure A3-6 CO emission trend from 2001 to 2020