2012 Hong Kong Emission Inventory Report

Report Number	:	EPD/TR X/14
Report Prepared by	:	C. C. Chang
Work Done by	:	Air Science Group
Checked by	:	Brian Lau
Approved by	:	S. W. Pang
Security Classification	:	Unrestricted

Air Science Group

•

Environmental Protection Department

•

The Government of the Hong Kong Special Administrative Region

March 2014

CONTENT

1 INTRODUCTION

1.1 The emission inventory for Hong Kong was first uploaded to EPD's website in March 2000. Emission inventory provides essential information on the levels of air pollutant emissions for the formulation of air quality management strategy. It helps assess the effectiveness of emission control measures that are in implementation, identify areas where control actions should be stepped up, support air quality impact modeling and assessment, etc.

1.2 This report presents the 2012 Hong Kong emission inventory. Section 3 shows a breakdown of emissions into various emission source categories. Changes made in the compilation methodology of 2012 emission inventory are elaborated in Section 4 and a comparison between the historical and recalculated emission inventories is presented in Section 6. Emission trends from 1997 to 2012 are described in Section 5.

2 SCOPE OF EMISSION INVENTORY

2.1 The emission inventory comprised six major air pollutants, namely: sulphur dioxide (SO_2), nitrogen oxides (NOx), respirable suspended particulates (RSP), fine suspended particulates (FSP or $PM_{2.5}$), volatile organic compounds (VOC), and carbon monoxide (CO).

2.2 Emissions are compiled for specific source categories including power electricity generation, road transport, navigation, civil aviation, other fuel combustion sources and non-combustion sources.

3 2012 EMISSION INVENTORY

3.1 The table below shows the emission inventory for 2012 under different emission source categories including public electricity generation, road transport, navigation, civil aviation, other fuel combustion sources and non-combustion sources. **Annex 1** shows a breakdown of emissions into various emission sources in 2011 and 2012.

Breakdown of 2012 Emission Inventory

Pollution Sources	**SO_2**	**NOx**	**RSP**	**FSP**	**VOC**	**CO**
Public Electricity Generation	15,500	32,000	960	448	442	3,890
Road Transport	50	30,700	1,200	1,100	7,420	44,100
Navigation	16,500	36,500	2,250	2,080	3,480	11,800
Civil Aviation	510	5,870	61	61	563	3,060
Other Fuel Combustion	190	9,410	723	667	917	5,410
Non-combustion	N/A	N/A	939	479	19,400	N/A
Total Emission (Tonnes)	32,700	115,000	6,130	4,840	32,200	68,300

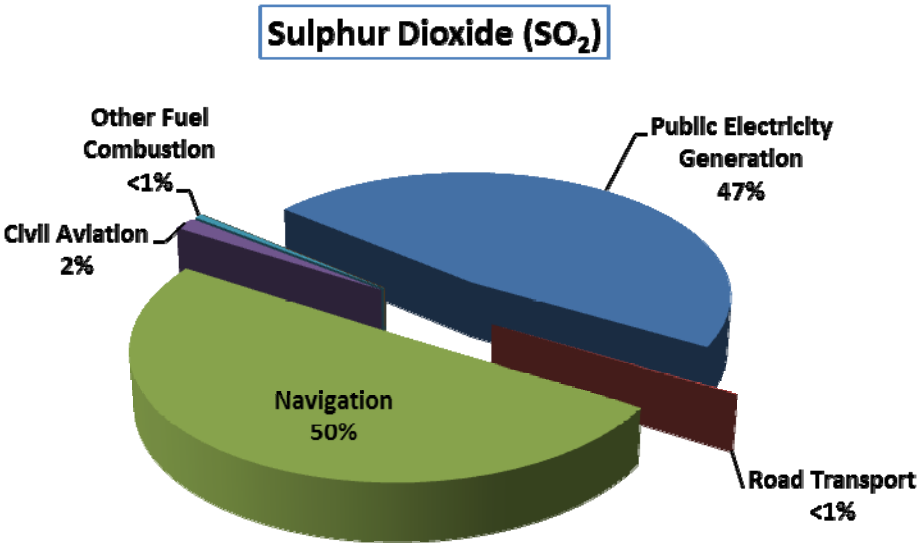
Note: All figures were rounded to three significant figures.
N/A denotes Not applicable

3.2 In 2012, the major emission sources of SO_2 were navigation and public electricity generation, accounting for 50% and 47% of the total emission respectively. For NOx, the major emitters were navigation (32%), public electricity generation (28%) and road transport (27%). RSP were mainly emitted from navigation (37%), road transport (20%), public electricity generation (16%), non-combustion sources (15%) and other fuel combustion sources (12%). FSP were mainly emitted from navigation (43%), road transport (23%) and other fuel combustion sources (14%). The major emission sources of VOC included non-combustion sources (60%), road transport (23%) and navigation (11%). For CO, the major sources were road transport (65%) and navigation (17%).

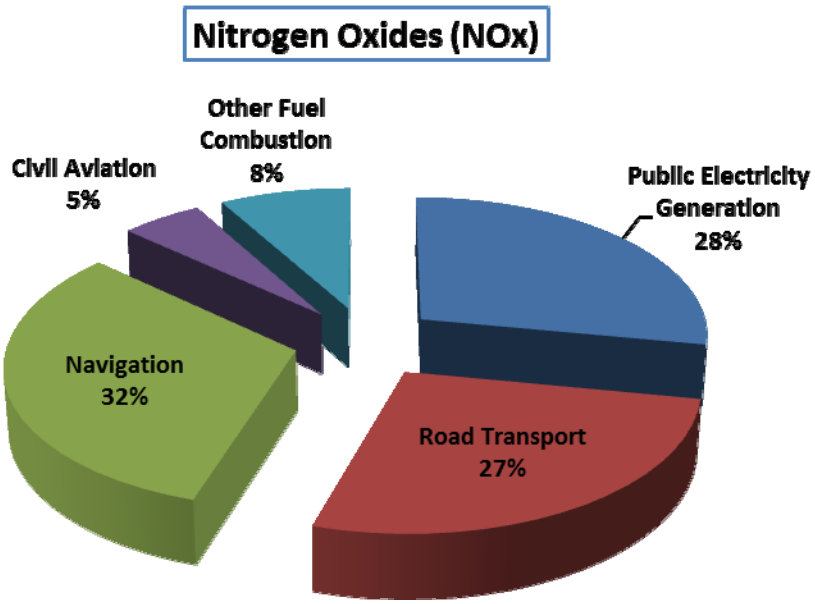
3.3 Emission benefits due to the Fair Winds Charter (FWC) and the Incentive Scheme were taken into account in the compilation of the 2012 emission inventory. The FWC was an industry-led voluntary ship emissions reduction scheme launched by shipping companies in January 2011 for two years to encourage ocean-going vessels at berth in Hong Kong to use low sulphur diesel with 0.5% sulphur. In January 2013, the shipping companies have extended the FWC for another year till end 2013. The Incentive Scheme was a 3-year scheme launched by EPD in September 2012 to reduce by half the port facilities and light dues charged on ocean-going vessels (OGVs) using fuel with sulphur content not more than 0.5% when at berth in Hong Kong.

3.4 The following pie charts show a breakdown of emissions for each pollutant in 2012 by source categories.

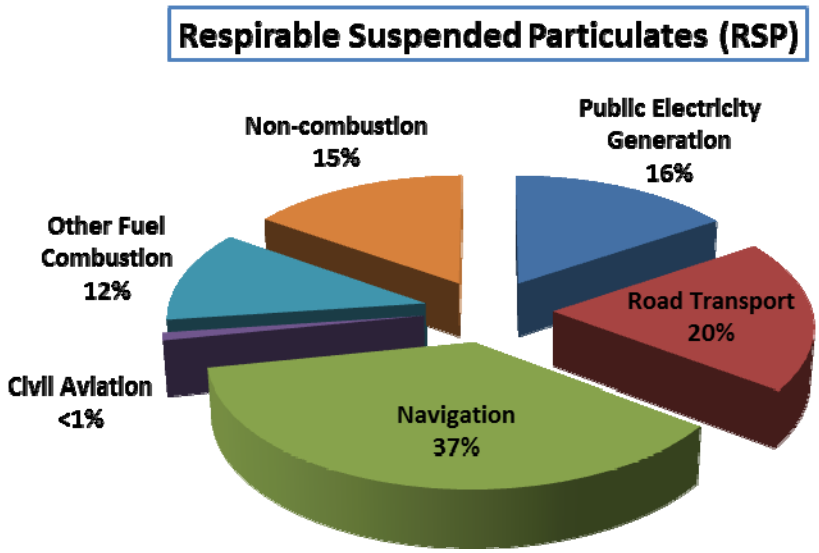
Total SO_2 emission = 32,700 Tonnes



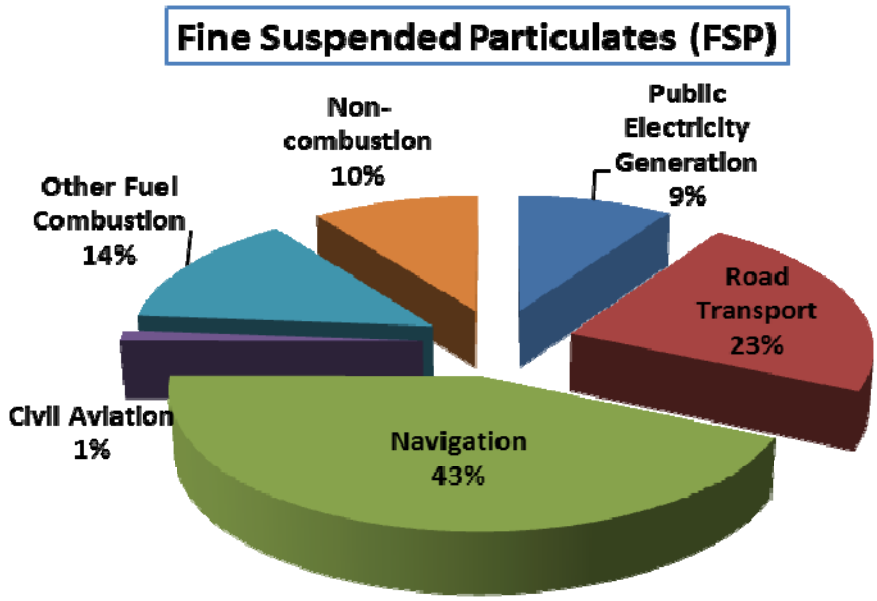
Total NOx emission = 115,000 Tonnes



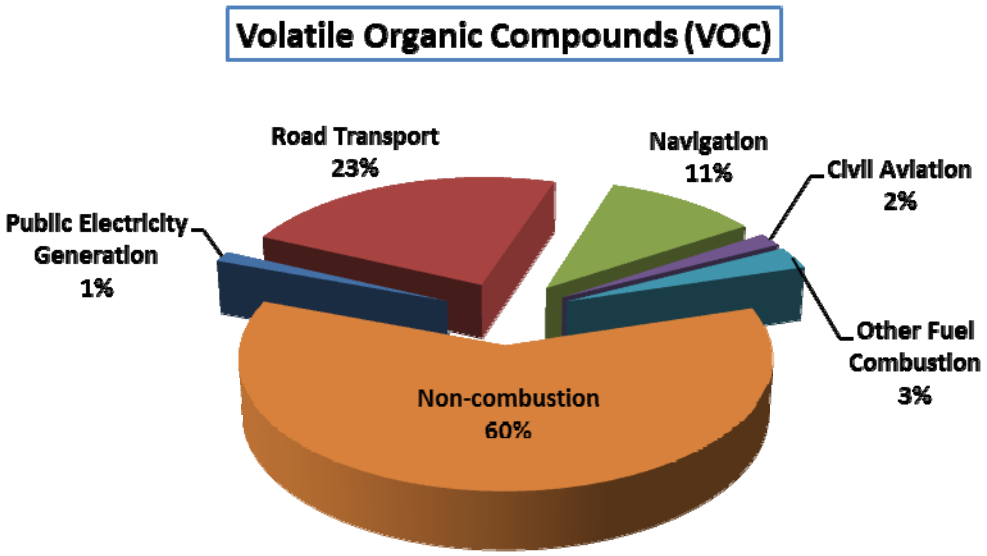
Total RSP emission = 6,130 Tonnes



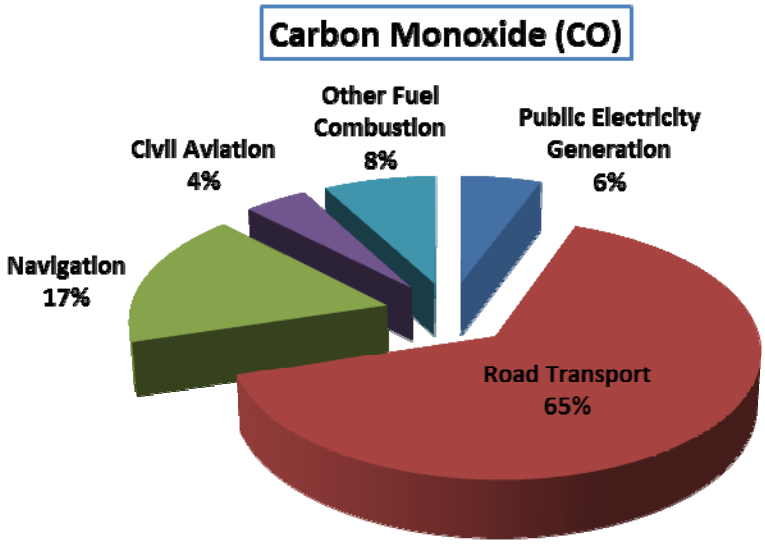
Total FSP emission = 4,840 Tonnes



Total VOC emission = 32,200 Tonnes



Total CO emission = 68,300 Tonnes



4 UPDATE OF EMISSION INVENTORY

4.1 Making reference to international developments and technological advancement, we have been updating the methodologies to compile emission inventory 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 inventory for past years as far as practicable based on the updated methods and data to enable meaningful emission trend analysis to be made.

4.2 Recalculation of historical emission inventory is widely adopted by environmental agencies such as European Environmental Agency of the European Community, California Air Resources Board (USA), 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.

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

Major updates to the emission inventory 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 inventory for marine vessels. The updated emissions from vessels were higher than the previous ones.

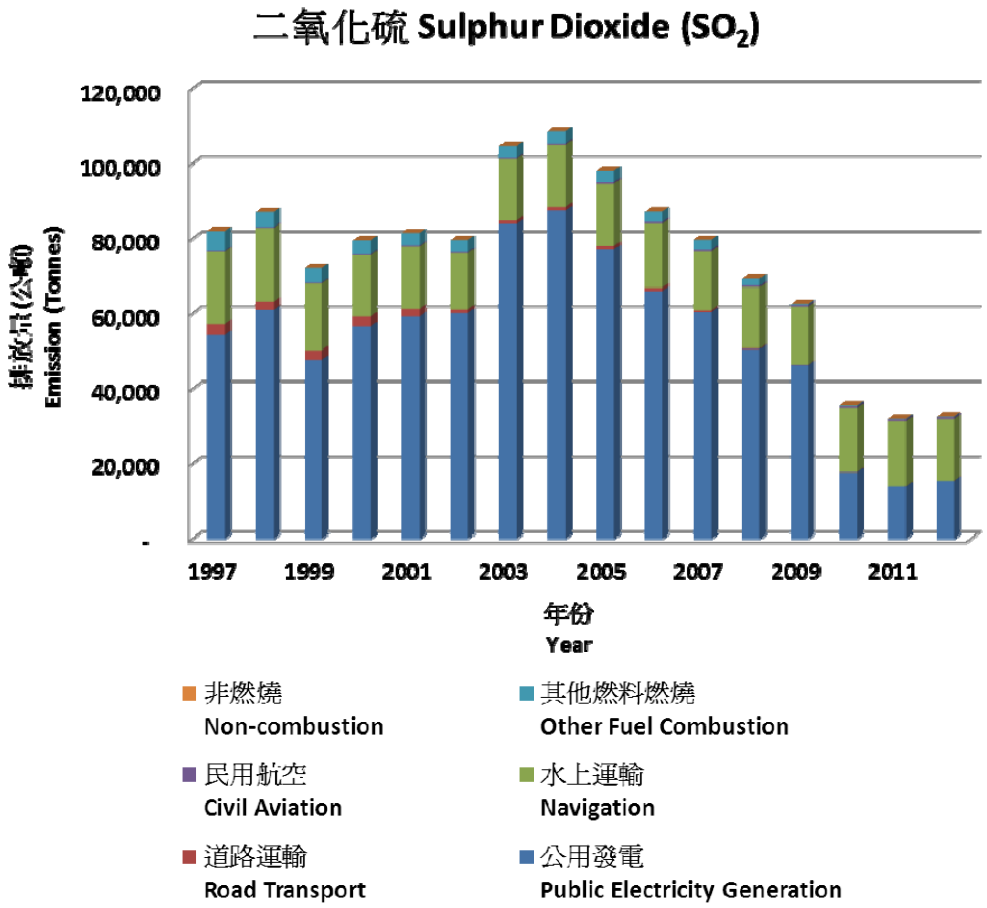
ii. EPD have been conducting emission measurements for on-road vehicles by means of remote sensing equipment and advanced portable emission measurement systems (PEMS). The measurements have provided a more robust basis for us to estimate vehicle emissions. They have also found that vehicles with inadequate 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, paints, adhesives and sealants. In 2012, we adopted sales report data of vehicle refinishing and marine paints (vessels and pleasure craft paints) to compile the VOC emissions since their VOC contents were regulated in April 2012.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.

4.4 Updates to the 2012 emission inventory , methodology, assumptions and emission data over the years are summarized in **Annex 2**.

5 EMISSION TRENDS FROM 1997 TO 2012

SO_2 Emission Trend



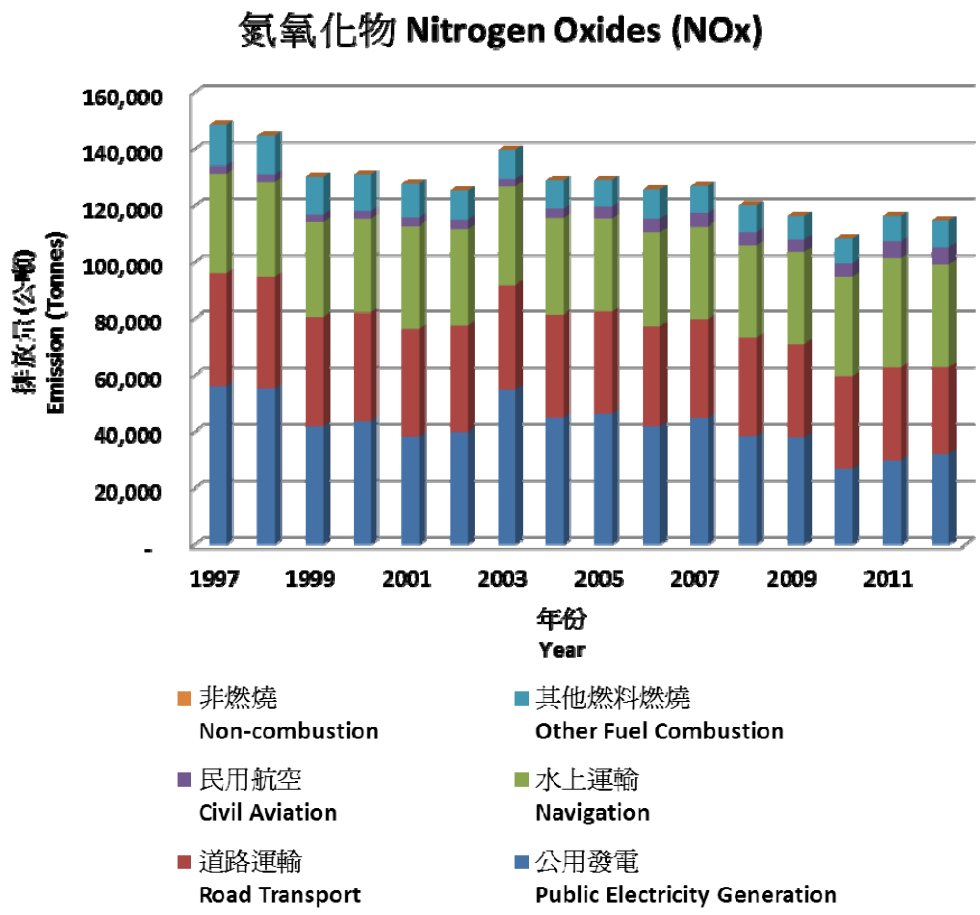
5.1 Subsequent to the control on land-based emission sources including tightening the emission caps of power plants and fuel standards for vehicles, industrial and commercial sectors over the past years, marine vessels became the largest emission source of SO_2 in 2012, accounting for 50% of the total SO_2 emission. Most ocean-going vessels (OGVs) nowadays burn heavy fuel oil while cruising and berthing with high sulphur content up to a maximum of 3.5%.

5.2 Public electricity generation is also a major emission source of SO_2. It contributed about 47% of Hong Kong's total emission in 2012. Since 2005, we have imposed on power plants statutory emission caps and have progressively tightened the caps over time with the latest caps promulgated in October 2012 for effective starting 2017. To meet the caps, power companies have to increase the use of clean fuel including natural gas and low emission coal and prioritize the use of coal-fired generation units equipped with flue gas desulphurization (FGD) units. As a result, SO_2 emissions from power plants had been substantially reduced by 80%, from 77,100 tonnes in 2005 to 15,500 tonnes in 2012. Meanwhile, there is slight increase in SO_2 emissions from power plants in 2012 due to a shortfall in the supply of natural gas and variations in the quality of coal and performance of control equipment.

5.3 The use of cleaner fuel with lower sulphur content has substantially reduced emissions from fuel combustion processes. Since December 2007, SO_2 emissions from vehicles had been substantially reduced after the introduction of Euro V diesel, whose sulphur content is capped at 0.001%.

5.4 The cap on the sulphur content of diesel used in industrial and commercial sectors was tightened in October 2008 from 0.5% by weight to 0.005% (i.e. the level of ultra-low sulphur diesel). According to the Census and Statistics Department (C&SD), ultra-low sulphur diesel (ULSD) was imported to Hong Kong until December 2008, whereas only Euro V diesel, whose sulphur content is capped at 0.001%, was imported to Hong Kong since January 2009. Hence, industrial sector and construction had been using Euro V diesel since 2009.

NOx Emission Trend



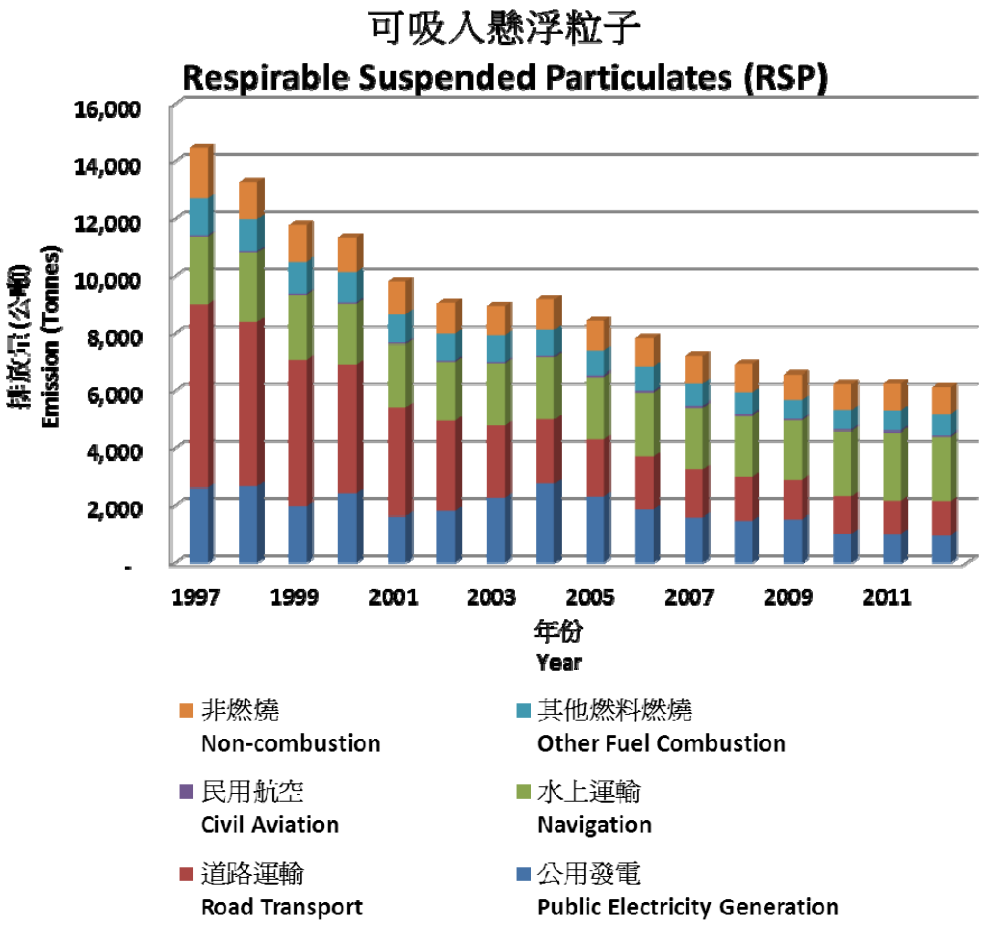
5.5 Subsequent to the implementation of control measures to reduce emissions from power plants and vehicles over the past years, marine vessels became the largest NOx emission source and accounted for 32% of the total emission in 2012. The decrease in NOx from marine vessels in 2012 was due to the decrease in ocean-going vessel arrival numbers by 6% and container throughput by 5%, as compared with 2011.

5.6 Public electricity generation was also a major NOx emitter. It contributed to 28% of the total NOx emission in 2012. Since 2005, we have imposed on power plants statutory emission caps and have progressively tightened the caps over time with the latest caps promulgated in October 2012 for effective starting 2017. To meet the emission caps, the power companies have to increase the use of natural gas and low emission coal and

prioritize the use of coal-fired generation units equipped with NOx abatement devices. As a result of the emission caps, NOx emissions from power plants had been reduced by 31%, i.e. from 46,400 tonnes in 2005 to 32,000 tonnes in 2012. Meanwhile, there is slight increase in NOx emissions from power plants in 2012 due to a shortfall in the supply of natural gas and variations in the quality of coal and performance of control equipment.

5.7 Vehicles were also a major NOx emission source. Their NOx emission accounted for 27% of the total emission in 2012 and has a direct impact on roadside air quality. Over the years, vehicle emission standards had been progressively tightened from Euro III in 2001 to Euro V in 2012. To reduce the emissions, we are taking forward control measures including enacting a new legislation to phase out pre-Euro IV diesel commercial vehicles, retrofitting Euro II and Euro III franchised buses with selective catalytic reduction devices, strengthening the inspection and maintenance of petrol and liquefied petroleum gas vehicles and encouraging a wider use of environment-friendly vehicles.

RSP Emission Trend



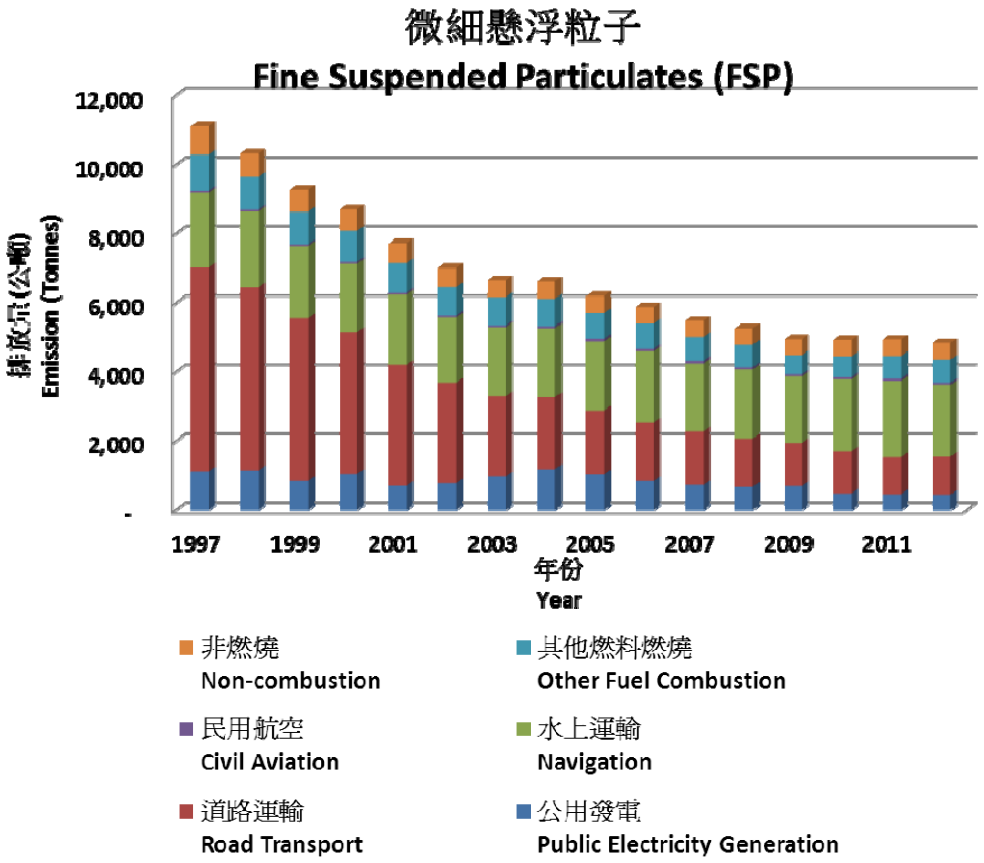
5.8 Most ocean-going vessels (OGVs) nowadays burn heavy fuel oil while cruising and berthing and emit a significant amount of RSP. Subsequent to the implementation of control measures to reduce emissions from power plants and vehicles over the past years, marine vessels became the largest RSP emission source and accounted for 37% of the total emissions in 2012.

5.9 Road transport is also a major RSP emission source. RSP emission from vehicles accounted for 20% of the total emission in 2012. To reduce the emissions, vehicle emission standards had been progressively tightened from Euro III in 2001 to Euro V in 2012. We are

taking forward a new legislation to phase out pre-Euro IV diesel commercial vehicles and a programme to encourage a wider use of environment-friendly vehicles to further reduce the emissions.

5.10 Public electricity generation is also a major RSP emitter. It contributed about 16% of total RSP emission in 2012. Since 2005, we have imposed on power plants statutory emission caps and have progressively tightened the caps over time with the latest caps promulgated in October 2012 for effective starting 2017. To meet the emission caps for RSP, the power companies have to increase the use of natural gas and low emission coal in electricity generation and prioritize the use of coal-fired generation units equipped with emission control devices. RSP emissions from power plants had been reduced by 59%, i.e. from 2,320 tonnes in 2005 to 960 tonnes in 2012.

FSP Emission Trend



5.11 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. FSP refers to suspended particles in air with a nominal aerodynamic diameter of 2.5 micrometers or less, and is a fraction of RSP.

5.12 Most ocean-going vessels (OGVs) nowadays burn heavy fuel oil while cruising and berthing and emit a significant amount of FSP. Subsequent to the implementation of control measures to reduce emissions from power plants and vehicles over the past years, marine vessels became the largest FSP emission source and accounted for 43% of the total emissions in 2012.

5.13 Road transport is also a major FSP emission source. FSP emission from vehicles accounted for 23% of the total emission in 2012. To reduce the emissions, vehicle emission standards had been progressively tightened from Euro III in 2001 to Euro V in 2012. We are

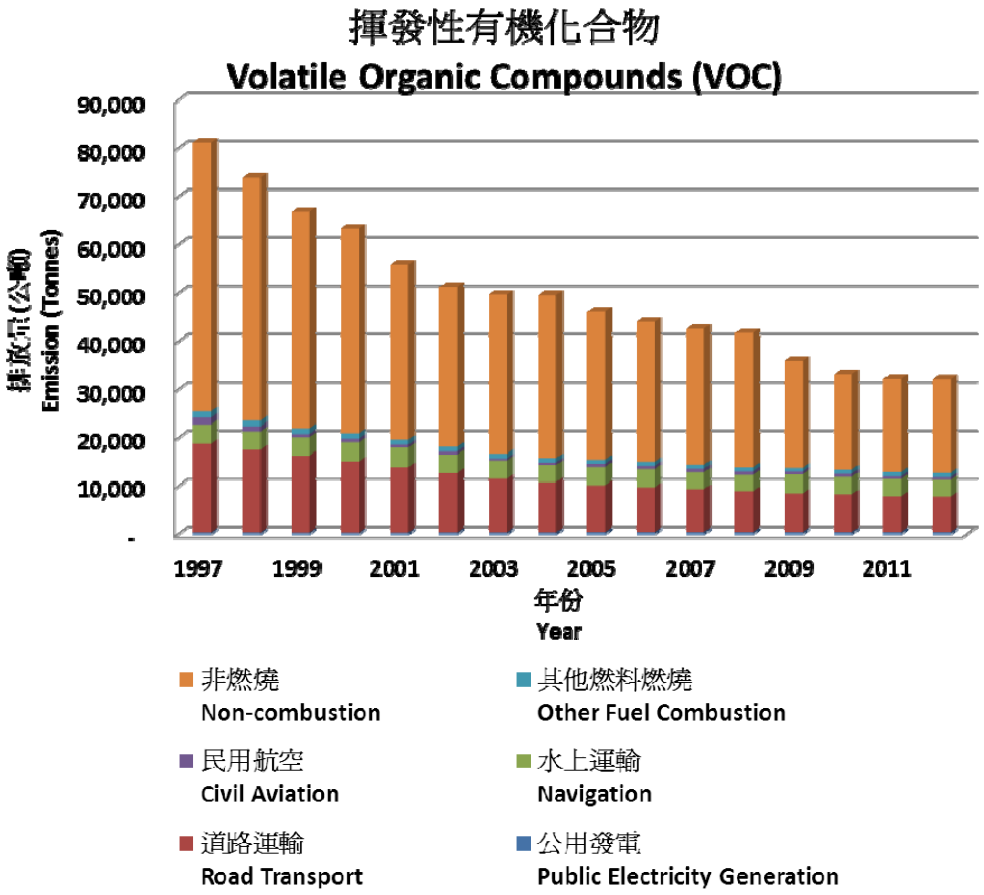
taking forward a new legislation to phase out pre-Euro IV diesel commercial vehicles and a programme to encourage a wider use of environment-friendly vehicles to further reduce the emissions.

5.14 Public electricity generation used to be a major source of FSP emission. With the increase use of natural gas and low emission coal in electricity generation and the retrofit of emission control devices at coal-fired generation units, FSP emissions from power plants had been reduced significantly by 57% from 1,039 tonnes in 2005 to 448 tonnes in 2012. FSP emissions from power plants accounted for only 9% of the total FSP emissions in 2012.

5.15 Other fuel combustion was one of the FSP emission sources accounting for 14% of the total emission in 2012. Major contributing activities included emissions from non-road mobile equipment in construction sites and container terminals.

5.16 The methodology and key assumptions for estimating the FSP emissions are summarized in **Annex 3.**

VOC Emission Trend

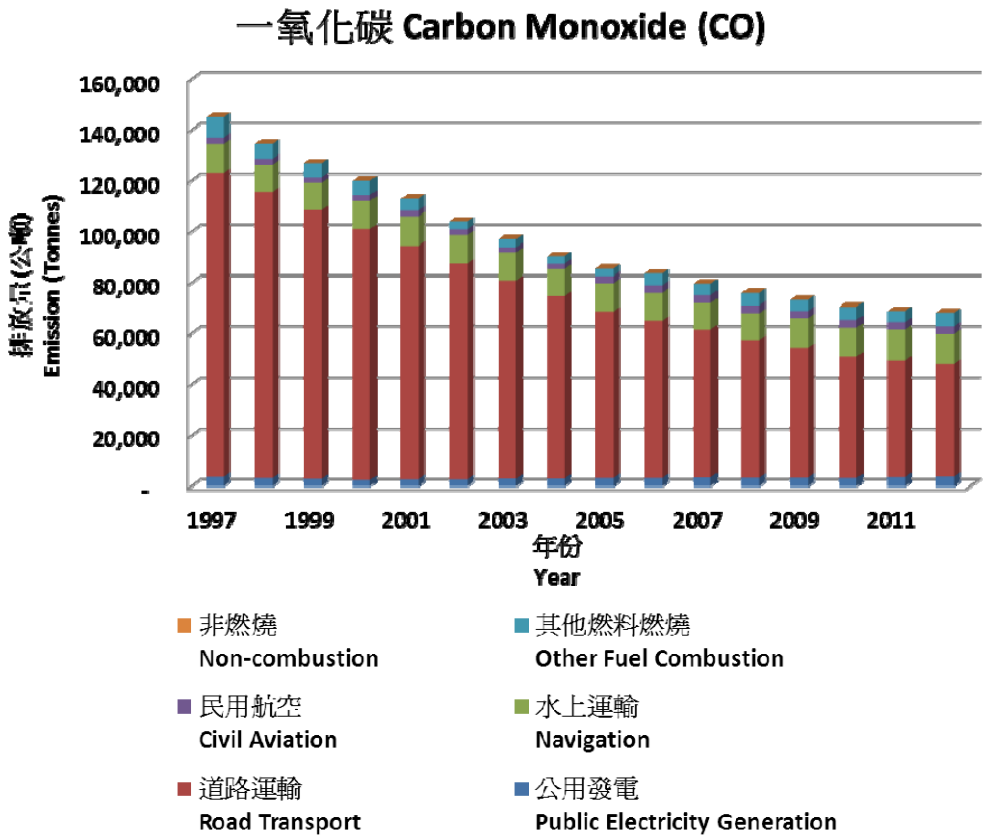


5.17 VOCs play a significant role in the formation of ozone and fine particulates in the atmosphere causing smog and visibility impairment. To reduce VOC emissions, the Air Pollution Control (Volatile Organic Compounds) Regulation introduced in April 2007 and amended in 2009 prohibits the import and 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 six 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. In

2012, the three major types of regulated products including paints, printing and consumer products contributed to about 51% of the total VOC emissions.

5.18 Road transport is also a major VOC emission source, contributing to 23% of total VOC emission in 2012. The introduction of the evaporative emission standard for newly registered vehicles in 1999 and the progressive tightening of vehicle emission standards from Euro III in 2001 to Euro V in 2012 had reduced the VOC emission from petrol vehicles. We are taking forward a new legislation to phase out pre-Euro IV diesel commercial vehicles and a programme to encourage a wider use of environment-friendly vehicles to further reduce the emissions.

CO Emission Trend



5.19 Road transport is a major CO emission source, contributing to 65% of total CO emission in 2012. The progressive tightening of vehicle emission standards from Euro III in 2001 to Euro V in 2012 had significantly reduced the CO emission. We are taking forward control measures including strengthening the inspection and maintenance of petrol and liquefied petroleum gas vehicles, phasing out pre-Euro IV diesel commercial vehicles and encouraging a wider use of environment-friendly vehicles to help reduce CO emissions.

6 COMPARISON OF PREVIOUS AND RECALCULATED EMISSION INVENTORY

6.1 Based on the updates mentioned in Section 4.4, we have recalculated historical emission inventories from 1997 to 2011. Comparisons between the previous and recalculated inventories are shown in **Annex 4**.

7 EMISSION REDUCTION PLAN UP TO 2020

7.1 The Hong Kong SAR and Guangdong Provincial Governments have long been collaborating to improve air quality in the Pearl River Delta (PRD) Region[1]. Over the past years, the two Governments reduced significantly the emissions of four major pollutants, namely SO_2, NOx, RSP and VOC. At the meeting of Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection held in November 2012, both sides endorsed a new set of emission reduction targets/ranges up to 2020, using 2010 as the base year (details in **Annex 5**). Both sides will implement additional pollution control measures on this basis for bringing continuous improvement to the regional air quality.

7.2 To achieve the emission targets set for 2015 and 2020, Hong Kong will implement the following key measures:

- tightening vehicle emission standards;
- phasing out pre-Euro IV diesel commercial vehicles;
- retrofitting Euro II and Euro III franchised buses with selective catalytic reduction devices;
- strengthening inspection and maintenance of petrol and liquefied petroleum gas vehicles;
- requiring ocean-going vessels to switch to low sulphur fuel while at berth;
- tightening the cap on the sulphur content of locally supplied marine diesel;
- controlling emissions from off-road mobile machinery;
- further tightening the emission caps on power plants; and
- controlling VOC contents of solvents used in printing and construction industry.

7.3 The changes in emissions in 2012 compared with emissions in 2010 in Hong Kong are shown in the following table.

Table 7-1 Changes in emissions between 2010 and 2012

Pollutant	**Emissions（Tonnes）**			**2015 Emission Reduction Targets**
	2010	**2012**	**Change in Emission**	
SO_2	35,500	32,700	-8%	-25%
NOx	108,000	115,000	+6%	-10%
RSP	6,250	6,130	-2%	-10%
VOC	33,200	32,200	-3%	-5%
Note: Emission figures are presented in 3 significant figures.				

7.4 Compared with 2010, the slight increase in NOx emission in 2012 were mainly due to the shortfall in the supply of natural gas in electricity generation and the increase in aviation and construction activities.

- End -

[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 (Huicheng, Huiyang, Huidong, Boluo), and Zhaoqing (Duanzhou, Dinghu, Gaoyao, Sihui).

Annex 1 – Breakdown of Emission Inventory by Source Categories from 2011 to 2012

Pollutant	Source Categories	2011	2012
SO_2	Public Electricity Generation	14,000	15,500
	Road Transport	51	50
	Navigation	17,400	16,500
	Civil Aviation	499	510
	Other Fuel Combustion	156	190
	Non-combustion	N/A	N/A
	Total	**32,100**	**32,700**
NOx	Public Electricity Generation	30,000	32,000
	Road Transport	32,700	30,700
	Navigation	38,900	36,500
	Civil Aviation	5,770	5,870
	Other Fuel Combustion	8,930	9,410
	Non-combustion	N/A	N/A
	Total	**116,000**	**115,000**
RSP	Public Electricity Generation	998	960
	Road Transport	1,170	1,200
	Navigation	2,390	2,250
	Civil Aviation	65	61
	Other Fuel Combustion	707	723
	Non-combustion	942	939
	Total	**6,270**	**6,130**
FSP	Public Electricity Generation	461	448
	Road Transport	1,070	1,100
	Navigation	2,210	2,080
	Civil Aviation	65	61
	Other Fuel Combustion	659	667
	Non-combustion	480	479
	Total	**4,940**	**4,840**
VOC	Public Electricity Generation	447	442
	Road Transport	7,450	7,420
	Navigation	3,630	3,480
	Civil Aviation	520	563
	Other Fuel Combustion	905	917
	Non-combustion	19,300	19,400
	Total	**32,300**	**32,200**
CO	Public Electricity Generation	3,720	3,890
	Road Transport	45,700	44,100
	Navigation	12,100	11,800
	Civil Aviation	2,980	3,060
	Other Fuel Combustion	4,540	5,410
	Non-combustion	N/A	N/A
	Total	**69,000**	**68,300**

* Figures are rounded to three significant figures.
N/A denotes Not applicable.

Annex 2 – Summary of Updates to the Emission Inventory

There are 6 major emission sources included in the emission inventory, namely, Public Electricity Generation, Road Transport, Navigation, Civil Aviation, Other Fuel Combustion and Non-Combustion sources. The table below summarizes the updates of the emission inventory since its first publication in March 2000.

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 emission 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 C&SD retained import data for fuel with Energy End-use data from EMSD. • Amended vkt data.
June 2004	1990-2002	• Replaced emission estimated using emission factors with sophisticated EMFAC 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 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.
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 activities were used to calculate the emission. • Amended emission factors for NOx emission from vehicles using data collected from PEMS. • Used updated version of EMFAC (version 2.1) for Road Transport emission estimation. • Used updated version of EDMS (version 5.1.3) for Civil Aviation emission estimation. • Included emissions when aircraft parking at the airport for cleaning, maintenance and loading/unloading of freights. • Used Sales Report data to calculated VOC emissions from products controlled under the VOC Regulation. • Used further local 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, cooking and VOC emissions from storage of naphthalene, kerosene 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.
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. • 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.

Annex 3 – Methodology and Key Assumptions for Estimating FSP Emissions

In general, the FSP emissions were estimated by multiplying the RSP emissions by conversion factors.

FSP Emission = RSP Emission x Conversion Factor

The conversion factors of RSP to FSP for major emission sources are summarized in the table below.

Emission Sources	RSP to FSP Conversion Factor	References
Public Electricity Generation	Coal-fired: 0.43 Gas turbine using light oil:1 Natural gas:1	1. USEPA AP-42, Volume 1, 5th Edition 2. EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013
Other Fuel Combustion	Ranging from 0.24 to 1	1. USEPA AP-42, Volume 1, 5th Edition 2. EMEP/EEA Air Pollutant Emission Inventory Guidebook 2009 3. EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013 4. USEPA's Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition, NR-009d, July 2010
Navigation	Ocean-going vessels: 0.75 to 0.92 River vessels and local vessels: 0.92 and 0.97	1. ICF International, "*Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories*", prepared for USEPA, Final Report, April 2009 2. Starcrest Consulting Group, *Port of Los Angeles Inventory of Air Emissions – 2011*, Technical Report, July 2012
Road Transport	Gasoline vehicles' exhaust w/catalyst, using unleaded fuel: 0.93 Gasoline vehicles' w/out catalyst, using unleaded fuel: 0.76 Diesel vehicles: 0.92	CARB, "*Public Meeting to Consider Approval of Revisions To The State's On-Road Moter Vehicle Emissions Inventory, Technical Support Document*", May 2000

Annex 4 – Comparison between the Previous and Recalculated Inventories from 1997 to 2011

Table A4-1 Changes in SO_2 emission inventories from 1997 to 2011

Year	SO_2 (Tonnes)	
	Previous*	Recalculated*
1997	80,800	82,100
1998	86,600	87,100
1999	71,600	72,300
2000	79,000	79,600
2001	81,100	81,600
2002	79,200	79,600
2003	104,000	105,000
2004	109,000	109,000
2005	97,500	98,200
2006	87,300	87,300
2007	80,700	79,700
2008	70,200	69,400
2009	62,600	62,600
2010	35,500	35,500
2011	31,900	32,100

* Figures are rounded to three significant figures.

Figure A4-1 SO_2 emissions trend from 1997 to 2011

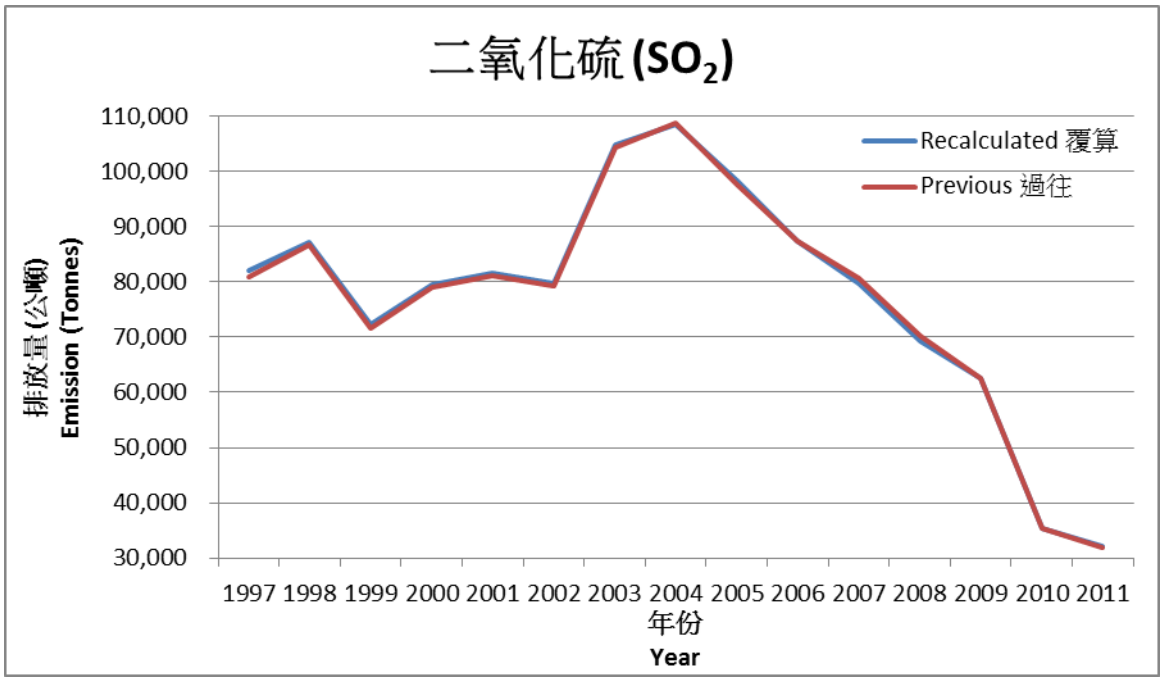


Table A4-2 Changes in NOx emission inventories from 1997 to 2011

Year	NOx (Tonnes)	
	Previous*	Recalculated*
1997	148,000	149,000
1998	144,000	145,000
1999	130,000	130,000
2000	131,000	131,000
2001	127,000	128,000
2002	125,000	125,000
2003	139,000	140,000
2004	129,000	129,000
2005	128,000	129,000
2006	125,000	126,000
2007	127,000	127,000
2008	120,000	120,000
2009	116,000	116,000
2010	108,000	108,000
2011	114,000	116,000

* Figures are rounded to three significant figures.

Figure A4-2 NOx emission trend from 1997 to 2011

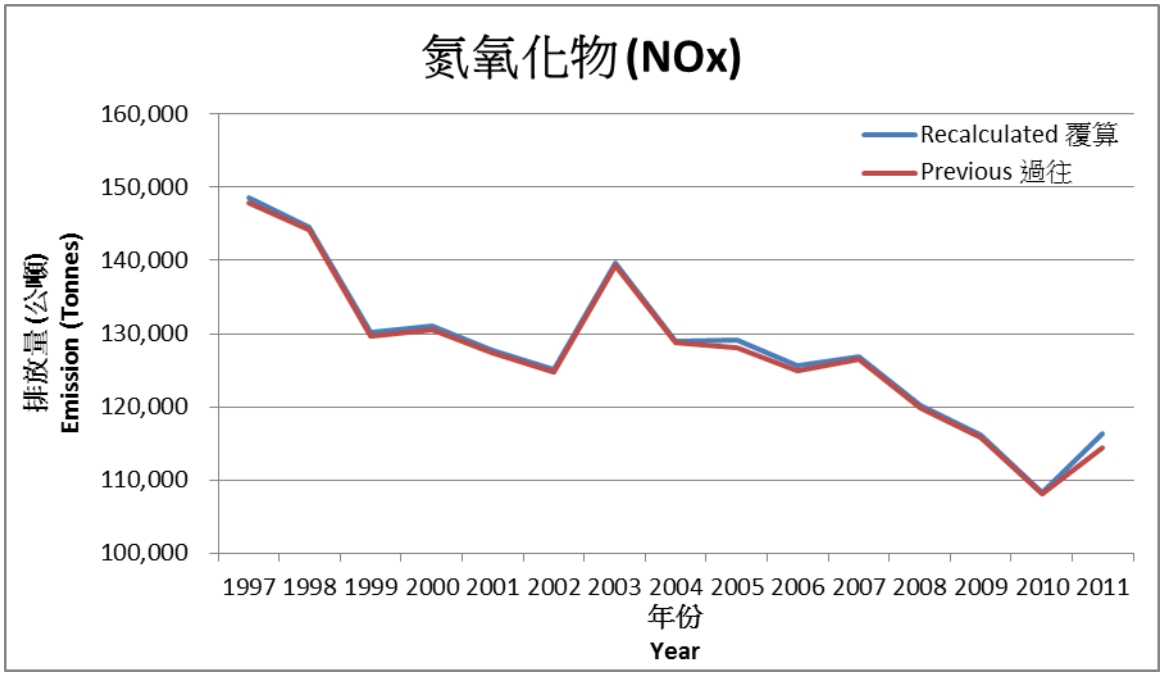


Table A4-3 Changes in RSP emission inventories from 1997 to 2011

Year	RSP (Tonnes)	
	Previous*	Recalculated*
1997	14,500	14,500
1998	13,300	13,300
1999	11,800	11,800
2000	11,400	11,400
2001	9,800	9,810
2002	9,050	9,080
2003	8,910	8,950
2004	9,200	9,210
2005	8,420	8,470
2006	7,820	7,840
2007	7,240	7,230
2008	6,950	6,940
2009	6,600	6,570
2010	6,290	6,250
2011	6,220	6,270

* Figures are rounded to three significant figures.

Figure A4-3 RSP emission trend from 1997 to 2011

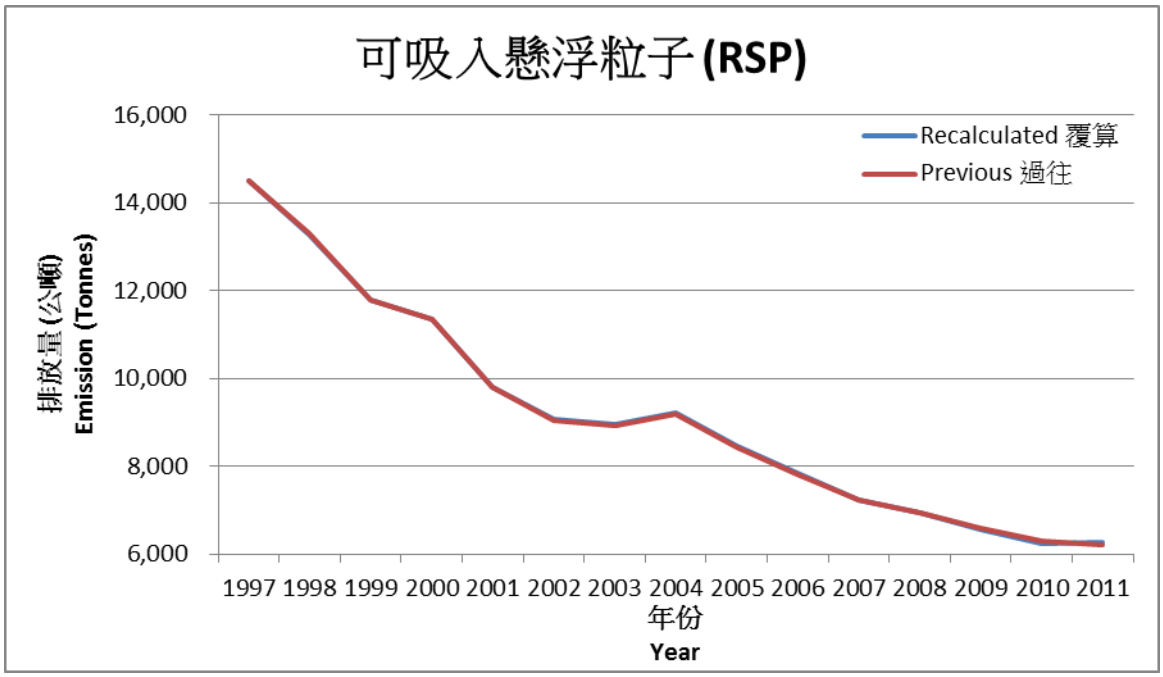


Table A4-4 Changes in FSP emission inventories from 1997 to 2011

Year	FSP (Tonnes)	
	Previous*	Recalculated*
1997	-	11,100
1998	-	10,300
1999	-	9,290
2000	-	8,700
2001	-	7,730
2002	-	7,010
2003	-	6,660
2004	-	6,620
2005	-	6,200
2006	-	5,880
2007	-	5,480
2008	-	5,270
2009	-	4,950
2010	-	4,920
2011	-	4,940

* FSP emissions have been included only since the publication of the 2012 emission inventory. Figures are rounded to three significant figures.

Figure A4-4 FSP emission trend from 1997 to 2011

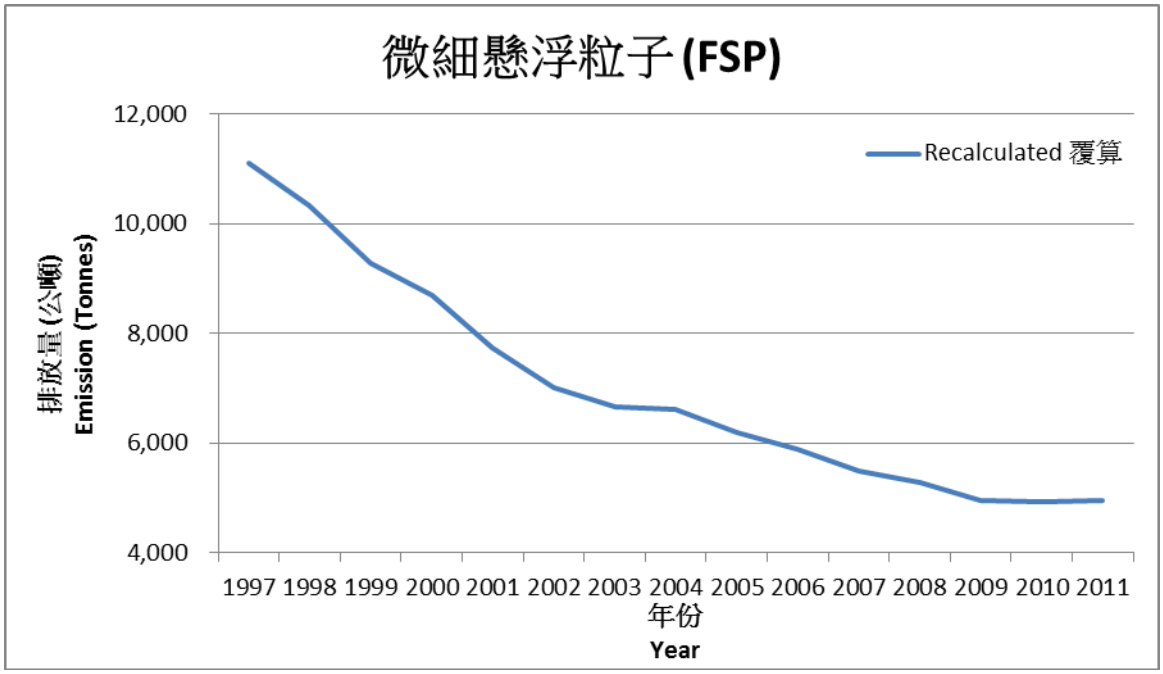


Table A4-5 Changes in VOC emission inventories from 1997 to 2011

Year	VOC (Tonnes)	
	Previous*	Recalculated*
1997	80,600	81,200
1998	73,500	74,000
1999	66,500	66,900
2000	63,100	63,500
2001	55,600	55,900
2002	51,100	51,300
2003	49,600	49,700
2004	49,400	49,600
2005	46,000	46,300
2006	43,900	44,100
2007	42,300	42,600
2008	41,500	41,800
2009	35,900	35,900
2010	33,300	33,200
2011	32,900	32,300

* Figures are rounded to three significant figures.

Figure A4-5 VOC emission trend from 1997 to 2011

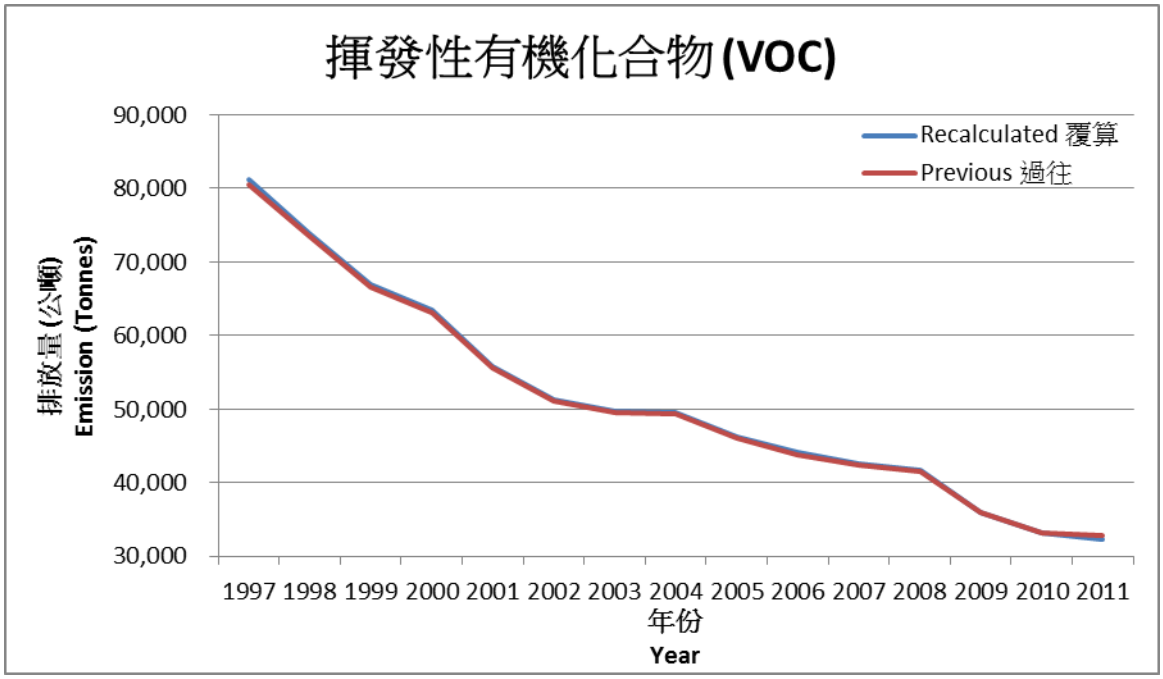
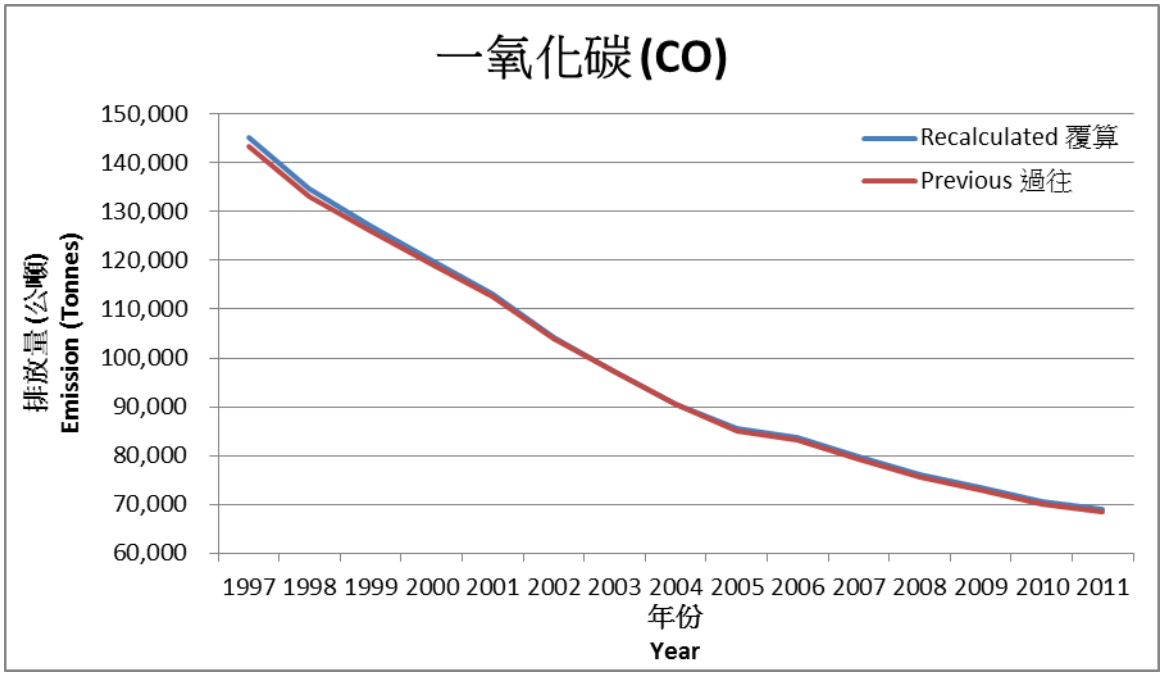


Table A4-6 Changes in CO emission inventories from 1997 to 2011

Year	CO (Tonnes)	
	Previous*	Recalculated*
1997	143,000	145,000
1998	133,000	135,000
1999	126,000	127,000
2000	119,000	120,000
2001	113,000	113,000
2002	104,000	104,000
2003	97,000	97,200
2004	90,600	90,600
2005	84,900	85,600
2006	83,100	83,700
2007	79,100	79,700
2008	75,600	76,100
2009	72,900	73,400
2010	70,100	70,600
2011	68,500	69,000

* Figures are rounded to three significant figures.

Figure A4-6 CO emission trend from 1997 to 2011



Annex 5 –Emission Reduction Targets / Ranges up to 2020

At the meeting of Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection held in November 2012, the two governments endorsed a new set of emission reduction targets/ranges up to 2020, using 2010 as the base year (see table below). The two governments will conduct a mid-term review in 2015 to assess the socio-economic development at the time and progress made in emission reduction, with a view to finalizing the emission reduction targets for 2020.

Pollutant	**Area**	**2015 Emission Reduction Target* (%)**	**2020 Emission Reduction Range* (%)**
SO_2	Hong Kong	-25%	-35% ~ -75%
	PRD Economic Zone	-16%	-20% ~ -35%
NOx	Hong Kong	-10%	-20% ~ -30%
	PRD Economic Zone	-18%	-20% ~ -40%
RSP	Hong Kong	-10%	-15% ~ -40%
	PRD Economic Zone	-10%	-15% ~ -25%
VOC	Hong Kong	-5%	-15%
	PRD Economic Zone	-10%	-15% ~ -25%

*Emission reduction targets/ranges using 2010 as the base year