2015 Hong Kong Emission Inventory Report

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Environmental Protection Department

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The Government of the Hong Kong Special Administrative Region

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CONTENT

Annexes

1 INTRODUCTION

1.1 The Environmental Protection Department (EPD) compiles the Hong Kong Air Pollutant Emission Inventory every year to analyze the quantity of local air pollutant emissions and their major emission sources, which helps formulate an effective air quality management strategy in Hong Kong. The emission inventory for Hong Kong was first uploaded to EPD's website in March 2000.

1.2 This report presents the 2015 Hong Kong Emission Inventory. It describes:

(i) the emission inventory by source category in 2015 (Chapter 3);
(ii) the emission trends from 1997 to 2015 for six major air pollutants (Chapter 4);
(iii) the sectoral analyses for seven emission source categories (Chapter 5); and
(iv) the emission reduction plan up to 2020 (Chapter 6).

2 SCOPE OF EMISSION INVENTORY

2.1 The emission inventory comprises estimates of the 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 biomass burning.

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 fume, construction dust and quarry production.

2.4 Biomass burning refers to the emission activities that involve the burning of vegetation. In Hong Kong, the only contributing source in this sector is hill fires, which can produce a large amount of particulates.

3 2015 EMISSION INVENTORY

3.1 The table below shows a breakdown of air pollutant emissions by source category in 2015, while **Annex 1** shows the changes in emissions between 2014 and 2015.

Breakdown of 2015 Emission Inventory

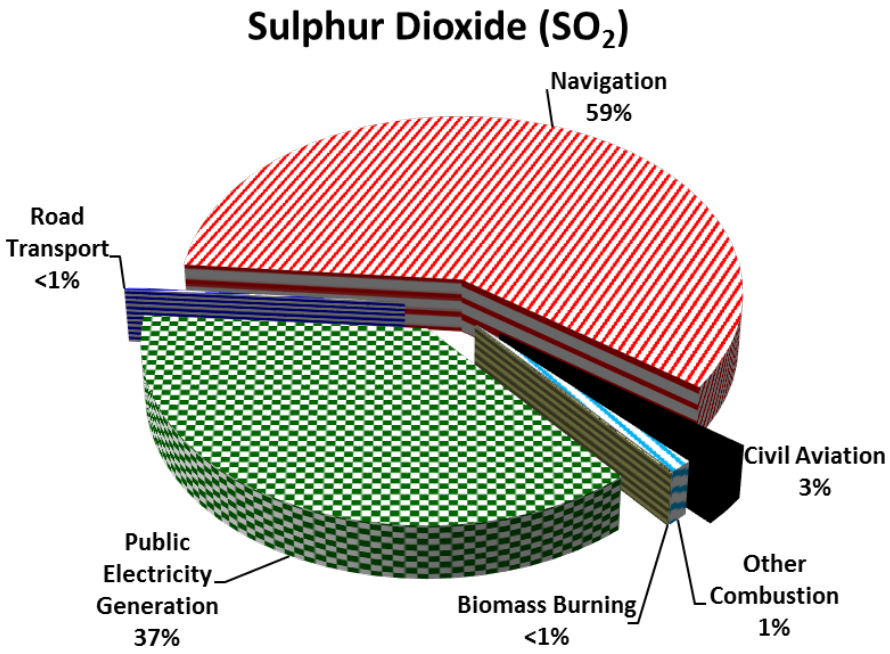
Pollution Sources	Emissions (Tonnes)					
	SO_2	**NOx**	**RSP**	**FSP**	**VOC**	**CO**
Public Electricity Generation	7,280	26,090	580	290	420	3,580
Road Transport	40	16,200	490	450	4,800	29,700
Navigation	11,460	33,900	1,860	1,690	4,160	13,280
Civil Aviation	510	5,000	50	50	710	3,950
Other Combustion	240	10,450	800	740	1,040	5,920
Non-combustion	N/A	N/A	910	470	15,320	N/A
Biomass Burning	10	60	740	600	160	1,720
Total Emissions	19,540	91,700	5,430	4,300	26,610	58,150

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.

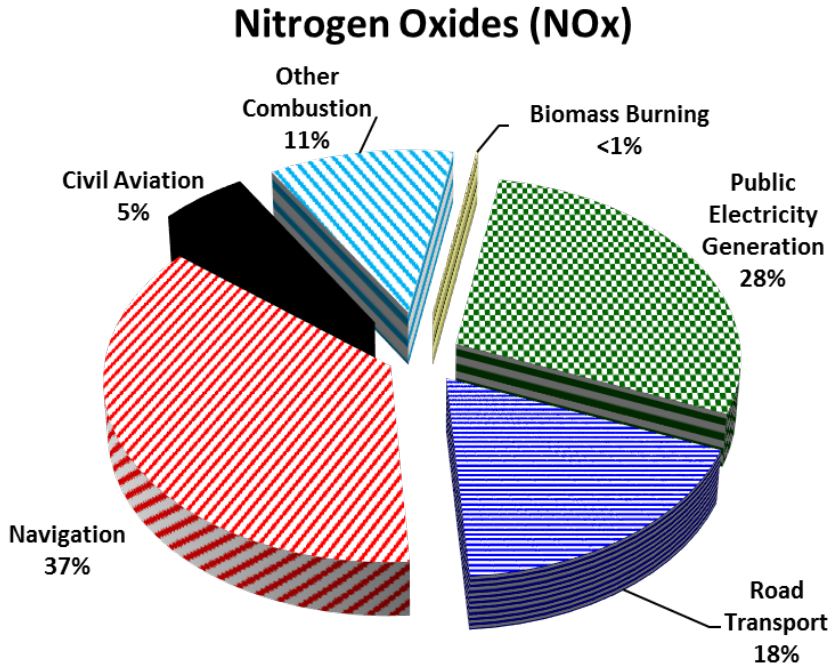
3.2 A summary of updates to the emission inventories is appended at **Annex 2**.

3.3 The following pie charts show the percentage share of emissions by source category for each pollutant in 2015.

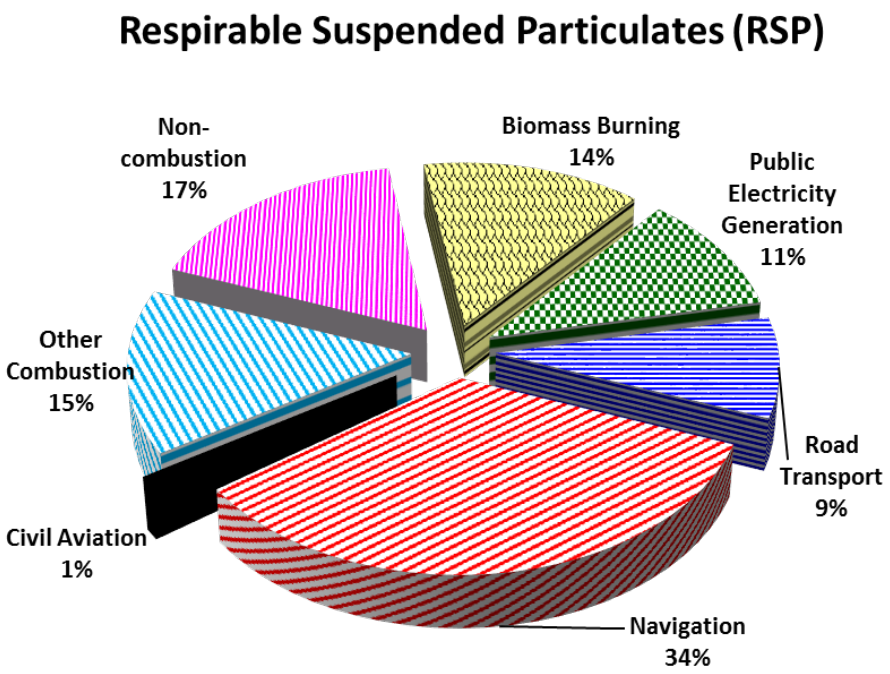
Total SO_2 emission = 19,540 Tonnes



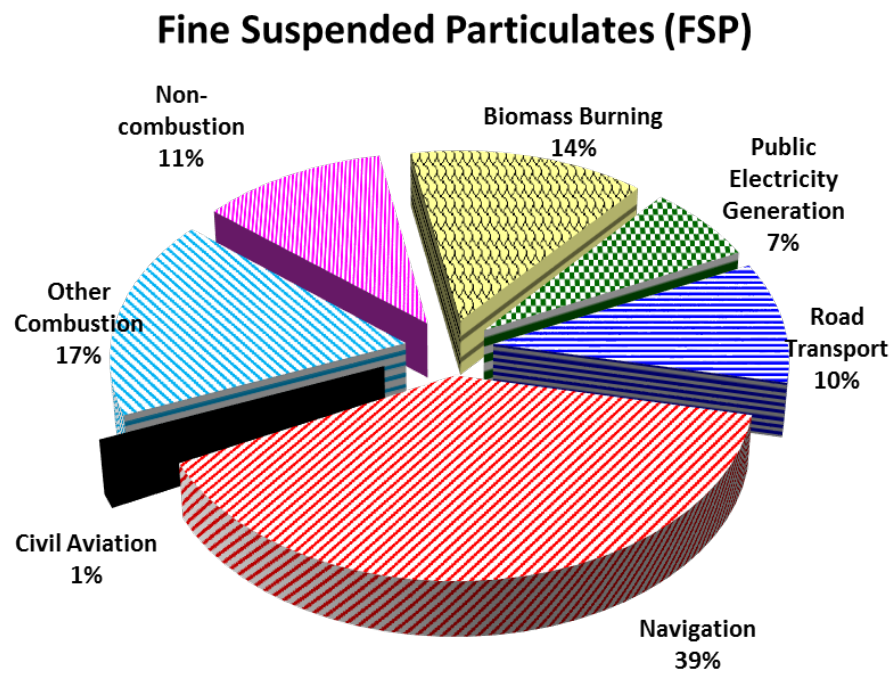
Total NOx emission = 91,700 Tonnes



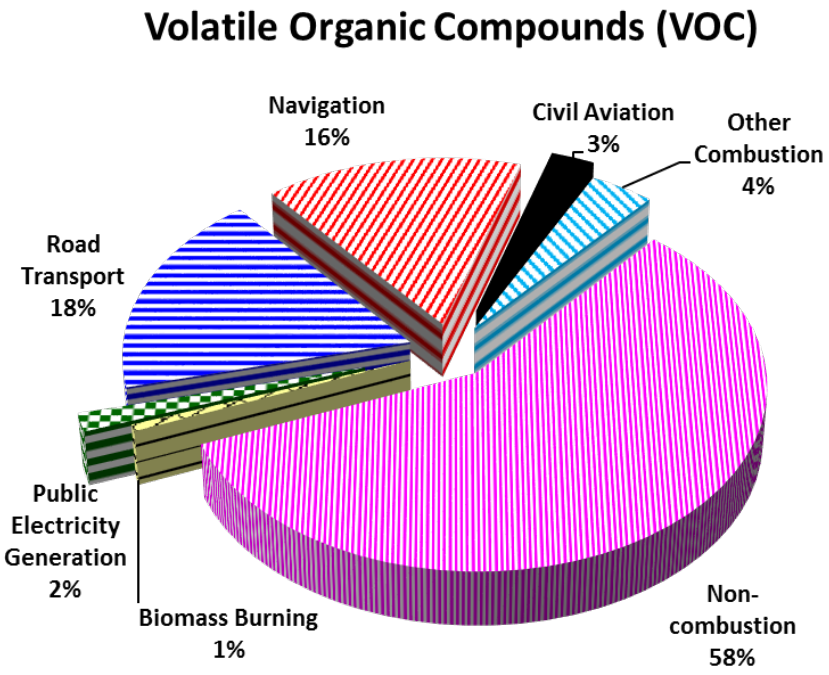
Total RSP emission = 5,430 Tonnes



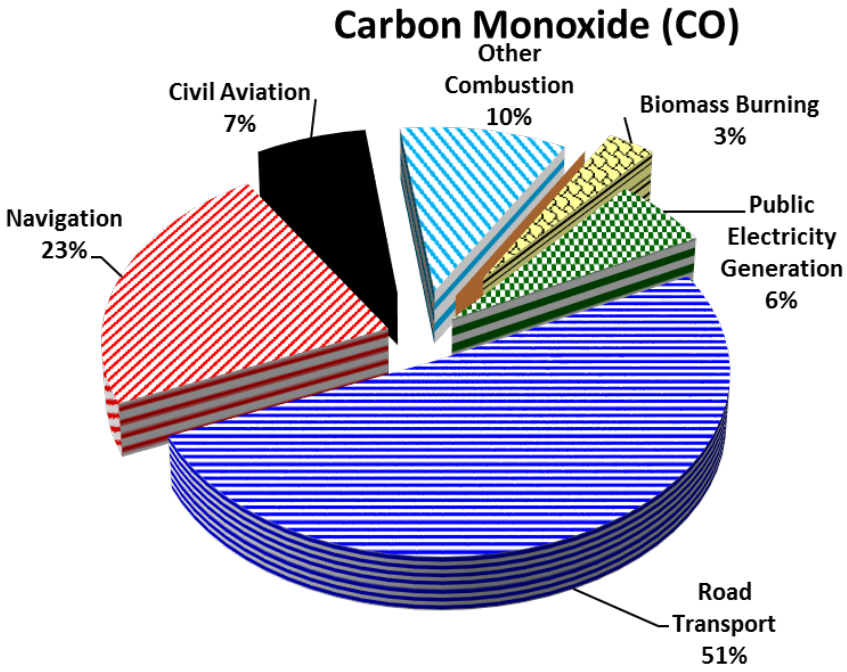
Total FSP emission = 4,300 Tonnes



Total VOC emission = 26,610 Tonnes

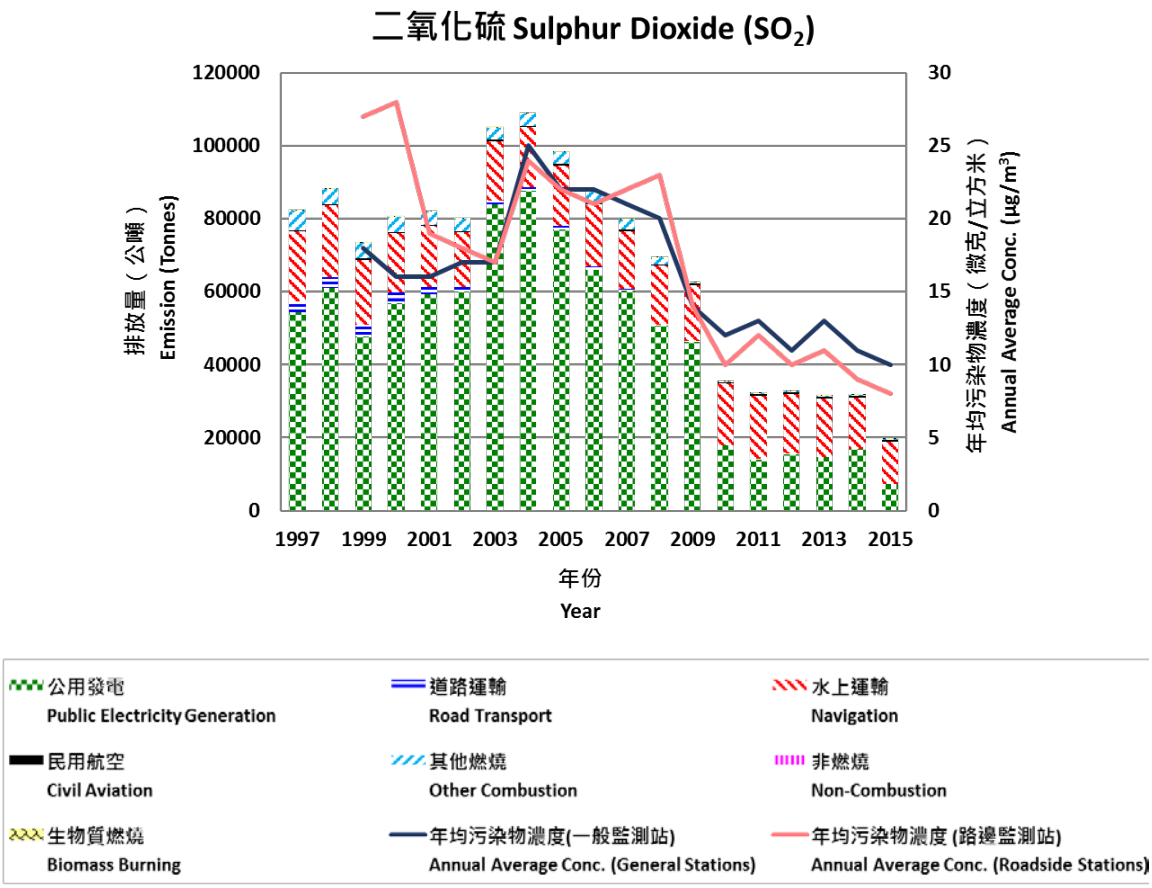


Total CO emission = 58,150 Tonnes



4 EMISSION TRENDS FROM 1997 TO 2015

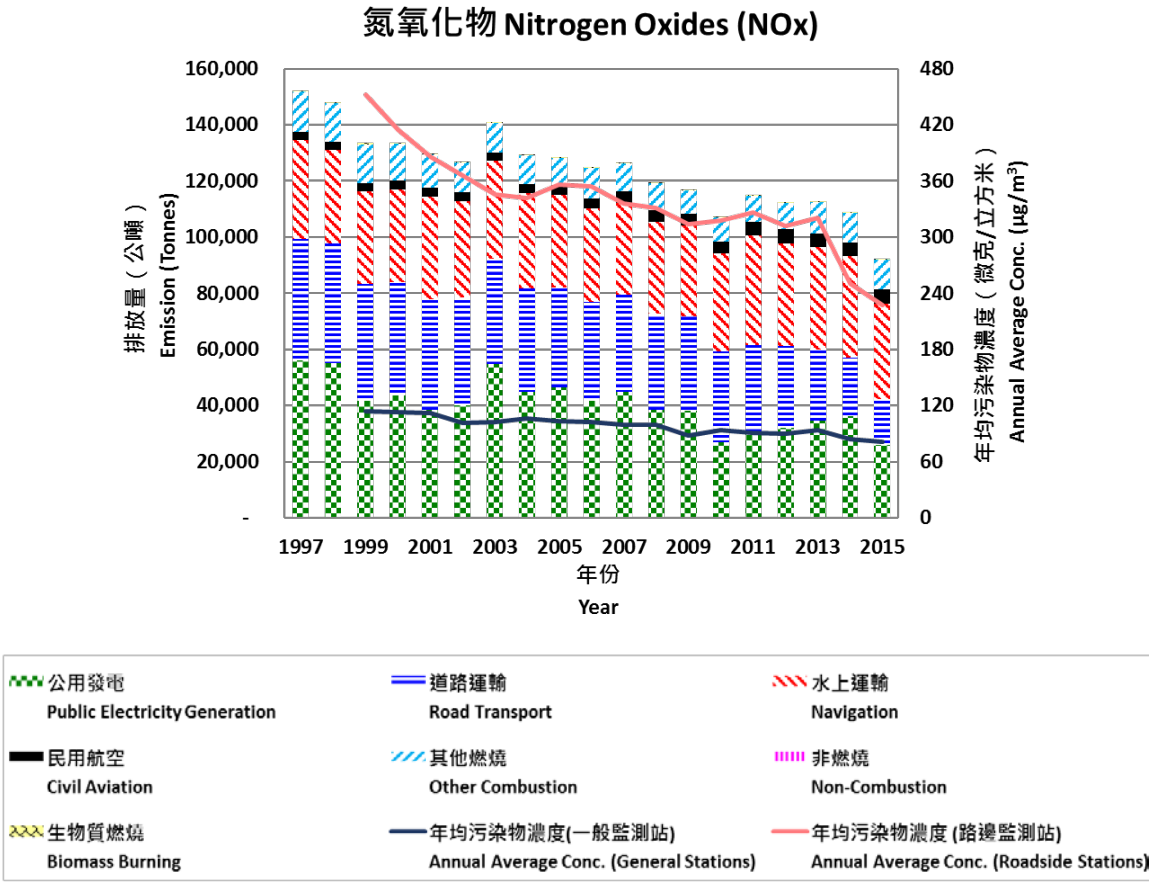
SO_2 Emission and Air Quality Trends



4.1 Between 1997 and 2015, SO_2 emissions decreased by 76%, which was mainly caused by a decline in emissions from the public electricity generation sector. Navigation and public electricity generation sectors were the top two sources of SO_2 emissions, accounting for 59% and 37% of total SO_2 emissions in 2015, respectively.

4.2 During the same period, SO_2 levels measured at the EPD's general air quality monitoring stations followed closely with 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.

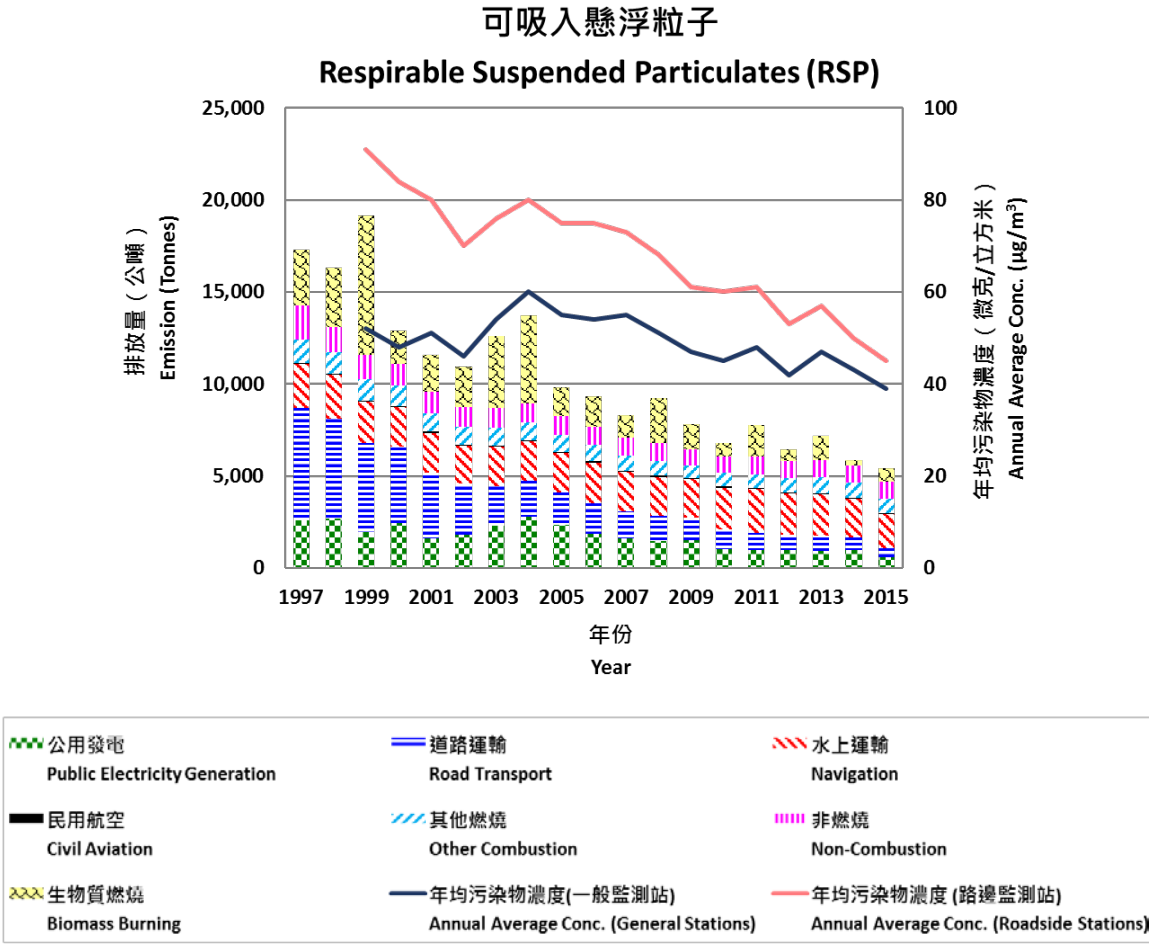
NOx Emission and Air Quality Trends



4.3 Between 1997 and 2015, NOx emissions decreased by 40%. Navigation, public electricity generation and road transport sectors were the top three sources of NOx emissions, accounting for 37%, 28% and 18% of total NOx emissions in 2015, respectively.

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

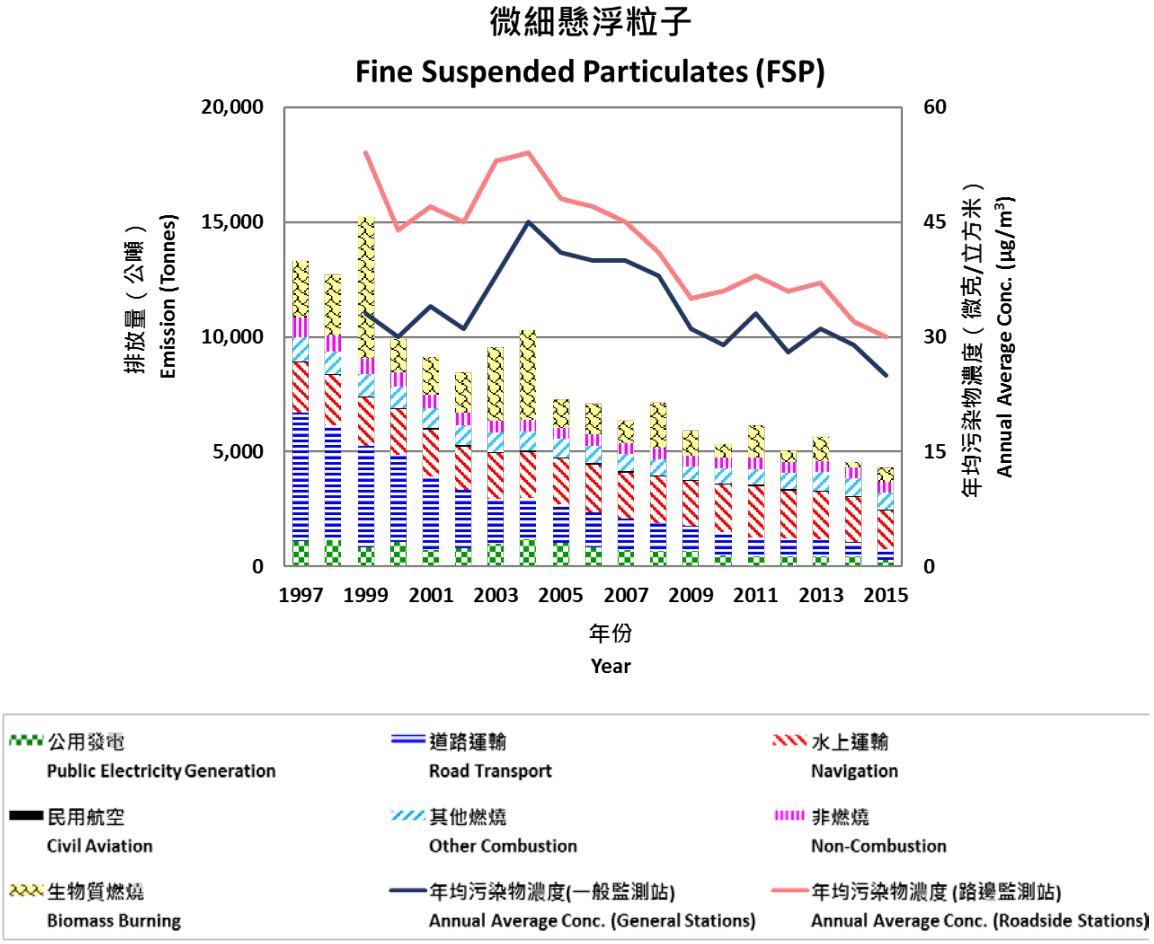
RSP Emission and Air Quality Trends



4.5 Between 1997 and 2015, RSP emissions decreased by 69% which was mainly caused by a decline in emissions from the road transport, public electricity generation and biomass burning sectors. Navigation, non-combustion and other combustion sectors were the top three sources of RSP emissions, accounting for 34%, 17% and 15% of total RSP emissions in 2015, respectively.

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

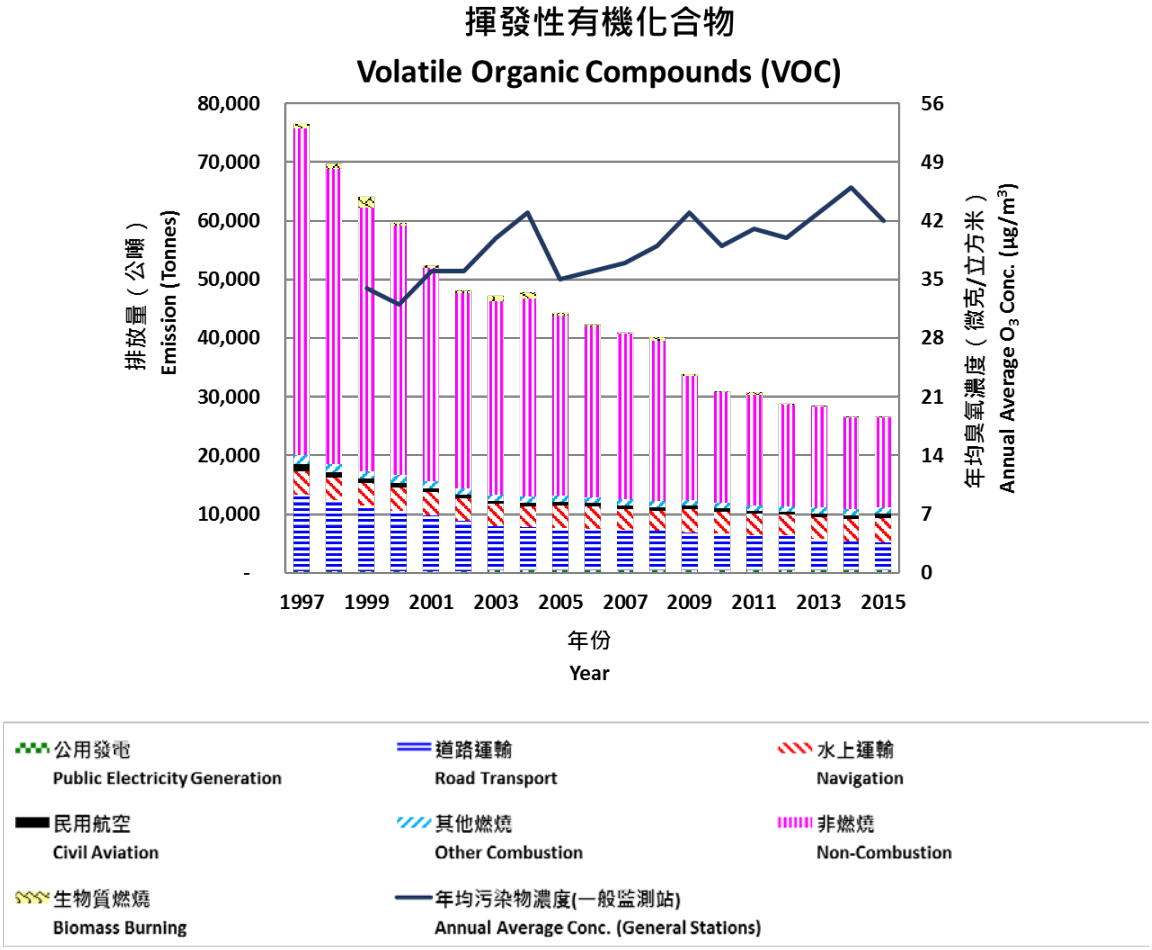
FSP Emission and Air Quality Trends



4.7 As FSP is a fraction of RSP, they share similar emission sources and emission trends. Between 1997 and 2015, FSP emissions decreased by 68%. Navigation, other combustion and biomass burning sectors were the top three sources of FSP emissions, accounting for 39%, 17% and 14% of total FSP emissions in 2015, respectively.

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

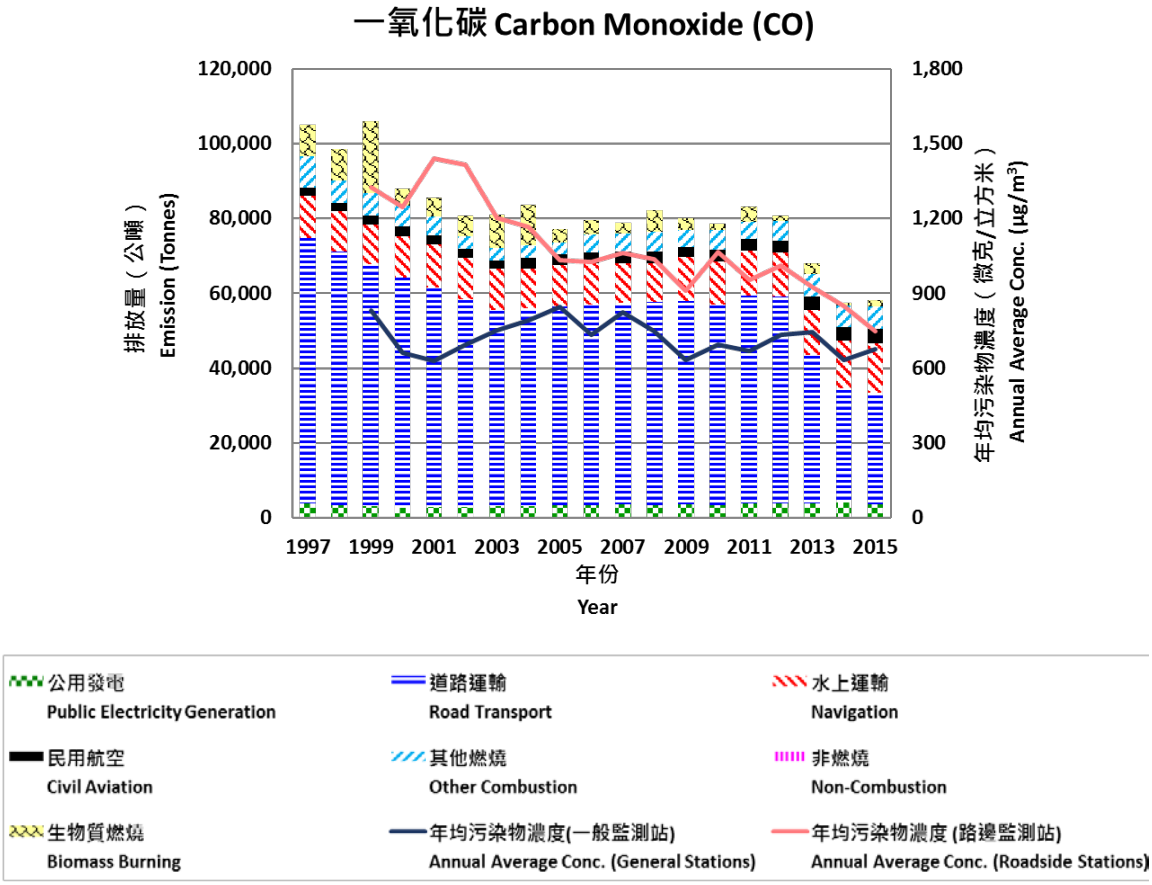
VOC Emission and Air Quality Trends



4.9 Between 1997 and 2015, VOC emissions decreased by 65% which was mainly caused by the decline in emissions from non-combustion and road transport sectors. Non-combustion and road transport sectors were the top two sources of VOC emissions, accounting for 58% and 18% of total VOC emissions in 2015, respectively.

4.10 During the same period, the ozone (O_3) levels measured at the EPD's general air quality monitoring stations and the estimated VOC emission trend went in nearly opposite directions. Ozone is a secondary pollutant, formed by the photochemical reaction of VOC and NOx. Despite the reduction of local emissions of VOC and NOx over the past years, the ambient O_3 level was still rising which indicates the contribution of regional influence.

CO Emission and Air Quality Trends

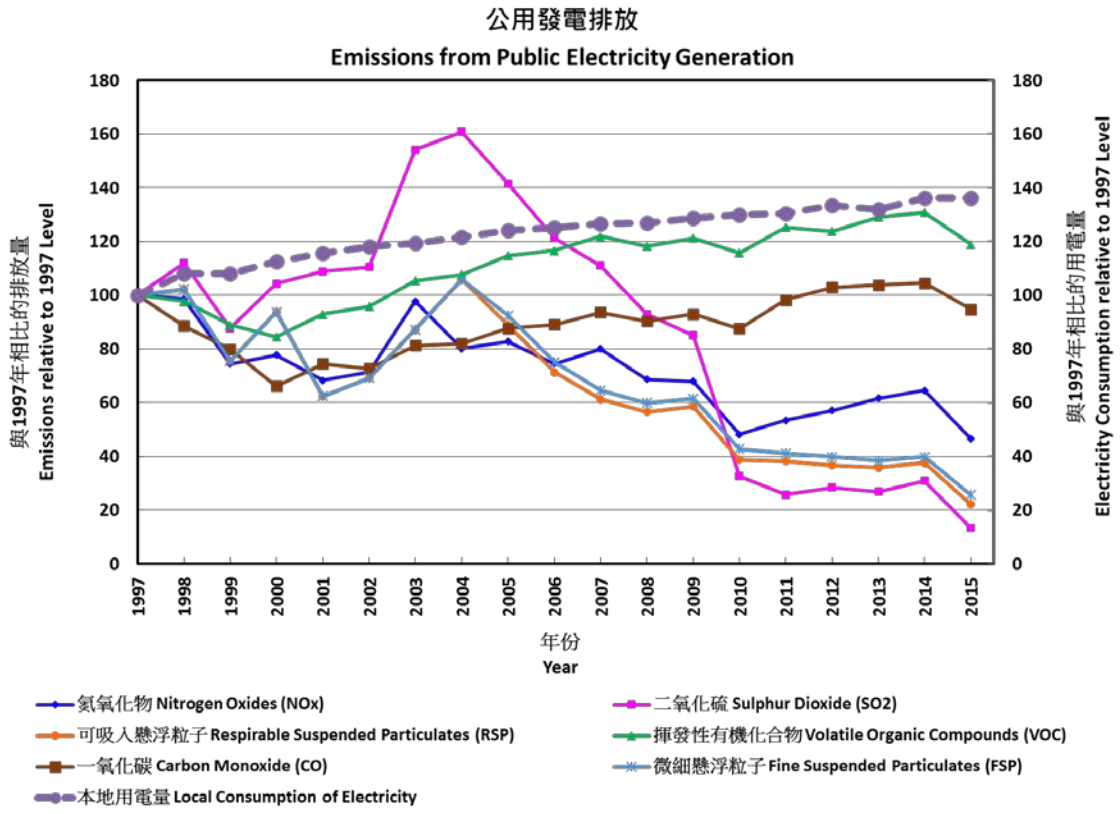


4.11 Between 1997 and 2015, CO emissions decreased by 45% which was mainly caused by a decline in emissions from the road transport sector. Road transport and navigation sectors were two major sources of CO emissions, accounting for 51% and 23% of the total CO emissions in 2015, respectively.

4.12 During the same period, CO levels measured at the EPD's roadside air quality monitoring stations were very low and followed closely with the CO emission trend, indicating that the roadside CO mainly originates from local emission sources.

5 SECTORAL ANALYSES

Sectoral analysis for "Public electricity generation"

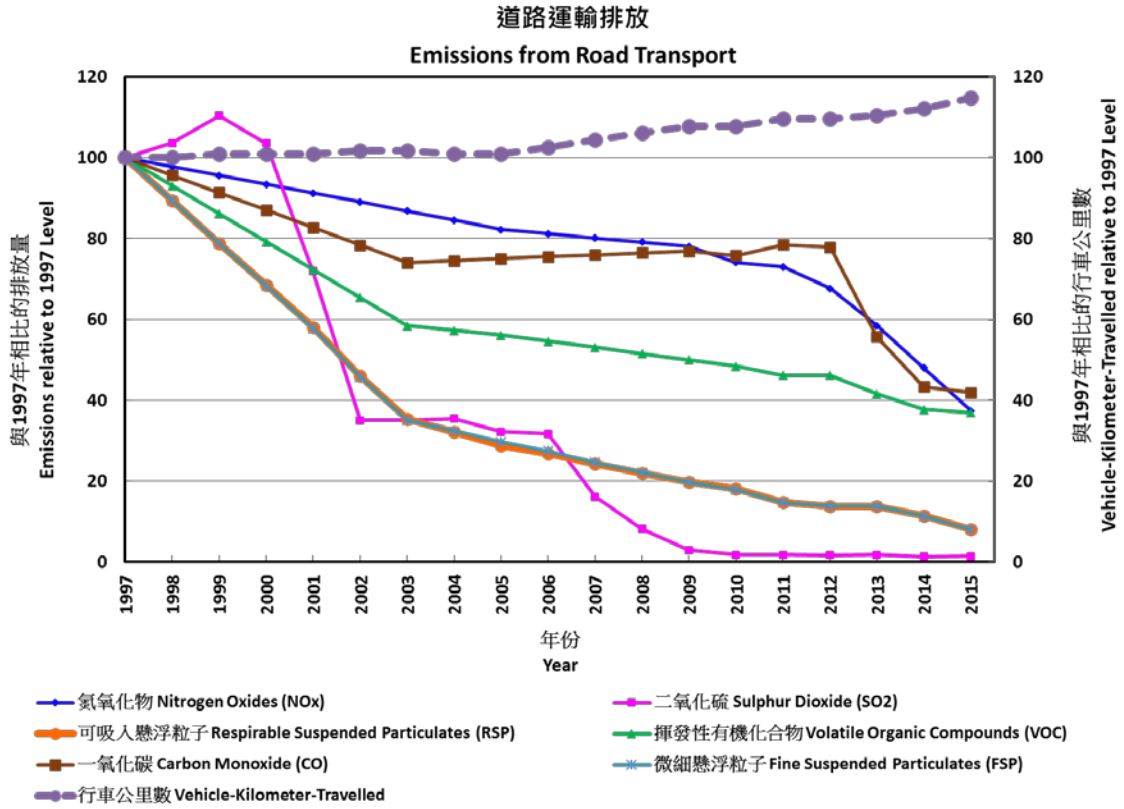


5.1 Power sector had been a major contributor to SO_2, NOx and RSP emissions. Subsequent to the imposition of statutory emission caps on power plants, its SO_2 emissions reduced substantially by 87%; NOx emissions by 53% and RSP emissions by 78% from 1997 to 2015, despite an increase of electricity consumption of 36%. In 2015, the emissions of SO_2, NOx and RSP accounted for 37%, 28% and 11% of the total emissions, respectively.

5.2 The emissions of SO_2, NOx and RSP from power sector showed decreasing trends from 2010 to 2015, which was due to increased use of natural gas in power generation, in order to meet the emission caps set out in the Second Technical Memorandum (TM).

5.3 The EPD has progressively tightened the emission caps since 2005. In 2008, we stipulated the stringent emission caps for 2010 and beyond through the first TM for power plants. The fifth TM was issued in 2015 to further tighten the emissions of air pollutants from 2020 onwards. By 2020, the emission caps of SO_2, NOx and RSP would be reduced by 69%, 50% and 54% respectively, as compared to the emission caps for 2010.

Sectoral analysis for "Road transport"

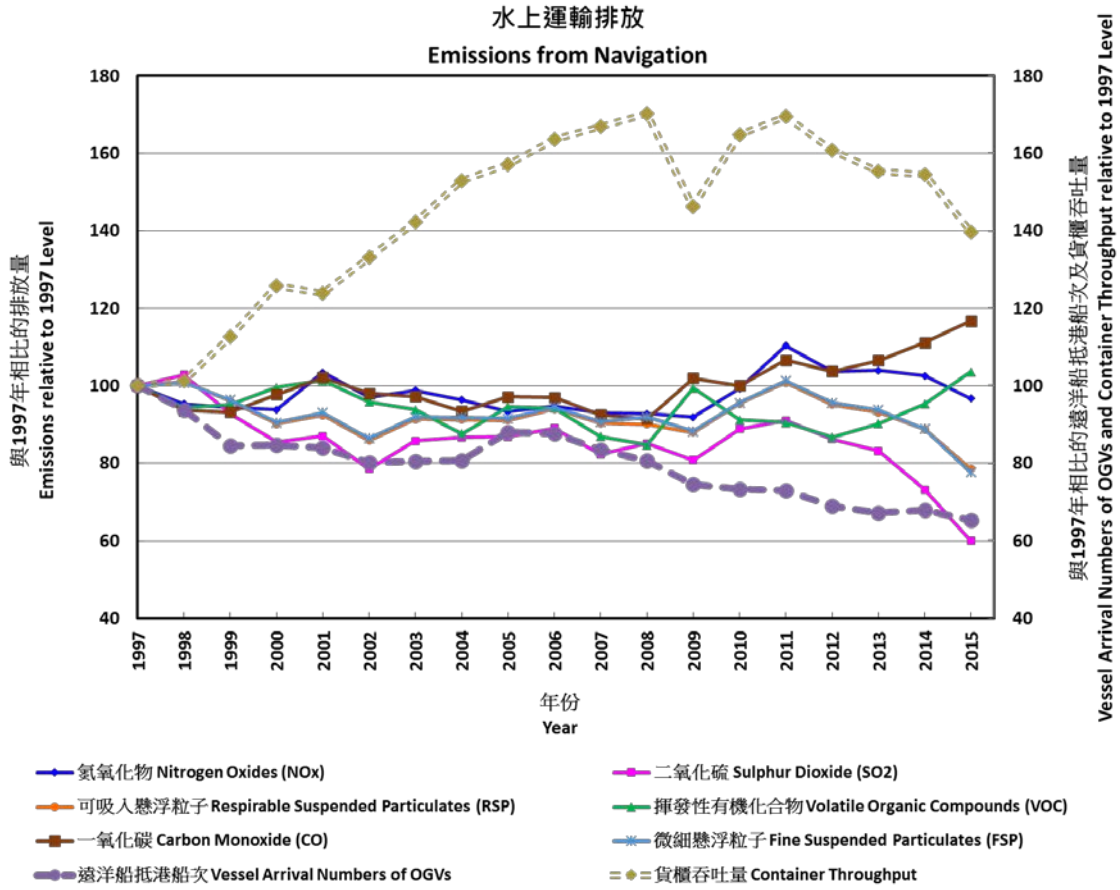


5.4 Road transport was a major emission source of NOx, VOC and CO, accounting for 18%, 18% and 51% of the total emissions in 2015, respectively. Overall, the emissions from road transport decreased by 58% to 99% from 1997 to 2015, despite an increase in vehicle-kilometer-travelled of 15% during the same period.

5.5 The substantial decreases in NOx, RSP, FSP, VOC and CO emissions from 2010 to 2015 could be attributed to an array of vehicle emission control programmes, which included the tightening of vehicle emission standards from Euro IV to Euro V in 2012, providing a one-off subsidy to vehicle owners for the replacement of the catalytic convertors and oxygen sensors of petrol / liquefied petroleum gas (LPG) taxis and light buses, strengthening the emissions control for LPG and petrol vehicles by deploying roadside remote sensing equipment to detect excessive emissions from petrol and LPG vehicles and launching an incentive-cum-regulatory scheme to progressively phase out some 82 000 pre-Euro IV diesel commercial vehicles by end 2019. By the end of 2015, 47% of the pre-Euro IV diesel commercial vehicles had already been phased out.

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%.

Sectoral analysis for "Navigation"



5.7 As more efforts have been made to tackle air pollution from vehicles and power plants over the years, other sources, particularly vessels, were contributing a larger share of emissions. Nonetheless, the emissions of SO_2, RSP, FSP from the navigation sector decreased considerably between 2013 and 2015 by 16% to 28%. In 2015, the emissions of SO_2, NOx, RSP and FSP accounted for 59%, 37%, 34% and 39% of the total emissions, respectively.

5.8 The emission reductions of SO_2, RSP and FSP from 2010 to 2015 were primarily achieved through the implementation of Air Pollution Control (Marine Light Diesel) Regulation in 2014 followed by the Air Pollution Control (Ocean Going Vessels) (Fuel at Berth) Regulation in 2015. The latter mandated ocean-going vessels to switch to low sulphur fuel not exceeding 0.5% (an 81% reduction from the previous average level of 2.6%) while at berth in 2015. The VOC emissions were low, hence a small fluctuation can make a big difference in percentage.

5.9 Among vessels, ocean going vessels (OGVs) were major emitters. The following are worth noting-

(i) the arrival numbers of OGVs decreased by 35% between 1997 and 2015 though the container throughput increased by 40%; and

(ii) as compared with 2010, the arrival numbers of OGVs decreased by 11% and container throughput by 15% in 2015.

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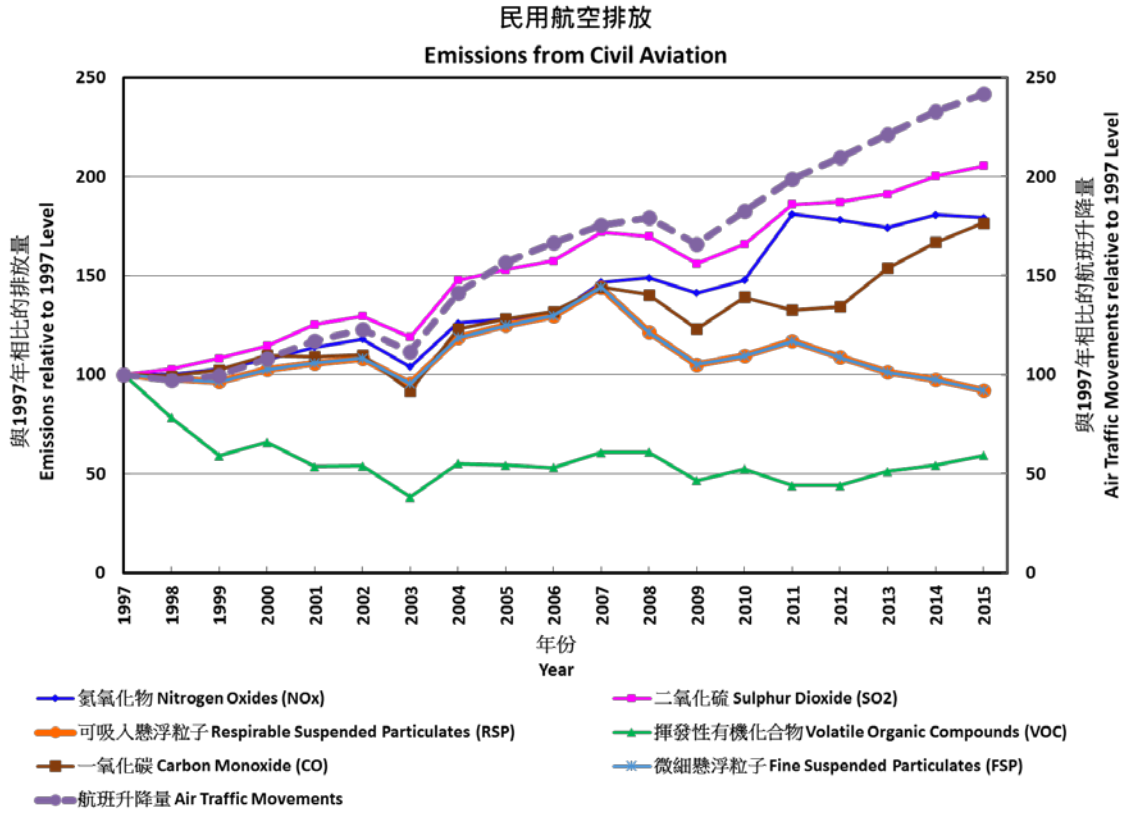
Sectoral analysis for "Civil aviation"

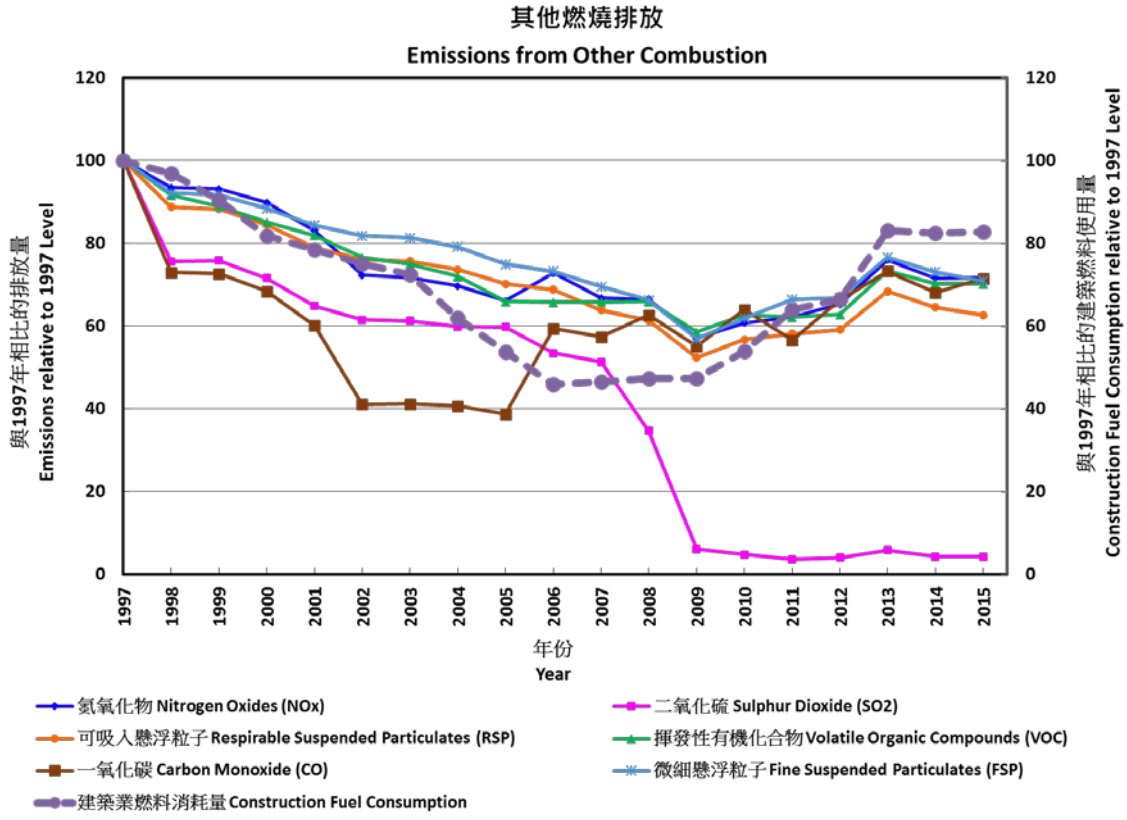


5.10 Emissions from civil aviation accounted for less than 7% of the total local emissions of air pollutants in 2015. From 1997 to 2015, the air traffic movements increased by 142%, while the emissions of NOx increased by 79%.

5.11 On the contrary, the emissions of RSP and FSP showed a decreasing trend from 2010 to 2015 due to the increased use of fixed ground power and pre-conditioned air systems for aircraft at parking stands of the Hong Kong International Airport (HKIA). Such measures reduce the operation time of onboard fuel combustion auxiliary power generation units (APU), and thereby reduce particulate emissions. Since December 2014, the use of APU at frontal stands was totally banned.

5.12 The Civil Aviation Department (CAD) has adopted the standards set out at Annex 16 to the Convention on International Civil Aviation, Volume 2, 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. Besides, since October 2009, CAD has introduced new air routes which have shorter travelling distances for aircraft arriving from the west and the north of Hong Kong. Each arrival flight has been able to save up to about 210 kilometres in flight distance or 14 minutes in flight time. Measures have also been taken to replace old aircraft with more fuel efficient models, hence reducing emissions from this sector.

Sectoral analysis for "Other combustion"

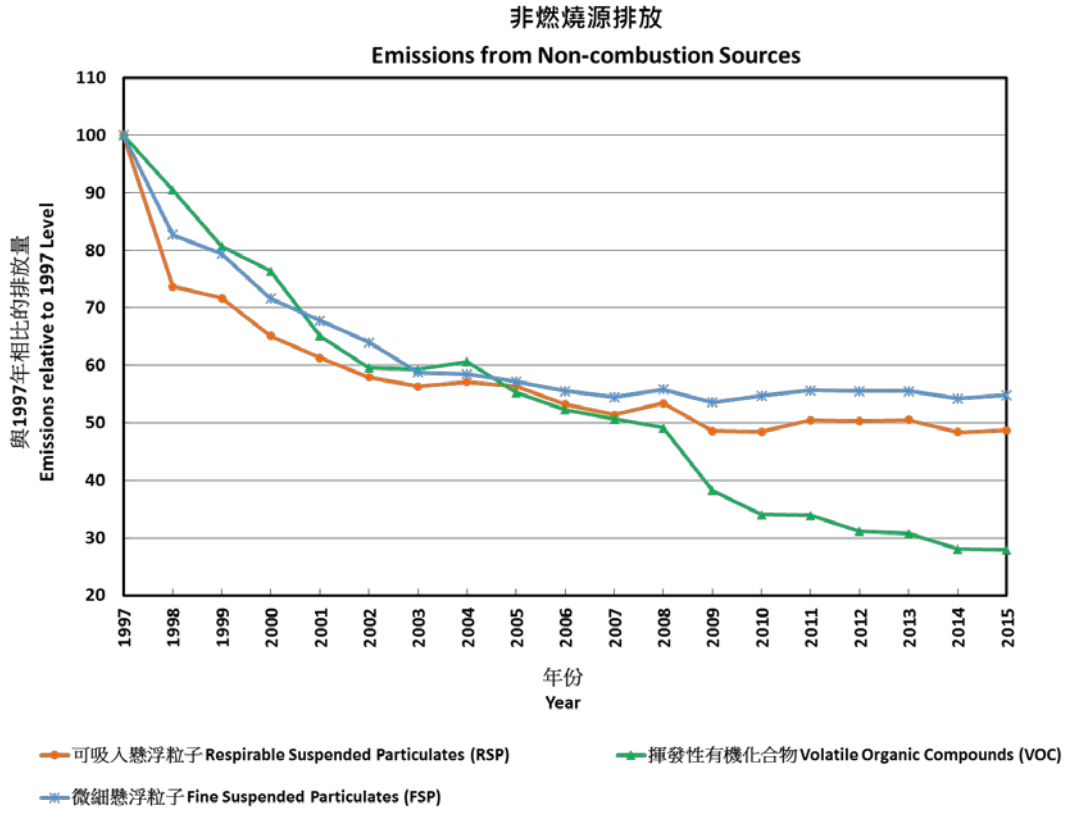


5.13 Other combustion sector is one of the important sources of RSP and FSP emissions, accounting for 15% and 17% of the total emissions in 2015, respectively. Overall, the emissions decreased by 28% to 96% from 1997 to 2015.

5.14 Major contributing sources in this sector are non-road mobile machineries (NRMMs), especially construction machinery, which accounted for 70%, 74% and 67% of other combustion source RSP, FSP and NOx emissions respectively in 2015. The emission trends from 2010 to 2015 more or less followed the fuel consumption growth in construction projects. On 1 June 2015, the Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation came into force which controls the air pollutant emissions from NRMMs. Starting from 1 September 2015, any regulated machine to be sold or leased for local use must be an approved or exempted NRMM and must comply with the emission standards of Stage IIIA of the European Union or equivalent, while non-road vehicles must comply with Euro V emission standards.

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. Information collected from the Customs and Excise Department indicated that since January 2009, only Euro V diesel (with sulphur content not exceeding 0.001%) has been imported for industrial and construction use.

Sectoral analysis for "Non-combustion sources"

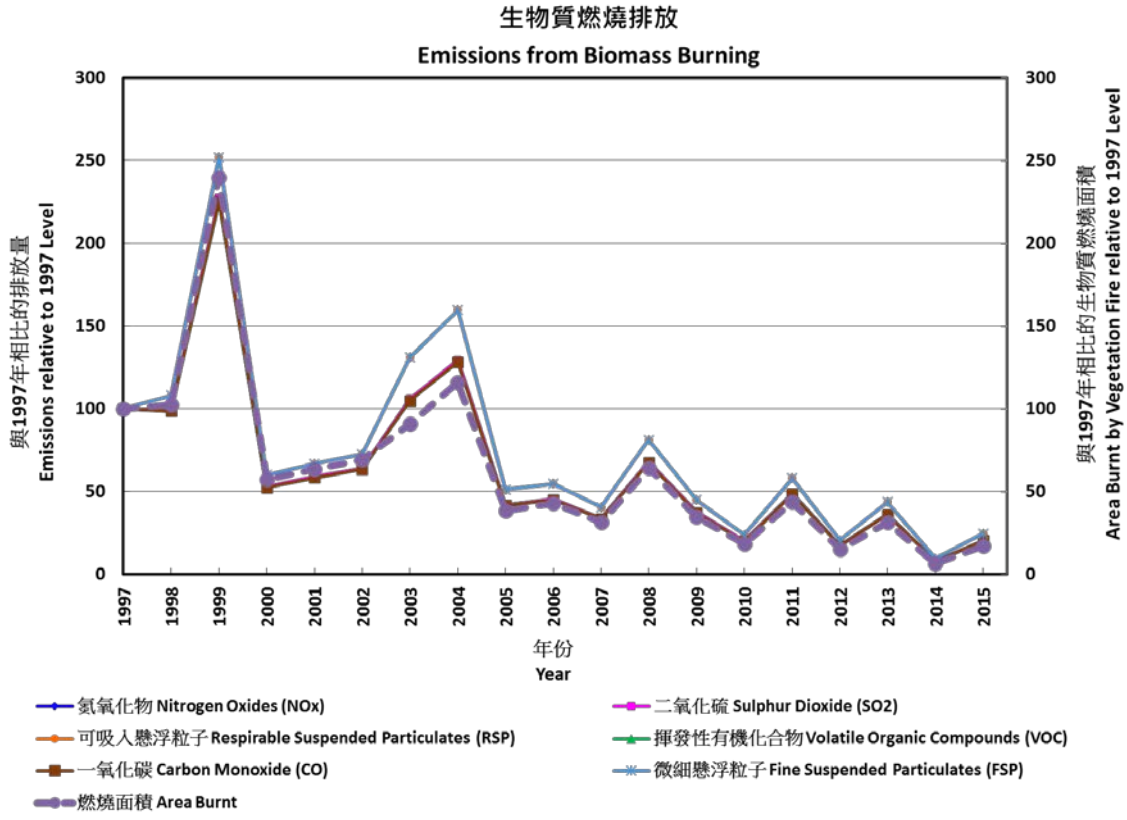


5.16 Non-combustion sources sector contributes considerably to local VOC emissions, accounting for 58% in 2015, whereas its contributions to local RSP and FSP emissions in 2015 were 17% and 11%, respectively. Overall, the emissions of the sector decreased by 45% to 72% from 1997 to 2015.

5.17 The use of paints, printing inks and associated solvents, and consumer products continued to be the major contributing sources for VOC in this sector, accounting for 82% of non-combustion sources VOC emissions in 2015. As compared with 2008, the VOC emissions from non-combustion sources decreased by 44% in 2015, thanks to 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 legal 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.

Sectoral analysis for "Biomass Burning"



5.19 Emissions from biomass burning accounted for less than 15% of the total local emissions of air pollutants in 2015. From 1997 to 2015, the area burnt due to biomass burning decreased by 83% and the emissions of FSP and RSP decreased by a similar extent.

5.20 The only contributing source in this sector is hill fires.

6 EMISSION REDUCTION PLAN UP TO 2020

6.1 Improving regional air quality in the Pearl River Delta (PRD) Region[1] has been one of the key areas in environmental collaboration between Hong Kong and Guangdong. The two governments endorsed the emission reduction targets/ranges up to 2020 at the 12th meeting of Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection held in November 2012.

6.2 Both sides started the 2015 Mid-term Review Study on air pollutant emission reduction in the PRD region and the Study on Finalising the Emission Reduction Targets for 2020 in order to assess the emission reductions in the PRD region for 2015 and conclude the emission reduction targets for 2020. It is expected that the studies will be completed around mid-2017.

Assessment results for 2015

6.3 Hong Kong fully met the 2015 emission reduction targets for the four major pollutants including SO_2, NOx, RSP and VOC. The emission reductions for these pollutants in 2015 ranged from 14% to 45% as compared with the emissions in 2010.

Table 1. Emission reduction results for Hong Kong in 2015.

Pollutant	Emissions[§] (Tonnes)		Actual Emission Reduction in 2015*	2015 Emission Reduction Targets*
	2010	2015		
SO_2	35,480	19,540	-45%	-25%
NOx	107,150	91,700	-14%	-10%
RSP	6,770	5,430	-20%	-10%
VOC	31,020	26,610	-14%	-5%

[§] All emission figures are rounded to the nearest ten.
* Reductions are relative to 2010 emission levels.

Emission reduction ranges for 2020

6.4 To achieve the emission reduction targets for Hong Kong in 2020, we have undertaken a number of enhanced measures with focus on the control of local pollution sources in recent years, which are explained in the ensuing paragraphs.

6.5 On reducing local vehicular emissions, we will continue to implement the incentive-cum-regulatory scheme to progressively phase out some 82 000 pre-Euro IV diesel commercial vehicles by the end of 2019, strengthen the emission control of petrol and liquefied petroleum gas vehicles using roadside remote sensing equipment, subsidise the franchised bus companies to retrofit about 1 100 Euro II and Euro III franchised buses with selective catalytic reduction devices and start tightening in stages the emission standard of newly registered vehicles to Euro VI from 1 July 2017.

6.6 On reducing vessel emissions, we introduced new regulations to cap the sulphur content of locally-supplied marine light diesel at 0.05 per cent in 2014 and mandate ocean-going vessels to switch to low sulphur fuel (with sulphur content not exceeding 0.5%) while at berth in 2015. In December 2015, the Ministry of Transport of the Mainland issued an Action Plan to establish three domestic emission control areas (DECA) including waters in the Pearl River

[1] PRD Region refers to the whole territory of HKSAR and the Pearl River Delta Economic Zone (PRDEZ). PRDEZ includes Guangzhou, Shenzhen, Zhuhai, Dongguan, Zhongshan, Foshan, Jiangmen, Huizhou and Zhaoqing.

Delta (PRD), the Yangtze River Delta, and the Bohai Rim (Beijing, Tianjin, Hebei). The Governments of Guangdong and Hong Kong will jointly promote the establishment of a DECA in the PRD waters to regulate emissions from marine vessels.

6.7 On reducing emissions from power plants, we will continue to require the power plants to adopt the best practicable means to reduce emissions and use more natural gas for electricity generation so as to meet the statutory emission caps imposed via TM. Besides, we will prepare for controlling the volatile organic compounds in fountain solutions and printing machine cleansing agents.

6.8 The above measures will help us to achieve the emission reduction targets for 2020 (Table 2) and to meet broadly the current Air Quality Objectives by 2020.

Table 2. Emission reduction ranges for Hong Kong in 2020.

Pollutant	**2020 Emission Reduction Range* (%)**
SO_2	-35% ~ -75%
NOx	-20% ~ -30%
RSP	-15% ~ -40%
VOC	-15%

* Relative to 2010 emission levels

- End -

Annex 1 – Breakdown of Emission Inventory by Source Categories from 2014 to 2015

Pollutant	Source Categories	Emissions (Tonnes)	
		2014	**2015**
SO_2	Public Electricity Generation	16,880	7,280
	Road Transport	40	40
	Navigation	13,990	11,460
	Civil Aviation	500	510
	Other Combustion	240	240
	Non-combustion	N/A	N/A
	Biomass Burning	0	10
	Total	**31,650**	**19,540**
NOx	Public Electricity Generation	36,210	26,090
	Road Transport	20,800	16,200
	Navigation	36,130	33,900
	Civil Aviation	5,040	5,000
	Other Combustion	10,440	10,450
	Non-combustion	N/A	N/A
	Biomass Burning	20	60
	Total	**108,640**	**91,700**
RSP	Public Electricity Generation	980	580
	Road Transport	690	490
	Navigation	2,100	1,860
	Civil Aviation	50	50
	Other Combustion	830	800
	Non-combustion	900	910
	Biomass Burning	280	740
	Total	**5,840**	**5,430**
FSP	Public Electricity Generation	450	290
	Road Transport	630	450
	Navigation	1,940	1,690
	Civil Aviation	50	50
	Other Combustion	760	740
	Non-combustion	470	470
	Biomass Burning	230	600
	Total	**4,530**	**4,300**

Pollutant	Source Categories	Emissions (Tonnes)	
		2014	**2015**
VOC	Public Electricity Generation	470	420
	Road Transport	4,900	4,800
	Navigation	3,830	4,160
	Civil Aviation	650	710
	Other Combustion	1,040	1,040
	Non-combustion	15,610	15,320
	Biomass Burning	60	160
	Total	**26,550**	**26,610**
CO	Public Electricity Generation	3,960	3,580
	Road Transport	30,700	29,700
	Navigation	12,660	13,280
	Civil Aviation	3,730	3,950
	Other Combustion	5,630	5,920
	Non-combustion	N/A	N/A
	Biomass Burning	660	1,720
	Total	**57,330**	**58,150**

Note: - All figures are rounded to the nearest ten.
- "N/A" denotes not applicable.
- "0" denotes data less than 5.
- There may be slight discrepancies between the sums of individual items and the totals 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, solvent usage for coatings and VOC-containing products, and survey data for marine paints to assess emissions from VOC-containing products.

5. Updates to the emission inventories since their first publication in March 2000 are summarized in the table below. Based on the latest updates, we have recalculated historical emission inventories from 1997 to 2013. Comparisons between the previous and recalculated inventories are shown in **Annex 3**.

Update Date	**Emission Inventory Revised**	**Revisions and Updates**
March 2000	1990-1998	• First publication of emission inventory for PM, SO_2, NOx, NMVOCs and CO from combustion sources at the EPD's website.
December 2000	1990-1999	• Amended emission inventory for Public Electricity Generation, Road Transport and Other Fuel Combustion sources.
December 2001	1990-2000	• Amended combustion sources emissions (including emission factors for VOC emissions from coal-fired electricity generation units, vehicle kilometer travel (VKT) for Road Transport, emission estimation methods for Navigation and Civil Aviation and surrogates for Other Fuel Combustion emissions).
February 2003	1990-2001	• Replaced Census and Statistics Department (C&SD) retained import data for fuel with Energy End-use data from Electrical and Mechanical Services Department (EMSD). • Amended VKT data.
June 2004	1990-2002	• Replaced emission estimated using emission factors with sophisticated EMFAC-HK model to estimate emissions from Road Transport. • Included additional emission sources for RSP and VOC. • Replaced 2000 to 2001 Public Electricity Generation emissions for SO_2, NOx and PM with data provided the power companies.
January to March 2005	1990-2003	• Amended 2000 to 2002 SO_2, NOx and PM emissions for Public Electricity Generation according to data provided by the power companies. • Updated emissions estimated using the EMFAC-HK model. • Amended 2001-02 emissions using Energy End-Use Data from EMSD. • Excluded Biogenic VOC emission sources from total VOC emission.
December 2005	1990-2004	• Amended 2002-03 emissions using Energy End-Use Data from EMSD. • Updated emission factors for VOC emissions from the printing industry.
December 2006	1990-2005	• Amended 2003 to 2004 SO_2, NOx and PM emissions for Public Electricity Generation according to data provided by the power companies. • Updated fuel use for vehicles to calculate 1998 to 2004 SO_2 emissions. • Updated emission factors for VOC emissions from the printing industry.

Update Date	Emission Inventory Revised	Revisions and Updates
January 2008	1990-2006	• Replaced Power Plant PM emissions with RSP emissions using emission factors from USEPA. • Updated emission factors for emission from non-road mobile equipment at the airport, container terminal and construction sites. • Included VOC emissions from evaporation of gasoline. • Included RSP emissions from tyre, brake and road wear. • Amended estimation method for VOC emissions from printing industry and fuel storage tanks. • Updated emission factors for Civil Aviation emission sources.
January 2009	1990-2007	• Used information collected from Government Departments and shipping industry to estimate emissions from local vessels. • Updated emission factors for emission from non-road mobile equipment at the airport and container terminal.
September 2012	1997-2010	• Based on the results from the Marine Emission Study report completed in 2012 to update emissions from Navigation. Additional information for fuel use and vessel activities were used to calculate the emission. • Used updated version of EMFAC-HK (version 2.1) for Road Transport emission estimation. • Used updated version of EDMS (version 5.1.3) for Civil Aviation emission estimation. • Included emissions from auxiliary power units of the aircrafts parking at the gates of the airport. • Used sales report data to calculate VOC emissions from products controlled under the VOC Regulation. • Used further local reported and survey data for VOC emission calculation. • Used new reported and survey results to calculate emissions from Other Fuel Combustion sources. • Included RSP emissions from construction sites and cooking; Included VOC emissions from storage of naphthalene, aviation fuel and use of cleaning solvents associated with paint use.
February 2013	1997-2011	• Used C&SD data to derive fuel consumption data for construction sector from 1997 to 2011. • Amended VOC emissions from architectural paints in 2010 due to a correction in the paint consumption data.

Update Date	Emission Inventory Revised	Revisions and Updates
January 2014	1997-2012	• We compiled the emission inventory of FSP as it is one of the major air pollutants stipulated in the new Air Quality Objectives (AQOs) which takes effect from 1 January 2014. • Emissions of OGVs during shifting between berthing locations were compiled since more detailed vessel activity data were collected from the Marine Department. • New surrogates for fuel consumption for the construction and industrial sectors were derived from C&SD data since the previously used Energy End-Use data from EMSD are no longer suitable after a major revision. • Having regard to the real world developments, the sulphur content of aviation fuel, duration of landing and take-off cycles of aircraft at Hong Kong International Airport and hence the air pollutant emissions from Civil Aviation sector have been updated. • Screen printing emissions were updated according to additional survey data to cover emissions in the application of screen printing inks on non-paper substrates, of which this type of inks was exempted from the VOC Regulation.
January 2015	2009-2012	• 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	1997-2014	• Emissions from asphalt production plants were estimated. • Emissions from Sludge Treatment Facility (STF) were estimated. • Emissions from landfill gas flaring were estimated. • Emissions from biomass burning 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	1997-2015	• 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.

Annex 3 – Comparison between the Previous and Recalculated Inventories from 1997 to 2014

Table A3-1. Changes in SO_2 emission inventories from 1997 to 2014

Year	SO_2 (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	82,330	82,340	0%
1998	87,390	88,170	1%
1999	72,660	73,360	1%
2000	79,830	80,410	1%
2001	81,820	81,900	0%
2002	79,860	79,940	0%
2003	104,980	105,050	0%
2004	108,830	108,890	0%
2005	98,340	98,320	0%
2006	87,360	87,360	0%
2007	79,860	79,850	0%
2008	69,470	69,470	0%
2009	62,600	62,590	0%
2010	35,490	35,480	0%
2011	32,180	32,150	0%
2012	32,740	32,710	0%
2013	31,460	31,440	0%
2014	31,710	31,650	0%

* Figures are rounded to the nearest ten.

Figure A3-1 SO_2 emissions trend from 1997 to 2014

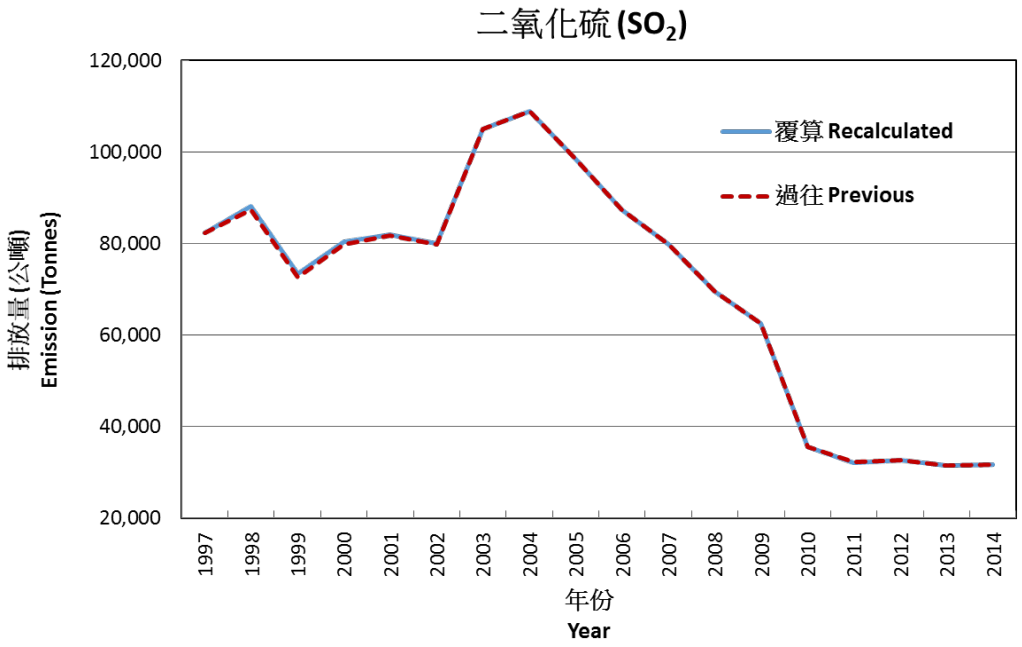


Table A3-2. Changes in NOx emission inventories from 1997 to 2014

Year	NOx (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	152,280	152,300	0%
1998	147,980	147,880	0%
1999	133,690	133,550	0%
2000	133,560	133,370	0%
2001	129,880	129,740	0%
2002	126,950	126,750	0%
2003	141,030	140,890	0%
2004	129,780	129,570	0%
2005	128,460	128,250	0%
2006	124,920	124,660	0%
2007	126,560	126,220	0%
2008	120,000	119,510	0%
2009	117,240	116,670	0%
2010	108,500	107,150	-1%
2011	115,540	114,760	-1%
2012	112,960	112,360	-1%
2013	113,440	112,570	-1%
2014	109,570	108,640	-1%

* Figures are rounded to the nearest ten.

Figure A3-2 NOx emission trend from 1997 to 2014

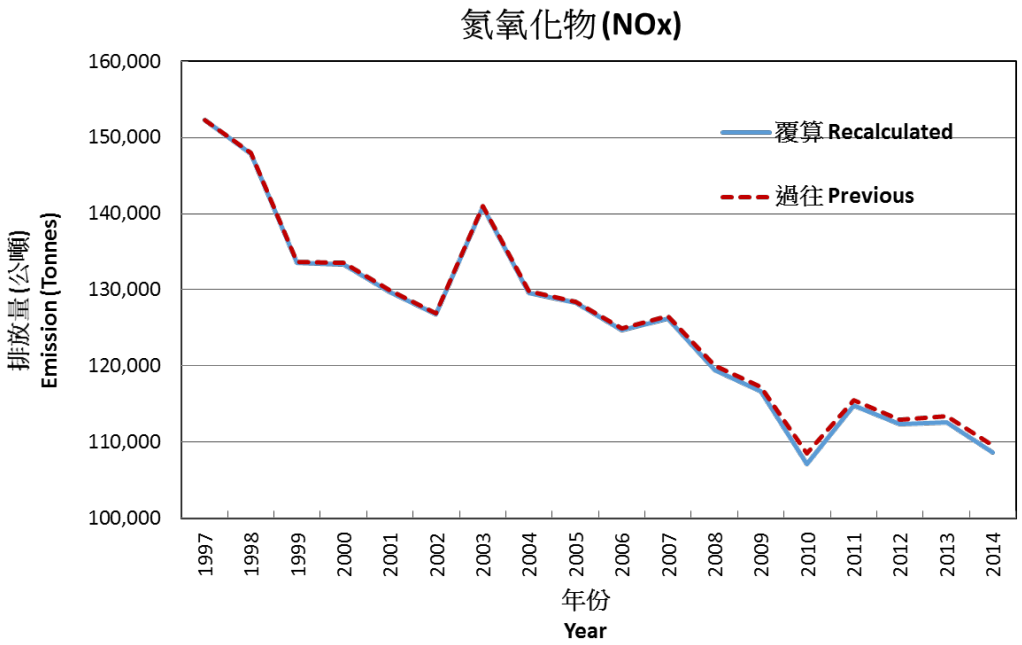


Table A3-3. Changes in RSP emission inventories from 1997 to 2014

Year	RSP (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	16,660	17,280	4%
1998	15,640	16,310	4%
1999	17,570	19,120	9%
2000	12,660	12,900	2%
2001	11,350	11,570	2%
2002	10,750	10,940	2%
2003	12,010	12,600	5%
2004	12,910	13,740	6%
2005	9,740	9,800	1%
2006	9,200	9,310	1%
2007	8,250	8,280	0%
2008	8,880	9,230	4%
2009	7,670	7,790	2%
2010	6,750	6,770	0%
2011	7,520	7,770	3%
2012	6,430	6,420	0%
2013	7,000	7,160	2%
2014	5,900	5,840	-1%

* Figures are rounded to the nearest ten.

Figure A3-3 RSP emission trend from 1997 to 2014

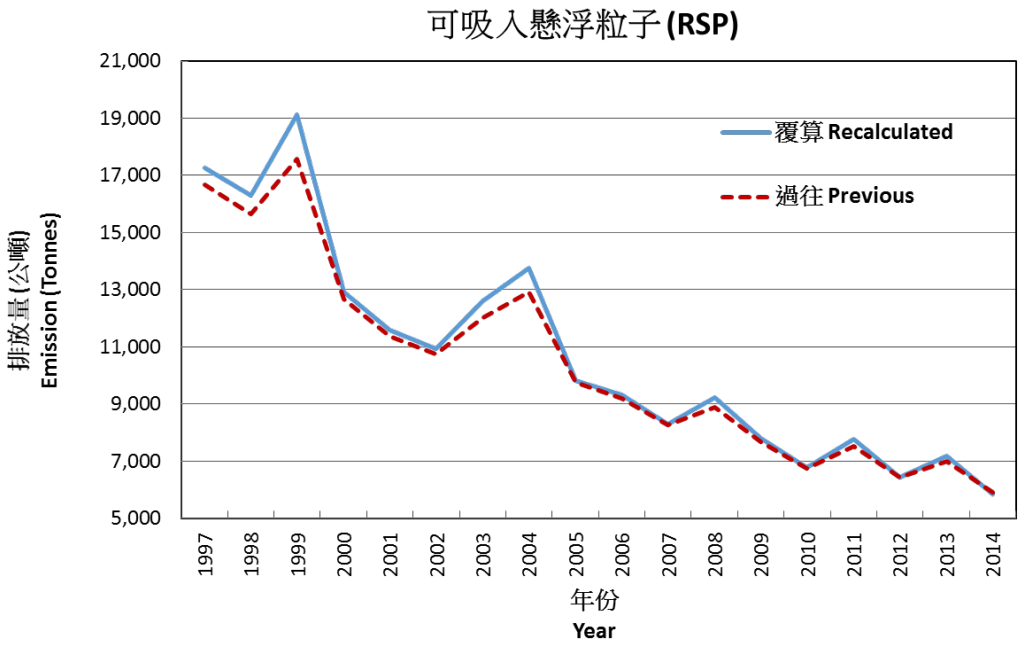


Table A3-4. Changes in FSP emission inventories from 1997 to 2014

Year	FSP (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	12,820	13,310	4%
1998	12,190	12,720	4%
1999	13,980	15,230	9%
2000	9,760	9,920	2%
2001	9,000	9,120	1%
2002	8,370	8,470	1%
2003	9,150	9,560	5%
2004	9,660	10,310	7%
2005	7,240	7,300	1%
2006	7,010	7,090	1%
2007	6,320	6,340	0%
2008	6,870	7,140	4%
2009	5,850	5,930	1%
2010	5,330	5,320	0%
2011	5,970	6,150	3%
2012	5,060	5,040	0%
2013	5,530	5,650	2%
2014	4,600	4,530	-1%

* Figures are rounded to the nearest ten.

Figure A3-4 FSP emission trend from 1997 to 2014

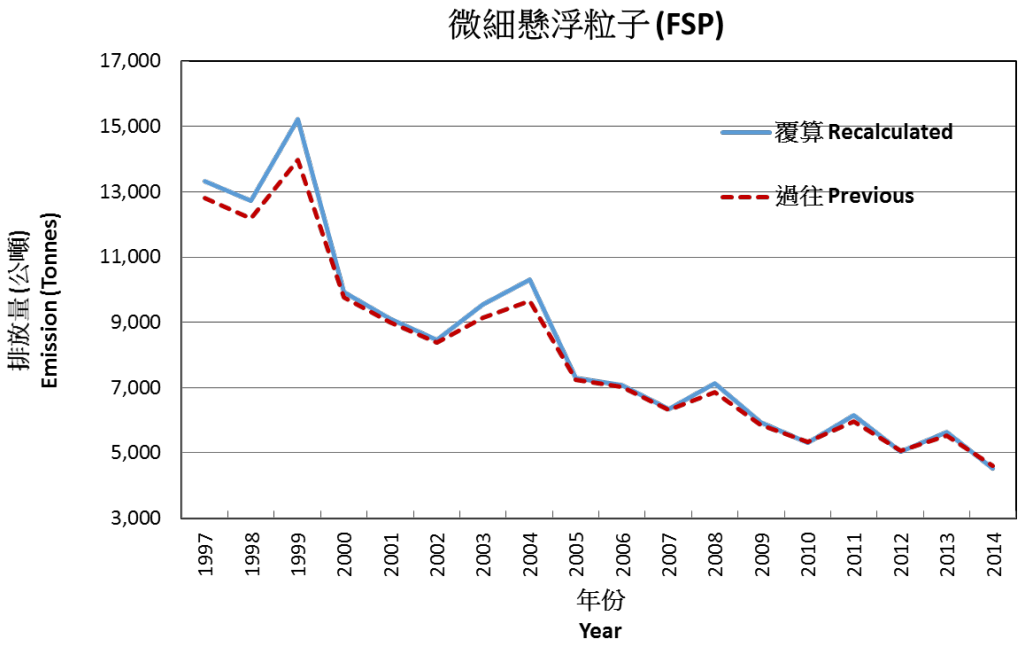


Table A3-5. Changes in VOC emission inventories from 1997 to 2014

Year	VOC (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	76,890	76,510	0%
1998	70,090	69,690	-1%
1999	64,470	64,040	-1%
2000	60,120	59,580	-1%
2001	52,830	52,360	-1%
2002	48,640	48,140	-1%
2003	47,640	47,150	-1%
2004	48,200	47,840	-1%
2005	44,510	44,240	-1%
2006	42,710	42,350	-1%
2007	41,430	40,990	-1%
2008	40,640	40,110	-1%
2009	34,570	33,940	-2%
2010	31,560	31,020	-2%
2011	31,480	30,780	-2%
2012	29,390	28,860	-2%
2013	28,830	28,580	-1%
2014	27,020	26,550	-2%

* Figures are rounded to the nearest ten.

Figure A3-5 VOC emission trend from 1997 to 2014

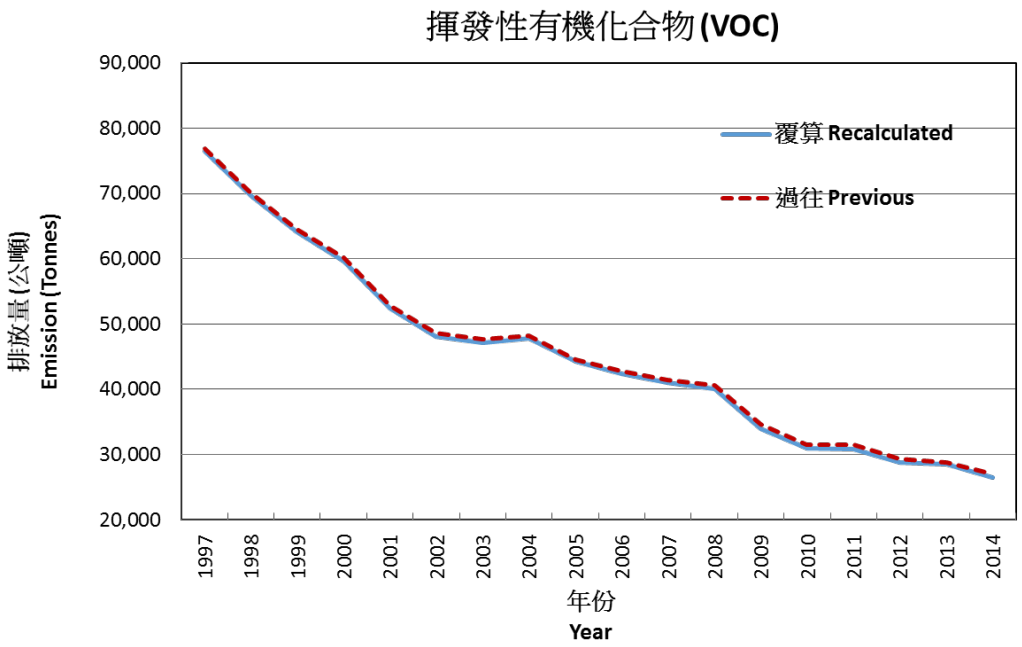
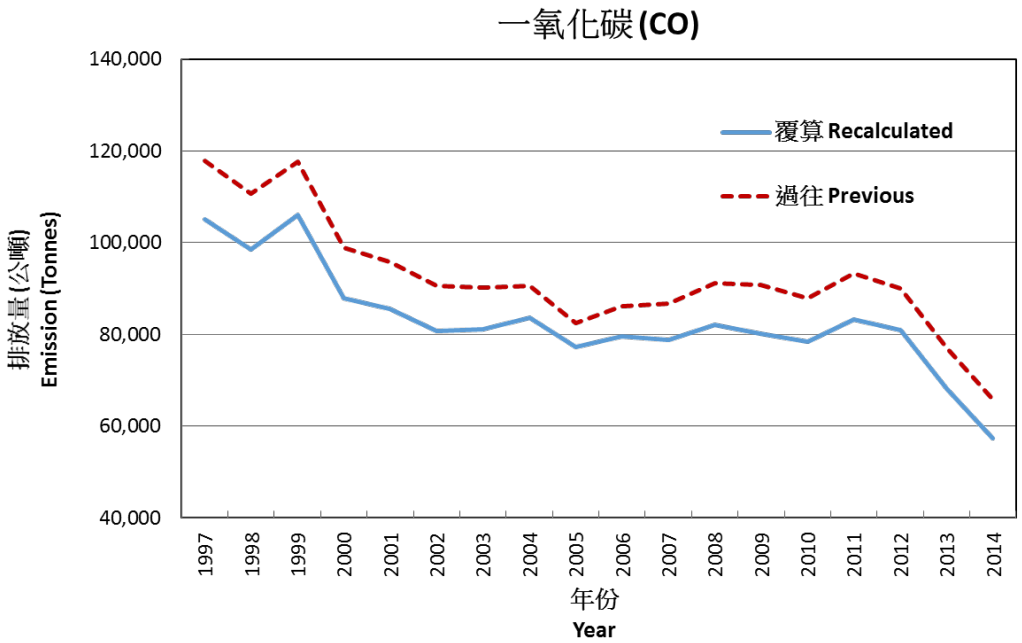


Table A3-6. Changes in CO emission inventories from 1997 to 2014

Year	CO (Tonnes)		
	Previous*	Recalculated*	% Changes
1997	117,880	105,130	-11%
1998	110,730	98,530	-11%
1999	117,610	105,950	-10%
2000	98,970	87,920	-11%
2001	95,800	85,480	-11%
2002	90,510	80,740	-11%
2003	90,140	81,050	-10%
2004	90,610	83,640	-8%
2005	82,390	77,200	-6%
2006	86,150	79,630	-8%
2007	86,610	78,750	-9%
2008	91,230	82,070	-10%
2009	90,820	80,120	-12%
2010	87,820	78,490	-11%
2011	93,230	83,250	-11%
2012	90,030	80,850	-10%
2013	76,990	68,120	-12%
2014	65,930	57,330	-13%

* Figures are rounded to the nearest ten.

Figure A3-6 CO emission trend from 1997 to 2014[§]



[§] The large discrepancies between recalculated and previous emission inventories for CO arose from the use of the updated version of EMFAC-HK (version 3.3).