2022 Hong Kong Emission Inventory Report

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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 2022 Hong Kong Emission Inventory. It covers:

(i) the emission inventory by source category in 2022 (Chapter 3);
(ii) the emission trends from 2001 to 2022 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 2022 EMISSION INVENTORY

3.1. In Hong Kong, the local activities in 2022 were still being affected by COVID-19 pandemic, which also impacted the emissions of major air pollutants. In 2022, the emissions of four major air pollutants including SO_2, NOx, VOC and CO decreased by 4% to 7% as compared with 2021, while PM_{10} and $PM_{2.5}$ showed slight increase by 1% and 3% respectively between 2021 and 2022. The changes in emissions of various air pollutants between 2021 and 2022 are shown in **Annex 1**. The table below provides a breakdown of air pollutant emissions in 2022 by source category.

Breakdown of 2022 Emission Inventory

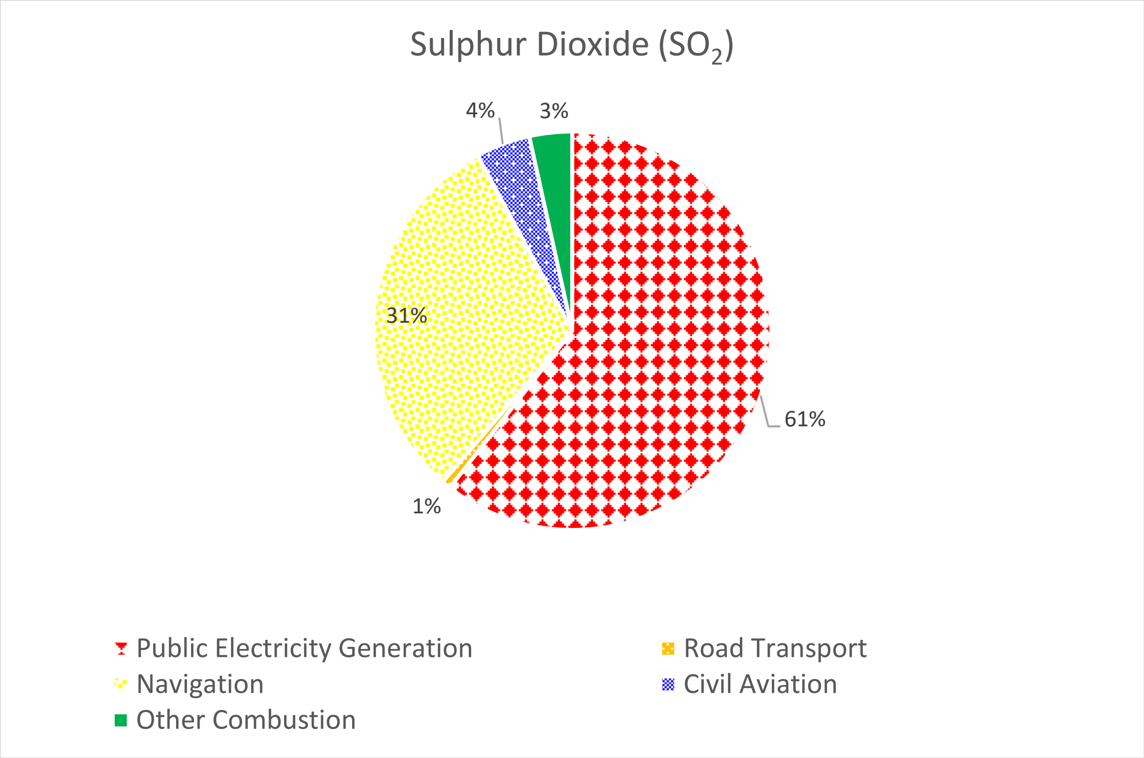
Pollution Sources	**Emissions (Tonnes)**					
	SO_2	**NOx**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**
Public Electricity Generation	2,660	13,480	370	240	330	2,640
Road Transport	30	9,300	280	250	4,700	25,700
Navigation	1,350	15,920	630	590	3,100	20,400
Civil Aviation	190	2,570	20	20	230	1,440
Other Combustion	150	8,750	750	720	920	4,660
Non-combustion	N/A	N/A	790	410	11,860	N/A
Total Emissions (without Hill Fires)	4,390	50,010	2,840	2,220	21,130	54,850
Hill Fires	10	30	440	360	90	960
Total Emissions (with Hill Fires)	4,400	50,040	3,280	2,580	21,220	55,810

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.

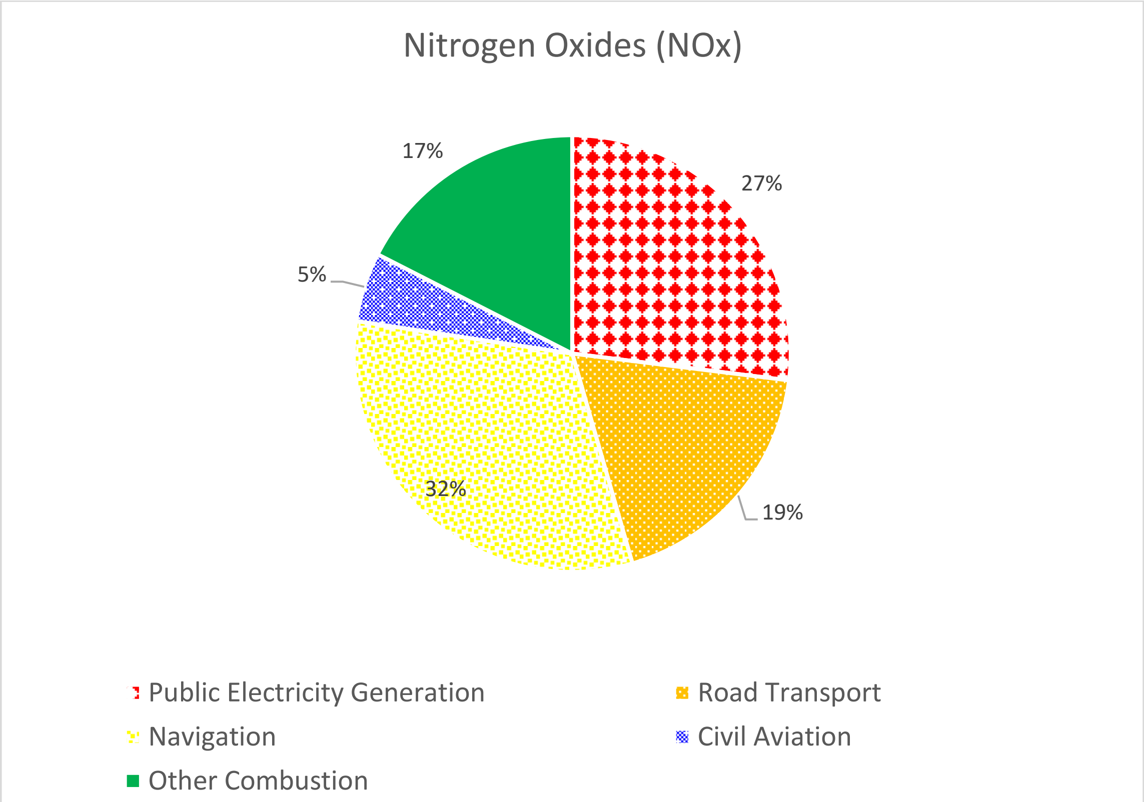
3.2. A summary of updates to the emission inventories compilation is appended at **Annex 2** while the recalculated figures are provided in **Annex 3**.

3.3. The following pie charts show the percentage share of emissions by source category (excluding hill fires) for each pollutant in 2022.

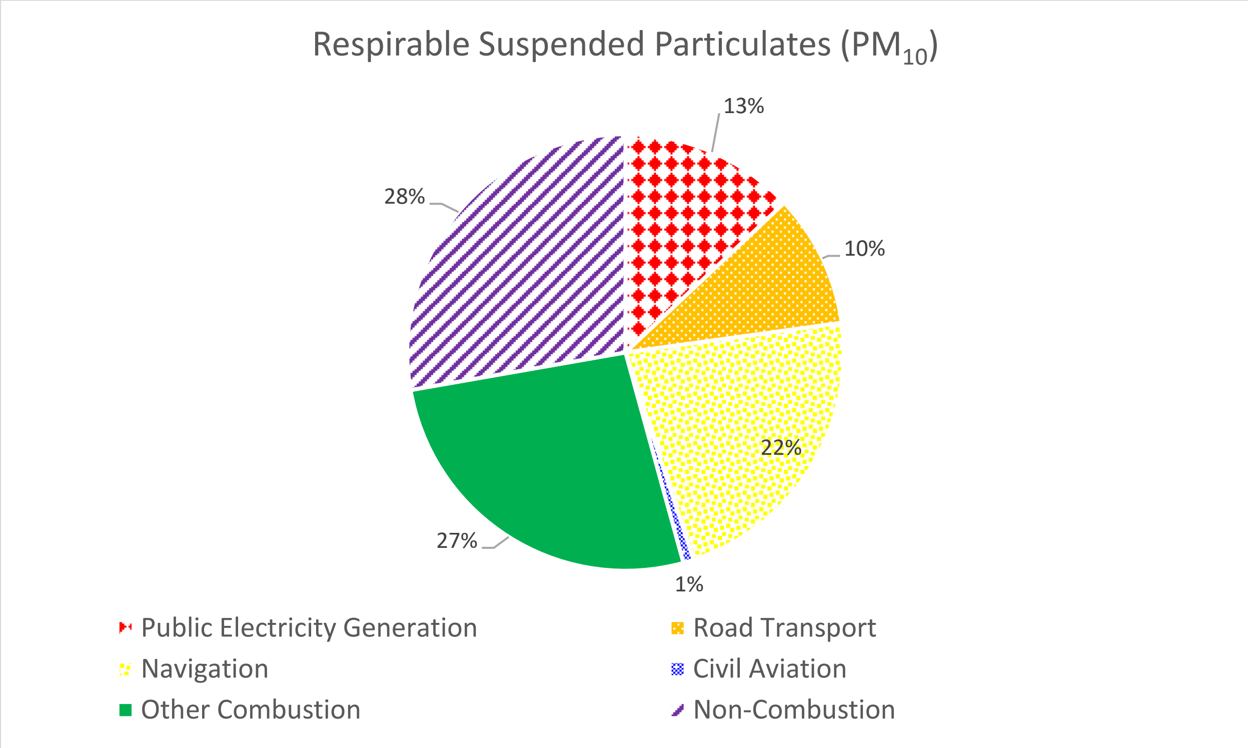
Total SO_2 emissions = 4,390 tonnes



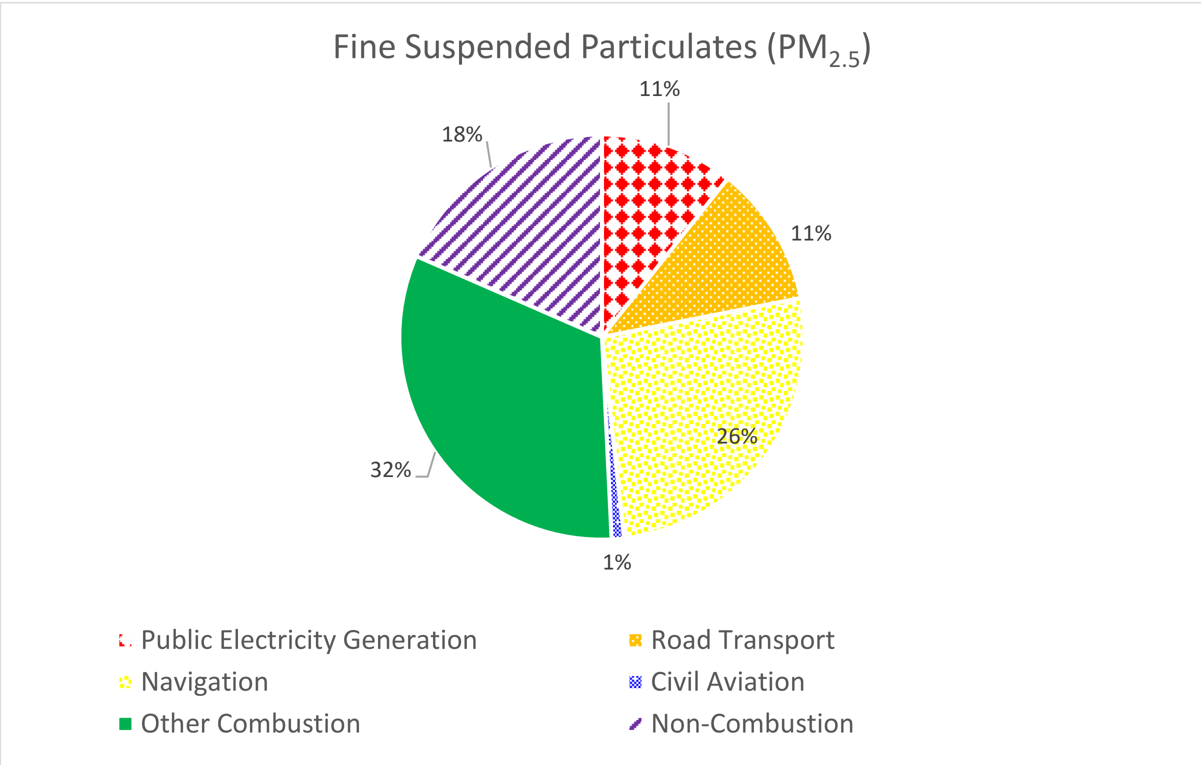
Total NOx emissions = 50,010 tonnes



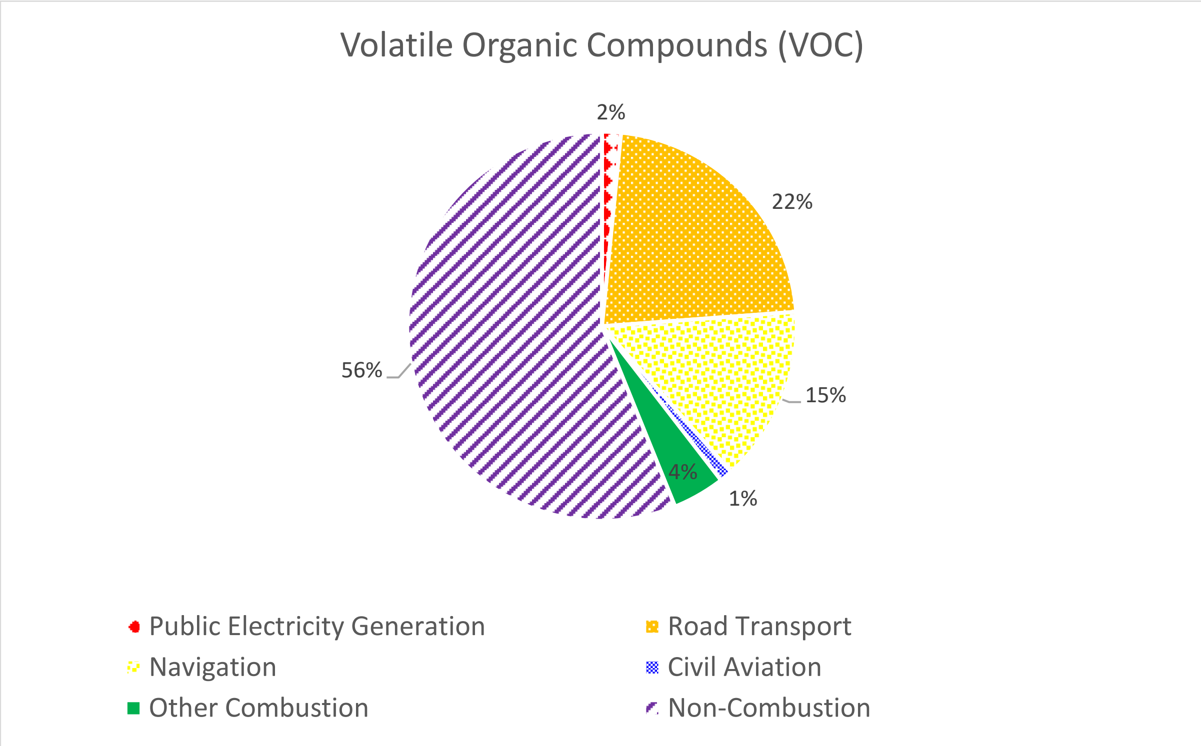
Total PM_{10} emissions = 2,840 tonnes



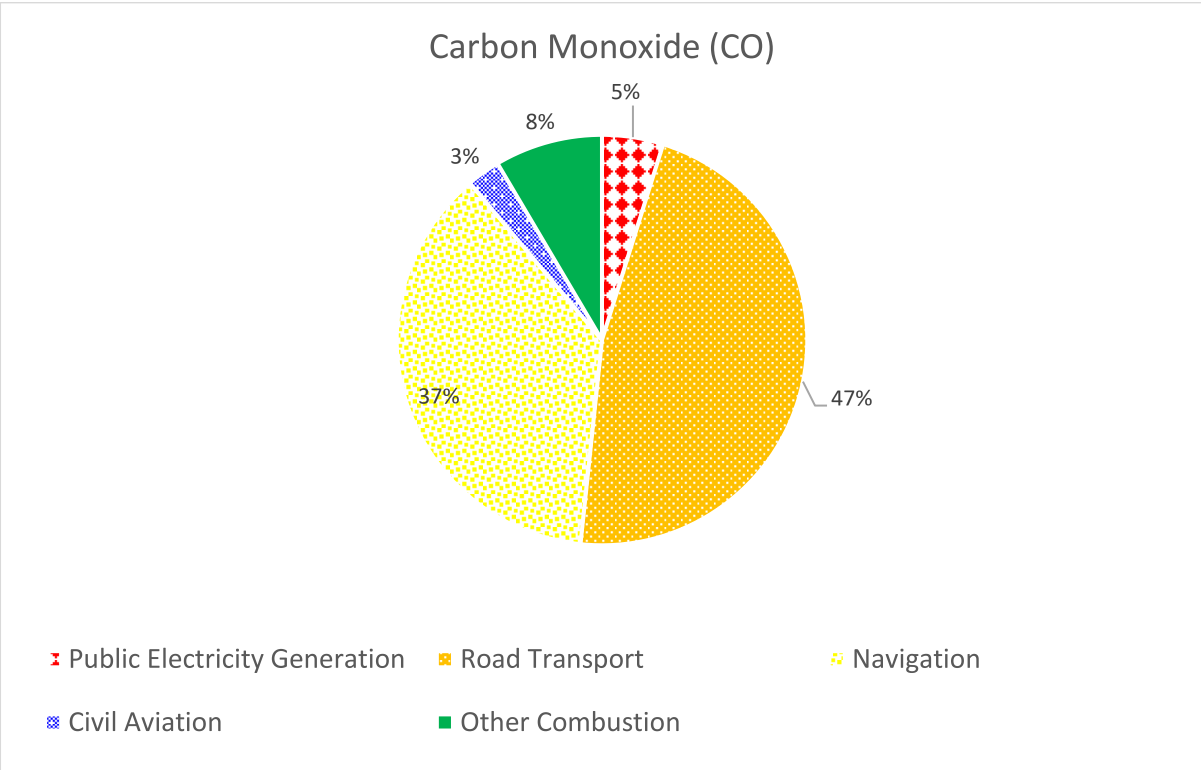
Total $PM_{2.5}$ emissions = 2,220 tonnes



Total VOC emissions = 21,130 tonnes



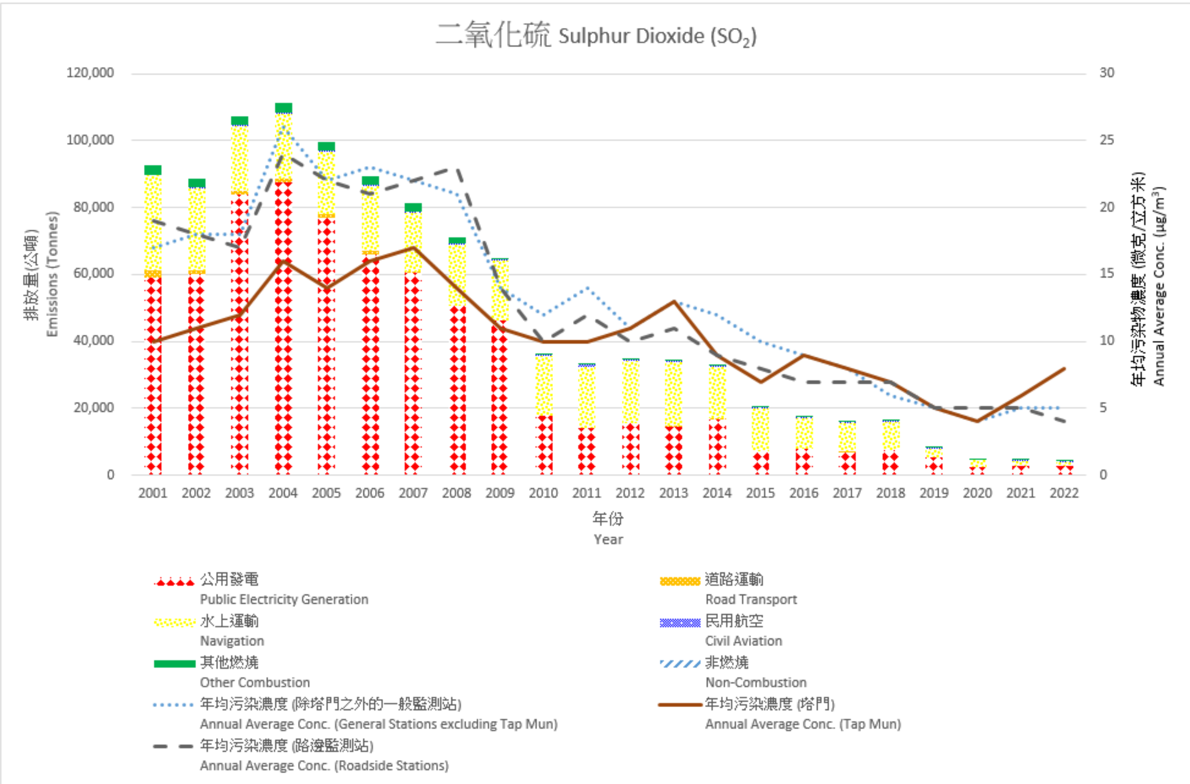
Total CO emissions = 54,850 tonnes



4 EMISSION TRENDS FROM 2001 TO 2022

To better 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.

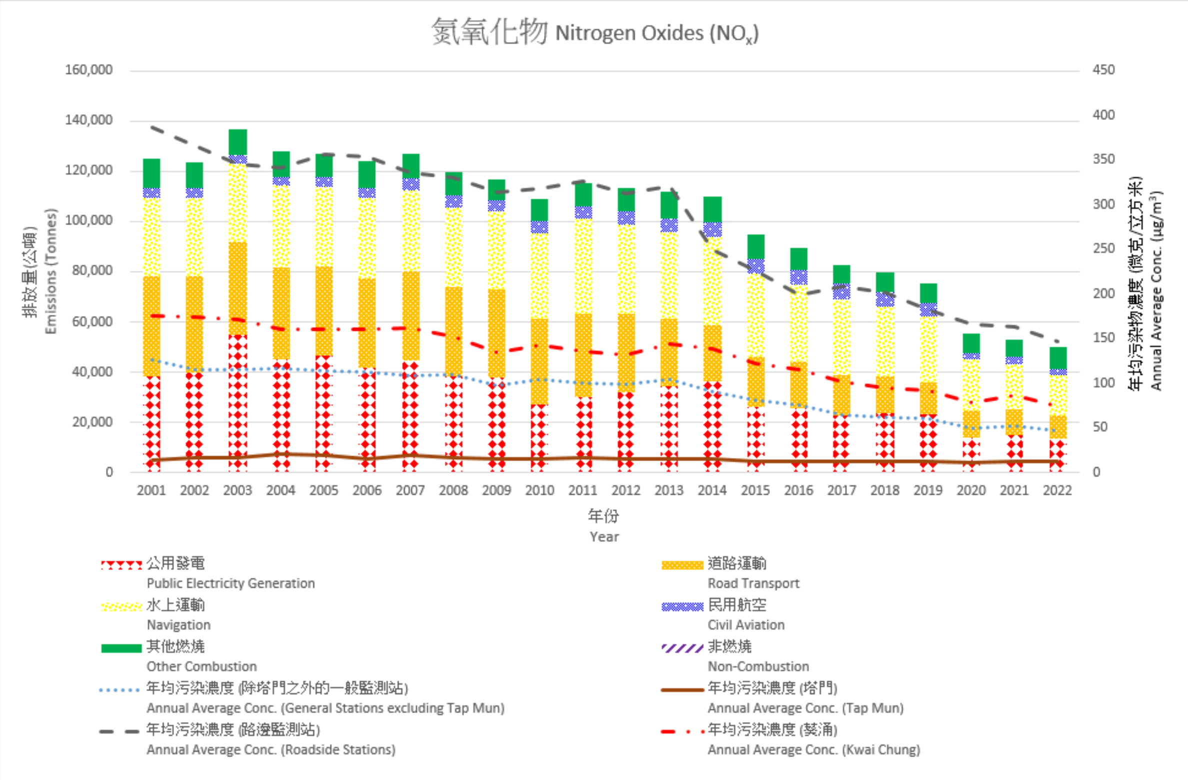
<u>SO_2 Emission and Concentration Trends</u>



4.1. Between 2001 and 2022, 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 two major emission sources of SO_2, accounting for 61% and 31% of its total emission in 2022.

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.

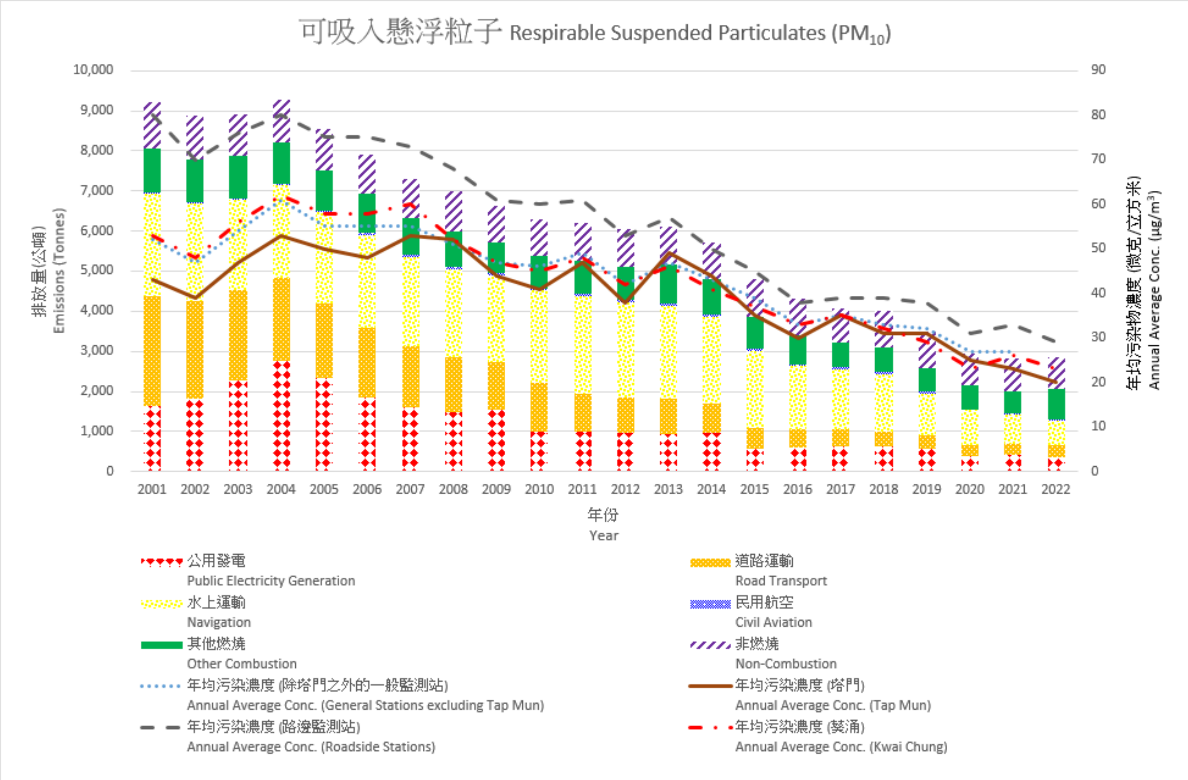
NOx Emission and Concentration Trends



4.3. Between 2001 and 2022, NOx emissions decreased by 60% 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 32%, 27% and 19% of its total emissions in 2022, 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 from 2020 to 2022 were significantly lower than 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.

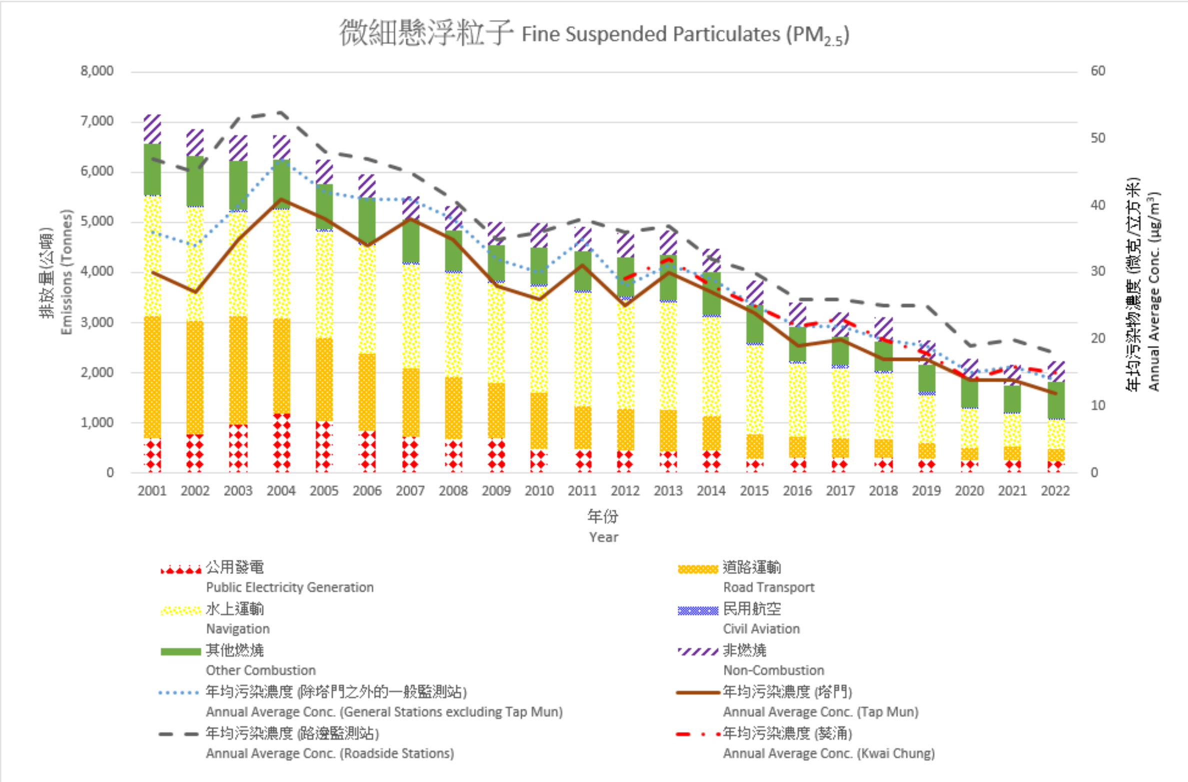
PM_{10} Emission and Concentration Trends



4.5. Between 2001 and 2022, 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"), other combustion and navigation sectors were the top three emission sources of total PM_{10} emissions in 2022, accounting for 28%, 27% and 22% 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.

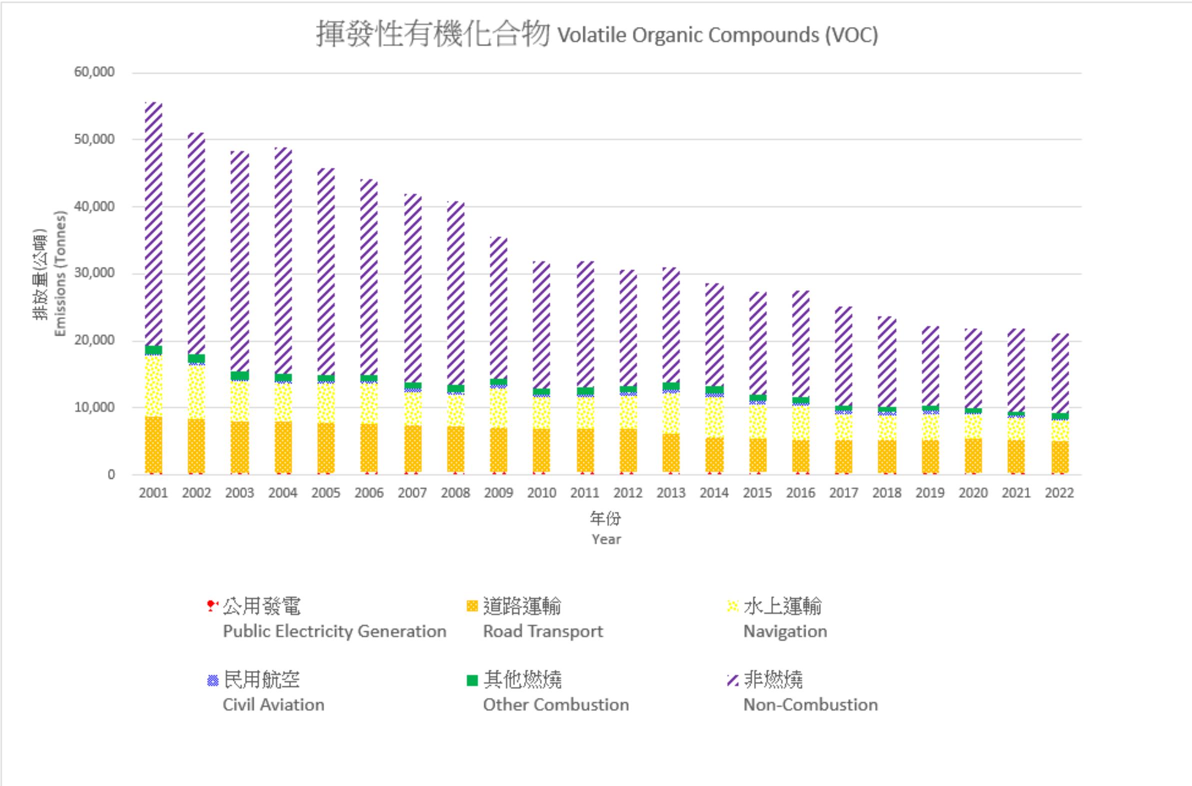
$PM_{2.5}$ Emission and Concentration Trends



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 2022, $PM_{2.5}$ emissions decreased by 69%. Other combustion, navigation, and non-combustion sectors were the top three emission sources, accounting for 32%, 26% and 18% of total $PM_{2.5}$ emissions in 2022, respectively.

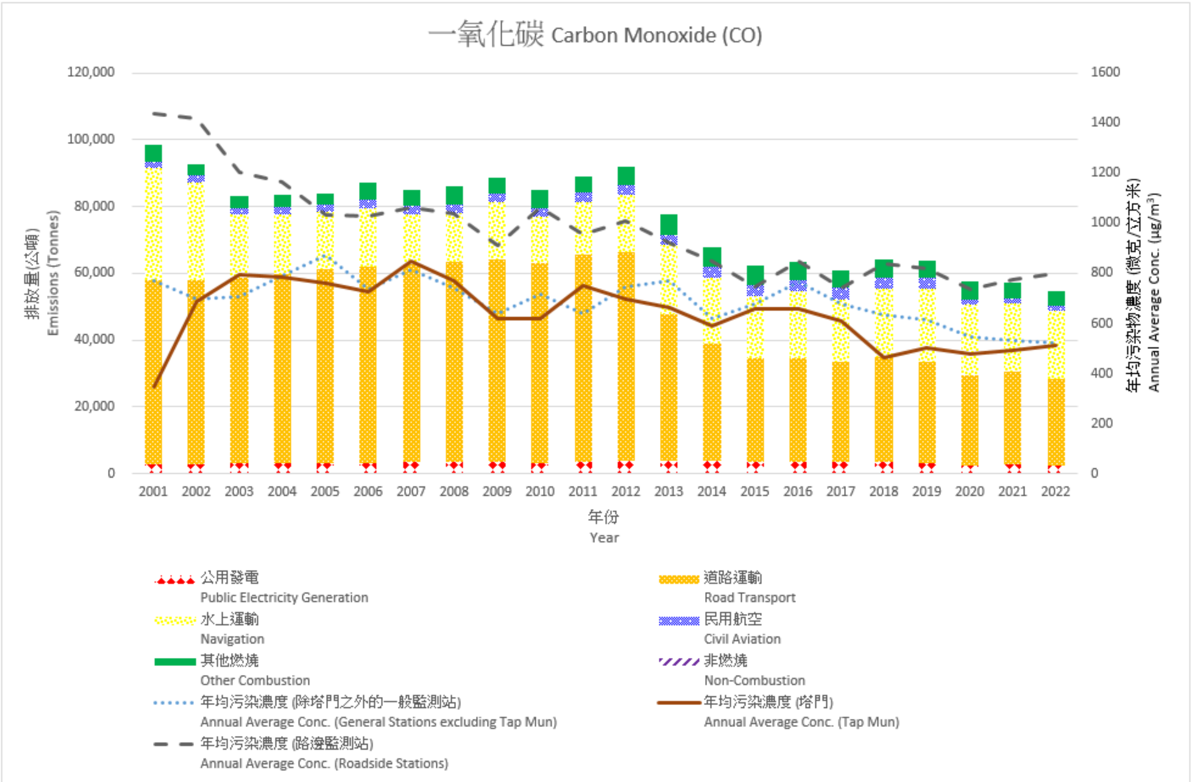
4.8. Similar to PM_{10}, $PM_{2.5}$ concentration levels in Hong Kong are also subject to strong influence of regional emissions.

VOC Emissions Trend



4.9. Between 2001 and 2022, VOC emissions decreased by 62% mainly due to reductions from the non-combustion sector. The downward trend has become less apparent since 2019. Non-combustion, road transport and navigation sectors were the top three emission sources, accounting for 56%, 22% and 15% of total VOC emissions in 2022, respectively.

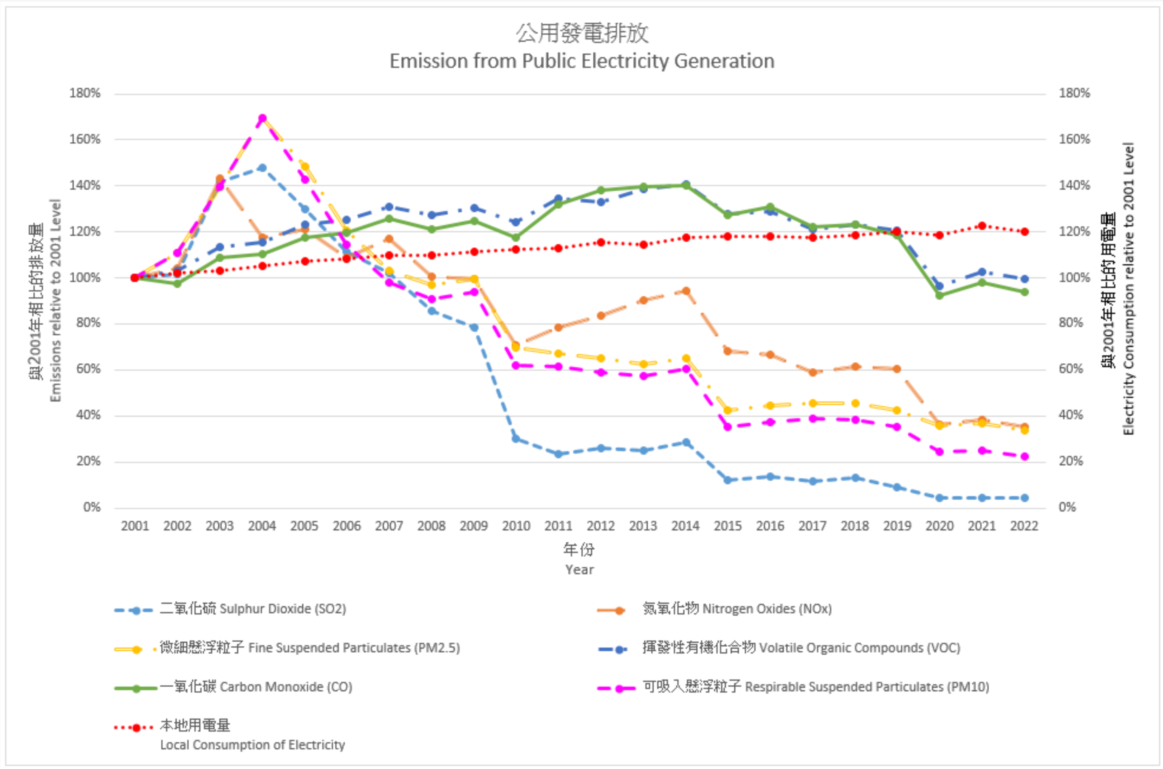
CO Emission and Concentration Trends



4.10. Between 2001 and 2022, CO emissions decreased by 44% 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 2022, 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.

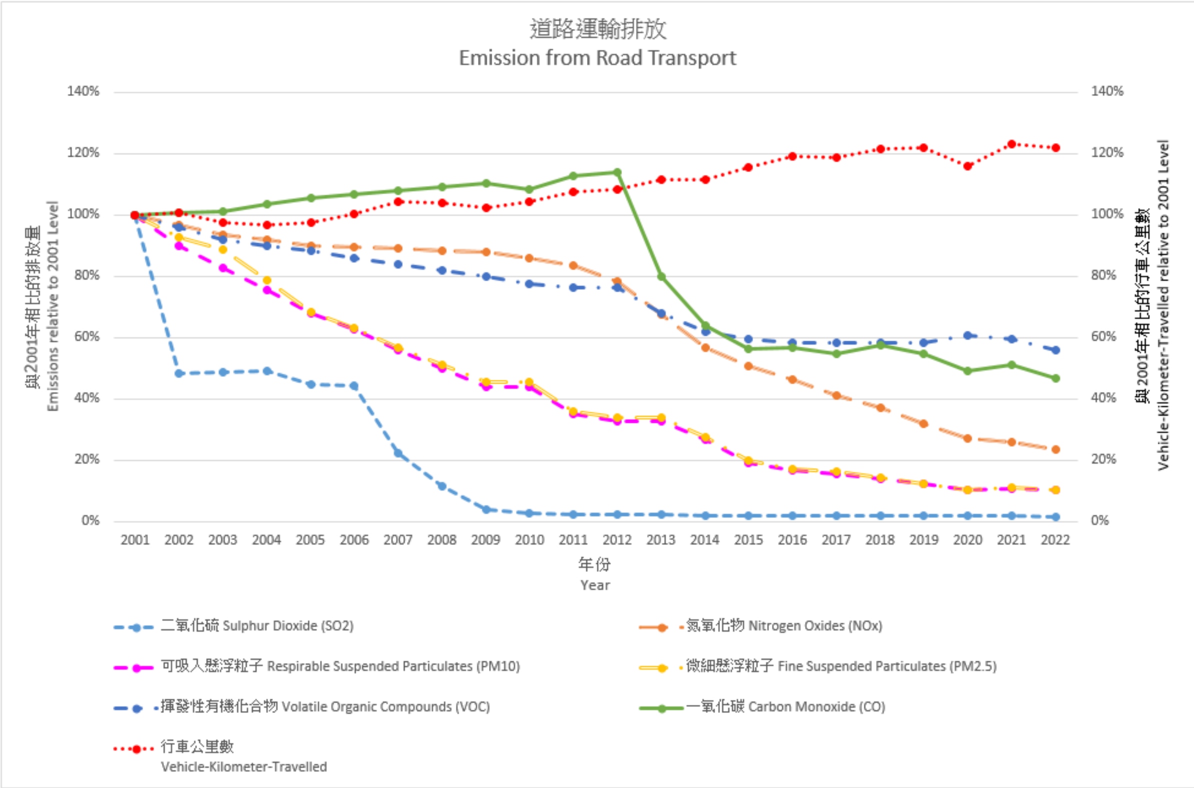
5.2. The Government has progressively tightened the emission caps via the promulgation of new TM and the latest one (i.e. the Ninth TM) was issued in June 2021 to further tighten the emission caps for 2026 and onwards.

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 2022 reduced substantially by 65 – 96%, despite an increase in electricity consumption of 20%.

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 air pollutants emission source. After the implementation of a series of reduction measures, the pollutant emissions from road transport decreased by 44% to 98% from 2001 to 2022, despite an increase in vehicle-kilometer-travelled of 22% during the same period. It accounts for 19%, 22% and 47% of the total emissions of NOx, VOC and CO in 2022, respectively.

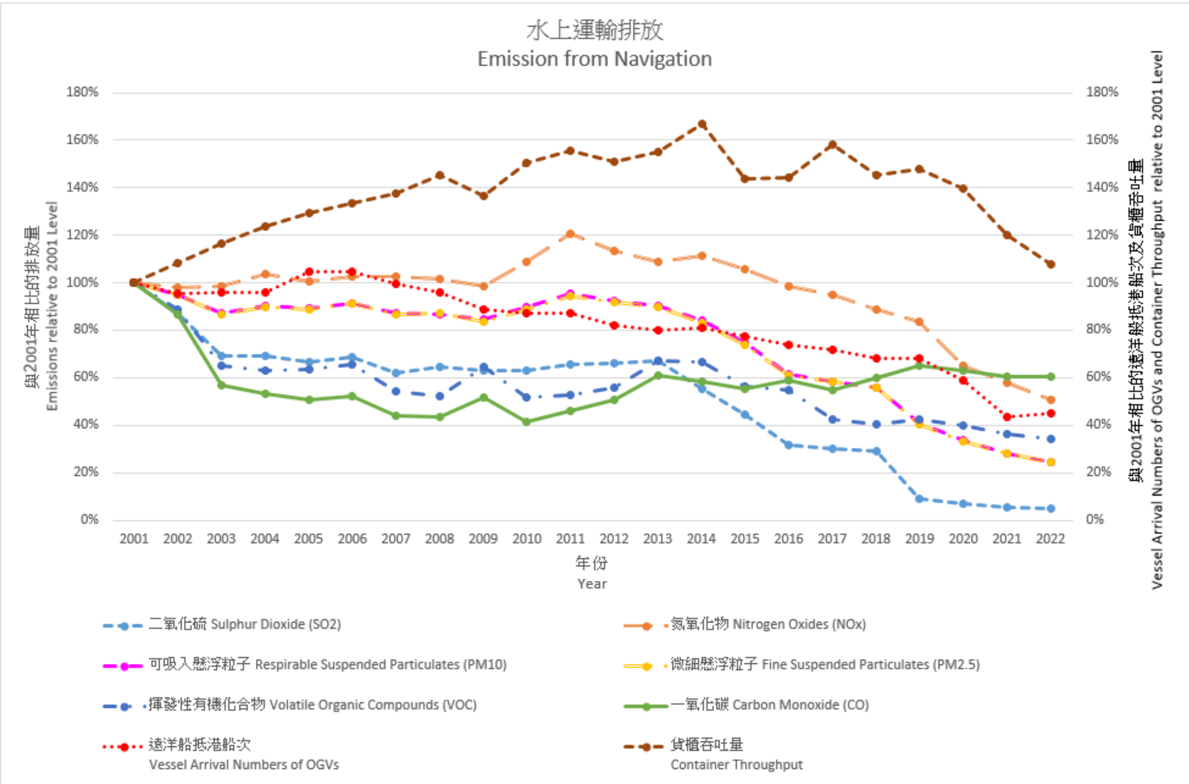
5.6. The substantial decreases in emissions of different pollutants could be attributed to a series of vehicle emission control programmes, which included strengthening the control of emissions from petrol and liquefied petroleum gas (LPG) vehicles by deploying roadside remote sensing technology to identify 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 2010-2022 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 striving to promote the use of new energy vehicles in order to reduce roadside air pollutant emissions and attain the target of zero vehicular emissions before 2050. Key measures include offering first registration tax concession for electric vehicles (EVs); encouraging the transport trade or charitable/non-profit making organisations to conduct trials of various new energy transport technologies through the New Energy Transport Fund; encouraging the operators of existing petrol filling stations (PFSs) to retrofit EV charging facilities and converting some PFSs into quick charging stations; subsidising the installation of EV charging-enabling infrastructure in car parks of existing private residential buildings; progressively marketising the EV charging services in existing government car parks with a view to expediting the expansion of EV charging network; and promoting trials of hydrogen fuel cell heavy vehicles.

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%.

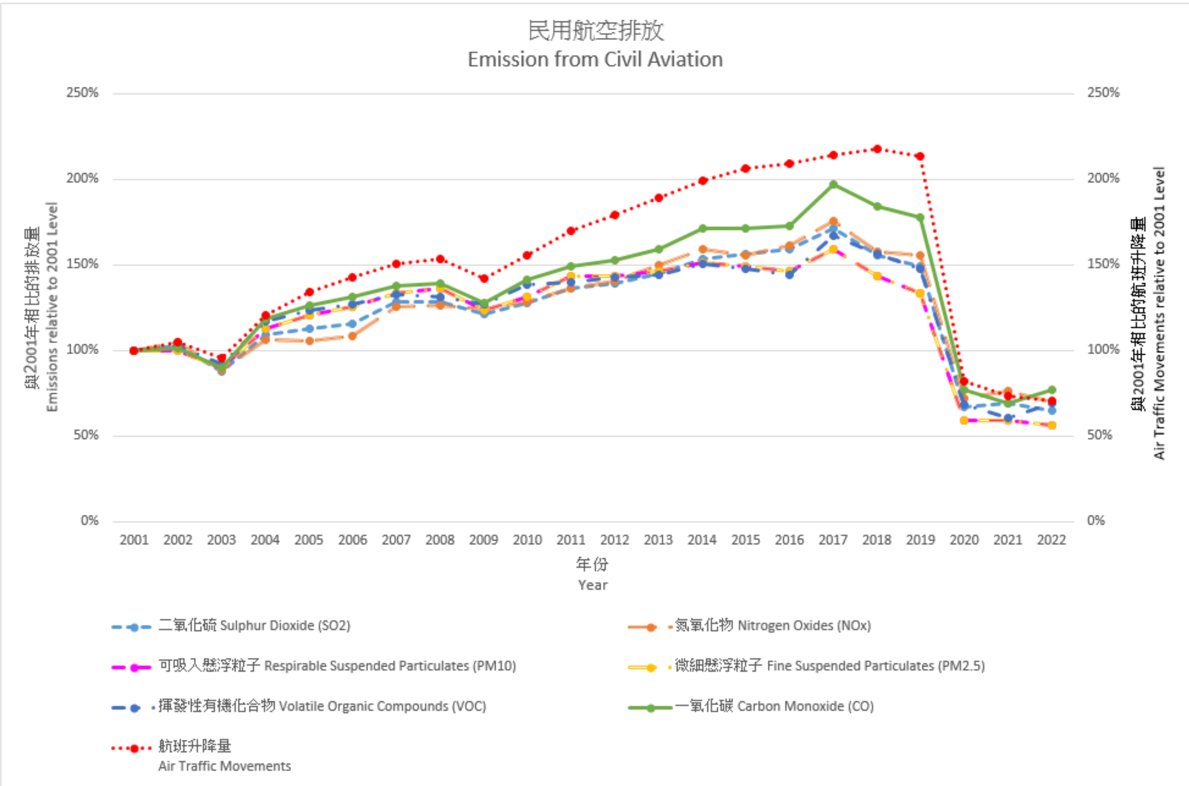
Sectoral analysis for "Navigation"



5.9. With the emission reduction measures for the public electricity generation and road transport taking effect, marine emissions have now become the major emission source in Hong Kong. In 2022, the emissions of SO_2, NOx, PM_{10}, $PM_{2.5}$ and VOC from marine vessels accounted for 31%, 32%, 22%, 26% and 15% of the total emissions, respectively.

5.10. Nonetheless, the emission of major air pollutants from vessels have decreased by 39% to 95% from 2001 to 2022. 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 for entering the Mainland waters.

Sectoral analysis for "Civil aviation"

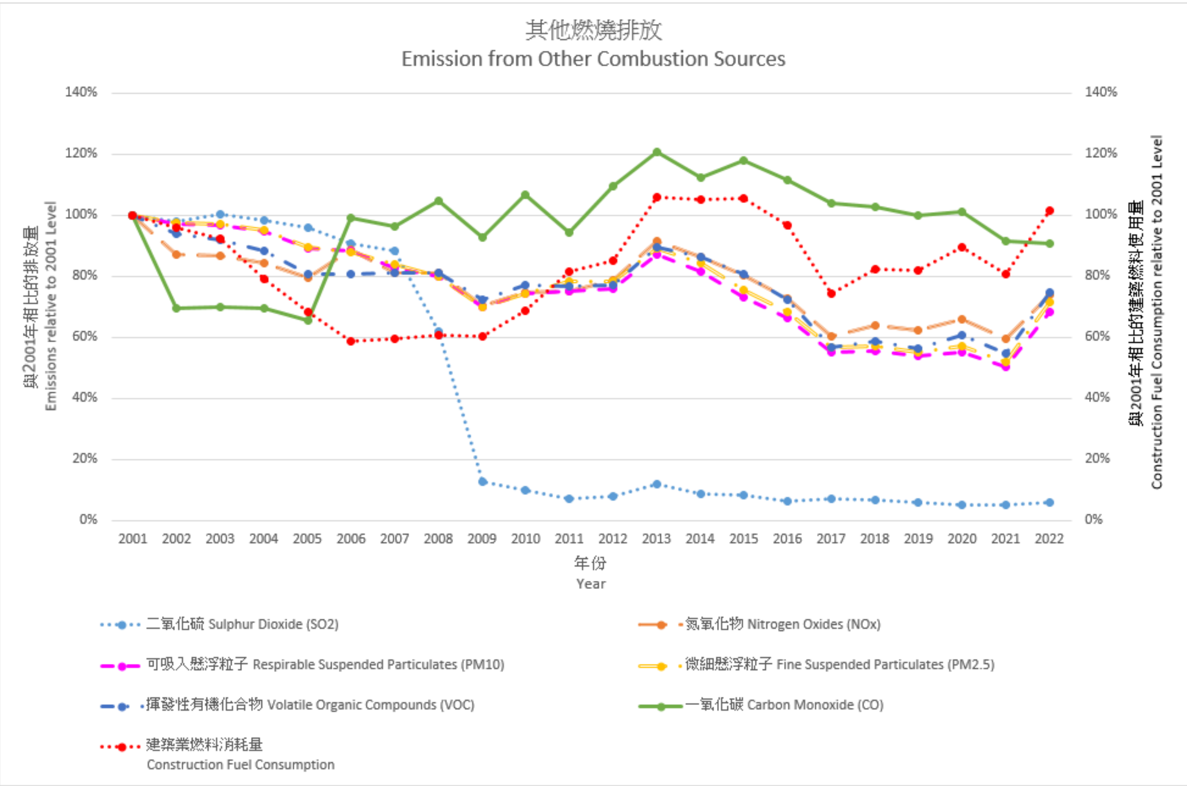


5.11. In 2022, emissions of from civil aviation accounted for less than 5% of the total local air pollutant emissions. As the overall air traffic movements dropped by 4% in 2022 compared to 2021, the emissions of SO_2, NOx, PM_{10} and $PM_{2.5}$ recorded a further decrease by 2% to 8%. On the other hand, the emissions of CO and VOCs increased 11% and 13% respectively in 2022 due to the increase of average aircraft taxi times by 10% compared to 2021.

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 different 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”

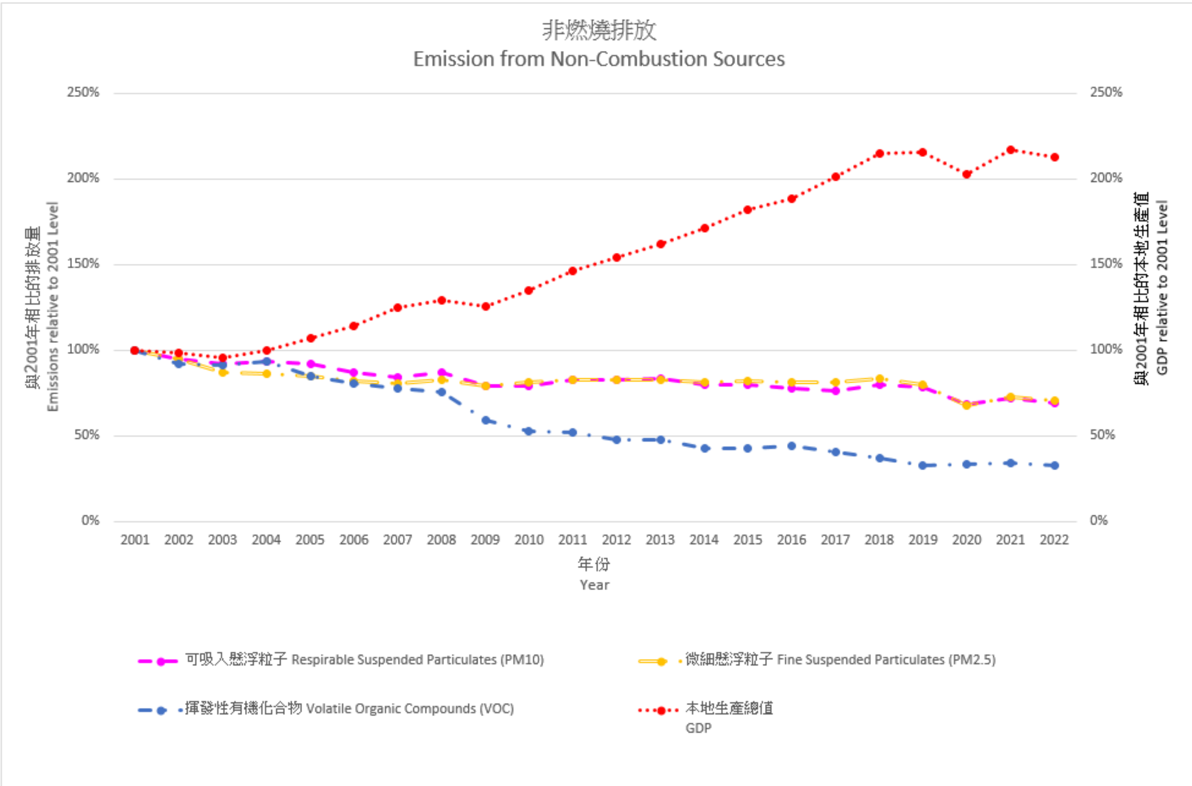


5.14. In 2022, due to increased construction activities, overall emissions from other combustion sector (except CO) increased compared to 2021. It is one of the important sources of NOx, PM_{10} and $PM_{2.5}$ emissions, accounting for 17%, 27% and 32% of total emissions in 2022 respectively. Overall, between 2001 to 2022, the emissions of the major air pollutants from other combustion sources decreased by 9% to 94%.

5.15. Major contributing sources in this sector are non-road mobile machinery (NRMMs), especially construction machinery, which accounted for 68%, 69% and 72% of PM_{10}, $PM_{2.5}$ and NOx emissions from other combustion sources respectively in 2022. 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) Regulations 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"

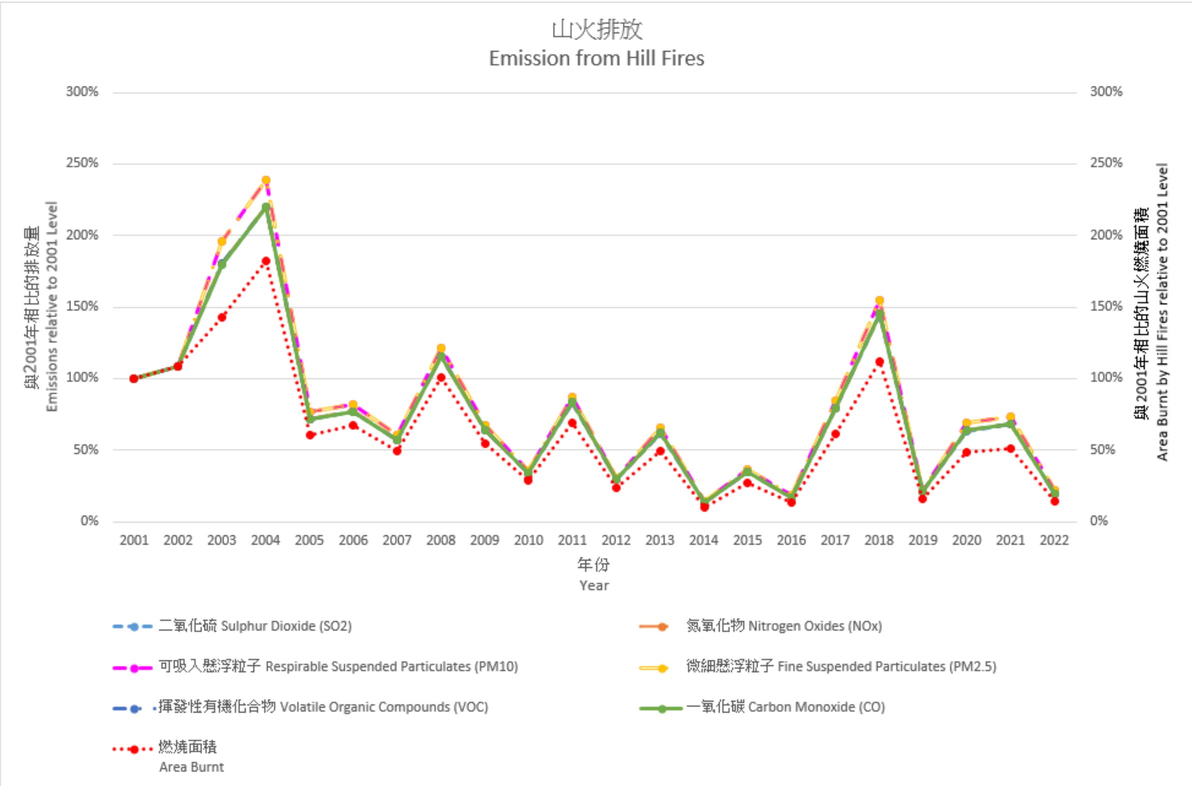


5.17. Non-combustion sources contribute considerably to local VOC emissions, accounting for 56% of total emissions in 2022, whereas its contributions to local PM_{10} and $PM_{2.5}$ emissions in 2022 were 28% and 18% of total emissions respectively. Overall, the emissions of the sector decreased by 30% to 67% from 2001 to 2022, despite the growth of Gross Domestic Product by 113%.

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 2022. As compared with 2006, the VOC emissions from non-combustion sources decreased by 59% in 2022 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 77% and 78% of non-combustion PM_{10} and $PM_{2.5}$ emissions respectively in 2022.

6 EMISSIONS FROM HILL FIRES



6.1. Emissions from hill fires is a major source of PM_{10} and $PM_{2.5}$, accounting for 13% and 14% of total local PM_{10} and $PM_{2.5}$ emissions in 2022, respectively.

Annex 1 – Breakdown of Emission Inventory by Source Category for 2021 and 2022

Pollutant	Source Category	Emissions (Tonnes)	
		2021	2022
SO_2	Public Electricity Generation	2,740	2,660
	Road Transport	30	30
	Navigation	1,600	1,350
	Civil Aviation	210	190
	Other Combustion	140	150
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	4,710	4,390
	Hill Fires	20	10
	Total (with Hill Fires)	4,740	4,400
NOx	Public Electricity Generation	14,760	13,480
	Road Transport	10,300	9,300
	Navigation	18,220	15,920
	Civil Aviation	2,800	2,570
	Other Combustion	7,000	8,750
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	53,080	50,010
	Hill Fires	120	30
	Total (with Hill Fires)	53,200	50,040
PM_{10}	Public Electricity Generation	410	370
	Road Transport	290	280
	Navigation	720	630
	Civil Aviation	20	20
	Other Combustion	550	750
	Non-combustion	820	790
	Total (without Hill Fires)	2,820	2,840
	Hill Fires	1,470	440
	Total (with Hill Fires)	4,280	3,280
$PM_{2.5}$	Public Electricity Generation	260	240
	Road Transport	270	250
	Navigation	670	590
	Civil Aviation	20	20

Pollutant	Source Category	Emissions (Tonnes)	
		2021	2022
	Other Combustion	520	720
	Non-combustion	430	410
	Total (without Hill Fires)	2,170	2,220
	Hill Fires	1,200	360
	Total (with Hill Fires)	3,370	2,580
VOC	Public Electricity Generation	340	330
	Road Transport	5,000	4,700
	Navigation	3,270	3,100
	Civil Aviation	200	230
	Other Combustion	670	920
	Non-combustion	12,420	11,860
	Total (without Hill Fires)	21,910	21,130
	Hill Fires	310	90
	Total (with Hill Fires)	22,230	21,220
CO	Public Electricity Generation	2,760	2,640
	Road Transport	28,000	25,700
	Navigation	20,380	20,400
	Civil Aviation	1,300	1,440
	Other Combustion	4,710	4,660
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	57,140	54,850
	Hill Fires	3,380	960
	Total (with Hill Fires)	60,520	55,810

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 2021 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 2021. 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.
January 2024	2001-2021	• Adopted Aviation Environmental Design Tool (AEDT) version 3f for estimating emissions from Civil Aviation sector.

Annex 3 – Comparison between the Previous and Recalculated Inventories (without Hill Fires) from 2001 to 2021

Table A3-1. Changes in SO_2 emission inventories from 2001 to 2021

Year	SO_2 (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	92,640	92,610	0%
2002	88,840	88,820	0%
2003	107,460	107,440	0%
2004	111,140	111,120	0%
2005	99,780	99,750	0%
2006	89,260	89,230	0%
2007	81,240	81,210	0%
2008	71,120	71,090	0%
2009	64,960	64,940	0%
2010	36,310	36,280	0%
2011	33,230	33,190	0%
2012	34,930	34,900	0%
2013	34,540	34,500	0%
2014	33,220	33,180	0%
2015	20,580	20,540	0%
2016	17,710	17,680	0%
2017	16,340	16,300	0%
2018	16,680	16,600	0%
2019	8,610	8,540	-1%
2020	4,910	4,850	-1%
2021	4,760	4,710	-1%

* Figures are rounded to the nearest ten.

Figure A3-1 **SO_2 emissions trend from 2001 to 2021**

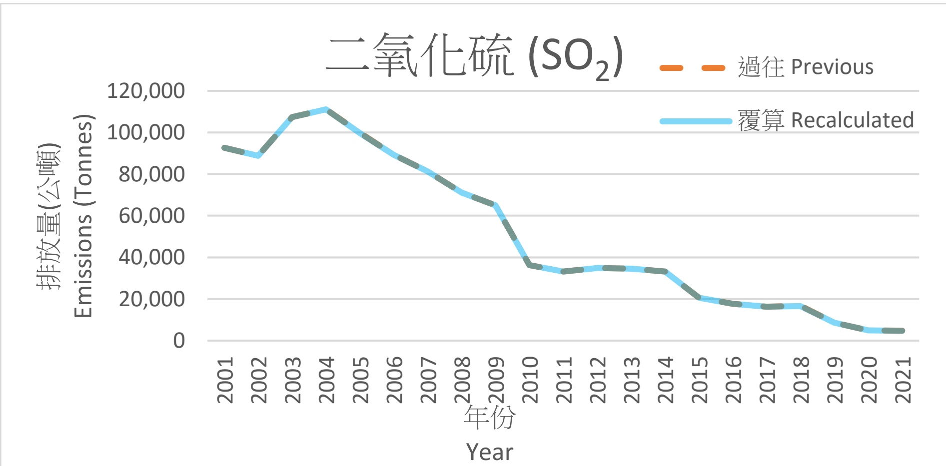


Table A3-2. Changes in NOx emission inventories from 2001 to 2021

Year	NOx (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	125,120	125,070	0%
2002	123,540	123,490	0%
2003	136,570	136,530	0%
2004	127,980	127,920	0%
2005	127,230	127,170	0%
2006	124,100	124,030	0%
2007	126,830	126,760	0%
2008	119,930	119,860	0%
2009	116,920	116,870	0%
2010	109,060	109,000	0%
2011	115,120	115,050	0%
2012	113,460	113,390	0%
2013	112,060	111,980	0%
2014	109,800	109,690	0%
2015	94,680	94,590	0%
2016	89,560	89,470	0%
2017	82,580	82,450	0%
2018	80,490	79,650	-1%
2019	75,930	75,160	-1%
2020	56,520	55,550	-2%
2021	53,620	53,080	-1%

* Figures are rounded to the nearest ten.

Figure A3-2 **NOx emission trend from 2001 to 2021**

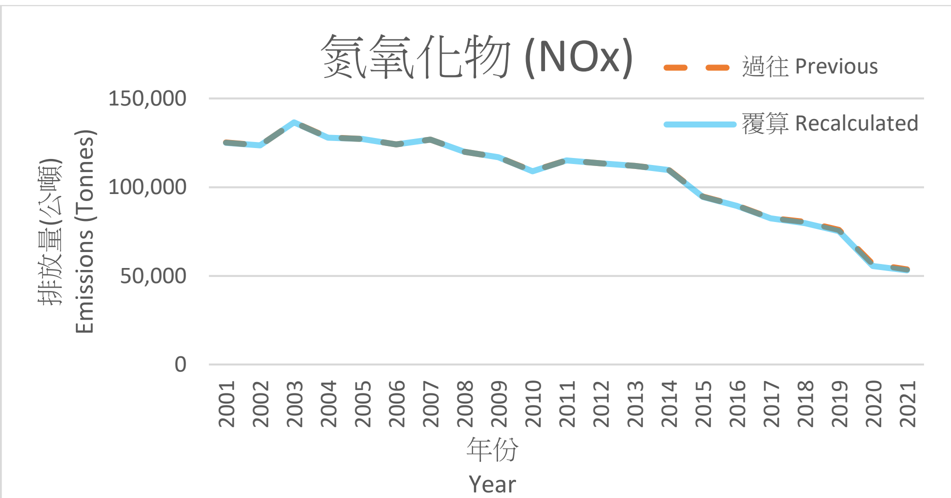


Table A3-3. Changes in PM_{10} emission inventories from 2001 to 2021

Year	PM_{10} (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	9,200	9,200	0%
2002	8,880	8,880	0%
2003	8,920	8,920	0%
2004	9,290	9,290	0%
2005	8,550	8,550	0%
2006	7,920	7,920	0%
2007	7,280	7,280	0%
2008	6,990	6,990	0%
2009	6,620	6,620	0%
2010	6,290	6,290	0%
2011	6,220	6,210	0%
2012	6,050	6,050	0%
2013	6,110	6,100	0%
2014	5,730	5,730	0%
2015	4,790	4,790	0%
2016	4,300	4,300	0%
2017	4,090	4,080	0%
2018	4,030	4,020	0%
2019	3,490	3,490	0%
2020	2,950	2,940	0%
2021	2,820	2,820	0%

* Figures are rounded to the nearest ten.

Figure A3-3 **PM_{10} emission trend from 2001 to 2021**

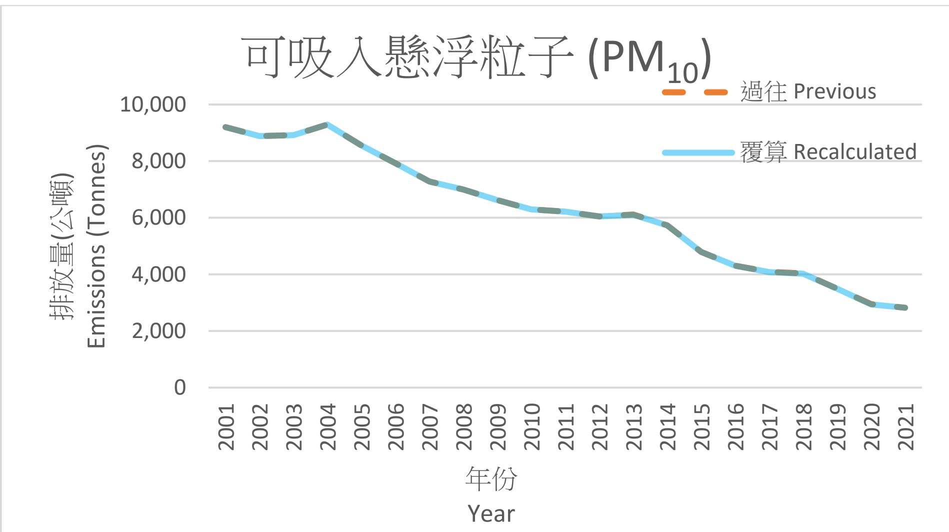


Table A3-4. Changes in $PM_{2.5}$ emission inventories from 2001 to 2021

Year	$PM_{2.5}$ (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	7,150	7,150	0%
2002	6,870	6,870	0%
2003	6,730	6,730	0%
2004	6,750	6,750	0%
2005	6,260	6,250	0%
2006	5,970	5,970	0%
2007	5,530	5,530	0%
2008	5,330	5,330	0%
2009	5,010	5,010	0%
2010	4,980	4,980	0%
2011	4,920	4,920	0%
2012	4,790	4,790	0%
2013	4,840	4,840	0%
2014	4,490	4,480	0%
2015	3,840	3,830	0%
2016	3,400	3,400	0%
2017	3,210	3,210	0%
2018	3,120	3,110	0%
2019	2,640	2,640	0%
2020	2,290	2,290	0%
2021	2,170	2,170	0%

* Figures are rounded to the nearest ten.

Figure A3-4 **$PM_{2.5}$ emission trend from 2001 to 2021**

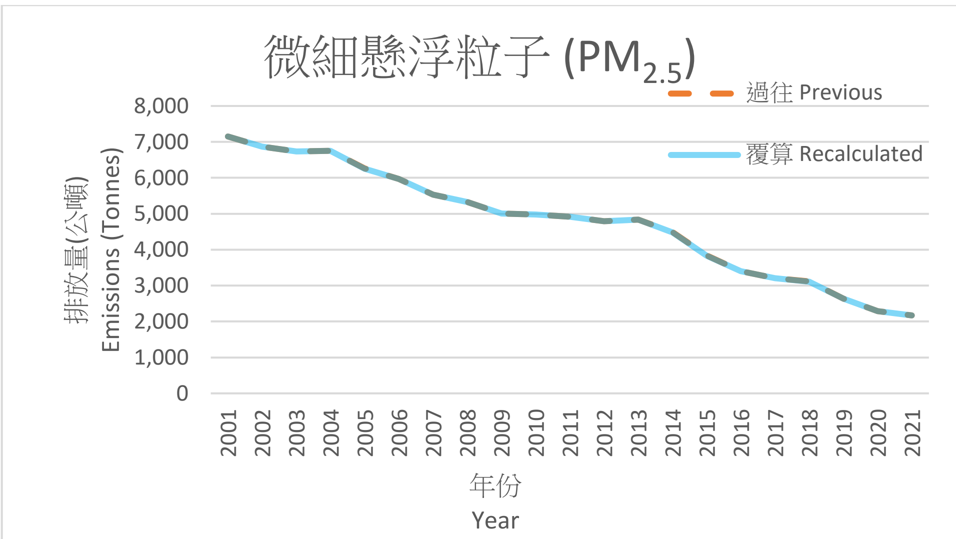


Table A3-5. Changes in VOC emission inventories from 2001 to 2021

Year	VOC (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	55,650	55,600	0%
2002	51,170	51,120	0%
2003	48,470	48,420	0%
2004	48,940	48,870	0%
2005	45,820	45,760	0%
2006	44,140	44,070	0%
2007	42,100	42,030	0%
2008	40,850	40,780	0%
2009	35,660	35,600	0%
2010	31,990	31,920	0%
2011	31,990	31,920	0%
2012	30,720	30,640	0%
2013	31,000	30,930	0%
2014	28,790	28,700	0%
2015	27,410	27,330	0%
2016	27,560	27,480	0%
2017	25,200	25,110	0%
2018	23,740	23,650	0%
2019	22,300	22,220	0%
2020	21,940	21,900	0%
2021	21,950	21,910	0%

* Figures are rounded to the nearest ten.

Figure A3-5 **VOC emission trend from 2001 to 2021**

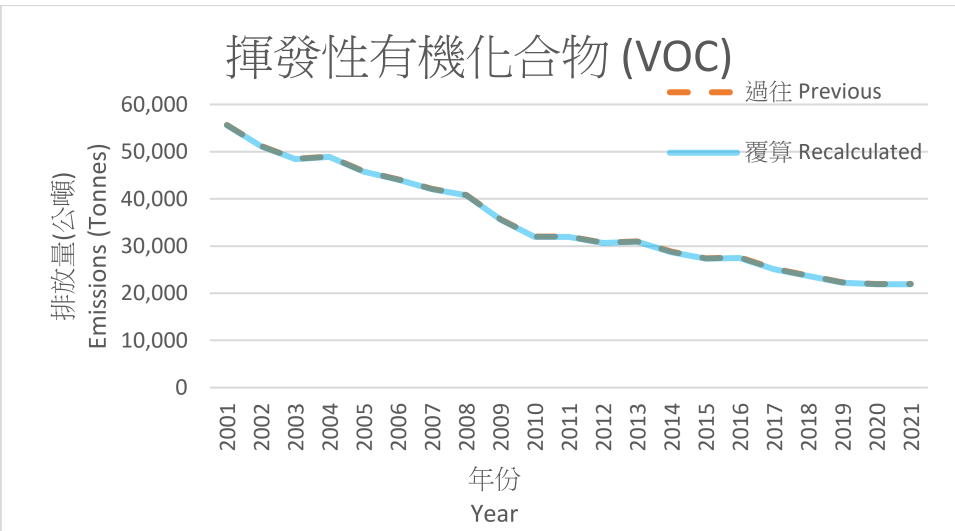


Table A3-6. Changes in CO emission inventories from 2001 to 2021

Year	CO (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	98,900	98,530	0%
2002	93,170	92,800	0%
2003	83,420	83,090	0%
2004	84,040	83,600	-1%
2005	84,530	84,060	-1%
2006	87,680	87,180	-1%
2007	85,640	85,120	-1%
2008	86,450	85,930	-1%
2009	89,130	88,670	-1%
2010	85,590	85,070	-1%
2011	89,510	88,950	-1%
2012	92,600	92,030	-1%
2013	78,230	77,610	-1%
2014	68,440	67,770	-1%
2015	63,120	62,460	-1%
2016	64,270	63,600	-1%
2017	61,820	61,050	-1%
2018	64,820	64,070	-1%
2019	64,560	63,850	-1%
2020	57,790	57,440	-1%
2021	57,400	57,140	0%

* Figures are rounded to the nearest ten.

Figure A3-6 **CO emission trend from 2001 to 2021**