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CAAC Clean Air Management Report

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This series applies CAAC management and evaluation tools to support Chinese provinces and cities to systematically evaluate their air quality management systems. The goal is to assist them in a sustainable manner to construct and ameliorate their quality management systems, and to select and implement efficient air quality management measures. This series of reports is compiled together by CAAC secretariat, CAAC member provinces and cities and CAAC experts.

Authors:

Innovation Center for Clean-air Solutions (Secretariat for Clean Air Alliance of China):

Tonny Xie, Lisha Wang, Xuan Ling, Yaning Miao, Xin Shen, Mudan Wang (intern), Yanchao Xin (intern)

Contributing Experts:

Steering Committee Members and Experts of CAAC (in the alphabet order without priority):

Prof. Chen Jianmin, Associate Director, Department of Environment Science and Engineering, Fudan University

Mr. Jia Feng, Director, Center for Environmental Education and Communications of MEP

Mr. Lei Yu, Research Fellow, Chinese Academy for Environmental Planning

Mr. Li Penghui, Director, Newroom of <World Environment>, Center for Environmental Education and Communications of MEP

Mr. Li Yuanshi, Deputy Director, Department of Strategic Environmental Assessment, Appraisal Center of Environmental Engineering of MEP

Prof. Ma Zhong, Dean, School of Environment, Renmin University of China

Ms. Miao Ning, Associate Research Fellow, Chinese Academy for Environmental Planning

Prof. Tang Dagang, Research Fellow, Chinese Research Academy of Environmental Sciences

Mr. Xue Wenbo, Associate Research Fellow, Chinese Academy for Environmental Planning

Acknowledgement:

CAAC Steering Committee

Shenzhen Human Settlement and Environment Committe

Shenzhen Academy of Environmental Sciences

Municipal People's Government of Lanzhou City

Energy Foundation

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Executive Summary

2015 marks the second year after the introduction of Air Pollution Prevention and Control Action Plan, it is also the last year of the Twelfth Five-year Plan. This year's air quality data is regarded as the foundation of mid-term Assessment of the plan and the benchmark of the Thirteenth Five-year Plan' air quality control. The air quality has significantly improved in 2015: among the 74 major cities, the cities which met the requirements of air quality standard increased from 8 to 11. The percent of days that the cities met the air quality standard ranged between 32.9% to 99.2%, with an average percentage of 71.2%, 5.2% more than 2014 and 10.7% more than 2013.

The continuous improvement of air quality is based on scientific studies and systematic management decisions. To address this need, the report focuses on the current state of 30 provinces, municipalities, and autonomous regions across mainland China (not including Tibet because of the lack of data), including air quality, pollution control, air quality management, and difficulties of air pollution control. It aims to provide reference for air quality management[1].

The main conclusions include:

▲ Air quality: particulate matter pollution has decreased in general, while the pollution still exceeds the standard. Air pollution episodes still frequently appear during the heating season in the Beijing-Tianjin-Hebei and surrounding regions. PM_{10} emission has increased rather than decreasing in some provinces.

Key areas of $PM_{2.5}$ emission control including Beijing, Tianjin, Hebei, Shandong, Shanxi, Shanghai, Jiangsu, Zhejiang, the Pearl River Delta Region, and Chongqing have reached an average reduction of 11.34% in $PM_{2.5}$ concentrations. In particular, the Pearl River Delta Region, Tianjin, Hebei, Shandong, Shanxi, Jiangsu, Zhejiang, and Chongqing areas are ahead of the schedule and have already reached the goal set for 2017.

Despite the reduction efforts, the emission of particulate matter is still serious. Beijing, Tianjin, southern Hebei, non-coastal areas in Shandong, and Henan merged to create one large block of severe $PM_{2.5}$ pollution, followed by the Yangtze Delta Region, Hunan, Hubei, Sichuan, and Chongqing. The Pearl River Delta Region has met the requirements. Heavily polluted episodes still frequently appear during the heating seasons in Beijing-Tianjin-Hebei and the surrounding regions. For the first time, Beijing put on a red alert on air quality on Dec 8th which alleviated pollutant accumulation. Hebei province published the first Guidelines in China for the Preparation of Emergency Response Operations for Air Pollution Episodes. The guidelines would hopefully assist companies to implement emergency response plan in a more scientific, accessible and verifiable way. PM_{10} (inhalable particles) emissions in Henan, Ningxia, Shanxi, Jilin, Liaoning, Hubei, and Gansu, among which have set the goals to have average annual PM_{10} concentration decreased, increased in 2015 compared to 2013 emissions.

▲ Air quality: O_3 and NO_2 emission still exceed the standard, O_3 and NO_2 emission in some provinces has increased rather than decreased.

O_3 emissions in Beijing, Jiangsu and Shanghai exceeded the standards in 2015. In fact, when compared to previous years, O_3 emission in Jiangsu, Shanghai, Zhejiang, Beijing, Liaoning, and Hebei increased in 2015. NO_2 (nitrogen dioxide) emission also exceeded the standard in Beijing, Hebei, Shanghai, Chongqing, Tianjin, Shandong,

1. Data from The State of Environment in China in 2015

and Henan. NO_2 emissions in Chongqing, Inner Mongolia, Henan, Gansu, Guizhou, Jilin, Anhui, and Shanghai also increased in 2015. Shanxi and Hunan did not publish their air quality data, and SO2 (sulfur dioxide) emissions of other 28 provinces met the requirements, but SO_2 emission in Shandong still exceeded the standard during heating seasons .

▲ Emission control: emission of SO_2 and NO_x were greatly reduced. Mercury pollution control was improved, and regulations on coal burning and yellow-label vehicles also contributes to emission reduction of greenhouse gases. In the future, emission controls on VOCs, ammonia, diesel exhaust particles , straw burning and other control measures which can both reduce air pollutants and greenhouse gases should be strengthened.

Since the implement of pollution control of Ninth Five-Year Plan**,** SO_2 emission peaked in 2015. SO_2 and NO_x emissions have decreased by 5.8% and 10.9% respectively since 2014. The Ministry of Environmental Protection has implemented a *Mercury Pollution Control Technology Policy* in order to give better regulations and guidelines to industries on mercury emission control.

Because air pollutants and greenhouse gases share the same source, these measures targeting emissions of air pollutants, such as regulations on coal burning and yellow-label vehicles, would also help to reduce greenhouse gas emissions. Primary assessment reveals that annual VOC (not including CFCs,HFCs,HCFCs) emissions from anthropogenic sources are equal to 250 million tons of CO_2(carbon dioxide) equivalent, N_2O(nitrous oxide) emissions from agricultural source are equal to 150 million tons of CO_2 equivalent, black carbon emissions from diesel vehicles are equal to 280 million tons of CO_2 equivalent, while CO_2 and black carbon emissions from straw burning are equal to 370 million tons of CO_2 equivalent. Therefore, the control of emission of VOCs, ammonia, diesel vehicle particulate matter, and straw burning, reduce 1.05 billion tons of CO_2 equivalent each year, which can also help to alleviate the pressure of tackling climate change.

▲ Air quality management: legislation, standard making, economic measures, air quality monitoring, and information availability have been strengthened, Shenzhen and Lanzhou's experiences may be referred to and used by other cities and areas.

The law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution was officially published in 2015. The law focused on air quality control, setting rights and responsibilities of local governments on air pollution control, and clarification of air quality attainment planning with allotted time , key area's air pollution control, and response to air pollution episodes. In 2015 the central government has published 12 environmental standards related to air pollution. Beijing, Tianjin, Hebei, Shanghai, Zhejiang, Fujian, and Chongqing have implemented 25 new standards which have been recorded in the Ministry of Environmental Protection. The increased discharge fee and fines based on daily infractions has achieved good results, controlling pollution through economic measures. All the 338 cities of prefecture level and above have the ability to measure the 6 indexes, including $PM_{2.5}$. Information availability has also improved in 2015 compared with the previous year. More provinces and cities have published the assessment report of their annual plan, and also share information and get the public involved through new social media.

Shenzhen's air quality has met the standards for 2 years, realizing multiple-wins for its situation on blue sky, low carbon and economic development. Lanzhou has strengthened law enforcement, creating the famous "Lanzhou blue". Their experiences may become useful learning material for other cities and areas.

▲ Difficulties of air management: difficulties of air management in different areas have sharp distinctions. While certain achievements have been made, the pressure of industrial and energy restructuring is great, and pressure on control of vehicle pollution is unprecedented.

The self-purification ability of atmospheric pollution in different areas varied sharply. Most of the areas with strong self- purification capacity are less polluted. In relation to industrial structure, the percentage of secondary and service sectors in the 30 provinces has declined in 2015 compared with the previous year, while the structure is still unbalanced and the secondary sector is still bigger than the service sector in half of these provinces. The percentage of industrial output of industries with heavy pollution is still high in Qinghai, Xinjiang, Jiangxi, Ningxia, and Hebei. Therefore the pressure to adjust the industrial structure is high. From the aspect of energy structure, in Inner Mongolia, Shanxi, Ningxia, Guizhou, Anhui, Heibei, and Shanxi, coal is used for more than 80% in primary energy structure in 2013. Coal consumption per unit area and energy consumption per 10,000 RMB GDP is different in different provinces. Although the percentage of coal consumption occupying the overall energy consumption in 2015 has declined greatly compared with 2013, the amount is still high (64%), which need further reduction. In terms of vehicle emission, except Beijing and Tianjin, the growth rates of private car ownership are above 11% in 2013, indicating an unprecedented need for car emission control.

The main suggestions of this report include:

Compile and implement scientific air control plan. Reaching the air quality standards is a key aspect of air quality management. In air quality management plans, local governments are responsible for achieving the air quality standards. Scientific measurements should be used in air quality management, as well as in the design and Assessment of air quality control. Each province and city should make air quality control plans based on the updated targets.

Cities which have achieved the standards on air quality should set targets for the next period. Because there is still gap between the current standards on $PM_{2.5}$,other indexes, and the standards of developed countries, the targets of each city should be based on the city's own current conditions and the standard of making continuous progress. For example, after achieving the air quality standards for two years, Shenzhen now is planning to achieve the second-stage target recommended by WHO before 2020, with the average $PM_{2.5}$ density of 25μg/m^3.

Further adjustment of energy structure and industrial structure. While the energy structure has been changing in recent years, there is still great need for more reform. Expectations for energy structure should be raised and law-enforcement strengthened, controlling the creation of more heavy pollution industry. Subsidies and penalties should be based on the company’s environmental performance. Energy prices should also vary. These measures can push heavy pollution industries out while stimulating clean energy to develop, leading to a more optimized energy structure and industrial structure.

In the Beijing-Tianjin-Hebei region, local governments should strengthen control on coal burning. Coal burning is one of the main causes of heavy pollution episodes in the Beijing-Tianjin-Hebei region. Coal burning control has made progress, but there are still challenges. In the future, local residential buildings should go through energy-saving reconstruction and convert to clean energy and central heating based on the promotion of clean coal use, elimination of outdated cookers, and electric power replacement.

Local governments should also increase transparancy of air quality index and pollution information. In the current system, information about clean air management of each province and city is not fully traceable. Every province and cities should establish and improve air quality data query system, allowing the public access to air quality information and encouraging related research. Moreover, as the pollutant discharge permit is implemented, all discharge units should disclose their information, such as emission statistics and facility operations. All discharge units are also required to compile an annual report and disclose the report to the public.

Chapter 1 Introduction

With the support of experts of the Clean Air Alliance of China (CAAC), the Innovation Center for Clean-air Solutions (ICCS) analyzed current air quality conditions and progress in efforts around pollutant emission control and management. The study looked at 30 provinces/cities in mainland China except for Tibet, which was not included due to data availability. The objectives of this report are: to provide references for air quality management strategies, to help individual province/city understand the status quo of its pollution and to discover pollution control difficulties and challenges. By using existing cases, provinces/cities can push for larger improvements in air quality.

The China Air Quality Management Assessment Report is a series of documents that include national, provincial and municipal level reports. The China Air Quality Management Assessment Report (2016) Lite Edition is a national report in the series. The default data the report uses are collected during year 2015. Since some data are unavailable, data collected in 2014 or 2013 are used in some places in the report with footnote.

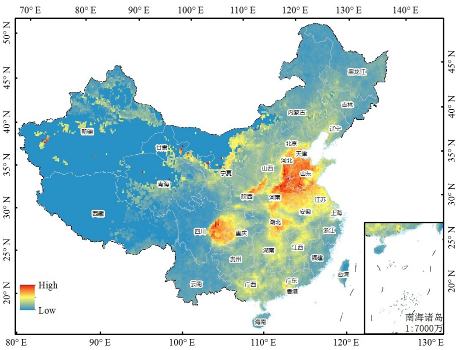
Chapter 2 Current Situations of Air Quality

In order to analyze the air quality in each individual province/city in China, this report investigates the concentrations of six air pollutants ($PM_{2.5}$, PM_{10}, O_3, SO_2, NO_2 and CO) and the air pollution episodes mainly based on the Report on the State of the Environment released by 30 provinces/cities.

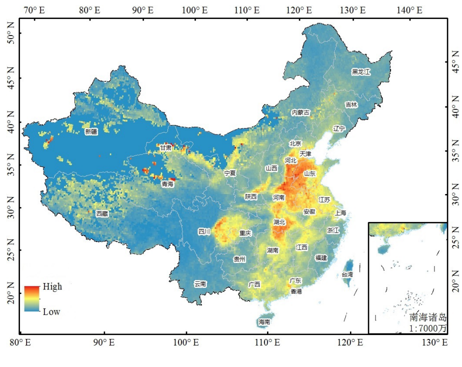
2.1 $PM_{2.5}$ Pollution

2.1.1 Overall $PM_{2.5}$ Pollution in China

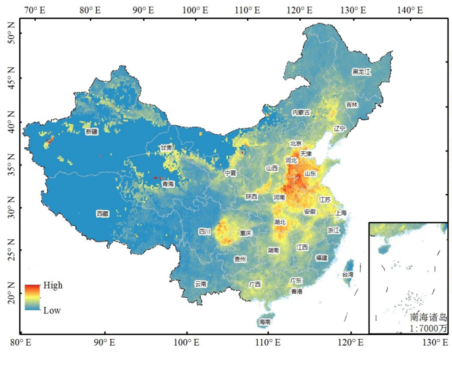
In 2015, the most polluted regions in China included Beijing, Tianjin, Southern Hebei, non-coastal areas in Shandong, and Henan, followed by the Yangtze River Delta region, Hubei and Hunan region, and Sichuan and Chongqing region. But in the Pearl River Delta region, the air quality was significantly improved. From 2013 to 2015, China's overall pollution showed a significant decline while the $PM_{2.5}$ pollution in the region at the junction between Inner Mongolia, Jilin, and Liaoning showed a slight upward trend (see Figure 2-1).



←(a) 2013



(b) 2014



(c) 2015

Fig. 2-1 Satellite inversion graph of ground level $PM_{2.5}$ concentrations throughout China in 2013-2015

2.1.2 Trends of PM2.5 Pollution in Three Major Regions

Beijing-Tianjin-Hebei and the surrounding regions: Though the annual $PM_{2.5}$ concentration showed a decrease, but overall pollution was still serious. In 2015, only Zhangjiakou satisfied the standards. The five most heavily polluted cities in 2015 (Baoding, Liaocheng, Xingtai, Dezhou and Hengshui) are located in Hebei and Shandong (see Fig. 2-2).

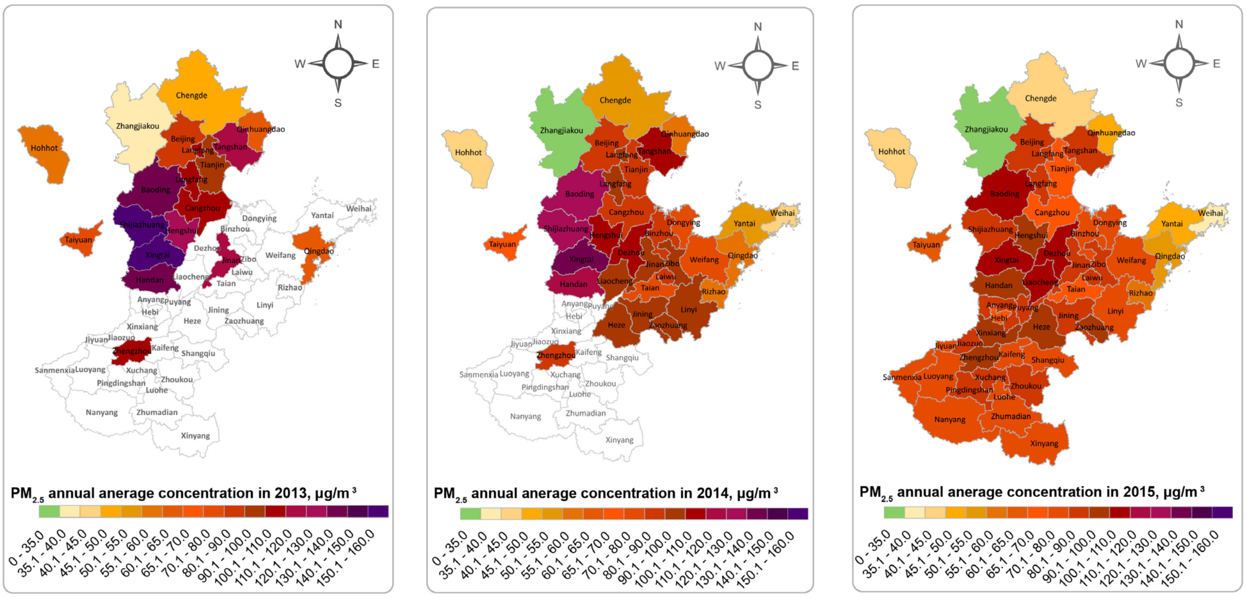


Fig. 2-2 $PM_{2.5}$ Annual Average Concentrations in Beijing-Tianjin-Hebei and the surrounding regions, 2013-2015

Yangtze River Delta region: The overall $PM_{2.5}$ concentration showed a downward trend year by year. In 2015, only Zhoushan satisfied the standards. The five most heavily polluted cities (Hefei, Xuzhou, Wuxi, Taizhou and Suqian) are located in Anhui and Jiangsu (see Fig. 2-3).

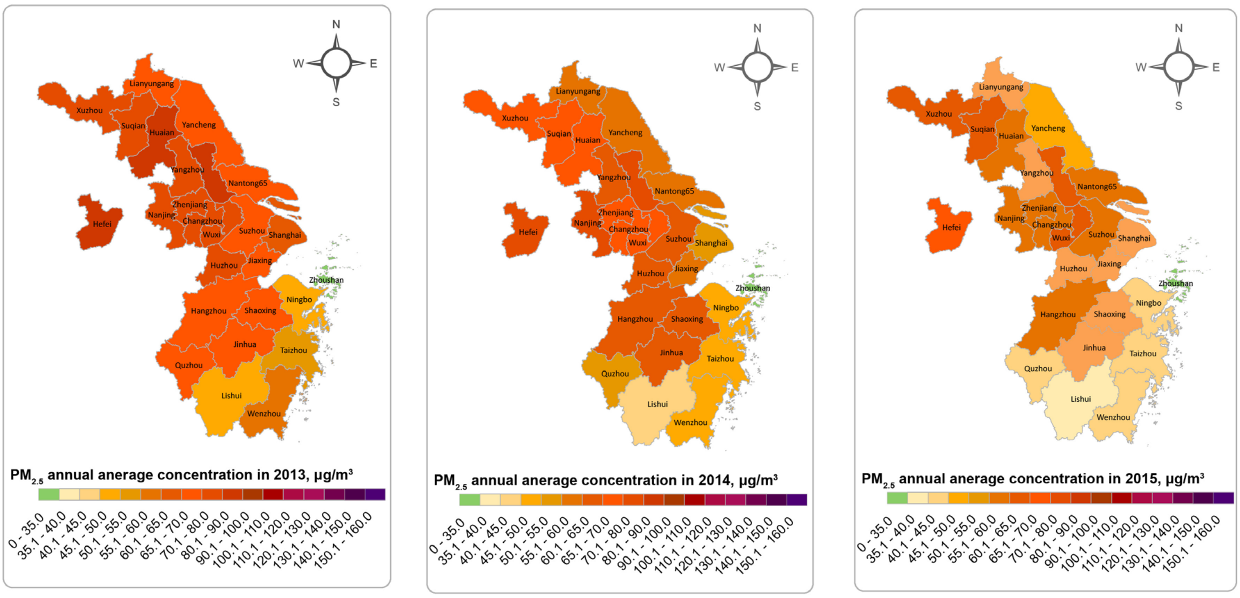


Fig. 2-3 $PM_{2.5}$ Annual Average Concentrations in Yangtze River Delta region, 2013-2015

Pearl River Delta region: $PM_{2.5}$ pollution was significantly improved In 2015. Five cities satisfied the standards, including Huizhou, Shenzhen, Zhuhai, Zhongshan, and Jiangmen. The pollution in Zhaoqing, Guangzhou and Foshan was relatively heavy (see Fig. 2-4).

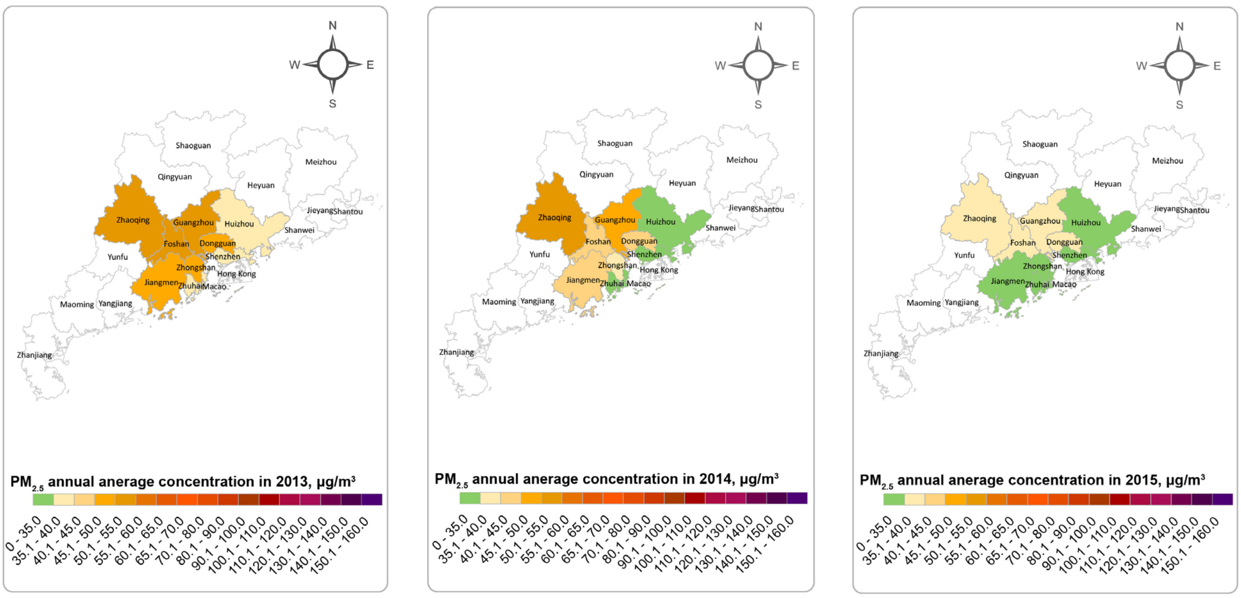


Fig. 2-4 $PM_{2.5}$ Annual Average Concentrations in Pearl River Delta Region, 2013-2015

2.1.3 Benchmarking on $PM_{2.5}$ Targets across ten major provinces/municipalities/autonomous regions

The annual $PM_{2.5}$ concentrations among the ten major provinces/municipalities/autonomous regions (Beijing, Tianjin, Hebei, Shanxi, Shandong, Shanghai, Jiangsu, Zhejiang, Pearl River Delta and Chongqing) dropped in 2015, with an average drop of 11.35% from 2014 levels. The biggest drops of $PM_{2.5}$ were seen in the Pearl River Delta and Hebei, while the smallest drop was in Beijing, and Shanghai showed a rise in $PM_{2.5}$ levels instead of a drop. Tianjin, Hebei, Shanxi, Shandong, Jiangsu, Zhejiang, the Pearl River Delta region, and Chongqing have reached the 2017 target for the annual average drop of $PM_{2.5}$ concentration ahead of time, while Beijing and Shanghai still had not reached the targets, with Beijing being the furthest from the target.(see Fig. 2-5).

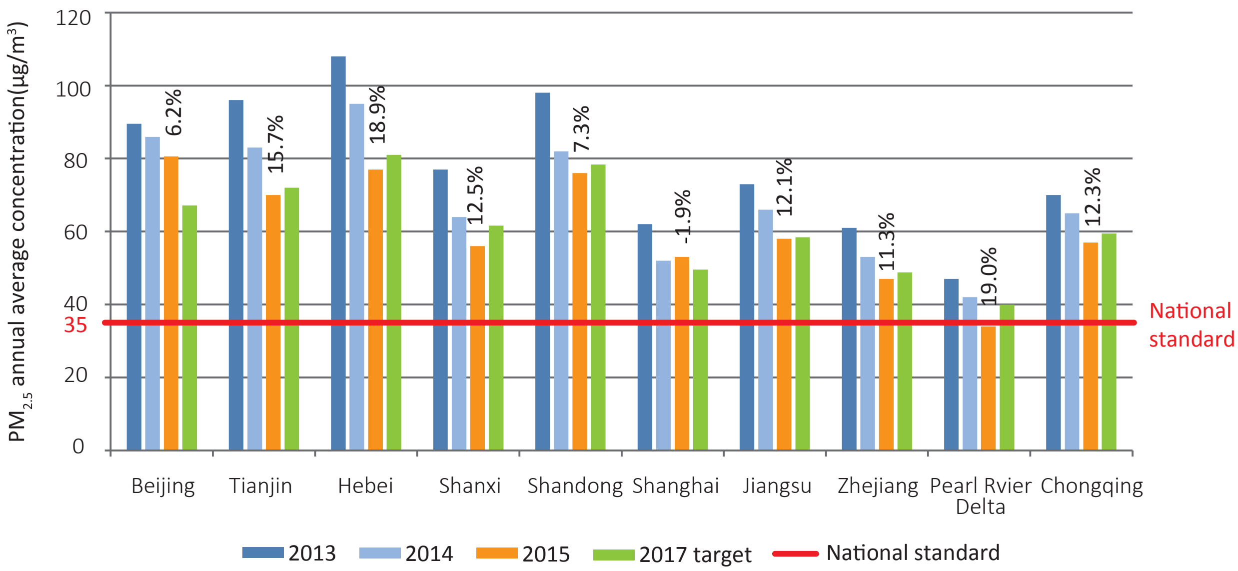


Fig. 2-5 Benchmarking on $PM_{2.5}$ Annual Average Concentrations across ten major provinces/municipalities/autonomous regions

2.2 PM_{10} Pollution

In 2015, the annual PM_{10} concentration in 10 provinces/cities including Hainan, Yunnan, Fujian, Guangdong, Guizhou, Guangxi, Heilongjiang, Jiangxi, Shanghai, and Zhejiang satisfied the standards. Compared to 2014, the annual PM_{10} concentration in Hebei dropped at the highest rate, but Henan, Inner Mongolia, Jilin, Ningxia and Shaanxi showed increases in concentration instead of drops. Among the provinces/cities with the target of lowering PM_{10} concentrations, 7 provinces/cities' concentration rose from 2013 levels in 2015 (Henan, Ningxia, Shaanxi, Jilin, Liaoning, Hubei and Gansu), especially in Henan and Ningxia, the increase was over 20% (see Fig. 2-6).

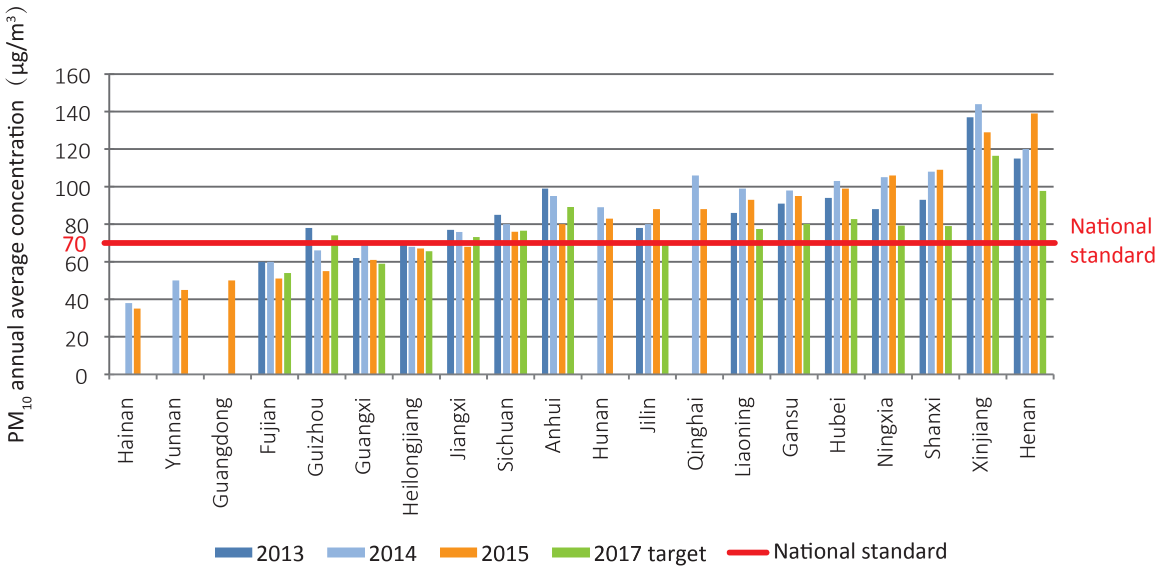


Fig. 2-6 Benchmarking on PM_{10} Annual Average Concentrations in 20 provinces/cities

2.3 O_3 Pollution

21 provinces/cities published their annual O_3 data in 2015, doubled the number that published data in 2014. In 2015, the O_3 concentrations in Beijing, Jiangsu, and Shanghai exceeded the limits, among which Beijing was the worst, at up to 26.6% over the limit. The levels of O_3 pollution in 6 provinces/cities (Jiangsu, Shanghai, Zhejiang, Beijing, Liaoning, and Hebei) rose in 2015, compared to 2014. Jiangsu had the largest increase in O_3, up to 8.4% (see Fig. 2-7).

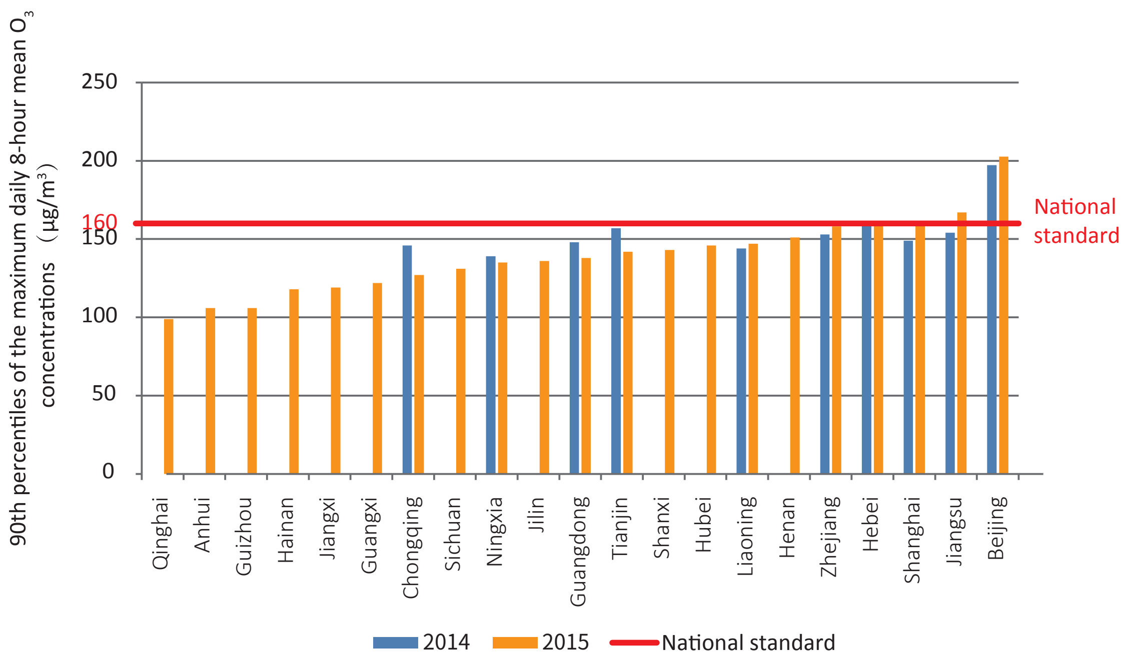


Fig. 2-7 90th Percentiles of the Maximum Daily 8-hour Mean O_3 Concentrations of 21 Provinces /cities

2.4 NO_2 Pollution

Other than Shanxi and Hunan, which did not publish their annual NO_2 concentration data of 2015, 7 provinces/cities out of 28 provinces/cities that had published the data exceeded the limits. They were Beijing, Hebei, Shanghai, Chongqing, Tianjin, Shandong and Henan. The situation in Beijing was the worst, up to 25% over the limit. There were 8 provinces/cities (including Chongqing, Inner Mongolia, Henan, Gansu, Guizhou, Jilin, Anhui and Shanghai) in which NO_2 concentrations rose compared to 2014. Chongqing and Inner Mongolia experienced the largest rises of annual NO_2 concentration, up to 15.4% and 13.6% respectively (Fig. 2-8).

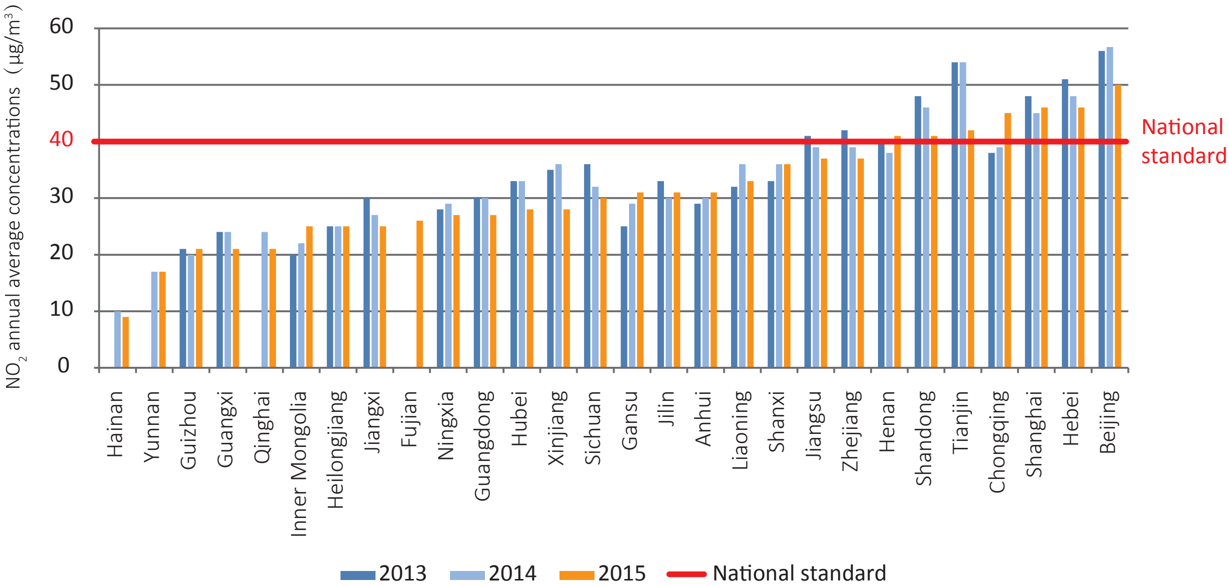


Fig. 2-8 NO_2 Annual Average Concentrations in 28 Provinces/Cities

2.5 SO_2 Pollution

Shanxi and Hunan did not publish the annual SO_2 concentration data for 2015. The 28 provinces/cities that had published the data all complied with the standards. Only the SO_2 concentration level in Inner Mongolia slightly rose compared to 2014. But there were some regions exceeding the limits during the heating season (see Fig. 2-9).

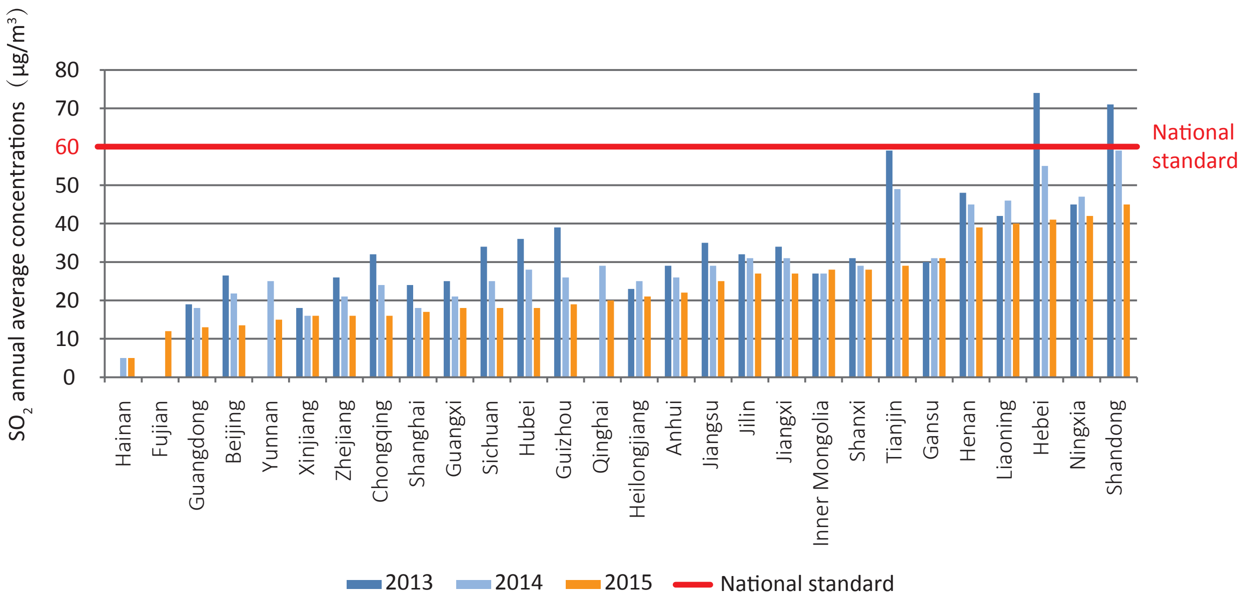


Fig. 2-9 SO_2 Annual average Concentrations in 28 Provinces/Cities

2.6 CO Pollution

There were 21 provinces/cities that published 2015's annual CO data, doubled the number that published data in 2014. All these 21 provinces/cities satisfied the limit standards. In 2015, the CO pollution level in 4 provinces/cities (Beijing Province, Shanghai, Tianjin and Hebei) had increases instead of decreases compared to 2014. Beijing and Shanghai had the largest increases, at 12.5% and 11.7% respectively (see Fig. 2-10).

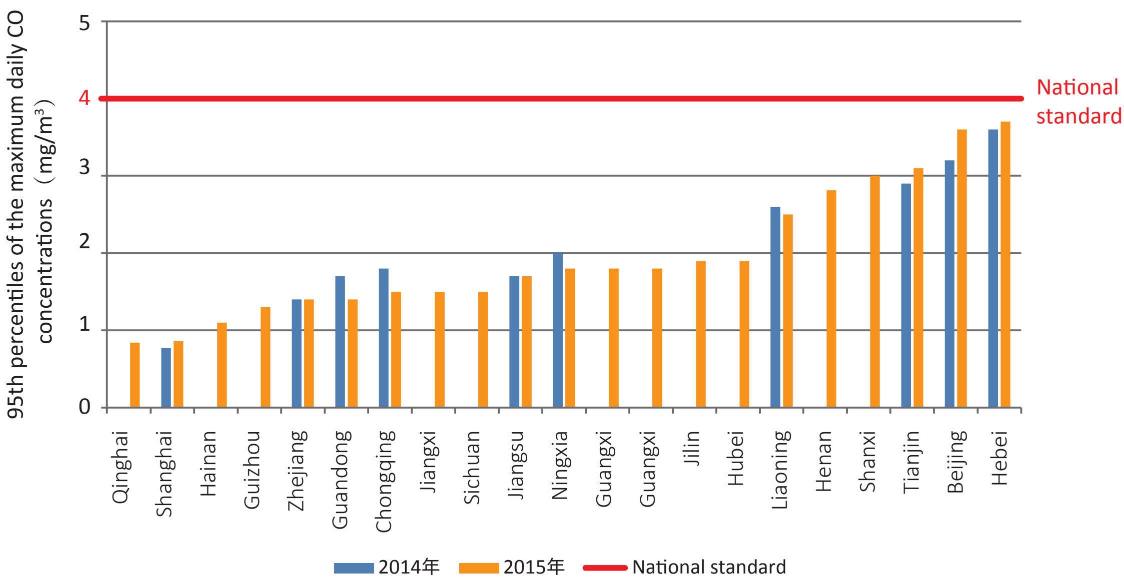


Fig. 2-10 95th Percentiles of the Maximum Daily CO Concentrations of 21 Provinces /Cities

2.7 Air Pollution Episode

The share of heavily polluted days in the first 74 cities implementing the new ambient air quality standards was 4.1% in 2015, with a drop of 1.5% compared to 2014 and a drop of 4.6% compared to 2013[2,3].

154 alerts were issued for air pollution episodes in the Beijing-Tianjin-Hebei region in 2015, far more than the 60 alerts in 2014. Beijing initiated red alerts for air pollution episodes for the first time, playing a role in “cutting the peak and reducing the acceleration” of pollution accumulation. Hebei completed China’s first “Guide on Developing Emergency Response Operation Plans Against Air Pollution Episodes” in order to improve the feasibility, effectiveness and accountability of enterprises’ emergency response plans. An off-peak cement production plan was under trial implementation in 15 provinces/cities that need heating supply in winter with the goal of reducing air pollution episodes in the winter.

2. NPC, http://www.npc.gov.cn/npc/xinwen/2016-04/25/content_1987688.htm.
3. Ministry of Environmental Protection, http://www.zhb.gov.cn/gkml/hbb/qt/201502/t20150202_295333.htm.

Chapter 3 Progress in Controlling Pollutant Emissions

This chapter analyzes the progress in air pollution emission reduction of the whole country and each individual province/city from the aspects of control of SO_2, NO_x and mercury emissions, and co-control of greenhouse gases (GHG) emissions.

3.1 Emission control of key pollutants

3.1.1 Emission control of SO_2 and NOx

China made significant progress in air pollution reduction in 2015. In 2015, the total emissions of SO_2 almost reached the lowest levels since the implementation of Pollutant Cap Control strategy proposed in the "Ninth-Five Year" Plan. In 2015, total emissions of SO_2 and NO_x in China were reduced by 5.8% and 10.9% respectively compared to 2014[4]. In 28 provinces/cities that disclosed emission data, the emission of both SO_2 and NO_x significantly decreased compared to 2014 levels, and among those provinces/cities, Guangxi's reduction of emissions was the largest.

3.2 Progress made through putting into effect the co-control measures of GHG emissions

3.2.1 Control of Coal Consumption

Total coal consumption in China continued a downward trend in 2015, with a decline of 3.7% from 2014 (see Fig. 3-1). Coal burning is a key source of pollution in Beijing-Tianjin-Hebei region. Though this region had achieved results through vigorous governance on coal burning, more efforts are still needed in the future.

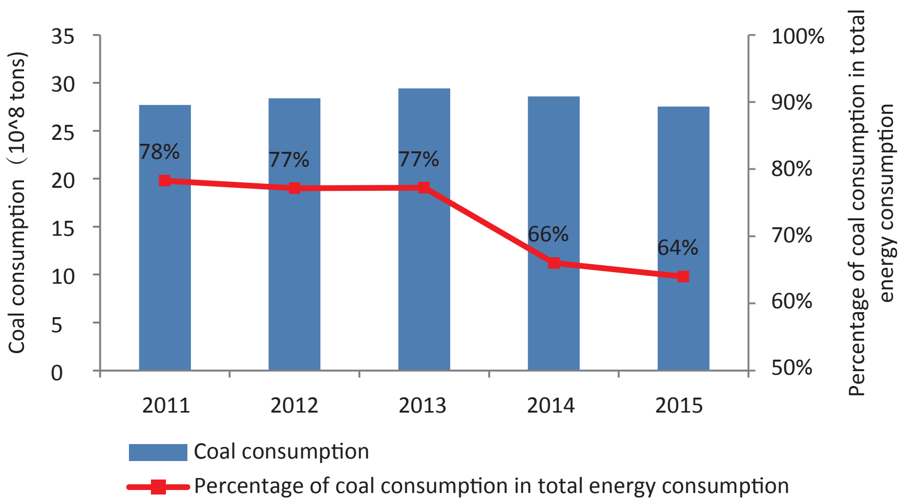


Fig. 3-1 Coal Consumption Trends in China, 2011-2015

4. Data are collected from the Report on the State of the Environment of China (2015)

3.2.2 Elimination of Yellow-Labeled Vehicles

By the end of November 2015, a total of 1.707 million yellow-labeled vehicles that were registered for operation before the end of 2005 had been taken off the roads in China. This Figure was 100.53% of the target set forth in the Government Work Report for eliminating yellow-labeled vehicles, meeting the target ahead of time.

3.2.3 Control of VOCs Emission

The anthropogenic emissions of VOCs in China was equivalent to 250 million tons of CO2e in 2010.

Table 3-1 shows the global warming potentials (GWP) of non-CFC VOCs. According to a study by Xi'an University of Architecture and Technology in 2013, the emission of VOCs from anthropogenic sources in China was about 2.23 million tons in 2010[5]. Calculating based on the GWP of non-methane hydrocarbon (11) given in Table 3-2, the VOCs emissions from anthropogenic sources are equal to 250 million tons of CO2e each year even without accounting for CFCs.

The newly promulgated Air Pollution Prevention Law included VOCs into the regulated coverage for the first time. Beijing, Shanghai, Hunan, Jiangsu and Anhui have issued administrative measures related to levying charges on VOCs emission.

5. Gong Fang, Emission Inventory of Anthropogenic Sources of Vocs emission in China And Characteristics Analysis by Industry, Xi'an University of Architecture And Technology, 2013.

Table 3-1 Global Warming Potential of Common non-CFC VOCs

Name	Chemical Formulate	GWP
dimethylether	CH_3OCH_3	1[6]
methylene dichloride	CH_2Cl_2	10[47]
methyl chloride	CH_3Cl	16[47]
methyl bromide	CH_3Br	5[47]
methylchloroform	CH_3CCl_3	144[47]
ethane	C_2H_6	8.4[7]
propane	C_3H_8	6.3[48]
butane	C_4H_{10}	7[48]
ethylene	CH_2CH_2	6.8[48]
propylene	CH_2CHCH_3	4.9[48]
toluene	C_7H_8	6[48]
isoprene	C_5H_8	2.7[48]
methanol	CH_3OH	2.8[48]
acetaldehyde	C_2H_4O	1.3[48]
acetone	CH_3COCH_3	0.5[48]
NMHC		11[8]

3.2.4 Control of Ammonia Emission

China is the biggest ammonia emitter in the world, with far ammonia emission than the U.S. and EU. The emissions from livestock and fertilizers account for more than 80% of the total ammonia emitted. Existing action plans for controlling emission air pollution did not effectively controll to ammonia emission. In 2014, the emissions from use of agricultural nitrogen was equivalent up to 150 million tons of CO2e.

6. IPCC/TEAP special report on safeguarding the ozone layer and the global climate systems: issues related to hydrofluorocarbons and perfluorocarbons. Eds, Bert Metz, et al. Cambridge University Press,Cambridge, 2005.

7. W.J.Collins,R.G.Derwent,C.E.Johnson andD.S.Stevenson.The oxidation of organic compounds in the troposphere and their global warming potentials(2002). Climatic Change, 52(4): 453-479.

8. K.P. Shine, R.G. Derwent, D.J. Wuebbles and J.-J. Morcrette. Radiative forcing of climate, in: Climate Change – The IPCC Scientific Assessment(1990),Cambridge University Press, Cambridge, 1990.

The emission coefficient of 1% for N_2O emission caused by agricultural use of nitrogen which is given by Intergovernmental Panel on Climate Change (IPCC) means that use of one ton of nitrogen would cause discharge of 10 kg N_2O-N. China's used 23.929 million tons of nitrogen fertilizer in 2014. According to IPCC’s emission coefficients, the N_2O emission from use of nitrogen fertilizer was about 0.5 million tons, equivalent to about 150 million tons of CO2e.

3.2.5 Control of Pollution from Diesel Engine Particulates

In 2015, diesel engine vehicles, while only making up 12.6% of total existing vehicles in China, emitted more than 99% of the total particulate matters emitted from total vehicles. In 2013, the total black carbon emitted from diesel engine vehicles was equivalent to 280 million tons of CO2e.

The particulate matter contained in diesel engine emission also contains black carbon, a short-lived climate pollutant which has a GWP up to 460-1500. Therefore, the co-control of diesel particulate matters is critical. According to research, the black carbon emitted from diesel vehicles was 313.3 thousand tons in 2013. Calculating based on its GWP (910), the black carbon emitted from diesel vehicles in China was equivalent to 280 tons of CO2e in 2013.

3.2.5.1 Control of Diesel vehicle Particulate Pollution

(1) Raising vehicle emission standards

By the end of 2015, Beijing had implemented National Stage V emission standards to all heavy diesel vehicles, and Shanghai, Tianjin and the Pearl River Delta region had also implemented National V standards to the heavy duty diesel vehicles used for public transportation, sanitation activities and postal services.

(2) Adding particulate traps (DPFs) to diesel vehicles

Shanghai added tail-gas treatment devices with DPFs to diesel busses, and both the mass concentration and quantity concentration of black smoke particulates were reduced by more than 90%.

3.2.5.2 Control of pollution of particulates from non-road mobile machinery

(1) Raising emission standards on non-road mobile machinery

The Limits and Measurement Methods for Exhaust Pollutants from Diesel Engines of Non-road Mobile Machinery (China Stage III and IV) promulgated in October 2014 expressly defined the limits on non-road mobile machinery.

(2) Adding DPFs to non-road mobile machinery

Shenzhen Limits And Measurement Methods For Exhaust Smoke from In-Use Diesel Engines of Non-Road Mobile Machinery was officially implemented, facilitating the installation of DPFs to non-road mobile machinery.

3.2.6 Control of Crop Straw Burning

CO_2 and black carbon emitted from crop straw burning in China are equivalent to 370 million tons of CO2e each year.

Straw output in China is about 800 million tons annually, of which 200 million tons are burned off. Based on the emission factor of straw burning, it is estimated that the straw burning emits 290 million tons of CO_2 and 0.92 million tons of black carbon. Calculating based on a GWP of 910 fro black carbon, the emission of CO_2 and black carbon from burning crop straw is equivalent to 370 million tons of CO_2e each year. According to the data of the Ministry of Environmental Protection, the cases in Heilongjiang, Liaoning, and Jilin were the worst from May to November in 2015.

Chapter 4 Progress in Air Quality Management

This chapter analyzes the central government and the provincial/municipal governments' progress in managing air quality from the following five aspects: legislation, standard formulation, economic measures, monitoring, information disclosure and economic measures.

4.1 Legislation

4.1.1 State-level legislations

The new Air Pollution Prevention Law was issued in 2014, providing a legal basis for developing plans for compliance with air quality standards within specified time limits, jointly preventing and controlling air pollution and responding to air pollution episodes. This new Air Pollution Prevention Law, taking air quality management as the core, defines local governments' rights and responsibilities in air pollution control.

4.1.2 Local legislations

By the end of 2015, 6 provinces/cities (Shaanxi, Beijing, Shanghai, Tianjin, Anhui, and Jiangsu) had promulgated and implemented the regulations on prevention and control of air pollution.

4.2 Establishing standards

4.2.1 State-level standards

Twelve air-related environmental standards were introduced in 2015, covering the standards of emissions from the petroleum refining industry, petrochemical industry, copper, aluminum, lead and zinc regeneration industry, synthetic resin industry, inorganic chemical industry, and crematorium industry, along with the methods of measuring nitrobenzene compounds, VOCs, lead, hexavalent chromium emitted in the process, and the methods of measuring metal elements contained in particulates.

4.2.2 Local standards

In 2015, 7 provinces/cities (Beijing, Tianjin, Hebei, Shanghai, Zhejiang, Fujian, and Chongqing) implemented 25 new air-related standards in total and submitted them to the Ministry of Environmental Protection for recording. These included 19 standards on pollutant emissions from polluting industries and 6 standards on emission limits of pollutants from vehicles and on relevant measurement methods.

4.3 Economic Measures

4.3.1 Power Pricing for Environment Protection

Environmental protection subsidies provided to coal-fired power generation units amount to RMB 100 billion each year.

Calculating based on a thermal power generation capacity of 4361.62 billion kwh[9] in 2014 and assuming that desulfurization and denitrification have been carried out for each kwh, the government subsidies for thermal power generators would be about RMB 100 billion in 2014.

9. http://www.cctcw.cn/news/2016-02-04/new_35515.html

Pros and Cons of Subsidy Mechanism for Thermal Power Generators

The subsidies to thermal power generators for environmental protection purpose greatly stimulated the installation of desulfurization, denitrification and dust removal facilities. By end of 2015, the installed coal-fired generating units installed with desulphurization facilities had accounted for 92.8% of total coal-fired generating units in China, an increase of 0.7% compared to 2014. Those installed with denitration facilities had accounted for 95%, an increase of 11.8% compared to 2014. Those installed with dust collectors or electric-bag composite dust collectors had accounted for over 31.4%, an increase of 8.9% compared to 2014[10].

These subsidies over billions of dollars, to some extent, however, weakened the role of price as an economic lever and might conceal the loss of some power plants. And, partial power plants installed pollution control facilities but did not actually operate them after obtaining the subsidies. It is difficult to completely avoid "cheating" behaviors[11]. Moreover, billions dollars of subsidies was far more than the pollutant discharge fees (over 10 billion yuan each year)[12], leading to ineffectiveness of pollutant discharge fees intended for stimulating emission reduction.

4.3.2 Discharge Fee

According to the Notice on Adjustment of Discharge Fees and Other Relevant Issues, Tianjin raised charges by up to 15 times their original levels, and Beijing raised sewage charges to 10 times the previous charge[13].

4.3.3 Penalty

The introduction of penalties levied on a daily basis specified in the new Environmental Protection Law enforced in 2015 addressed the issue of the low cost of breaching environmental laws. Most provinces/cities raised the penalty on violation of environmental laws in 2015. The penalty amounts levied in Tianjin, Liaoning, Henan and Gansu were over 2 times of those in 2014. The amount levied in Tianjin was up to 4 times of penalty charges in 2014.

4.4 Air Quality Monitoring

All 338 cities at the prefectural level in China have the capability of monitoring 6 indicators including $PM_{2.5}$. Some heavily polluted regions (e.g. most cities in Henan and some cities in Shandong) still have big gaps in deployment of monitoring sites (see Fig. 4-1).

10. China Electricity Council, CEC Publishes Information of Green Thermal Power Plants 2014 (http://www.cec.org.cn/huanbao/jienenghbfenhui/fenhuidongtai/fenhuixinwen/2015-05-12/137681.html), CEC Publishes Information of Green Thermal Power Plants 2015 (http://huanzi.cec.org.cn/tuoliu/2016-04-25/152005.html)

11. CBN, http://www.yicai.com/news/3944020.html

12. *National Report on Environmental Statistic 2014*

13. CAAC, Assessment on Air Quality Management in China, 2015, http://www.cleanairchina.org/product/7225.html

Fig. 4-1 Deployment of Air Quality Monitoring Sites across China[14]

4.5 Information Disclosure

According to the scoring of air quality management information disclosure in 30 provinces/cities, the average score was 6.63 points (full score of 10) for 2015, an increase of 11.4% compared to 2014. The provinces/cities with the highest scores were Beijing, Tianjin, Shandong, Jiangsu, and Zhejiang (all 8.5 points), followed by Chongqing (8 points) (see Figure 4-2).

14. IPE, Episode 2, serial articles in 4 Issues of Blue Sky Roadmap Reports

Fig. 4-2 Scores of Air Quality Management Information Disclosure in 30 Provinces/Cities

4.6 Good Practices of Air Quality Management

4.6.1 Shenzhen Experience: Multiple Benefits – Blue Sky, Low Carbon and Economy

Shenzhen is the first megacity (over 10 million population) that has met the air quality standards. While the air quality is improving significantly, Shenzhen has also been maintaining its rapid growth, shown in Figure 4-3. Though we may ascribe Shenzhen's success to certain extent to its special geographical location and special path of economic development which might not be easily copied by other cities, Shenzhen's experiences in promoting the adjustment of industrial structure's energy structures, managing motor vehicles and non-road mobile polluting sources, and co-control of multi pollutants and greenhouse gases are worth learning from for other cities[15]. The key experiences include:

1. Adjustment to industrial structure and energy structure contributes most for air quality improvement.

2. Prevention and control of pollution of motor vehicles and non-road mobile sources is an effective co-control measure, though can be difficult.

3. Co-control of multiple air pollutants and GHGs.

15. CAAC, Multiple Benefits -- Blue Sky, Low Carbon and Economy – Shenzhen Experiences, http://www.cleanairchina.org/product/7569.html

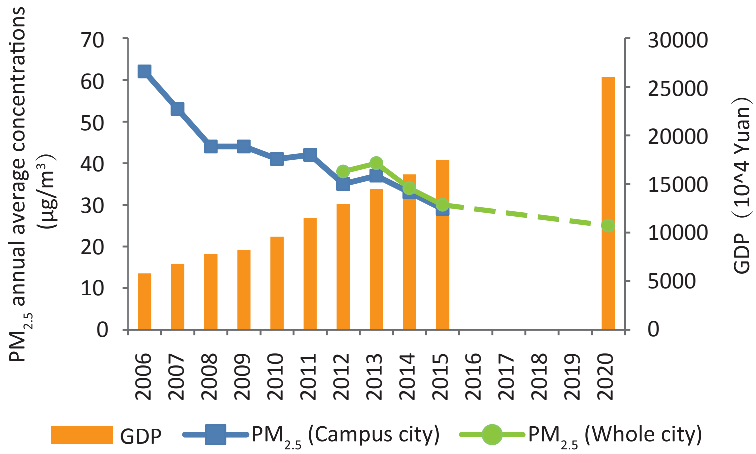


Fig. 4-3 Progress of improving $PM_{2.5}$ Pollution, the Targets and GDP Growths

4.6.2 Lanzhou Experience: Strengthening Law Enforcement to Create "Lanzhou Blue"

Lanzhou has always been called "polluted city". Since 2011, Lanzhou has enhanced its environmental legislation for air pollution control and created a "Lanzhou Blue," well known both nationally and internationally. Lanzhou has become a city in which the air quality index dropped the fastest among any key monitored cities in China.

Such success can be attributed to the following 3 key frameworks for air quality legislation[16]:

1. Put the thought and way of the rule of law throughout pollution control to highlight the legal principle of work, and efforts to build a legal system for pollution control law.

2. Introduce urban grid management to air pollution control, combine with the smart city construction and make efforts to build a social treatment system of air pollution treatment.

3. Have a strong executive power to ensure the strict environmental enforcement and supervision and focus on building supervision and efficacy-asking system of air pollution control.

16. Presentations at the forum on low carbon development and air quality promotion at second session of Sino-US Climate Smart /Low Carbon City Summit, 2016

Chapter 5 Challenges in Air Pollution Control

This charpter investigates the challenges and difficulties in addressing air pollution control in different regions in four dimensions: air pollution purification capacity, industrial structure, energy use, and vehicle emissions.

5.1 Self-purification Capacity

Figure 5-1 shows the capacity for self-purification of air pollution across China. By comparing Figure 5-1 with Figure 2-1 (c), it can be seen that most regions with better self-purification capability have lower levels of pollution.

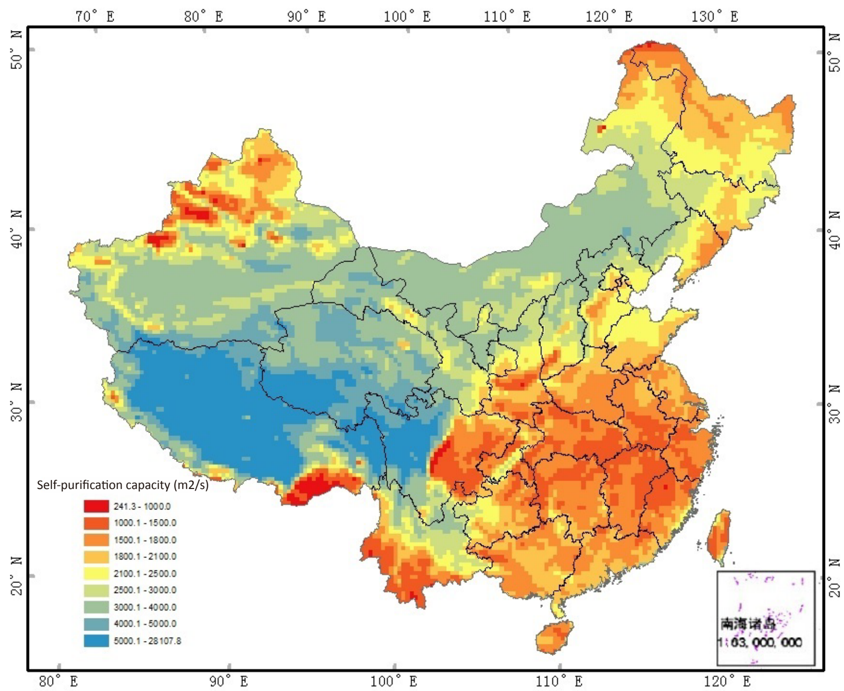


Fig. 5-1 National distribution of self-purification

5.2 Industrial Structure

5.2.1 Proportion of Second to Tertiary Industry

Both Shanghai and Beijing maintained high growth of GDP, while the propotion of second to teritary industry decreased significantly (see Fig. 5-2)

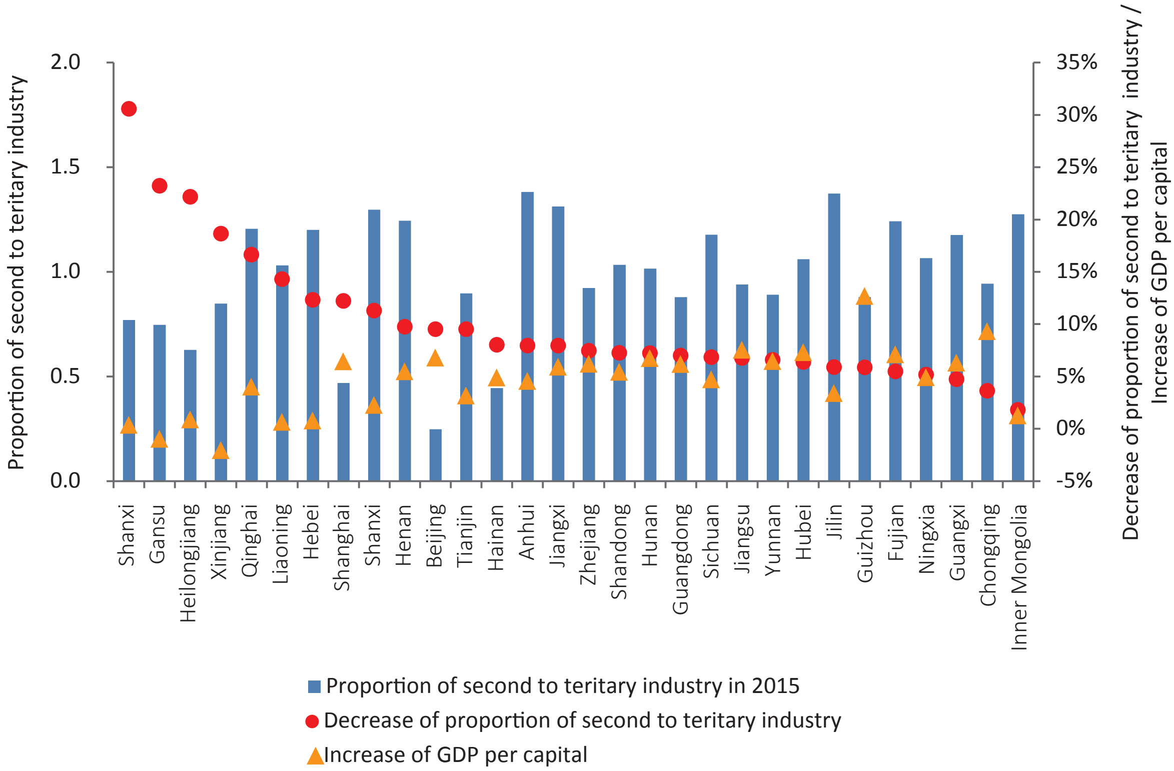


Fig. 5-2 Industrial Structures and Per Capita GDPs in 30 Provinces/Cities in 2015

5.2.2 Shares of heavily polluting industries output to total industrial output

The share of heavily polluting industries output to total industrial output in Qinghai, Xinjiang, Jiangxi, Ningxia and Hebei were relatively high. In addition, they faced relatively high pressure to implement air pollution control.

5.3 Energy structure and consumption

5.3.1 Share of Coal in Primary Energy

Coal consumption occupied 80% of total primary energy production in 7 provinces/cities (Inner Mongolia, Shanxi, Ningxia, Guizhou, Anhui, Hebei, and Shaanxi) in 2013. Among the 30 provinces/cities, coal consumption occupied a relatively small share of primary energy production in Beijing, Hainan, and Shanghai (below 40%). The share in Beijing was the lowest, at only 25%.

5.3.2 Coal consumption per unit of area

The coal consumption per unit area varies greatly among the provinces/cities. In the Yangtze River Delta region, the coal consumption per unit area in Shanghai, Jiangsu, Zhejiang, and Anhui respectively took the 1st, 3rd, 8th and 12th place in China in

2013. These 4 provinces/cities formed a high-coal-consuming area, bringing great challenges to air quality control in the Yangtze River Delta region.

5.3.3 Energy consumption per 10,000 RMB of GDP

In 2013, there were huge differences in primary energy consumption per unit GDPs among the provinces/cities in China. The primary energy consumption per unit GDP of Beijing was relatively low, and those in some less developed regions (such as Ningxia) were relatively high.

5.4 Vehicle emissions

5.4.1 Number of vehicles per 100 Persons

Except for Beijing and Tianjin, the amount of private vehicles in the other 28 provinces/cities increased by over 11%, placing unprecedented pressure on control of vehicle pollution (see Fig. 5-3).

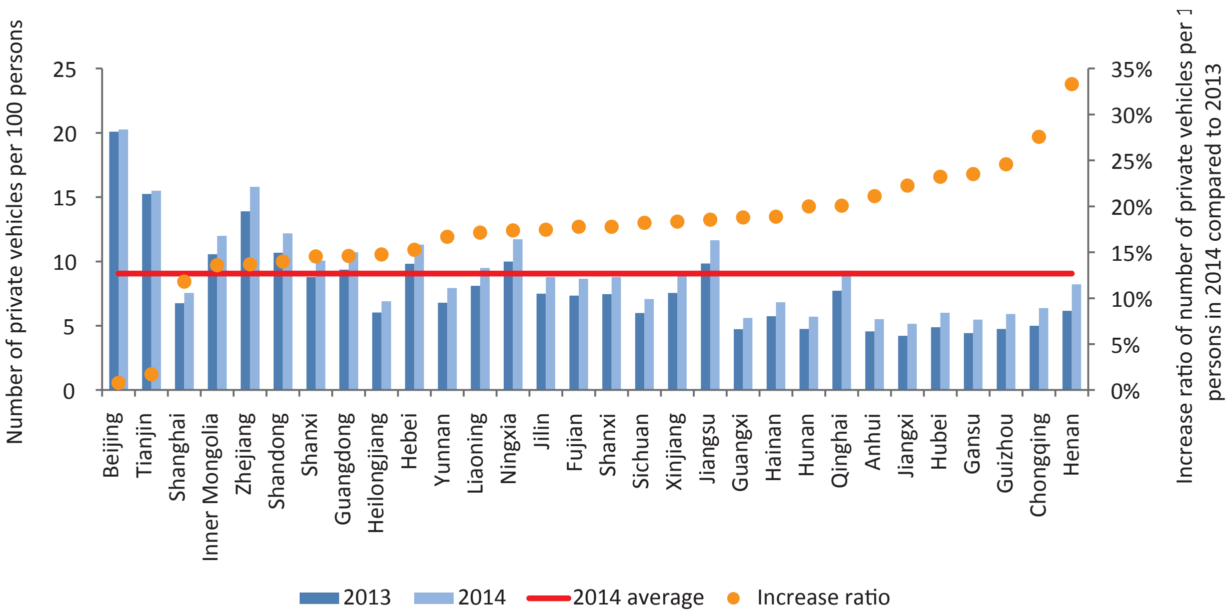


Fig. 5-3 Numbers of Private Vehicles per 100 Persons and Growths in 30 Provinces/Cities

5.4.2 Upgrade of Automobile Gasoline/Diesel Fuel

By the end of 2015, 7 provinces/cities (Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Shandong, and Guangdong) out of 11 eastern provinces/cities and Shaanxi out of the western region had successfully created a widespread supply of China V gasoline and diesel.

Chapter 6 Conclusions and Recommendations

▲ While the overall air quality improved in 2015, pollution of particulate matters remained prominent, and some provinces/cities experienced an increase of pollutants instead of decrease. Air pollution episodes were frequently seen in the Beijing-Tianjin-Hebei and the surrounding regions during the heating season. Beijing initiated a red alert for air pollution episodes for the first time, thus enhancing the response to air pollution episodes.

The overall air quality was apparently improved in 2015 compared to 2014, but the pollution of particulate matter remains prominent. The most heavily polluted area by $PM_{2.5}$ spanned Beijing, Tianjin, southern Hebei, non-coastal area of Shandong, and Henan, followed by the Yangtze River Delta region, Hunan and Hubei region, Sichuan and Chongqing region, while the Pearl River Delta region already met the standards. After becoming China's first megacity to meet the air quality standards in 2014, Shenzhen maintained a decline of $PM_{2.5}$ concentration in 2015. The city also decided to reach the second-stage transition targets proposed by WHO in 2020.

In 2015, compared to 2014, $PM_{2.5}$ concentration in Shanghai rose; PM_{10} concentrations in 5 provinces/cities (Henan, Inner Mongolia, Jilin, Ningxia, and Shaanxi) rose; O_3 concentrations in 6 provinces/cities (Jiangsu, Shanghai, Zhejiang, Beijing, Liaoning, and Hebei) rose; NO_2 concentrations in 8 provinces/cities (Chongqing, Inner Mongolia, Henan, Gansu, Guizhou, Jilin, Anhui, and Shanghai) rose; SO_2 concentration in Inner Mongolia rose slightly; and CO concentrations in 4 provinces/cities (Beijing, Shanghai, Tianjin and Hebei) rose.

Air pollution episodes were frequently seen in the Beijing-Tianjin-Hebei region during the heating season in 2015. Beijing initiated a red alert for air pollution episodes for the first time in December 8, 2015, playing a role in "cutting the peak and reducing the acceleration" of pollution accumulation. Hebei completed China's first Guide on Developing Emergency Response Operation Plan Against Air Pollution Episodes, in order to improve the feasibility, effectiveness, and accountability of enterprises' operation plans for emergency response. In 15 provinces/cities that need heating supply in winter, an off-peak cement production plan in winter was under trial implementation to reduce air pollution episodes in winter.

▲ Progresses of SO_2 and NO_X emission control have been achieved. It is still necessary to continue co-control of multiple pollutants and GHGs in the future.

In 2015, total SO_2 emissions in China almost reached their lowest level since the implementation of Cap Control strategy proposed in "Ninth-Five" Plan. In 2015, the total emissions of SO_2 and NO_X in China was reduced by 5.8% and 10.9% respectively compared to 2014 levels.

The total coal consumption further decreased in China. Results have been received with respect to coal burning in Beijing-Tianjin-Hebei region through vigorous governance, but there is still huge pressure. The goal of eliminating yellow labeled and out-date cars was fulfilled ahead of schedule. The reduction of pollutants brought a co-reduction result, i.e. emission of greenhouse gases was reduced. It is suggested to, in the future, continue the efforts on co-control of multi pollutants and GHGs, and intensify the control of emissions of VOCs, ammonia, diesel particulates, and crop straw burning to obtain more co-benefits.

▲ Great progresses have been made in air quality management. Local governments are suggested to, as soon as possible, start air quality attainment planning within time limits in accordance with the new Air Pollution Prevention Law. The disclosure of historical air quality data and environmental information of polluting sources needs to be enhanced.

With introduction of a number of air-related standards after the new Air Pollution Prevention Law was promulgated in 2015 (e.g. raised discharge fees levied on daily basis), all 338 cities above prefecture level have established the capability of mornitoring 6 pollutants (e.g. $PM_{2.5}$). Progress had also been made towards the disclosure of environmental information.

The new Air Pollution Prevention Law provides a legal basis for developing plans to comply with air quality standards within specified time limits, jointly preventing and controlling air pollution, and responding to air pollution episodes. Air quality attainment planning wiithin time limits is the core of air quality management as well as the responsibility of local governments. It is suggested that compliance be the goal, scientific means be employed for regional air quality management, measures for improving air quality be designed and accessible, and a management pattern for on-going improvement and compliance be maintained. It is also suggested that all provinces/cities properly develop plans of air quality improvements/compliance as well as reasonable and effective emission reduction strategies by systematically managing the efforts for compliance with air quality standards, linking the control of polluting sources with air quality improvement, and assessing the cost benefits of emission reduction measures.

In relation to disclosure of air quality control information, all provinces/cities should improve their air quality data query systems in order to inform the public of historical air quality data, which also helps related research. Moreover, the polluting sources should promptly and truthfully disclosed in the data in accordance with the Interim Measures for Administration on Sewage Discharge with Permit (Draft).

▲ Generally, there are difficulties in air pollution control. Though positive results have been achieved through recent industrial structure adjustment and total coal consumption control, there is still great need for further restructuring, such as greater control of motor vehicle pollution.

The average ratio of 2nd to 3rd industry in 30 provinces /cities in China was 0.987 in 2015, with a drop of 10.3% compared to 2014. However, the industrial structure was still biased – the share of 2nd industry was larger than that of the 3rd industry in more than half of these provinces/cities. Therefore, it is necessary to strengthen the adjustment of industrial structures, strictly control the access of heavily polluting enterprises, and proactively adopt differential sewage charges or differential energy prices and other economic policies to encourage the end of heavily polluting enterprises.

In 2015, China's coal consumption continued declining, with a drop of 3.7% compared to 2014. However, coal is still the main energy source of most provinces/cities. Therefore, all provinces/ cities should, while developing targets of total coal consumption control and implementation measures, vigorously expand and encourage the use of clean energy through incentive policies on clean energy development and facilitate sustainable optimization of energy structures.

In light of the rapidly growing amount of motor vehicles in most provinces/cities, it is suggested that the strategies of controlling the quantity of motor vehicles on-road and be reconsidered as soon as possible to implement more stringent emission limits on motor vehicles and fuel quality standards, in order to control pollution from motor vehicles.

Clean Air Alliance of China (CAAC)

To address the air pollution challenge in China, ten leading Chinese technical institutions in the air quality field joined hands to launch the Clean Air Alliance of China (CAAC). It is envisioned that CAAC will provide an integrated platform for provinces and cities to access the international experience, tools and practices on the one hand; and facilitate the communication and collaboration among provinces and cities on the other. The overarching goal is to improve air quality of Chinese provinces and cities and mitigate the negative impacts on public health due to air pollution. CAAC will be led and supervised by the alliance steering committee, and be managed by the alliance secretariat regarding general operation and coordination.

Ten Founding Members:

Tsinghua University, Appraisal Center for Environment & Engineering of MEP, Chinese Academy for Environmental Planning (CAEP), Nanjing University, Beijing Normal University, Fudan University, Chinese Research Academy of Environmental Sciences (CRAES), Peking University, Renmin University of China, Vehicle Emission Control Center (VECC) of MEP

Founding Supporter:

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中国清洁空气联盟
Clean Air Alliance of China

Innovation Center for Clean-air Solutions (CAAC Secretariat)

Suite 709, East Ocean Center, 24A Jianguomenwai street, Beijing 100004

Tel: +86-10-65155838

Email: cleanairchina@iccs.org.cn