2017 Hong Kong Emission Inventory Report

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Environmental Protection Department

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The Government of the Hong Kong
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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 2017 Hong Kong Emission Inventory. It covers:

(i) the emission inventory by source category in 2017 (Chapter 3);
(ii) the emission trends from 2001 to 2017 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). The emission sources include public electricity generation, road transport, navigation, civil aviation, other combustion sources, non-combustion sources, and hill fires.

2.2. Other combustion sources are defined as sources involving combustion, other than public electricity generation, road transport, navigation and civil aviation. Major contributing sources in this sector include non-road mobile machineries operating in construction sites and container terminals.

2.3. Non-combustion sources are defined as those remaining sources that do not involve combustion, from which only VOC, RSP and FSP emissions are significant. In this category, 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 2017 EMISSION INVENTORY

3.1. The table below shows a breakdown of air pollutant emissions by source category in 2017, while Annex 1 shows the changes in emissions between 2016 and 2017.

<u>Breakdown of 2017 Emission Inventory</u>

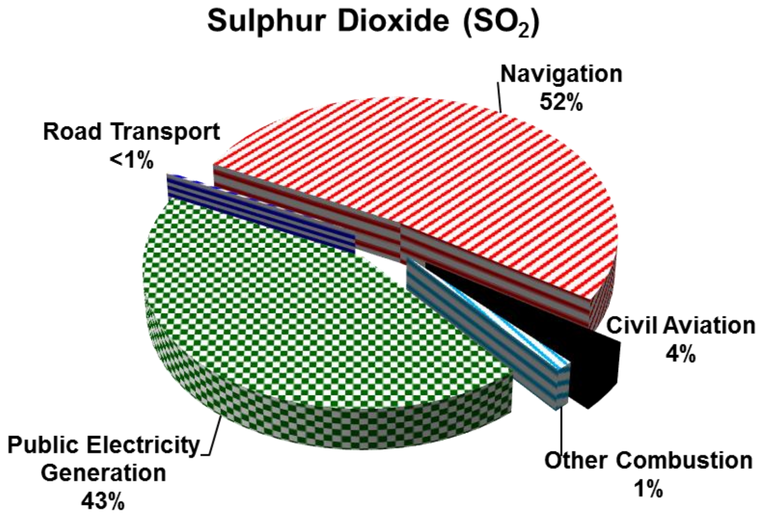
Pollution Sources	Emissions (Tonnes)					
	SO_2	**NOx**	**RSP**	**FSP**	**VOC**	**CO**
Public Electricity Generation	7,000	22,640	630	320	400	3,450
Road Transport	40	16,800	420	390	4,900	30,100
Navigation	8,350	31,580	1,370	1,270	4,310	13,600
Civil Aviation	570	6,300	60	60	600	4,470
Other Combustion	200	7,650	650	600	720	5,490
Non-combustion	N/A	N/A	880	480	14,590	N/A
Total Emissions (without Hill Fires)	16,160	84,960	4,020	3,120	25,520	57,110
Hill Fires	30	140	1,690	1,380	360	3,950
Total Emissions (with Hill Fires)	16,180	85,090	5,710	4,500	25,880	61,050

Notes:
- All figures are rounded to the nearest ten.
- "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.

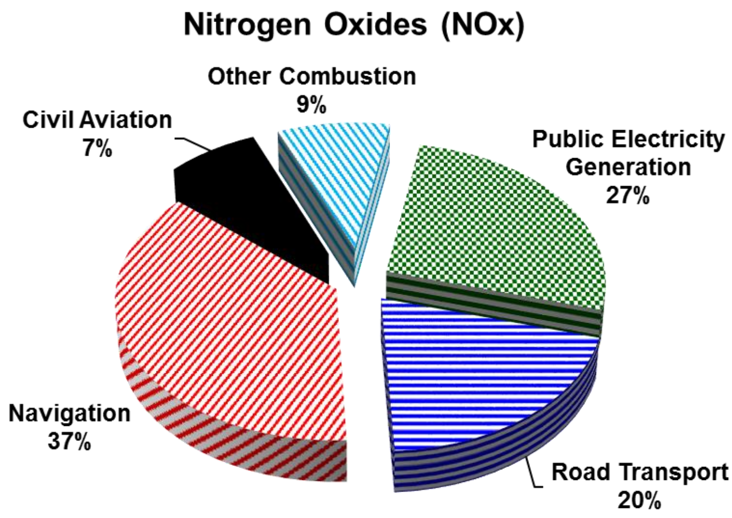
3.2. A summary of updates to the emission inventories is appended at Annex 2.

3.3. The following pie charts show the percentage share of emissions by source category (excluding hill fires) for each pollutant in 2017.

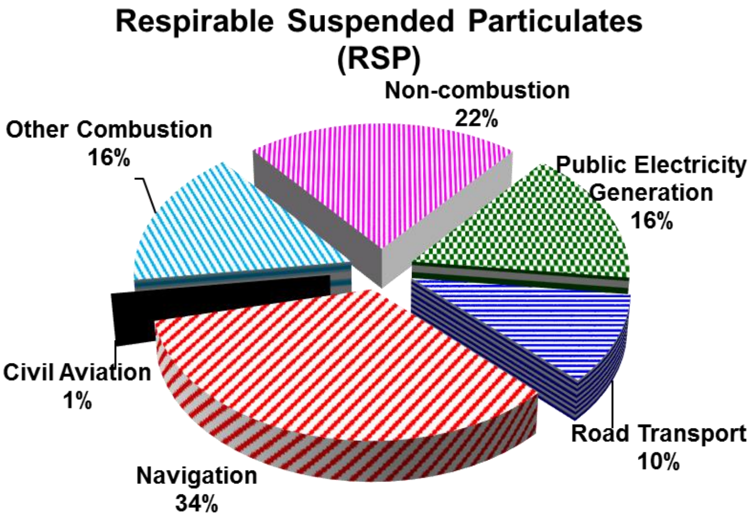
Total SO_2 emissions = 16,160 Tonnes



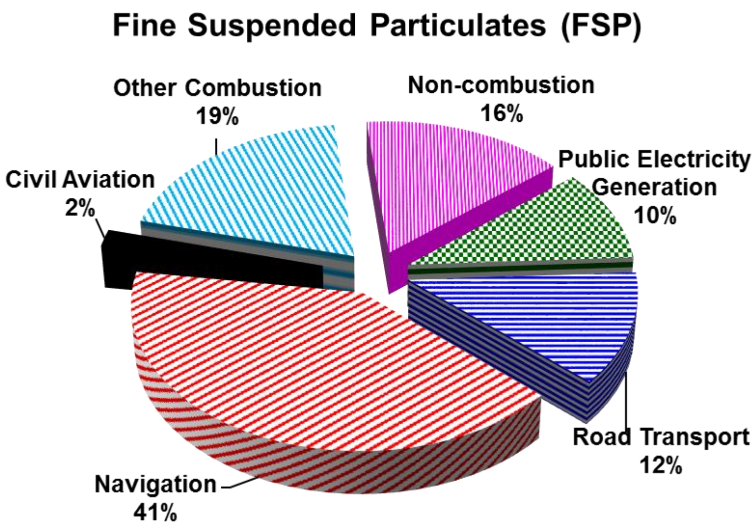
Total NOx emissions = 84,960 Tonnes



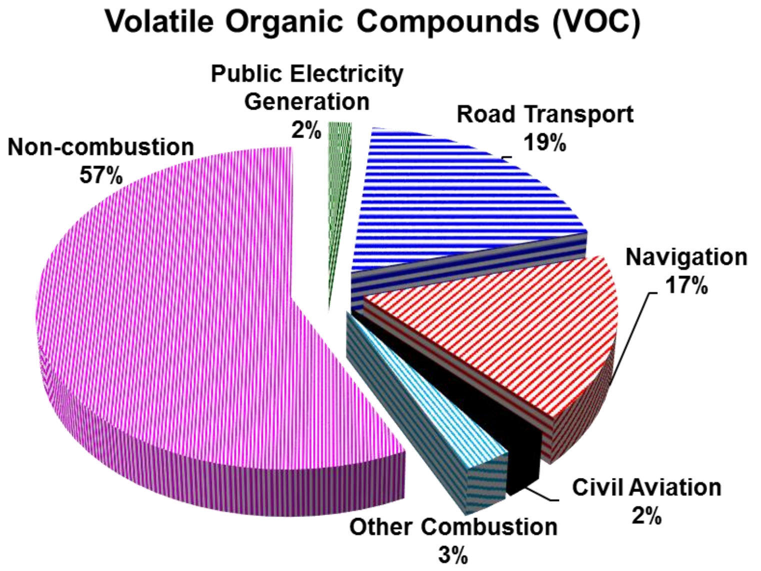
Total RSP emissions = 4,020 Tonnes



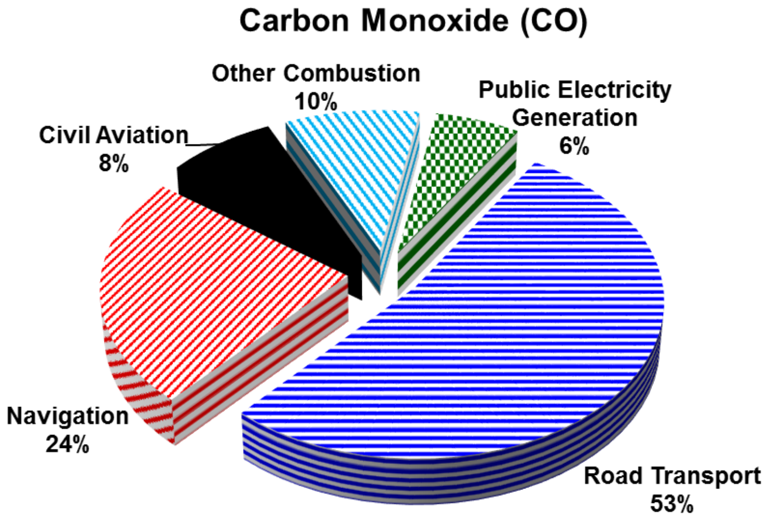
Total FSP emissions = 3,120 Tonnes



Total VOC emissions = 25,520 Tonnes

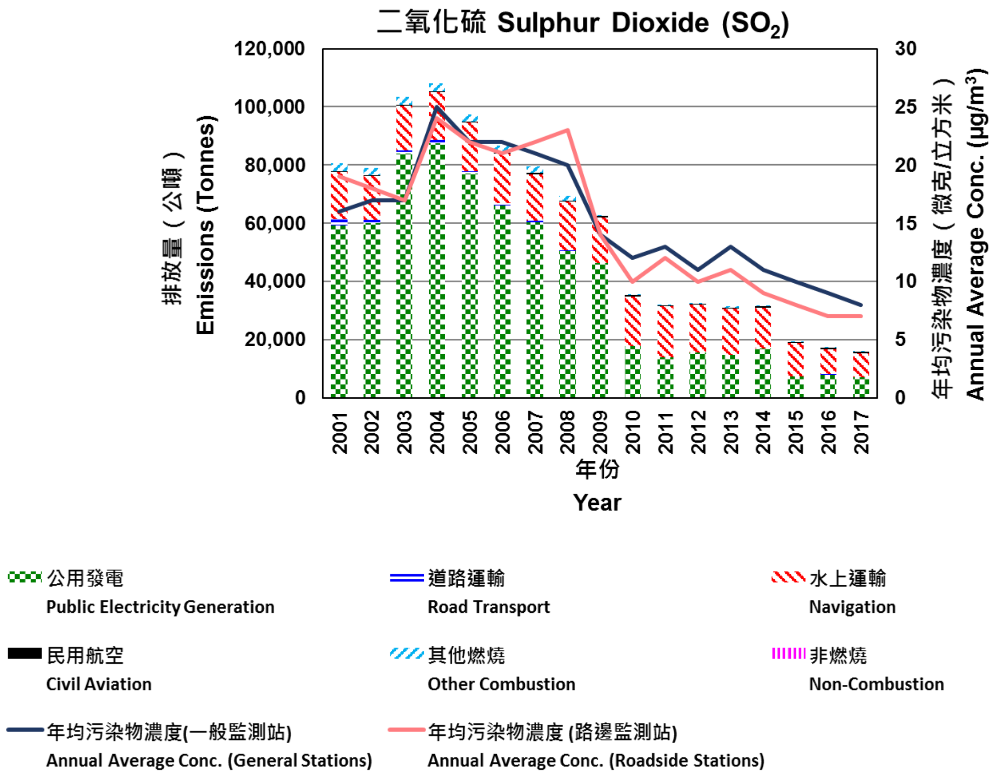


Total CO emissions = 57,110 Tonnes



4 EMISSION TRENDS FROM 2001 TO 2017

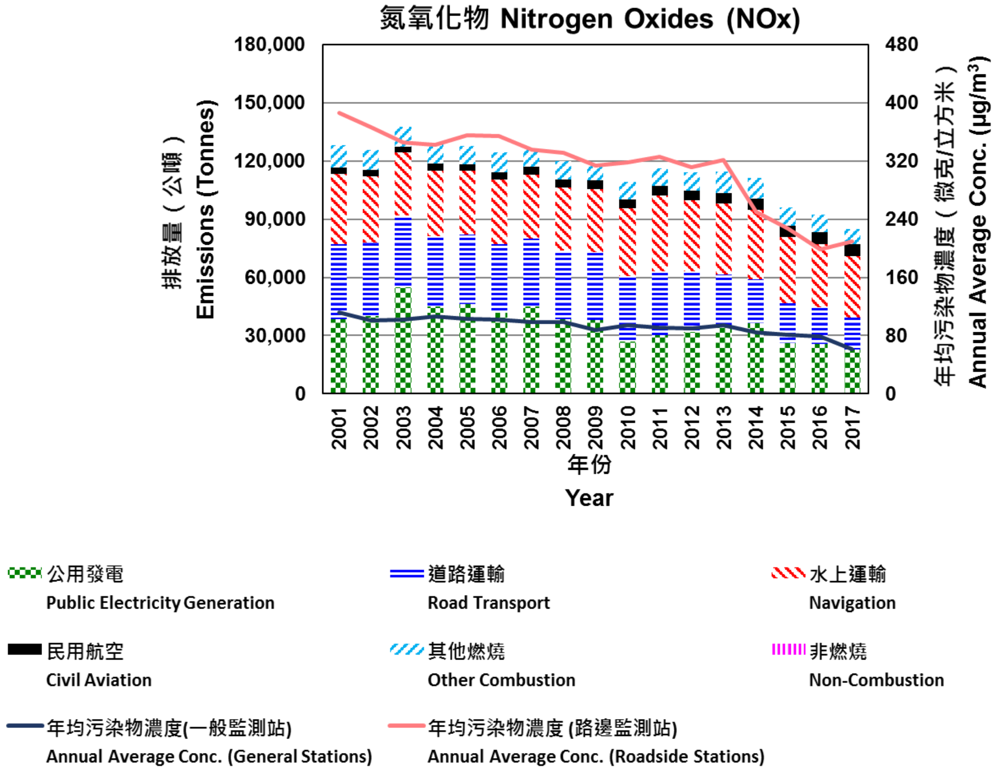
<u>SO_2 Emissions and Air Quality Trends</u>



4.1. Between 2001 and 2017, SO_2 emissions decreased by 80%, which were mainly caused by a decline in emissions from the public electricity generation and navigation sectors. Navigation and public electricity generation sectors were the top two sources of SO_2 emissions, accounting for 52% and 43% of total SO_2 emissions in 2017, respectively.

4.2. During the same period, SO_2 levels measured at the EPD's general air quality monitoring stations by and large followed the SO_2 emission trend, indicating that the ambient SO_2 mainly originates from local emission sources, in addition to other factors such as meteorological conditions.

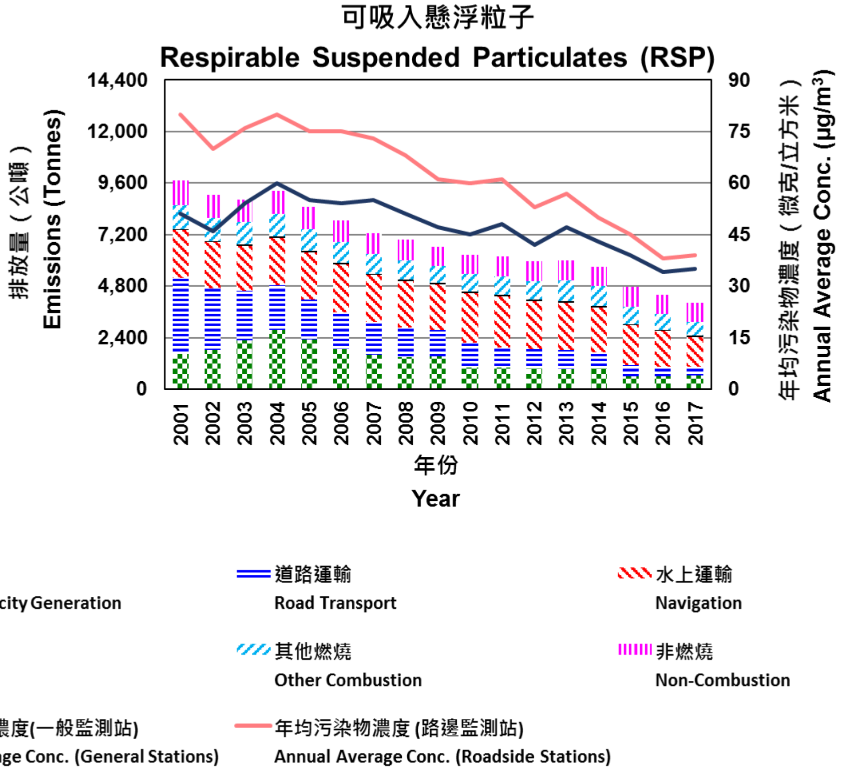
NOx Emissions and Air Quality Trends



4.3. Between 2001 and 2017, NOx emissions decreased by 34%. Navigation, public electricity generation and road transport sectors were the top three sources of NOx emissions, accounting for 37%, 27% and 20% of total NOx emissions in 2017, respectively.

4.4. During the same period, NOx levels measured at the EPD's roadside air quality monitoring stations by and large followed the NOx emission trend, indicating that the roadside NOx mainly originates from local emission sources.

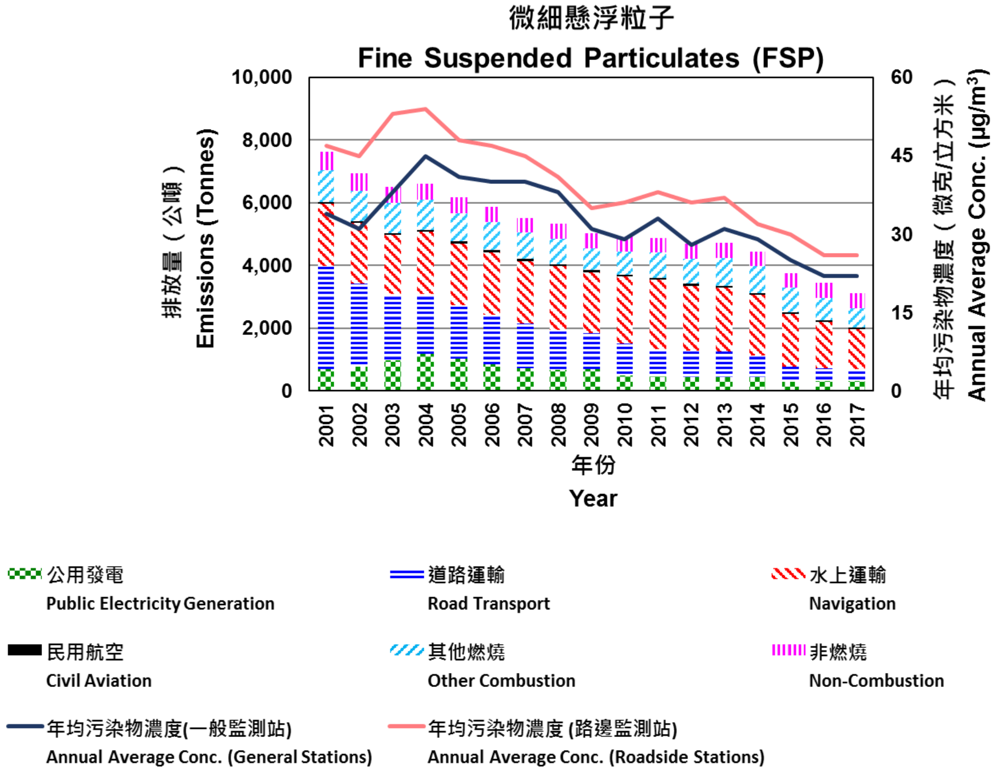
RSP Emissions and Air Quality Trends



4.5. Between 2001 and 2017, RSP emissions decreased by 59% which were mainly caused by a decline in emissions from the road transport and public electricity generation sectors. Navigation and non-combustion sectors were the top two sources of RSP emissions, accounting for 34% and 22% of total RSP emissions in 2017, respectively.

4.6. During the same period, RSP levels measured at the EPD's general air quality monitoring stations did not follow closely with the RSP emission trend. It indicated that the ambient RSP originates from both local and regional emission sources.

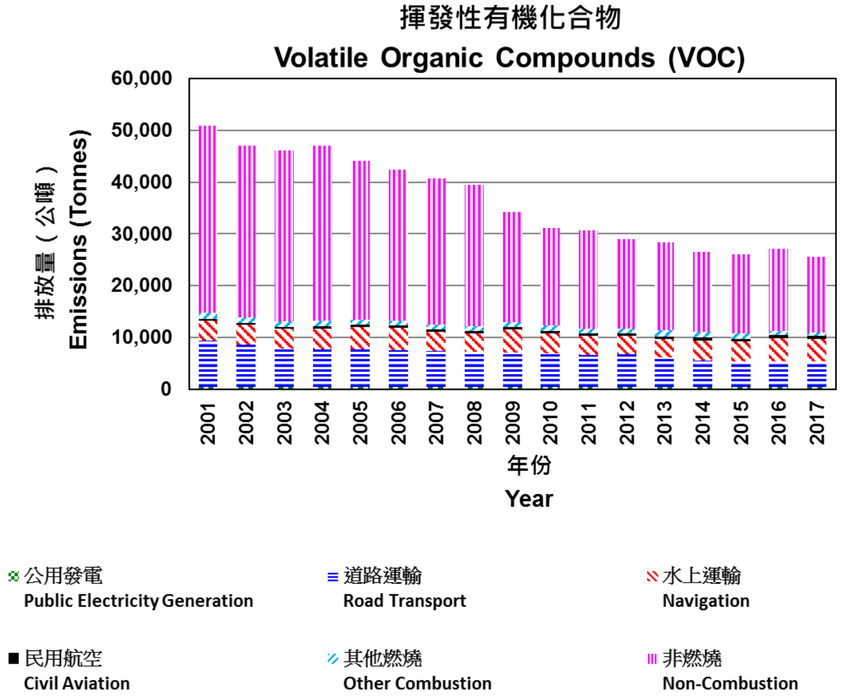
FSP Emissions and Air Quality Trends



4.7. As FSP is a fraction of RSP, they share similar emission sources and emission trends. Between 2001 and 2017, FSP emissions decreased by 59%. Navigation, other combustion and non-combustion sectors were the top three sources of FSP emissions, accounting for 41%, 19% and 16% of total FSP emissions in 2017, respectively.

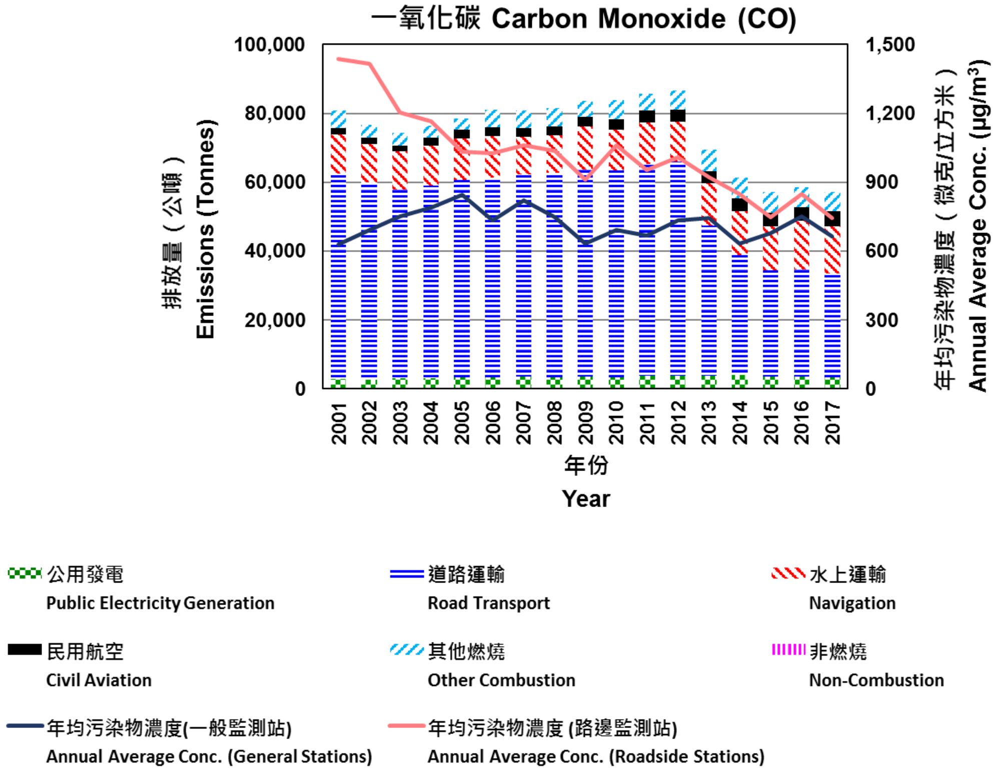
4.8. Similar to RSP, FSP levels measured at the EPD's general air quality monitoring stations did not follow closely with the FSP emission trend, indicating that the ambient FSP originates from both local and regional emission sources.

VOC Emissions Trend



4.9. Between 2001 and 2017, VOC emissions decreased by 50% which were mainly caused by the decline in emissions from non-combustion and road transport sectors. Non-combustion, road transport and navigation sectors were the top three sources of VOC emissions, accounting for 57%, 19% and 17% of total VOC emissions in 2017, respectively.

CO Emissions and Air Quality Trends

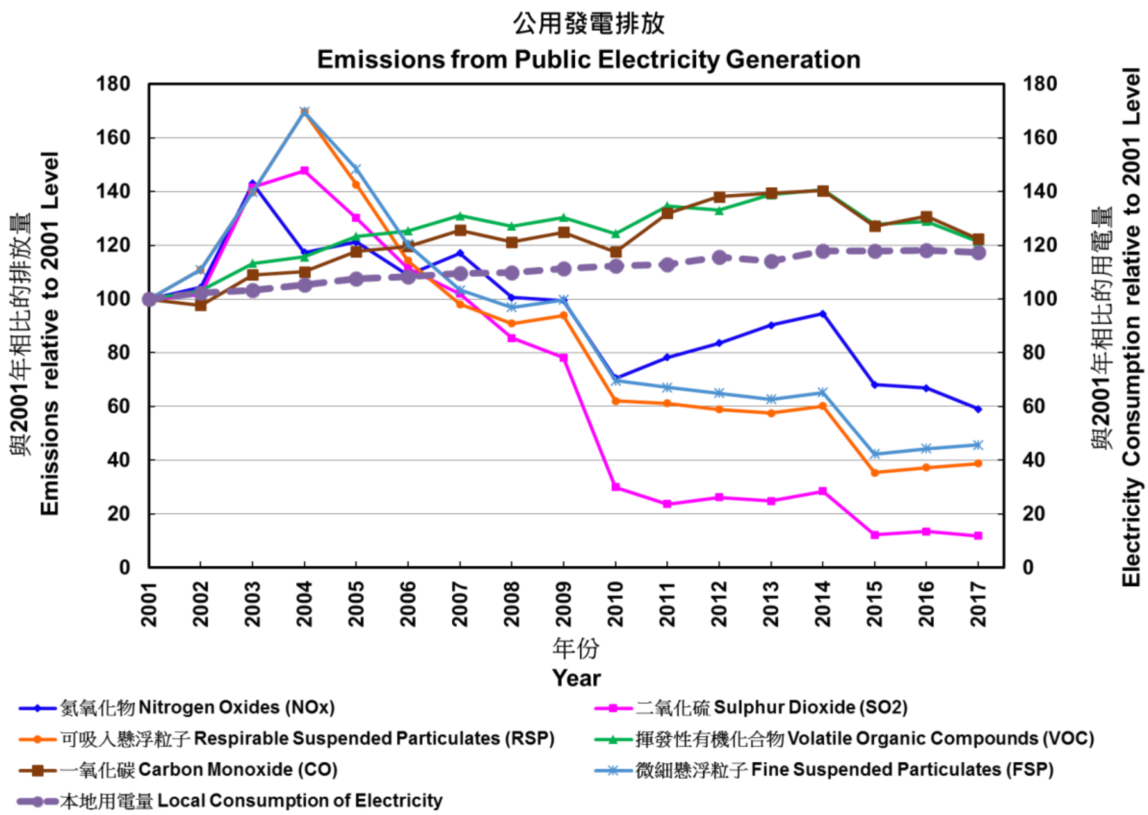


4.10. Between 2001 and 2017, CO emissions decreased by 29% which were mainly caused by a decline in emissions from the road transport sector. Road transport and navigation sectors were two major sources of CO emissions, accounting for 53% and 24% of the total CO emissions in 2017, respectively.

4.11. During the same period, CO levels measured at the EPD's ambient and roadside air quality monitoring stations were very low and did not follow closely with the CO emission trend, indicating that CO could originate from both local and regional sources.

5 SECTORAL ANALYSES

Sectoral analysis for "Public electricity generation"

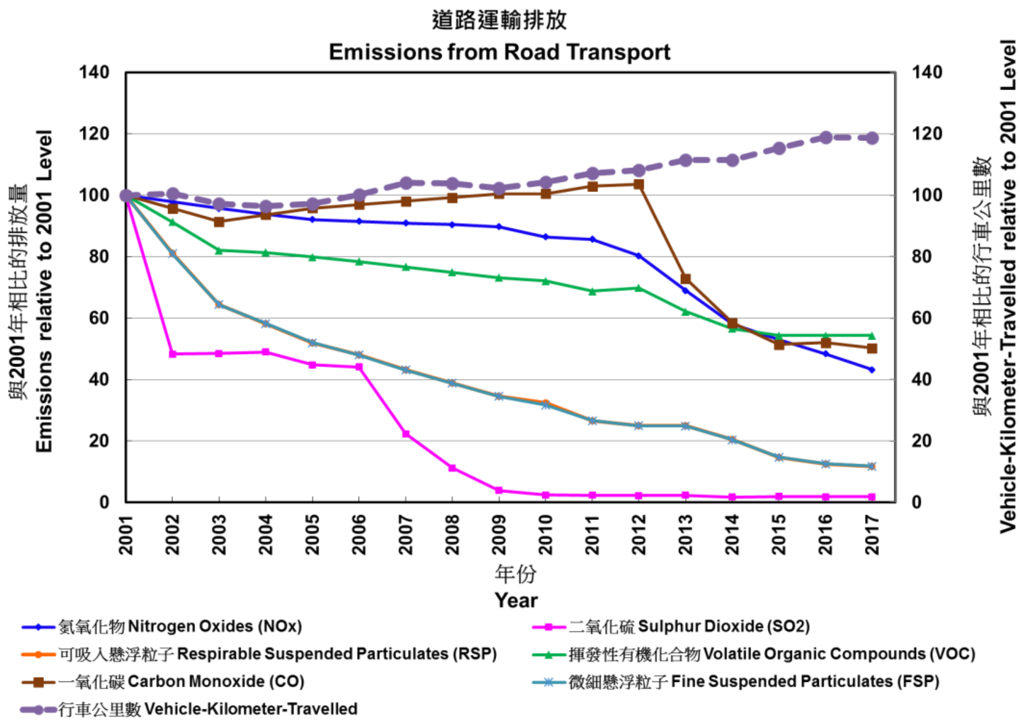


5.1. Electricity sector had been a major contributor to SO_2, NOx and RSP emissions. Due to government's continuous efforts to control emissions from the power sector, including the imposition of statutory emission caps on power plants, its SO_2 emissions reduced substantially by 88%, NOx emissions by 41% and RSP emissions by 61% from 2001 to 2017, despite an increase in electricity consumption of 17%. In 2017, the emissions of SO_2, NOx and RSP accounted for 43%, 27% and 16% of the total emissions, respectively.

5.2. The emissions of SO_2, NOx and RSP from power sector continue to show a decreasing trend from 2010 to 2017, as power companies increased the use of natural gas for electricity generation in order to meet the emission caps on power plants set out in the Technical Memorandum for Allocation of Emission Allowances in respect of Specified Licences (TM). The proportion of natural gas in the fuel mix would be increased to around 50% by 2020.

5.3. The EPD has progressively tightened the emission caps since 2005. In 2008, we issued the first TM and stipulated emission caps for power plants for 2010 and beyond. So far, we have issued seven TMs and the last TM was issued in 2017 to further tighten the emission caps for 2022 and onwards. By 2022, the emission caps of SO_2, NOx and RSP would be reduced by 79%, 59% and 61% respectively, as compared with the emission caps for 2010.

Sectoral analysis for "Road transport"§



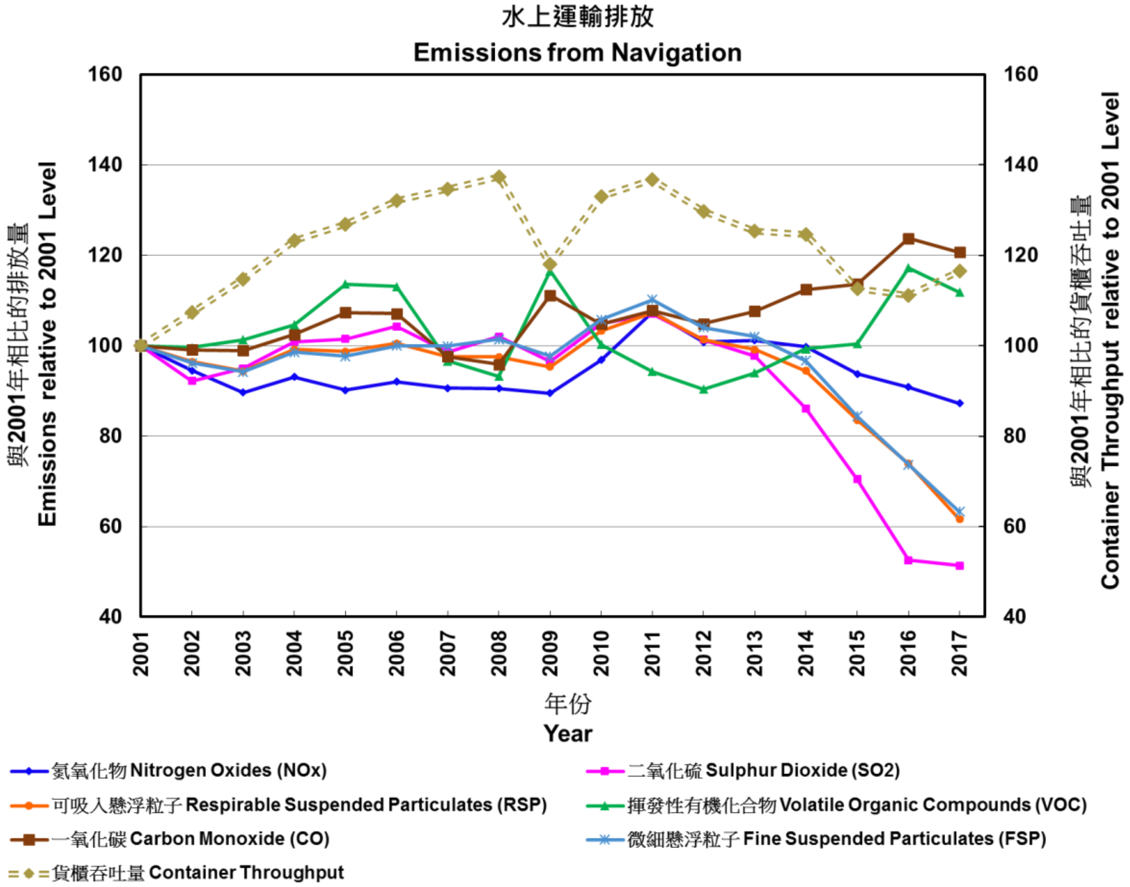
5.4. Road transport was a major emission source of NOx, VOC and CO, accounting for 20%, 19% and 53% of the total emissions in 2017, respectively. Overall, the emissions from road transport decreased by 45% to 98% from 2001 to 2017, despite an increase in vehicle-kilometer-travelled of 19% during the same period.

5.5. The substantial decreases in NOx, RSP, FSP, VOC and CO emissions from 2010 to 2017 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 some 82 000 pre-Euro IV diesel commercial vehicles (DCVs) by end 2019 and tightening in phases by vehicle type the emission standards for first registered vehicles to Euro VI starting from 1 July 2017. It is anticipated that emissions from this sector will decrease further, as we are preparing a programme to progressively phase out about 40 000 Euro IV DCVs; working on legislative amendments to tighten in phases the emission standards of first registered motorcycles to Euro IV and the emission standards of 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 starting from the second half of 2020; and will fully subsidise franchised bus companies in conducting trials to retrofit Euro IV and Euro V franchised buses with enhanced SCR systems to upgrade their NOx emission performance to Euro VI level.

5.6. 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 has the sulphur content capped at 0.001%.

§ Except SO_2, emissions of major air pollutants for 1997, 2003, 2005, 2009 and 2010-2017 were calculated based on actual data, while interpolated figures were used for the remaining years. Vehicle-Kilometer-Travelled was provided by the Transport Department.

Sectoral analysis for "Navigation"

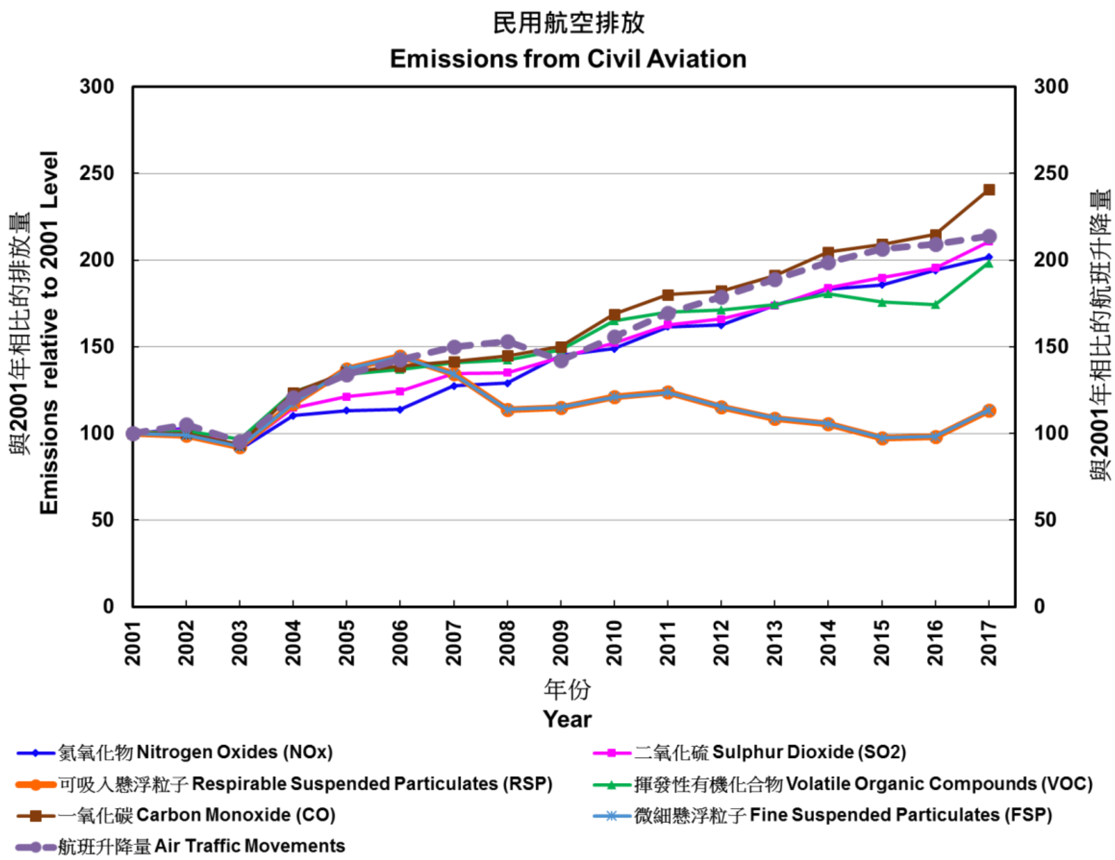


5.7. With the significant reduction in emissions from the electricity and road transport sectors over the past years, marine emissions have now become the major emission source in Hong Kong. Nonetheless, the emissions of SO_2, RSP, FSP had already decreased substantially by 38% to 47% from 2013 to 2017. In 2017, the emissions of SO_2, NOx, RSP and FSP from marine vessels accounted for 52%, 37%, 34% and 41% of the total emissions, respectively.

5.8. The reductions of SO_2, RSP and FSP emissions from marine vessels from 2010 to 2017 were primarily achieved through marine control measures including the implementation of the Air Pollution Control (Marine Light Diesel) Regulation in April 2014 and the Air Pollution Control (Ocean Going Vessels) (Fuel at Berth) Regulation in July 2015. The Air Pollution Control (Fuel for Vessels) Regulation requiring all vessels to use compliant fuel, including fuel with sulphur content not exceeding 0.5%, within the waters of Hong Kong took effect on 1 January 2019. It is anticipated that emissions from marine vessels will be further reduced.

5.9. Among vessels, ocean going vessels (OGVs) were the major emitters. As compared with 2010, the container throughput decreased by 12% in 2017.

Sectoral analysis for "Civil aviation"

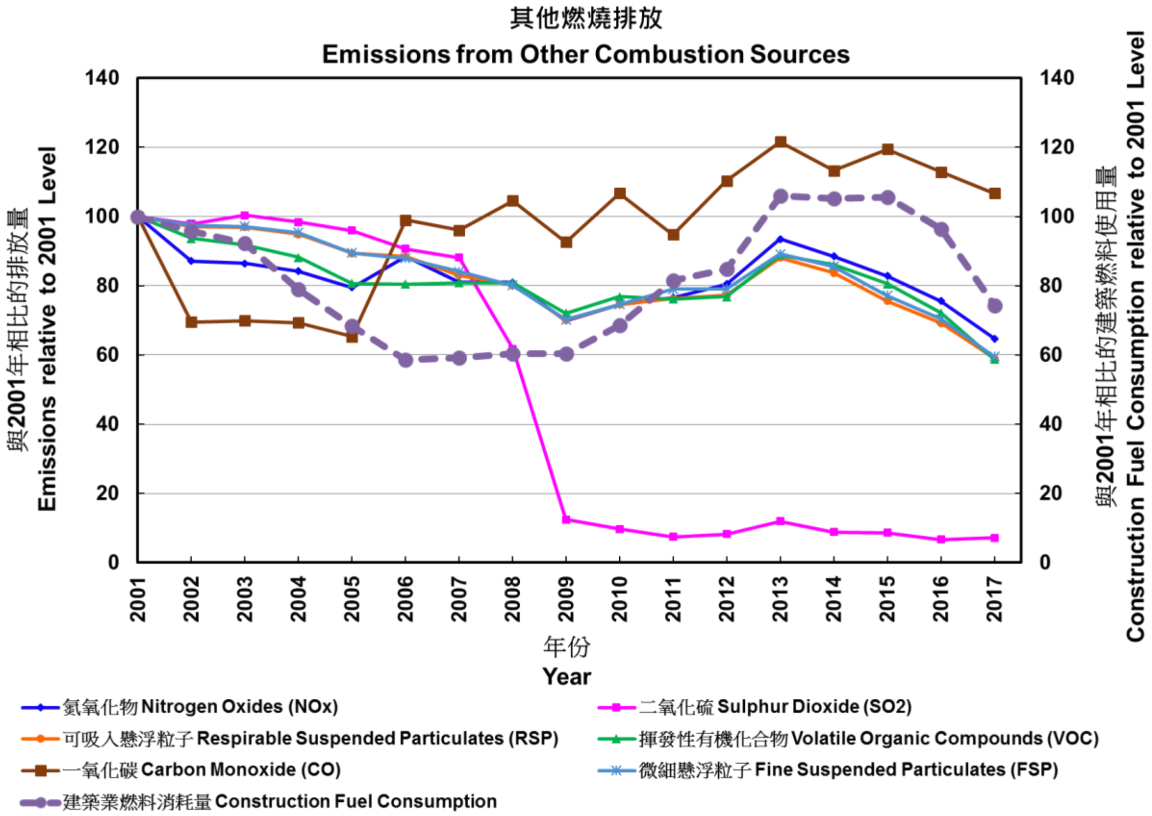


5.10. Emissions from civil aviation accounted for less than 8% of the total local emissions of air pollutants in 2017. From 2001 to 2017, the air traffic movements increased by 114%, while the emissions of NOx increased by 102%.

5.11. 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.

5.12. 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"

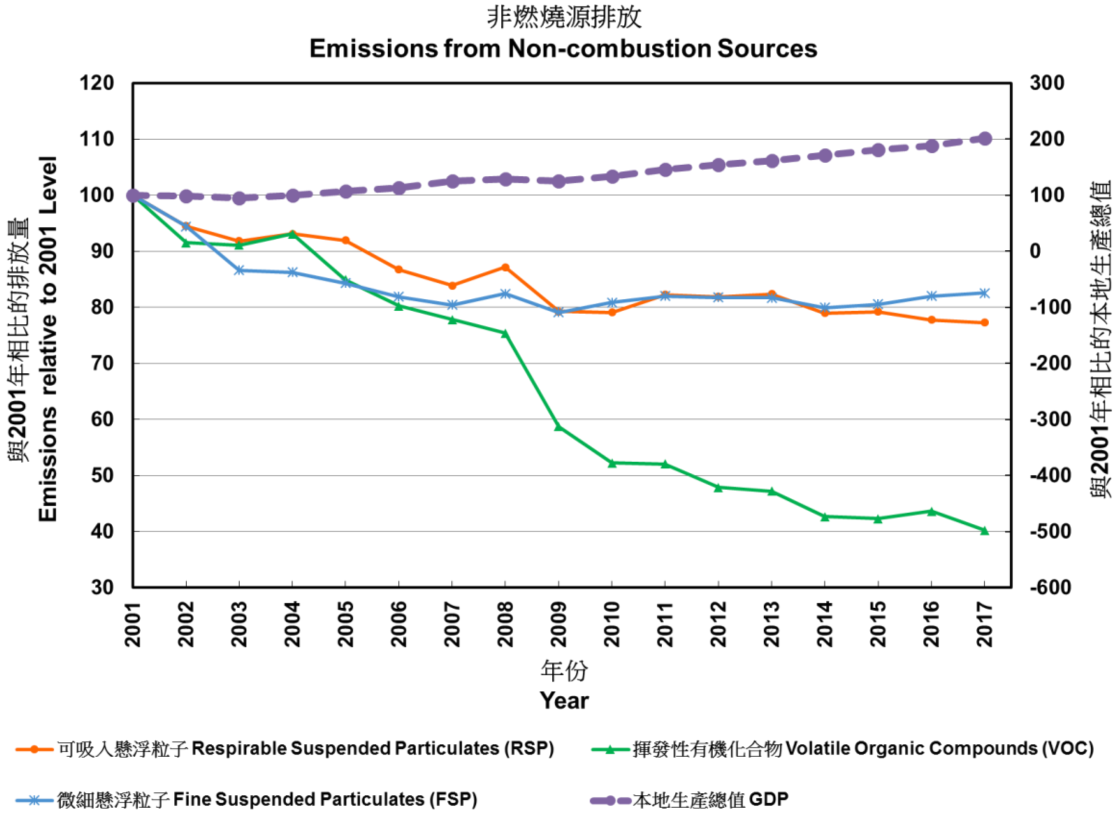


5.13. Other combustion sector is one of the important sources of RSP and FSP emissions, accounting for 16% and 19% of their total emissions in 2017 respectively. Overall, the emissions of various pollutants from other combustion sources decreased by 35% to 93% from 2001 to 2017, except for CO which slightly increased by 7%.

5.14. Major contributing sources in this sector are non-road mobile machinery (NRMMs), especially construction machinery, which accounted for 52%, 55% and 57% of RSP, FSP and NOx emissions from other combustion sources respectively in 2017. The emission trends from other combustion sources from 2010 to 2015 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.

5.15. The SO_2 emissions from this sector have been reduced to a very low level since the Air Pollution Control (Fuel Restriction) Regulation tightened the cap on the sulphur content of diesel used in industrial and commercial sectors from 0.5% to 0.005% in October 2008. 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"

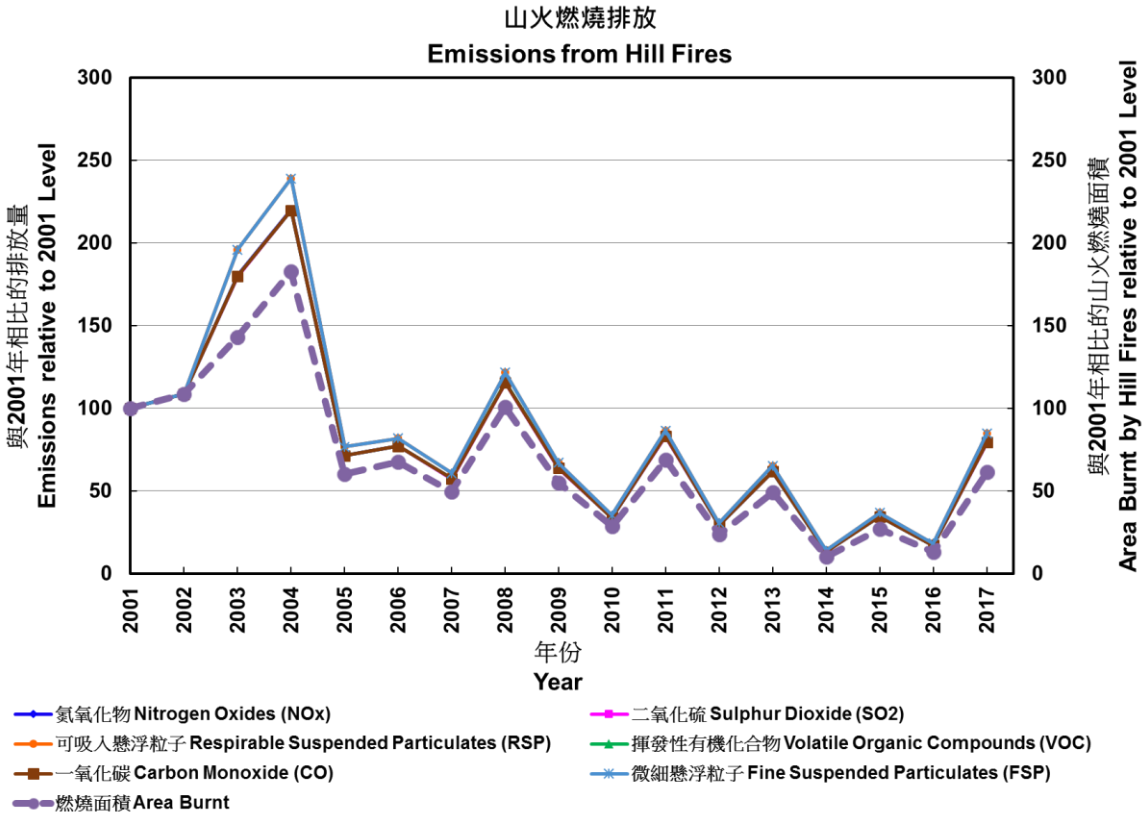


5.16. Non-combustion sources sector contributes considerably to local VOC emissions, accounting for 57% in 2017, whereas its contributions to local RSP and FSP emissions in 2017 were 22% and 16%, respectively. Overall, the emissions of the sector decreased by 17% to 60% from 2001 to 2017, despite the growth of Gross Domestic Product by 101%.

5.17. The use of paints, printing inks and associated solvents, consumer products, adhesive and sealants continued to be the major contributing sources, accounting for 88% of non-combustion sources VOC emissions in 2017. As compared with 2007, the VOC emissions from non-combustion sources decreased by 48% in 2017, as a result of the VOC control programme under the Air Pollution Control (Volatile Organic Compounds) Regulation since 2007.

5.18. 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 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.

6 EMISSIONS FROM HILL FIRES



6.1. Emissions from hill fires mainly contribute to RSP and FSP emissions, accounting for 30% and 31% of total local RSP and FSP emissions in 2017, respectively. From 2001 to 2017, the area burnt due to hill fires decreased by 39% and hence, the emissions of FSP and RSP from hill fires decreased by a similar extent over the same period.

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 been reduced substantially over the past 2 decades.

Annex 1 – Breakdown of Emission Inventory by Source Category from 2016 to 2017

Pollutant	Source Category	Emissions (Tonnes)	
		2016	2017
SO_2	Public Electricity Generation	8,020	7,000
	Road Transport	40	40
	Navigation	8,540	8,350
	Civil Aviation	530	570
	Other Combustion	180	200
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	**17,300**	**16,160**
	Hill Fires	10	30
	Total (with Hill Fires)	**17,310**	**16,180**
NOx	Public Electricity Generation	25,620	22,640
	Road Transport	18,800	16,800
	Navigation	32,900	31,580
	Civil Aviation	6,060	6,300
	Other Combustion	8,940	7,650
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	**92,310**	**84,960**
	Hill Fires	30	140
	Total (with Hill Fires)	**92,340**	**85,090**
RSP	Public Electricity Generation	610	630
	Road Transport	450	420
	Navigation	1,640	1,370
	Civil Aviation	50	60
	Other Combustion	760	650
	Non-combustion	890	880
	Total (without Hill Fires)	**4,410**	**4,020**
	Hill Fires	370	1,690
	Total (with Hill Fires)	**4,770**	**5,710**
FSP	Public Electricity Generation	310	320
	Road Transport	410	390
	Navigation	1,480	1,270
	Civil Aviation	50	60

Pollutant	Source Category	Emissions (Tonnes)	
		2016	2017
	Other Combustion	710	600
	Non-combustion	480	480
	Total (without Hill Fires)	**3,440**	**3,120**
	Hill Fires	300	1,380
	Total (with Hill Fires)	**3,740**	**4,500**
VOC	Public Electricity Generation	430	400
	Road Transport	4,900	4,900
	Navigation	4,510	4,310
	Civil Aviation	520	600
	Other Combustion	890	720
	Non-combustion	15,820	14,590
	Total (without Hill Fires)	**27,080**	**25,520**
	Hill Fires	80	360
	Total (with Hill Fires)	**27,160**	**25,880**
CO	Public Electricity Generation	3,690	3,450
	Road Transport	31,100	30,100
	Navigation	13,940	13,600
	Civil Aviation	3,990	4,470
	Other Combustion	5,810	5,490
	Non-combustion	N/A	N/A
	Total (without Hill Fires)	**58,520**	**57,110**
	Hill Fires	850	3,950
	Total (with Hill Fires)	**59,370**	**61,050**

Notes:
- All figures are rounded to the nearest ten.
- "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. Making reference to international developments and technological advancement, we have been updating the methodologies to compile emission inventories including the collection of most updated data with an aim to provide a better support to the management of air quality. Whenever the compilation methodology is updated, new activity data are collated, or errors in the estimates are identified, we will follow international practice to update the emission inventory and to revise the emission inventories for past years as far as practicable based on the updated methods and data to enable consistent and reliable emission trend analysis to be made.

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 in recent years 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. They have also found that vehicles with inadequate maintenance, e.g. LPG vehicles with worn-out catalytic converters, could emit considerably above their normal levels. 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 types 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 paints based on their sales report data. Emissions from cleansing solvents during the application of paints have also been estimated. To compile VOC emissions for the 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.

5. Updates to the emission inventories over the past 5 years are summarized in the table below. Based on the latest updates, we have recalculated historical emission inventories from 2001 to 2017. Comparisons between the previous and recalculated inventories are shown in **Annex 3**.

Update Date	**Emission Inventory Revised**	**Revisions and Updates**
January 2015	2001-2012	• VOC emissions from architectural paints in 2012 were updated using VOC contents of the latest sales reports submitted by importers. • VOC emissions from screen printing from 2009 to 2012 were revised based on our latest survey which revealed a reduction in the local use of non-regulated screen printing ink.
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 ICAO, 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.

Annex 3 – Comparison between the Previous and Recalculated Inventories (without Hill Fires) from 2001 to 2016

Table A3-1. Changes in SO_2 emission inventories from 2001 to 2016

Year	SO_2 (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	80,560	80,560	0%
2002	79,060	79,060	0%
2003	103,310	103,310	0%
2004	107,930	107,930	0%
2005	97,420	97,420	0%
2006	86,700	86,700	0%
2007	79,620	79,620	0%
2008	69,440	69,440	0%
2009	62,820	62,820	0%
2010	35,560	35,560	0%
2011	32,070	32,100	0%
2012	32,660	32,690	0%
2013	31,400	31,410	0%
2014	31,640	31,650	0%
2015	19,530	19,530	0%
2016	17,310	17,300	0%

* Figures are rounded to the nearest ten.

Figure A3-1 SO_2 emissions trend from 2001 to 2016

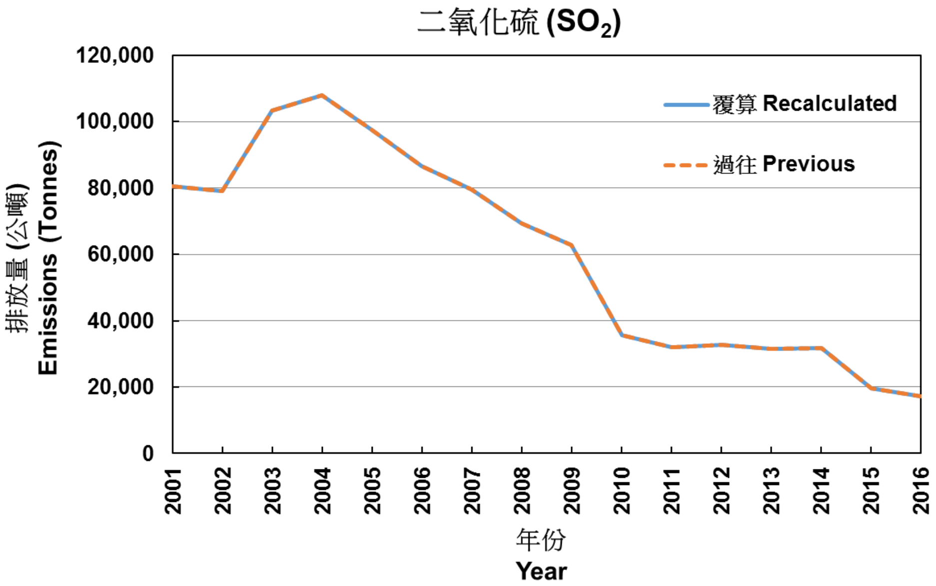


Table A3-2. Changes in NOx emission inventories from 2001 to 2016

Year	NOx (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	126,730	128,320	1%
2002	124,220	125,780	1%
2003	136,010	137,520	1%
2004	126,950	128,540	1%
2005	126,170	127,820	1%
2006	123,000	124,660	1%
2007	125,020	126,580	1%
2008	118,390	120,060	1%
2009	116,480	118,200	1%
2010	107,080	109,170	2%
2011	113,730	116,280	2%
2012	111,390	114,320	3%
2013	111,830	114,490	2%
2014	108,050	111,130	3%
2015	93,020	96,210	3%
2016	89,640	92,310	3%

* Figures are rounded to the nearest ten.

Figure A3-2 NOx emission trend from 2001 to 2016

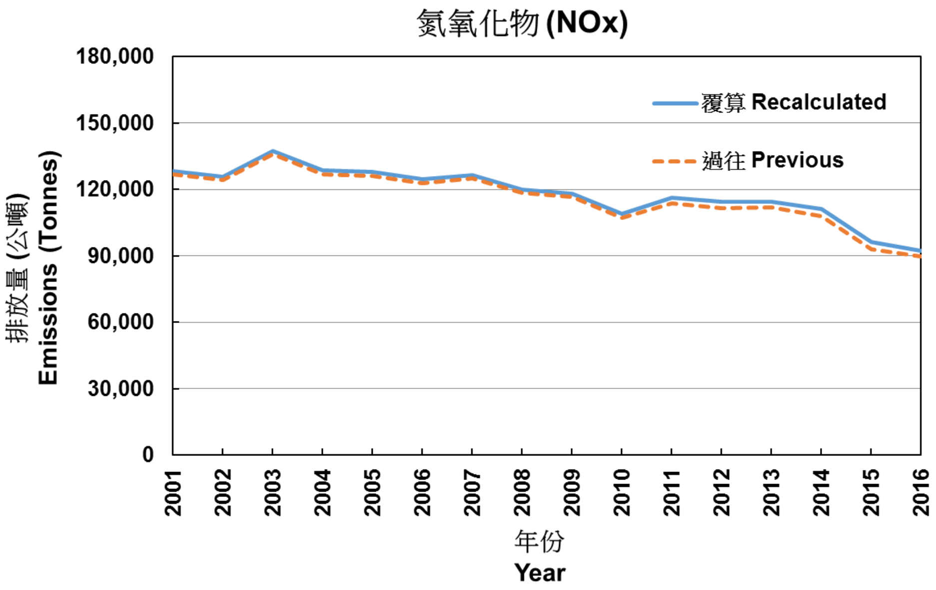


Table A3-3. Changes in RSP emission inventories from 2001 to 2016

Year	RSP (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	9,620	9,710	1%
2002	8,900	9,050	2%
2003	8,650	8,840	2%
2004	9,000	9,220	2%
2005	8,250	8,480	3%
2006	7,640	7,850	3%
2007	7,070	7,250	3%
2008	6,810	6,970	2%
2009	6,490	6,630	2%
2010	6,090	6,260	3%
2011	6,030	6,180	2%
2012	5,800	5,960	3%
2013	5,820	6,000	3%
2014	5,510	5,690	3%
2015	4,640	4,750	2%
2016	4,350	4,410	1%

* Figures are rounded to the nearest ten.

Figure A3-3 RSP emission trend from 2001 to 2016

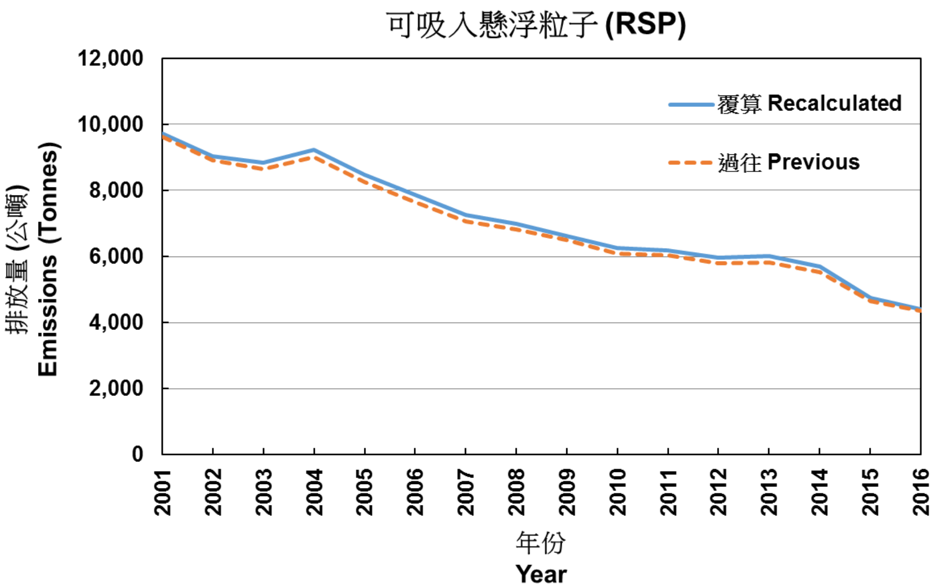


Table A3-4. Changes in FSP emission inventories from 2001 to 2016

Year	FSP (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	7,520	7,630	1%
2002	6,790	6,950	2%
2003	6,300	6,510	3%
2004	6,400	6,600	3%
2005	5,980	6,170	3%
2006	5,690	5,860	3%
2007	5,370	5,530	3%
2008	5,180	5,330	3%
2009	4,890	5,020	3%
2010	4,780	4,930	3%
2011	4,740	4,890	3%
2012	4,540	4,690	3%
2013	4,550	4,730	4%
2014	4,270	4,450	4%
2015	3,660	3,770	3%
2016	3,380	3,440	2%

* Figures are rounded to the nearest ten.

Figure A3-4 FSP emission trend from 2001 to 2016

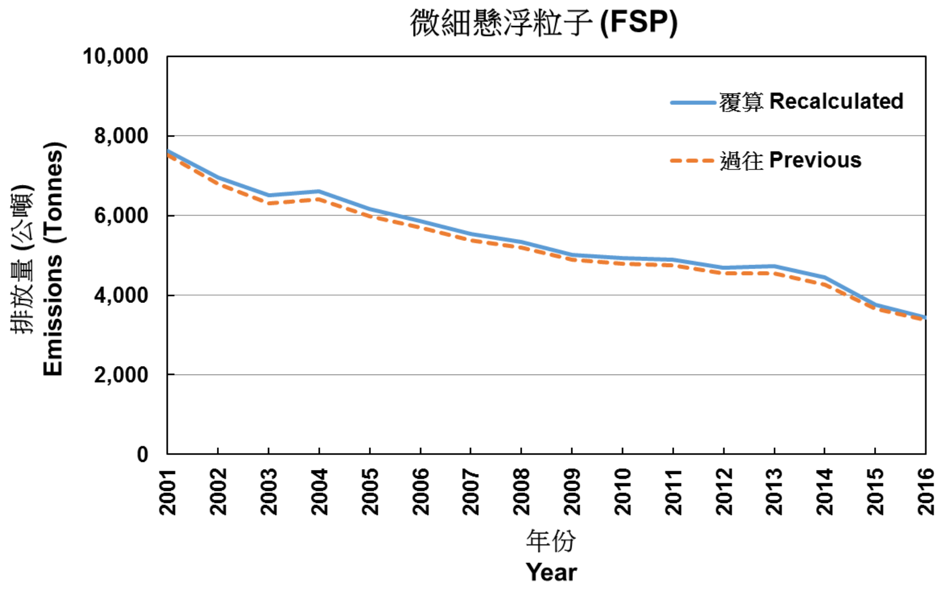


Table A3-5. Changes in VOC emission inventories from 2001 to 2016

Year	VOC (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	50,650	50,970	1%
2002	46,690	47,040	1%
2003	45,770	46,110	1%
2004	46,590	46,960	1%
2005	43,830	44,160	1%
2006	41,990	42,340	1%
2007	40,320	40,690	1%
2008	39,160	39,510	1%
2009	33,830	34,160	1%
2010	30,830	31,160	1%
2011	30,500	30,610	0%
2012	28,740	29,030	1%
2013	28,360	28,410	0%
2014	26,840	26,460	-1%
2015	25,860	26,050	1%
2016	26,240	27,080	3%

* Figures are rounded to the nearest ten.

Figure A3-5 VOC emission trend from 2001 to 2016

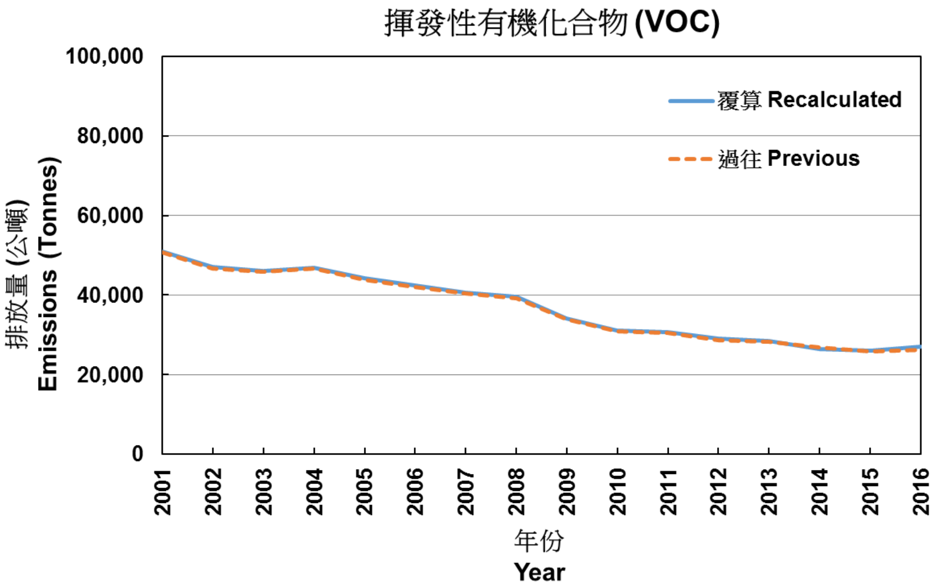


Table A3-6. Changes in CO emission inventories from 2001 to 2016

Year	CO (Tonnes)		
	Previous*	Recalculated*	% Changes
2001	78,940	80,890	2%
2002	74,580	76,610	3%
2003	72,160	74,250	3%
2004	73,950	76,520	3%
2005	75,580	78,580	4%
2006	78,130	81,110	4%
2007	77,680	80,790	4%
2008	78,610	81,670	4%
2009	80,700	83,690	4%
2010	80,690	83,840	4%
2011	82,920	85,680	3%
2012	83,650	86,760	4%
2013	67,470	69,450	3%
2014	59,190	61,250	3%
2015	57,380	57,210	0%
2016	58,600	58,520	0%

* Figures are rounded to the nearest ten.

Figure A3-6 CO emission trend from 2001 to 2016