China Air 2016

Air Pollution Prevention and Control Progress in Chinese Cities

Clean Air Asia

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About Clean Air Asia

Clean Air Asia (CAA) is an international non-profit organization established in 2001 by the Asian Development Bank, World Bank, and United States Agency for International Development (USAID). Our mission is to reduce air pollution and greenhouse gas emissions in Asia and contribute to a livable and healthy Asia for all people, both now and in the future. Clean Air Asia is a platform for change, working with partners around the world to reduce emissions through such key approaches as research, policies, information and capacity building.

Since 2007, Clean Air Asia has been a UN-recognized partnership. Our network is comprised of 261 organizations around the world, including seven Country Networks - Indonesia, Malaysia, Nepal, Pakistan, the Philippines, Sri Lanka and Vietnam. Our headquarters are in Manila, Philippines, and we have offices in Beijing, China, and New Delhi, India.

Clean Air Asia has worked in China for more than a decade to promote green transportation and improve the air quality in Chinese cities. In collaboration with the Foreign Economic Cooperation Office (FECO) of the Ministry of Environmental Protection (MEP), CAA established a City Air Quality Management Network in China in 2005. To date, Clean Air Asia organized 11 annual workshops and 22 training activities on air quality attended by more than 100 cities.

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Foreword

In June 2013, the State Council issued the Action Plan for Air Pollution Prevention and Control. This document laid out the roadmap for air pollution prevention and control across China for 2013-2017. To aid decision-makers, businesses and NGOs in better understanding the relevant policy landscape, and enable better public support to implement these measures, Clean Air Asia (CAA) will produce a series of reports, entitled *China Air - Air Pollution Prevention and Control Progress in Chinese Cities (China Air)*. These reports come from the perspective of an independent third-party, aiming to provide clarity on air pollution prevention and control policies enacted by the central and local governments in China from 2014 to 2017, in addition to the implementation process and impacts of these policies. We hope that these reports will motivate civic leaders throughout Chinese cities to learn from each other's experiences and also provide a comprehensive understanding of China's air quality efforts in other countries.

China Air 2015, a bilingual (Chinese and English) report released by CAA, enjoyed positive feedback from national and local environmental protection departments, NGO's and other international organizations, and the media. This report is the most detailed of its kind and is designed to help interested parties understand the policies of the Chinese government at all levels. The report also monitors the pollution levels and pollution control capacity of certain cities in Northeastern, Central and Southwestern China, and documents the experiences of cities that are high-performers in air pollution control. We believe this information will be of great help to city-level administrators in China.

China Air 2016 is the second report in this series. Compared with our first report, this report covers more cities (expanding from 74 to 161) and compares the progress of air pollution control in Beijing-Tianjin-Hebei (BTH), and other key cities in Northeastern, Central and Southwestern China. Our detailed case studies focus on two of the important contributors to air pollution - control of VOCs and retrofitting industrial coal-fired boilers.

All the original data and policy references from the report are online at: www.allaboutair.cn. Created in November 2015 by CAA, this Chinese online information platform shares city best practices and international experience in air pollution prevention and control, as well as training materials on key topics, such as air pollution measures in Kawasaki, Japan, Singapore's emergency management of haze, ozone control in and around the San Francisco Bay Area, as well as information on the control of VOCs. The platform recently launched an interactive question and answer tool, providing direct responses from international and Chinese experts to questions from users.

CAA is an independent NGO and a leading organization in Asia specializing in air quality management. We have worked in China for more than a decade and we are committed to improving the air quality management of Chinese cities. By the end of 2015, the CAA organized 31 capacity building and policy workshops which were attended by representatives of more than 100 Chinese cities. We hope that through close collaboration with our partners, this series of reports, intensive training programs, and our new interactive online platform, we can continue to help improve air quality in China so that every citizen can breathe clean air.

Fu Lu
China Director
Clean Air Asia

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Content and Scope

As the second report in the series, *China Air – Air Pollution Prevention and Control Progress in Chinese Cities*, this report provides an overview of the air quality data of 161 cities at and above the prefecture level in 2015. It features the plans and progress of air pollution control policies and measures adopted by the national government, Beijing-Tianjin-Hebei region (BTH), Yangtze River Delta (YRD) and Pearl River Delta (PRD) and the 161 cities concerned, the progress of the plans, and summaries of Shanghai's experience in retrofitting industrial coal-fired boilers and Shenzhen's experience with managing VOCs. The 161 cities covered are those that started air quality monitoring and data release in the second phase of the "three-step" implementation plan for building a monitoring network.

Development Methodology

With the goal of providing an objective perspective, this report systematically incorporates air quality data and policy information to ensure accuracy and comprehensiveness. We also provide accurate descriptions of air quality changes at the national, regional and municipal level, as well as the efforts and progress made in air pollution control in 2015.

The data and information contained have all been released and shared by the government. Specific sources include: 1) Air quality data: Air quality bulletins and official news released by the Ministry of Environmental Protection (MEP), provincial environmental protection departments and municipal environmental protection bureaus; 2) Policy information: Government documents, speeches by officials, meeting reports, and media reports that cite official sources.

Based on feedback from municipal environmental protection authorities on the first report in this series, *China Air 2015 – Air Pollution Prevention and Control Progress in Chinese Cities*, CAA has decided to focus this second report on sharing specific cities' experiences (Shanghai and Shenzhen were selected as examples) in controlling industrial coal-fired boilers and VOCs.

Main Conclusions

Air Quality

As of 2015, Chinese cities have monitored air quality and released real-time data on a large scale for three years and there has been continuous improvement in air quality in most of the cities. However, it is still common for $PM_{2.5}$ concentrations to exceed relevant standards by large margins, while some regions are also confronted with O_3 pollution.

Air quality improved as a whole, but non-attainment was still widespread

The air quality of Chinese cities improved in 2015 compared with the previous year. Of the six pollutants, the annual mean concentration of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 was generally on the decline in 74 cities as compared with 2014, decreasing by 14.1%, 11.4%, 21.9% and 7.1% on average, respectively. In the meanwhile, the annual mean concentration of CO was about the same as levels in 2014. The figures in respect of SO_2, NO_2, CO and O_3 all attained the National Secondary Standard under the Ambient Air Quality Standards (GB3095-2012) (the National Secondary Standard).

Nevertheless, it is still common for Chinese cities to not meet standards, especially in the winter when heavy pollution was more frequent. In 2015, the number of non-attainment days in the 161 cities covered by the report averaged 99, with that of the 74 key cities being 105. BTH and its surrounding areas (Shanxi, Shandong, Inner Mongolia and Henan) was still the region with the poorest air quality and highest frequency of heavy pollution in the country. Among the 161 cities, the top 20 with the most days of not meeting standards were all concentrated in the BTH region. Furthermore, 70 cities at or above the prefecture level in the region had a total of 1,710 days of heavy or higher-level pollution and issued 154 alerts on heavy pollution.

Fine particulate matter continued to be a serious issue, with O_3 pollution worsening in key regions

$PM_{2.5}$ was still the primary problem for most of the cities, especially the 74 key cities that were among the first to conduct air quality monitoring. The annual mean concentration of $PM_{2.5}$ in these cities was relatively high, at 1.5 times the National Secondary Standard (35 μg/m^3).

Moreover, the issue of O_3 pollution surfaced in 2014 and continues to worsen. The annual mean concentration of O_3 in the 74 key cities continued to rise at a rate of 3.4%, whereas the proportion of cities that achieved standards continued to fall at a rate of 5.4%. In BTH, the days that saw O_3 as the primary pollutant already outnumbered PM_{10}, making it second only to $PM_{2.5}$. In YRD, O_3 became the only pollutant whose concentration rose instead of dropping.

Eight cities failed to lower the concentration of particulate matter, with PM pollution worsening in several cities

Particulate matter was assessed as a key indicator in the 161 cities based on their air-quality improvement targets. Of these cities, 90% attained their targets. PRD did the best among all the key regions, and was the first to achieve its target. Some cities in Central and Western China and Hebei

Province did fairly well, with the annual mean concentration of $PM_{2.5}$ decreasing by over 20%, including Jingzhou, Yichang, Liuzhou, Guilin, Xining, Zhuzhou, Xi'an, Hefei, Panzhihua, Qinhuangdao, Cangzhou, Shijiazhuang, Handan and Xingtai.

Cities that failed to attain their PM improvement targets in 2015 were Zhengzhou, Sanmenxia, Jiaozuo, Zaozhuang, Rizhao, Yingkou, Changchun and Langfang. Among these, Zhengzhou and Jiaozuo even saw a 9% higher annual mean concentration of $PM_{2.5}$ compared with 2014 levels, while the concentration in Yingkou increased significantly at 23%. Cities with relatively poor air quality that decreased concentrations by less than less than 5% included Sanmenxia, Zaozhuang, Jinan, Dezhou, Harbin, Shenyang, Changchun and Zigong.

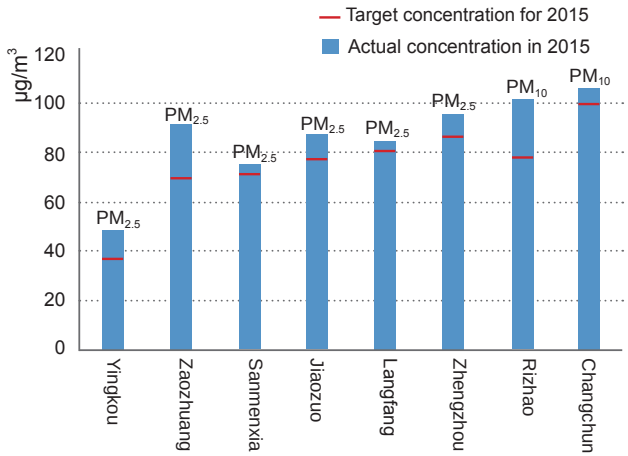


Fig.Cities that failed to achieve PM reduction target in 2015

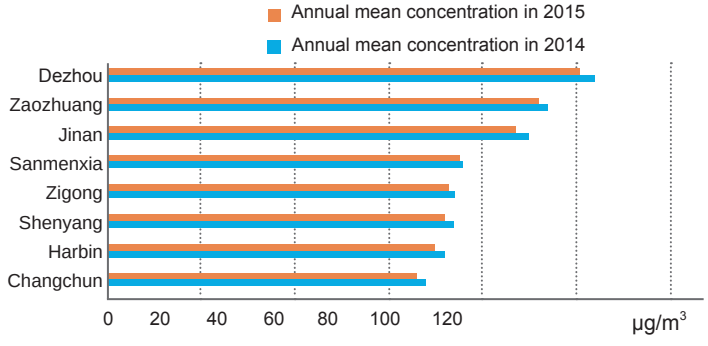


Fig.Cities that had poor air quality and realized less than 5% $PM_{2.5}$ concentration reduction in 2015

Policy Measures

Improvement in air quality relies heavily on sustained efforts towards air pollution prevention and control. In 2015, significant improvements were seen in many aspects, including coal control, VOCs control, control of emissions from ports and vessels, and regional collaboration.

Total Coal Consumption Control Achieving "Ten Measures" Target Ahead of Schedule and Comprehensive Efforts Towards Using Clean Coal

Due to China's energy availability and use patterns, pollution from coal-burning is an inevitable challenge. In 2015, both total consumption control and using clean coal were adopted to alleviate pollution from burning coal. Measures like eliminating industrial coal-fired boilers were also implemented in cities such as Beijing and Shanghai to phase out coal consumption.

The national total energy consumption saw a minor increase (up by 0.9%) in 2015, but the percentage of coal of total energy consumption was 64.0%, down by 3.7% compared to 2014. The target to reduce the percentage of coal of total energy consumption to 65% or lower by 2017 from the Action Plan was accomplished ahead of schedule.

The raw coal separation rate reached 65.9%, which is close to the target of 70% or above for 2017. During the 12th Five-Year Plan period, the total capacity of coal-fired units with desulfurization increased from 530 million kW to 890 million kW, with the installation rate of desulfurization facilities increasing from 83% to more than 99%. The total capacity of coal-fired units equipped with denitration facilities increased from 80 million kW to 830 million kW, with the installation rate increasing from 12% to 92%.

An executive meeting of the State Council set the requirement that all coal-fired power plants that can be retrofitted in China should achieve ultra-low emissions by 2020. For this goal, MEP, National Development and Reform Commission and National Energy Administration issued relevant documents to specify the schedule, electricity rate subsidies, rewards on generated electricity and discharge fees along with credit and financing support.

Initiating VOCs Discharge Fees and Comprehensive Control Measures in Major Cities

VOCs are precursors to ozone and fine particulate matters - controlling them is a key task for air pollution prevention and

control. However, since the problem was identified late, there are great technical difficulties involved with the management and control of VOCs from complicated sources. In 2015, China initiated comprehensive control of VOCs in the petrochemical industry by setting industrial emission standards of pollutants for three sectors, petroleum refining, petroleum chemistry, and synthetic resin. Such standards served as policy basis for VOCs control in key industries.

A pilot for Measures for VOCs Discharge Fees was also implemented throughout the country with petrochemical, packaging, and printing industries being the pilot sectors. Shortly after, regulations on charging VOCs emissions were released in five provinces and cities, including Beijing, Shanghai, Jiangsu Province, Anhui Province, and Hunan Province.

Emission Control Areas for Vessels Addressing the Blind Spots

China's east coast has some of the world's biggest ports. Of the top ten ports in terms of handling capacity in 2014, seven were in China. With the relatively stagnant pollution control policies, pollutants discharged from ports and vessels have become a major source of air pollution in cities like Shanghai, Guangzhou and Shenzhen.

To address the issue, the national government issued a policy document to set policies and targets for the prevention and control of vessel and port pollution in 2015 for 2015-2020. PRD, YRD and Bohai Rim were required to set up emissions control areas for vessels in their water areas. At the regional level, BTH and YRD both required that emissions from vessels and ports be managed through air pollution prevention and control coordination mechanism in 2015.

Regional Prevention and Control Measures Implemented in BTH, and YRD Efforts Relatively Slower

As air pollution usually has regional impacts, regional collaboration that involves all cities is important, and strategies must be coordinated and focused on integrating social, economic, and environmental considerations. In 2015, regional collaboration deepened on the prevention and control of air pollution in key regions, particularly in the BTH region. A joint mechanism for environmental law enforcement and control of motor vehicle emissions was initiated. Guidelines for an integrated approach were enacted through creating a cooperation framework agreement and coordinated development plan. Beijing was matched with Langfang and Baoding, while Tianjin with Tangshan and Cangzhou, so that these cities could provide mutual support for air pollution control funds and technologies.

YRD identified key tasks for air pollution prevention and control, including total coal consumption control and replacing with clean-energy, upgrading and retrofitting of coal-fired power plants for energy conservation and emission reductions, industrial restructuring and pollution prevention and control, vehicle pollution prevention and control, and agricultural waste burning and dust pollution control. However, from the publicly available information, it seems that YRD has yet to formulate policy documents and action measures through joint control beyond the measures for prevention and control of pollution from vehicles and vessels.

Government Monitoring and Supervision yet Publicly Available Data on Progress Insufficient

In 2015, the MEP held more admonitory talks and established a working mechanism for environmental protection supervision. Through "government supervision", local governments were urged to take responsibility for local environmental quality and ensure effective implementation of the Action Plan. In 2015, the MEP held admonitory talks on air pollution with key government officials from 15 cities, doubling the number of cities that were involved in 2014.

The environmental protection supervision mechanism established by the MEP in 2015 shifted the focus from "supervising enterprises" to "supervising governments". By the end of 2015, the MEP had conducted comprehensive supervision of 33 cities on environmental issues such as air pollution. Through the comprehensive supervision, 31 cities were admonished, regional environmental impact assessments were not approved in 20 cities (counties), and local governments were required to address 176 problems within specified time frames. However, there is still insufficient publicized information on the assessment of pollution control effects after the admonitory talks, with only a few cities including Linyi and Zhumadian having publicly disclosed results after the talks.

Recommendations

Since the Action Plan was enacted in 2013, experience has accumulated at the national, regional and municipal level from implementing a variety of measures. Such experience is crucial for cities to be able to accomplish their air quality improvement targets for 2017 and restore air quality. As this report was being drafted, the Chinese Academy of Engineering published the interim review on the Action Plan. According to the review, in the next few years, China needs to further use energy structure adjustment to

reduce pollution, establish a more effective haze treatment system, enhance capacity in dealing with heavy pollution days, and ensure the long-term improvement of air quality. As an independent third-party, Clean Air Asia provides the following recommendations on air pollution prevention and control in Chinese cities for the short and long-term:

Set up a timeline and roadmap for air quality attainment

For most cities in China, the 2017 target for particulate matter ($PM_{2.5}$ and PM_{10}) set in the Action Plan is still far behind the national standard and WHO guidelines. Moreover, as a document aimed at reducing particulate matter level, the Action Plan does not sufficiently deal with combined pollution, such as the increase of ozone concentration in recent years.

A clear timeline and roadmap is key to formulating mid- to long-term air quality improvement strategies at the national and local level with step-by-step actions. Experience from many developed countries and cities prove this is an effective strategy. However, this has not been done in China's current policies, laws and regulations. To protect public health, the MEP should provide clear timelines and roadmaps for air-quality attainment in regions and cities during the 13th Five Year Plan period. Relevant attainment plans, technical methods, assessment methods, and incentive mechanisms should also be enacted.

Create a science-based system for pre-evaluation, tracking, and post-implementation evaluation of policies

After the State Council's release of the Action Plan, governments at all levels introduced a series of policy measures. However, as is often the case, local governments are unsure if the measures will work under local conditions and often lack understanding of the actual impacts of the measures. This creates a lack of confidence in achieving the relevant targets on time.

Setting up a science-based system for the pre-evaluation, tracking, and post-implementation evaluation of policies will help governments choose the most effective measures, adjust their control plans during the implementation process, and improve the precision of control measures. This is essential to air quality management. The 13th Five Year Plan period is an ideal time for setting up such a system. Governments at all levels, especially those at the municipal level, should incorporate it in their air quality management work plans.

Enhance capacity support in air quality management for local governments

In 2015, the focus of the environmental protection supervision mechanism was shifted from "supervising enterprises" to "supervising governments". In conjunction with measures like city ranking, public admonitory talks, and liability statements, the national government put significant pressure on local governments to implement the Action Plan. However, cities still need technical capacity and resources in order to achieve air quality improvement.

This report finds that cities that failed to attain the 2015 air quality target and suffered from poor air quality and slow progress were concentrated in Henan Province, Shandong Province, and Northeast China. Compared with the more developed regions, these cities had less experience and insufficient capacity in air pollution prevention and control. In addition to using direct pressure, the national government should also provide comprehensive capacity-building for local policymakers with relatively weak management capacity.

Continue to release information on air pollution prevention and control

By implementing the "three-step" plan on air quality monitoring system building and reporting, China has achieved a major accomplishment towards publicizing information related to air quality. It is now the third year for the Action Plan implementation and CAA has still found it difficult to acquire data and information on the actual progress for the air pollution prevention and control measures, law enforcement results for air pollution cases, and the results from admonitory talks and environmental protection supervision.

This report recommends that local governments should disclose the above mentioned information to help organizations, including research institutes, NGOs, media, and the public, develop a better understanding of the progress in air pollution prevention and control in China. This will help these organizations monitor policy implementation and conduct relevant research to provide effective support to improve air quality in China.

Current Air Quality Status

At the beginning of 2015, 338 cities at or above the prefecture level across the country started to monitor and publish their air quality data in accordance with the Ambient Air Quality Standards (GB3095-2012) (the standards), providing real-time monitoring data on six pollutants (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3 and CO) and the air quality index (AQI).This report has incorporated the air quality information of 161 cities that monitored and published their air quality data according to the Ambient Air Quality Standards in the second phase of the "three-step" implementation plan for building a monitoring network. The data used in this section is sourced from disclosed government information. Constrained by data availability, this chapter presents the available data of 161 cities, but only conducts comparison of the air quality between 2014 and 2015 of the 74 cities which monitored and published their air quality since 2013, and were covered in the *China Air 2015*.

Air quality improved as a whole, but non-attainment was still widespread

Of the six pollutants, the annual mean concentration of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 was generally on the decline in 74 cities as compared with 2014, decreasing by 14.1%, 11.4%, 21.9% and 7.1% on average, respectively. In the meanwhile, the annual mean concentration of CO remained at the same level as in 2014. The figures in respect of SO_2, NO_2, CO and O_3 all attained the National Secondary Standard under the Ambient Air Quality Standards (the National Secondary Standard).

Aside from CO, of which the percentage of attainment cities decreased by 1.3%, the change in the percentage of attainment cities of other five pollutants remained the same as in 2014. Specifically, the percentages of attainment cities of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 increased by 4%, 6.8%, 6.7% and 2.8%, respectively, but the percentage of attainment cities of O_3 declined by 5.4%. 95.9% of the cities attained the standard in terms of annual mean concentration of SO_2 in 2015, representing the highest percentage of attainment. The number of attainment cities whose annual mean concentrations of the six pollutants were all in compliance increased from eight (Haikou, Lhasa, Zhoushan, Shenzhen, Zhuhai, Fuzhou, Huizhou and Kunming) in 2014 to eleven in 2015, with Xiamen, Jiangmen and Zhongshan added to the list. All the other 63 cities exceeded the standards to some extent.

BTH and its surrounding areas (including Shanxi, Shandong, Inner Mongolia and Henan) was still the region with the poorest air quality and highest frequency of heavy pollution in the country. In 2015, 70 cities at or above the prefecture level in the region recorded a total of 1,710 days of heavy or higher-level pollution, and issued 154 alerts for heavy air pollution. During December 8-10, Beijing issued a red alert on heavy pollution for the first time, which was initiated again during December 19-22.

Fine particulate matter continued to be a serious issue, with O_3 pollution worsening in key regions

In terms of non-attainment pollutants, particulate matter remained the primary pollutant among non-attainment cities. The annual mean concentration of $PM_{2.5}$ exceeding the standards ranged from 36μg/m^3 to 107μg/m^3, with the percentage of non-attainment cities reaching 83.8% (the National Secondary Standard is 35μg/m^3). The annual mean concentration of PM_{10} exceeding the standards ranged from 72μg/m^3 to 174μg/m^3, with the percentage of non-attainment cities reaching 71.6% (the National Secondary Standard is 70μg/m^3). The annual mean concentrations of $PM_{2.5}$ and PM_{10} were significantly higher than the National Secondary Standard by 1.5 and 1.3 times, respectively. Hence PM pollution continued to be the primary problem faced by the 74 cities.

In the meantime, O_3 pollution, the issue which emerged in 2014, has not been improved yet. The annual mean concentration of O_3 continued to rise, at a rate of 3.4%; and the percentage of attainment cities continued to fall, at a rate of 5.4%. In BTH, the days that saw O_3 as the major pollutant already outnumbered PM_{10}, making it second only to $PM_{2.5}$. In YRD, O_3 became the only pollutant whose concentration rose instead of dropping.

Air quality improved to varying degrees in different regions, while air quality of some cities worsened

The concentration of pollutants in BTH, YRD and PRD continued to show a gradient feature. The concentration of pollutants and the number of non-attainment days were significantly higher in BTH than in YRD and PRD, but in terms of $PM_{2.5}$, O_3 and PM_{10}, the pollution levels were getting closer to the average levels of the 74 cities. In YRD, except for O_3, the annual mean concentration of which was 8.7% higher than the average level of the 74 cities, the concentrations of other pollutants in the region were lower than the average levels. PRD retained its lead in terms of air quality, with concentrations of the six pollutants all complying with the standards. In addition, among 10.8% of non-attainment days in PRD, neither heavy nor severe pollution was reported.

The annual mean concentrations of $PM_{2.5}$ in cities of Hebei, Shandong, Henan, Liaoning, and Hubei were more than two times higher than the National Secondary Standard in 2015. The air quality of some cities worsened in 2015, such as Zhengzhou and Jiaozuo, the $PM_{2.5}$ concentrations of which increased by 9% than in 2014, and the $PM_{2.5}$ concentration in Yingkou increased substantially by 23%.

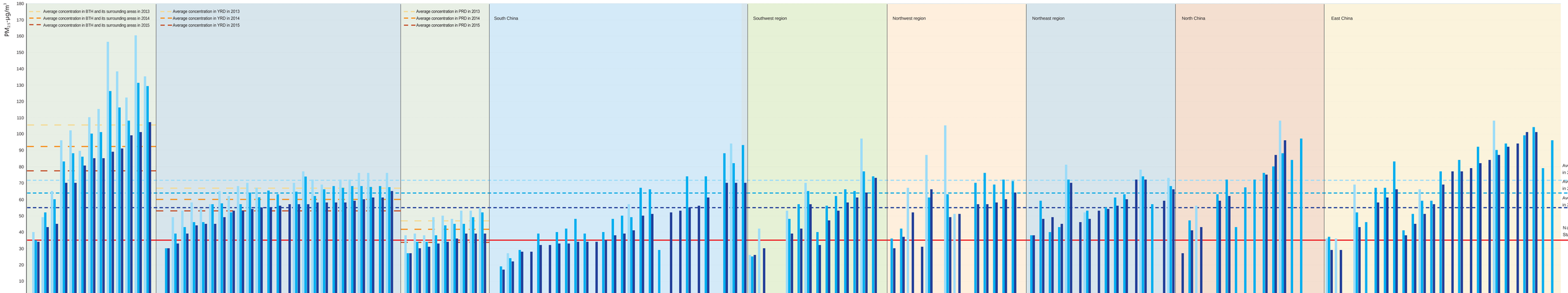


Fig.1: Annual Mean Concentration of $PM_{2.5}$ in 161 Cities and Key Regions

Annual mean concentration in 2013
Annual mean concentration in 2014
Annual mean concentration in 2015

◆ The annual mean concentration of $PM_{2.5}$ continued to decrease, yet still heavily exceeded the standards. Compared to 2014, in 2015, the range of annual mean concentration of $PM_{2.5}$ in 74 cities decreased from 23-130 μg/m^3 to 22-107 μg/m^3, and the mean concentration decreased from 64 μg/m^3 to 55 μg/m^3, which are 1.8 and 1.5 times higher than the National Secondary Standard (35 μg/m^3), respectively.

◆ The number of attainment cities increased: The percentage of attainment cities increased from 12.2% to 16.2%.

◆ Among the three key regions, PRD experienced the greatest decrease in the annual mean concentration of $PM_{2.5}$, complying with the National Secondary Standard. A 19% decrease in the concentration was noted in PRD, from 42μg/m^3 to 34μg/m^3. A 11.7% drop in the concentration was noted in YRD, from 60 μg/m^3 to 53 μg/m^3, and a 17.2% decrease was noted in BTH, from 93 μg/m^3 to 77 μg/m^3.

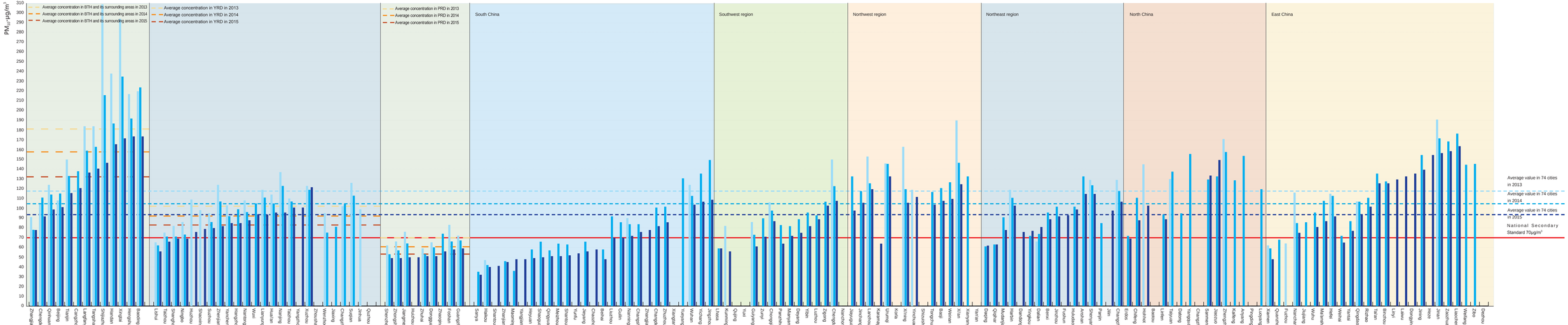


Fig.2: Annual Mean Concentration of PM_{10} in 161 Cities and Key Regions

Annual mean concentration in 2013
Annual mean concentration in 2014
Annual mean concentration in 2015

◆ The annual mean concentration of PM_{10} continued to decrease, yet still heavily exceeded the standards. Compared to 2014, in 2015, the range of annual mean concentration of PM_{10} in 74 cities decreased from 42-233 μg/m^3 to 40-174 μg/m^3, and the mean concentration decreased from 105 μg/m^3 to 93 μg/m^3, which were 1.5 and 1.3 times higher than the National Secondary Standard (70 μg/m^3), respectively.

◆ The number of attainment cities increased: The percentage of attainment cities increased from 21.6% to 28.4%.

◆ Among the three key regions, BTH was ranked as the highest in terms of the annual mean concentration of PM_{10}, but experienced the greatest decrease. A 16.4% drop in the concentration was noted in BTH, from 158 μg/m^3 to 132 μg/m^3. A 9.8% decrease was noted in YRD, from 92 μg/m^3 to 83 μg/m^3, and a 13.1% drop was noted in PRD, from 61 μg/m^3 to 53 μg/m^3.

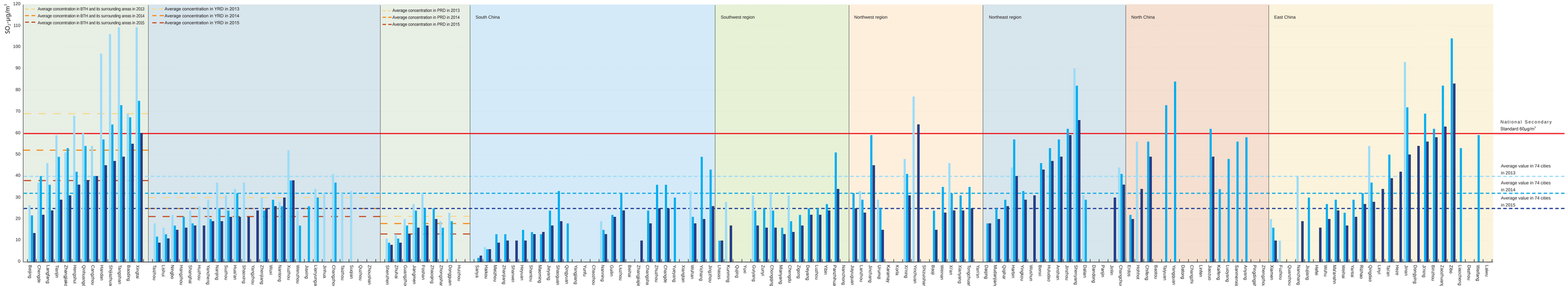


Fig.3: Annual Mean Concentration of SO_2 in 161 Cities and Key regions

◆ The annual mean concentration of SO_2 complied with the standards and further declined on that basis. Compared to 2014, in 2015, the range of annual mean concentration of SO_2 in 74 cities decreased from 6-82 μg/m³ to 5-71 μg/m³, and the mean concentration decreased from 32 μg/m³ to 25 μg/m³, complying with the National Secondary Standard (60 μg/m³).

◆ All the cities can be expected to reach the standard: The percentage of attainment cities has increased from 89.2% to 95.9%. SO_2 has become a pollutant with the largest number of attainment cities.

◆ All three key regions complied with the standards and experienced a decrease in the annual mean concentration of SO_2. BTH was ranked as the highest in terms of the annual mean concentration, and a 26.9% drop in the concentration was noted in BTH, from 52 μg/m³ to 38 μg/m³. A 16% decrease was noted in YRD, from 25 μg/m³ to 21 μg/m³, and a 27.8% decrease was noted in PRD, from 18 μg/m³ to 13 μg/m³.

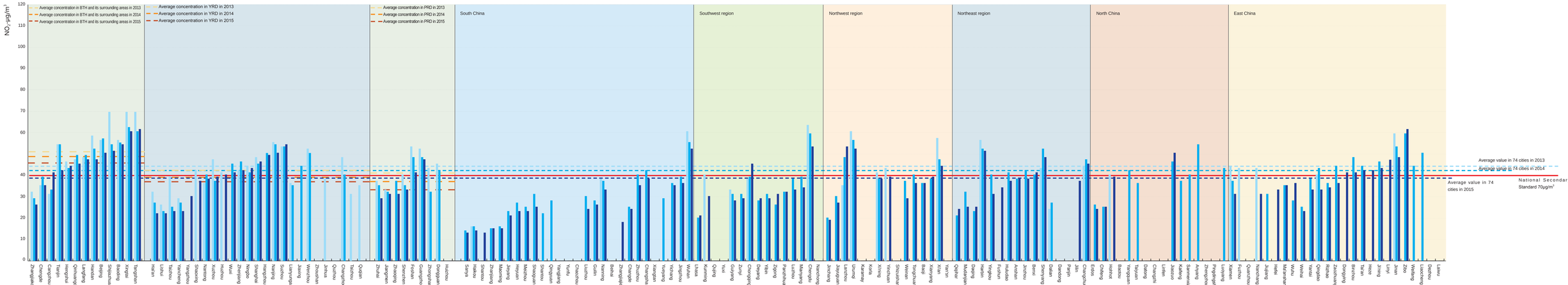


Fig.4: Annual Mean Concentration of NO_2 in 161 Cities and Key Regions

Annual mean concentration in 2013
Annual mean concentration in 2014
Annual mean concentration in 2015

◆ The annual mean concentration of NO_2 complied with the standards. Compared to 2014, in 2015, the range of annual mean concentration of NO_2 in 74 cities decreased from 16-61 $\mu g/m^3$ to 14-61 $\mu g/m^3$, and the mean concentration decreased from 42 $\mu g/m^3$ to 39 $\mu g/m^3$, complying with the National Secondary Standard (40$\mu g/m^3$).

◆ The number of attainment cities increased further: The percentage of attainment cities increased from 48.6% to 51.4%.
◆ Among the three key regions, BTH was ranked as the highest in terms of the annual mean concentration of NO_2. A 6.1% drop in the concentration was noted in BTH, from 49 $\mu g/m^3$ to 46 $\mu g/m^3$. A 5.1% decrease was noted in YRD, from 39 $\mu g/m^3$ to 37 $\mu g/m^3$, and a 10.8% decrease was noted in PRD, from 37 $\mu g/m^3$ to 33 $\mu g/m^3$. In YRD and PRD, the annual mean concentration of NO_2 complied with the standards and further declined on that basis.

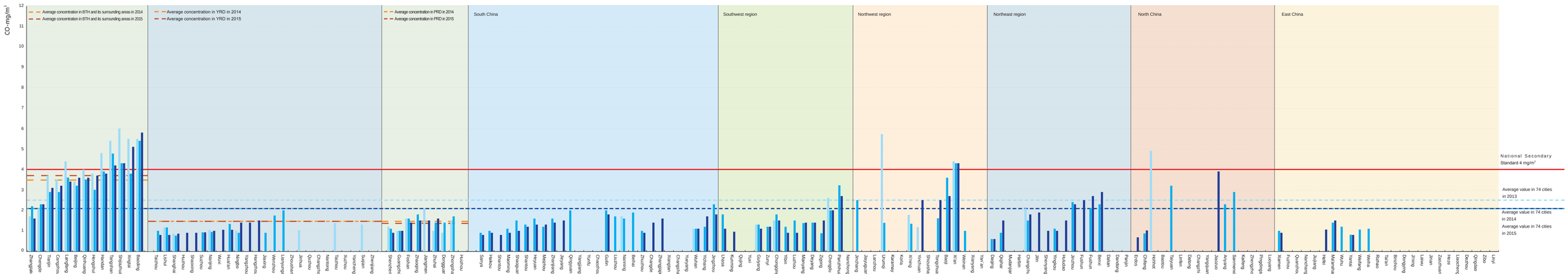


Fig.5: 24-Hour Mean Concentration of CO in 161 Cities and Key Regions

Annual mean concentration in 2013
Annual mean concentration in 2014
Annual mean concentration in 2015

◆ The annual mean concentration of CO remained at the same level as the previous year. In 2015, the 95th percentile of the daily average concentration range in 74 cities changed from 0.9-5.4 mg/m³ to 0.9-5.8 mg/m³. The average concentration was 2.1 mg/m³, complying with the National Secondary Standard (4 mg/m³).

◆ The number of attainment cities decreased slightly: the number was 70, one less than in 2014.

◆ The annual mean concentration of three key regions complied with the standards, but the mean concentration in BTH increased; A 5.7% increase in the mean concentration was noted in BTH, from 3.5 mg/m³ to 3.7 mg/m³. In YRD, the mean concentration remained at the same level as the previous year, which was 1.5 mg/m³. A 6.7% decrease was noted in PRD, from 1.5 mg/m³ to 1.4 mg/m³.

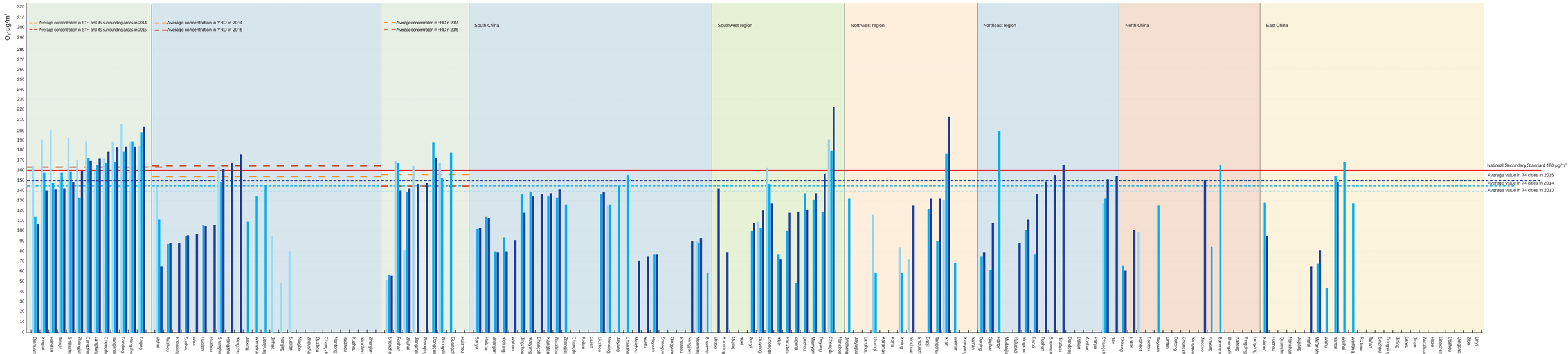


Fig.6: Daily Maximum 8-Hour Average Concentration of O_3 in 161 Cities and Key Regions

◆ Although the annual mean concentration of O_3 complied with the standards, it continued to increase: In 2015, even though the 90th percentile of the daily maximum 8-hour average concentration of O_3 in 74 cities was in compliance with the National Secondary Standard (160 μg/m^3), the range of the concentration increased from 69-200 μg/m^3 to 95-203 μg/m^3. The mean concentration increased from 145 μg/m^3 to 150 μg/m^3.

◆ The number of attainment cities continued to decrease: The percentage of attainment cities decreased from 67.6% to 62.2%.

◆ Among the three key regions, the annual mean concentration of O_3 in BTH remained at the same level as the previous year, which was 162 μg/m3, failing to comply with the standards. A 5.8% increase was noted in YRD, from 154 μg/m^3 to 163 μg/m^3. A 7% decrease was noted in PRD, from 156 μg/m^3 to 145 μg/m^3, showing that improvements were emerging.

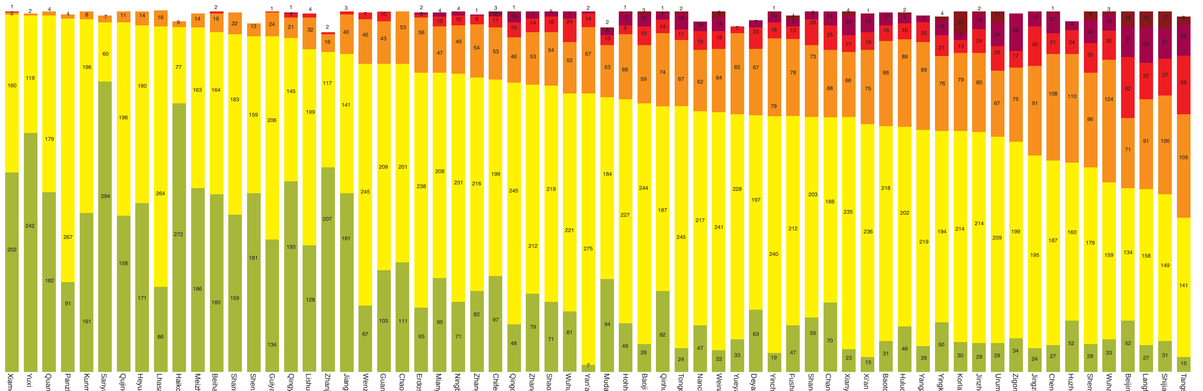
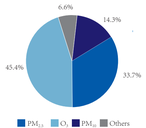


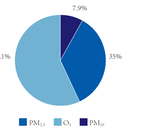
Fig.7: Distribution of AQI in Selected Cities in 2015

1-50 Good | 51-100Moderate | 101-150 Unhealthy for Sensitive Groups | 151-200 Unhealthy | 201-300 Very Unhealthy | >300 Hazardous

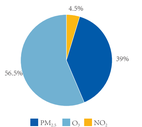
* Data collected from cities that publish their AQI distribution



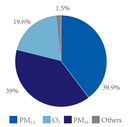
The number of non-attainment days in Dalian was 95 in 2015



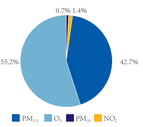
The number of non-attainment days in Chaozhou was 53 in 2015



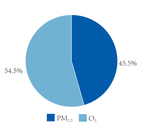
The number of non-attainment days in PRD was 39 in 2015



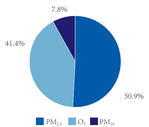
The number of non-attainment days in Tongchuan was 96 in 2015



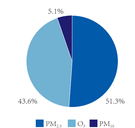
The number of non-attainment days in Huzhou was 143 in 2015



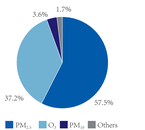
The number of non-attainment days in Zhoushan was 33 in 2015



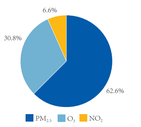
The number of non-attainment days in Yangzhou was 116 in 2015



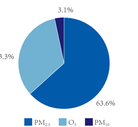
The number of non-attainment days in Heyuan was 14 in 2015



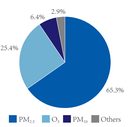
The number of non-attainment days in YRD was 102 in 2015



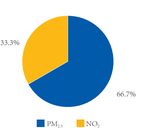
The number of non-attainment days in Shanghai was 107 in 2015



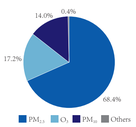
The number of non-attainment days in Deyang was 96 in 2015



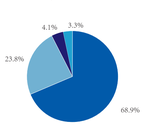
The number of non-attainment days in Wuhan was 173 in 2015



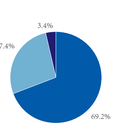
The number of non-attainment days in Xiamen was 3 in 2015



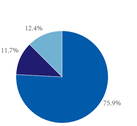
The number of non-attainment days in BTH was 174 in 2015



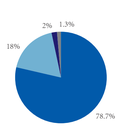
The number of non-attainment days in Jinzhou was 122 in 2015



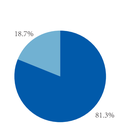
The number of non-attainment days in Jingzhou was 146 in 2015



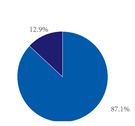
The number of non-attainment days in Tianjin was 145 in 2015



The number of non-attainment days in Mianyang was 61 in 2015



The number of non-attainment days in Changsha was 107 in 2015



The number of non-attainment days in Karamay was 31 in 2015

Fig.8: Number of Days with Different Primary Pollutants in Key Regions and Cities in 2015

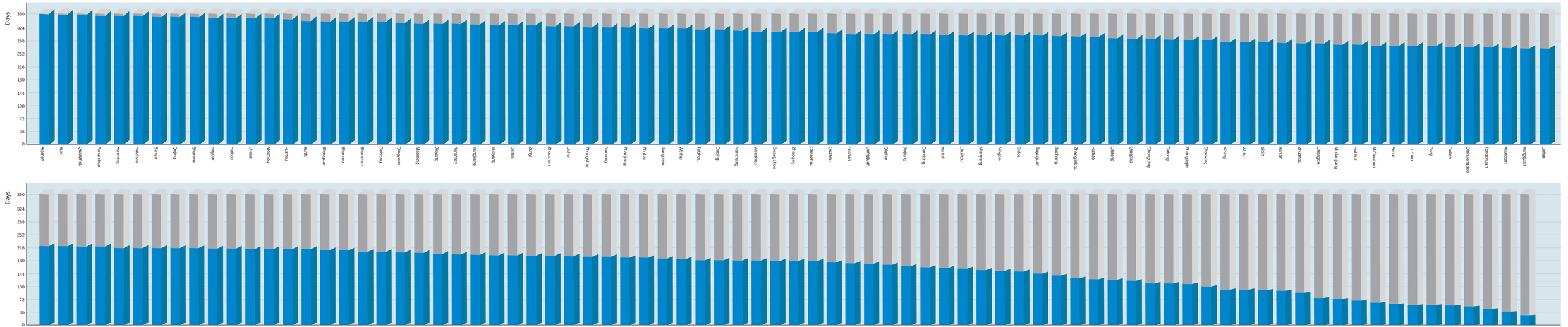


Fig.9: Number of Attainment Days in 161 Cities in 2015

Policy Implementation and Progress

Major Events of Air Pollution Prevention and Control in 2015

2015 was a critical year for the implementation of the Air Pollution Prevention and Control Action Plan (hereinafter, the Action Plan). In this year, significant policy advcances were seen in many areas, including coal control, VOCs control, control of emissions from ports and vessels, and regional collaboration. See Figure 10.

In 2015, both total consumption control and using clean coal were adopted to alleviate pollution from burning coal. Measures like eliminating industrial coal-fired boilers were also implemented in cities such as Beijing and Shanghai to phase out coal consumption. The target to reduce the percentage of coal in total energy consumption to 65% or lower by 2017 was accomplished ahead of schedule, and the raw coal separation rate was close to the target of 70% or above for 2017. During the 12th Five-Year Plan period, the installation rate of desulfurization facilities and denitration facilities in coal fired units significantly increased. In addition, an executive meeting of the State Council set the requirement that all coal-fired power plants that can be retrofitted in China should achieve ultra-low emissions by 2020.

China initiated comprehensive control of VOCs in the petrochemical industry by setting industrial emission standards of pollutants for three sectors, petroleum refining, petroleum chemistry, and synthetic resin. Such standards served as policy basis for VOCs control in key industries. In addition, a pilot for Measures for VOCs Discharge Fees was also implemented throughout the country with petrochemical, packaging, and printing industries being the pilot sectors. Shortly after, regulations on charging VOCs emissions were released in five provinces and cities, including Beijing, Shanghai, Jiangsu Province, Anhui Province, and Hunan Province.

To address pollution from ports and vessels, the national government issued a policy guidance document to set policies and targets for the prevention and control of vessel and port pollution in 2015 for 2015-2020. PRD, YRD and Bohai Rim were required to set up emissions control areas for vessels in their water areas.

In 2015, regional collaboration deepened with regards to the prevention and control of air pollution in key regions, particularly in the BTH region. A joint mechanism for environmental law enforcement and control of motor vehicle emissions was initiated. Guidelines for an integrated approach were enacted through creating a cooperation framework agreement and coordinated development plan. Beijing was matched with Langfang and Baoding, while Tianjin with Tangshan and Cangzhou, so that these cities could provide mutual support for air pollution control funds and technologies.

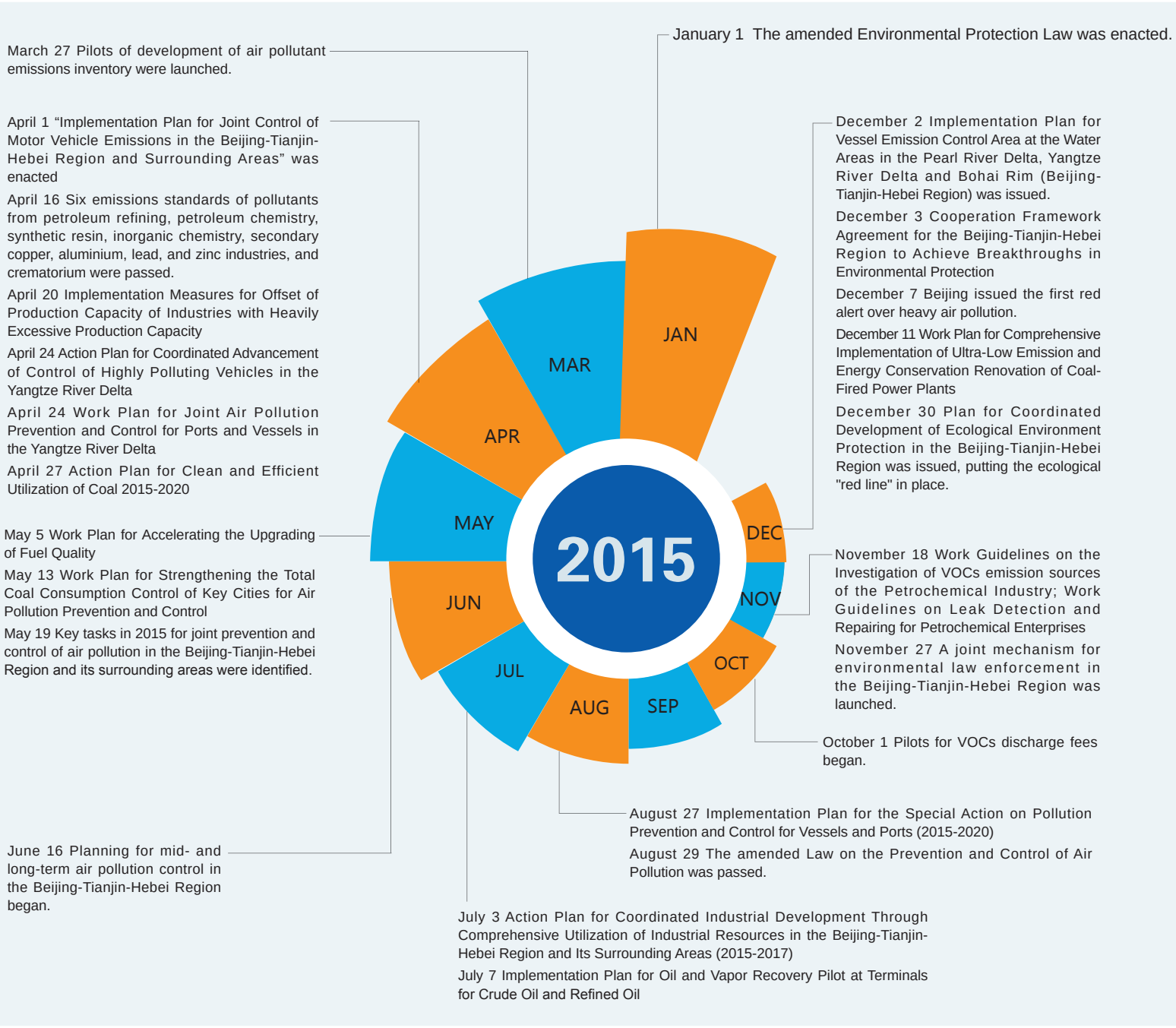


Fig.10: Major Events of Air Pollution Prevention and Control in 2015

Air Pollution Prevention and Control Policy Framework

In 2013, the Action Plan set an air pollution prevention and control policy framework that covered capacity building, emission reduction measures, and supporting measures. In 2015, the national government issued a number of supporting policies to further air pollution prevention and control within the existing policy framework. See Figure 11 for details.

More than 120 of the 161 cities issued their implementation plan for their clean air action plans of 2015. These plans, covering energy structure adjustment, industrial restructuring, vehicle pollution control, dust control, and comprehensive control over industrial pollution, set forth requirements with respect to the air quality improvement targets, control measures, supporting measures, responsible entities, and deadlines. For some of the cities where soot is the main air pollutant in the winter, the local authorities also issued specific work plans that aim to reduce air pollution caused by coal-fired heating and vehicle cold-start and warm-up in winter.

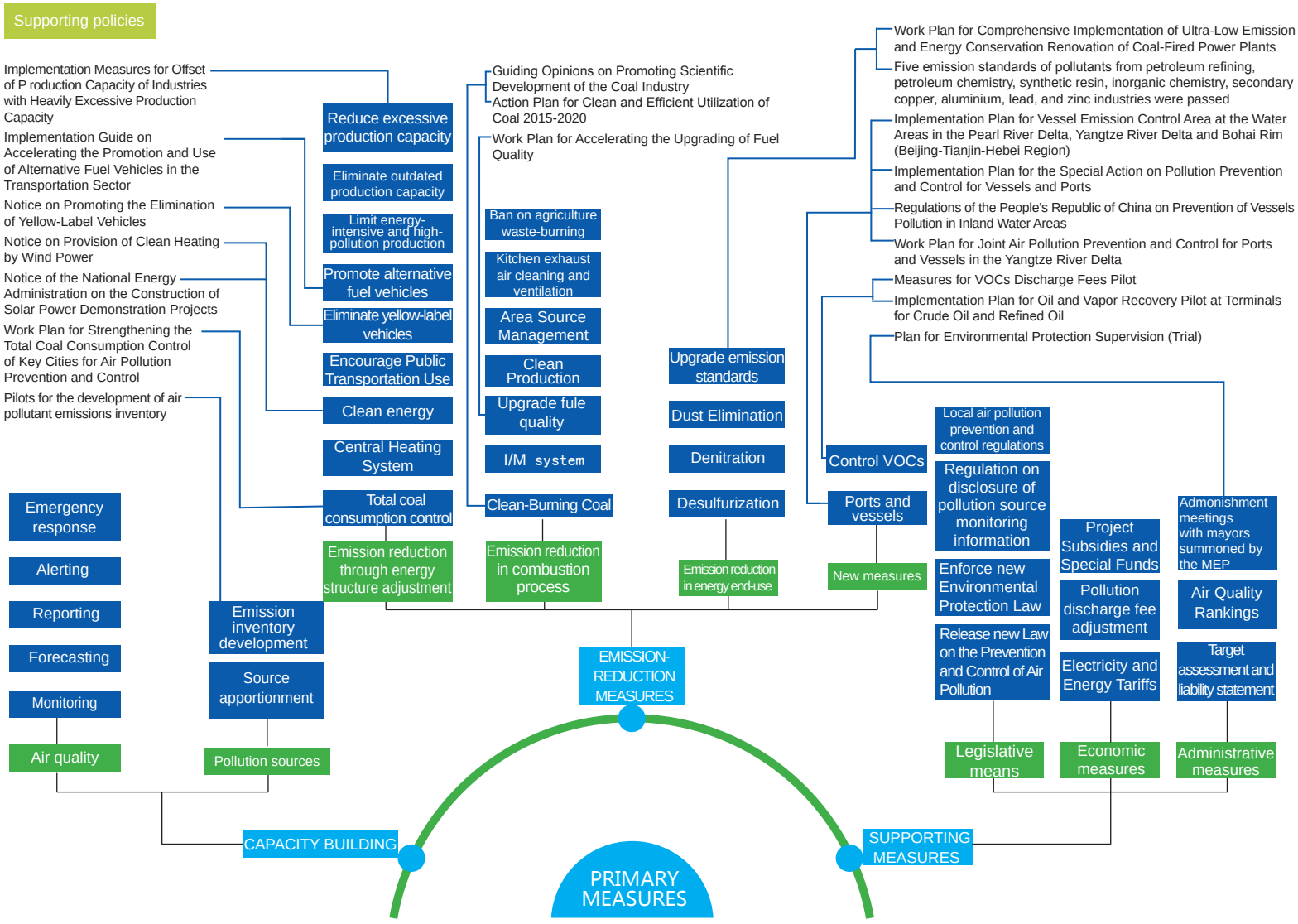


Fig.11: Air Pollution Prevention and Control Policy Framework and Documents in 2015

Targets for 2015

All the implementation plans issued by cities in 2015 included air quality improvement targets for 2015, identifying $PM_{2.5}$ or PM_{10} as the primary pollutants for improvement, and setting target pollutant concentration levels or concentration reduction percentages compared with a benchmark year (2012/2013/2014). See Figure 12-13 for further details.

Air Quality Improvement Targets

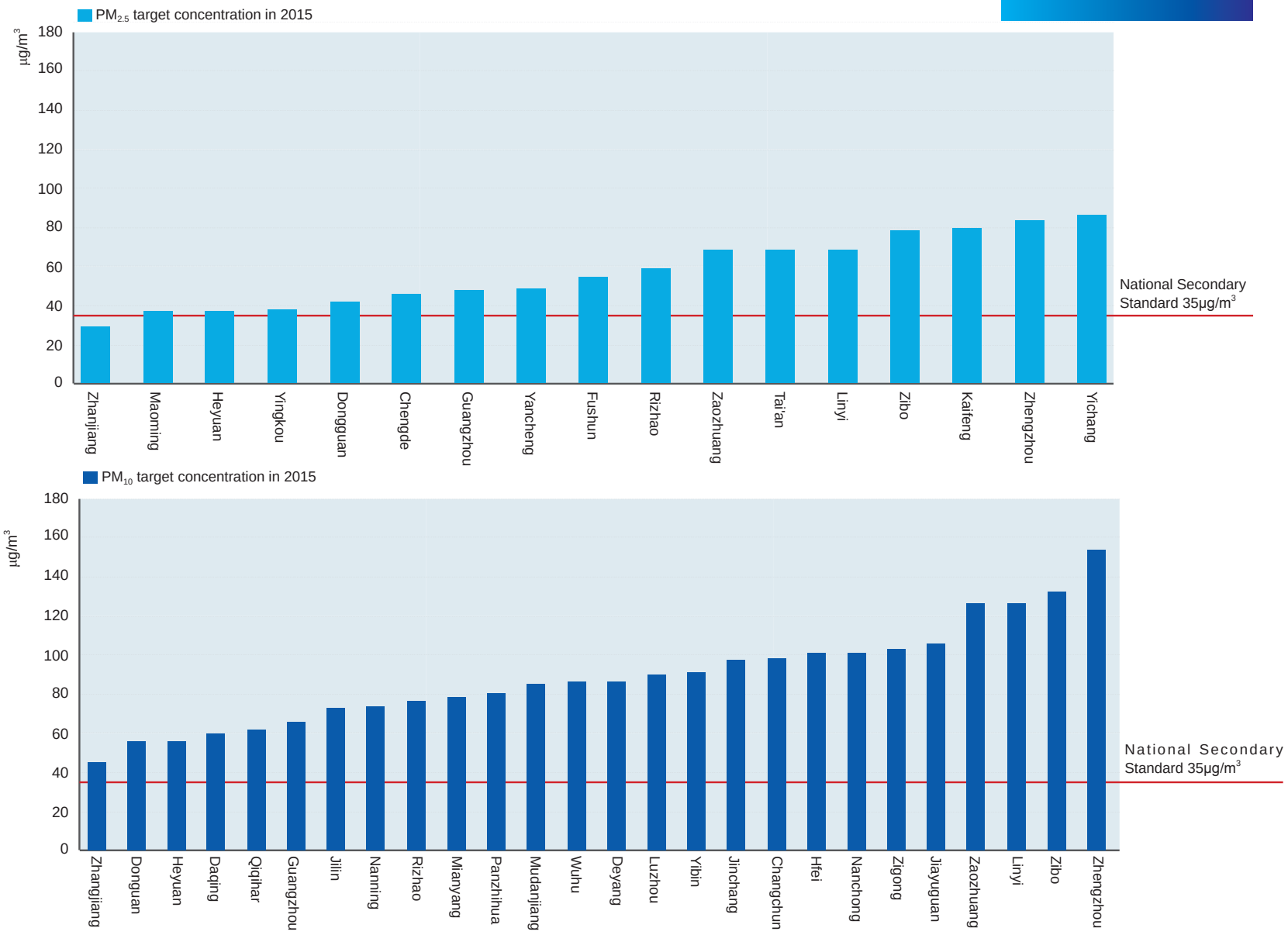


Figure 12 City Air Quality Improvement Targets for 2015 (measured by target concentration)

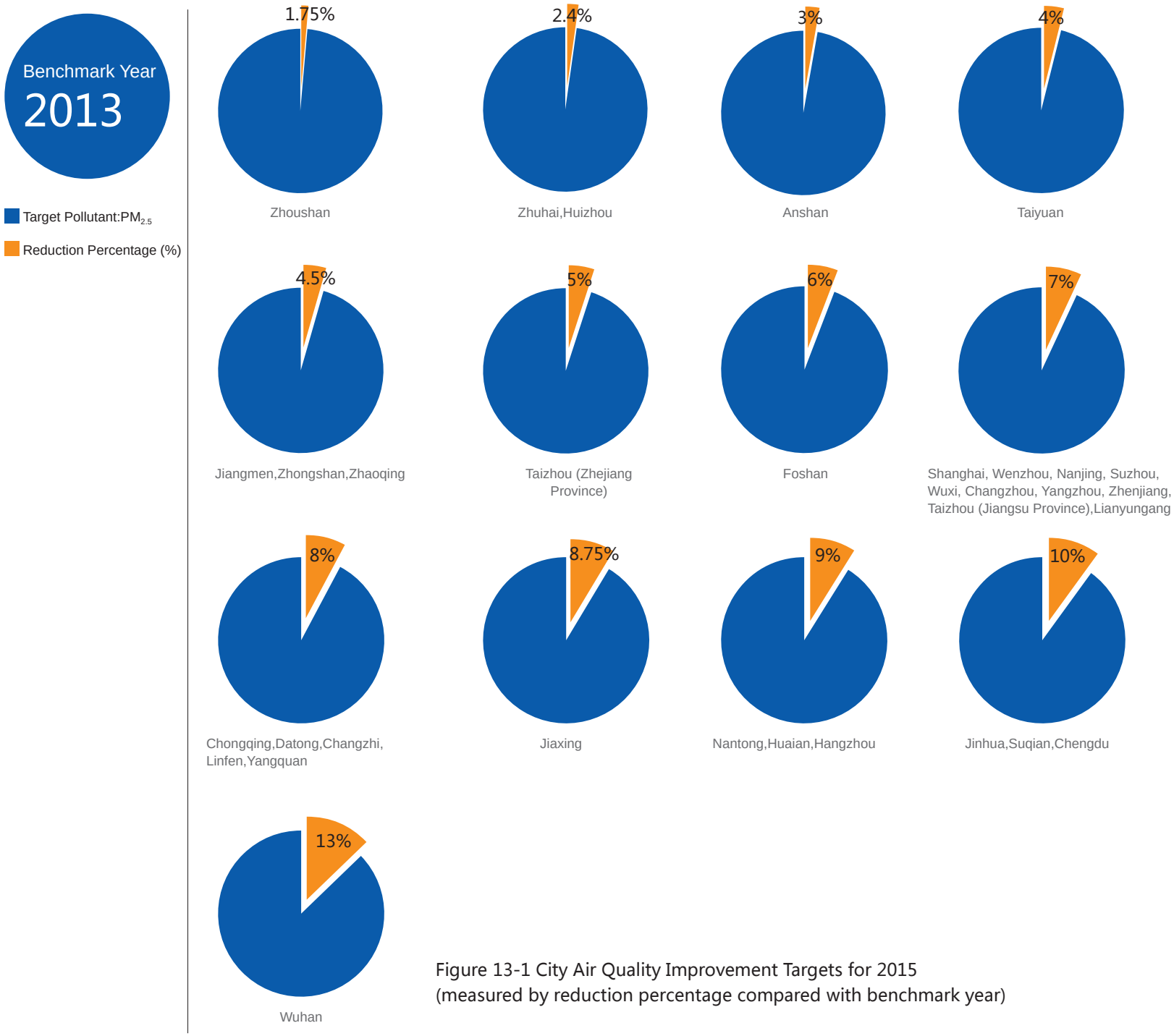


Figure 13-1 City Air Quality Improvement Targets for 2015
(measured by reduction percentage compared with benchmark year)

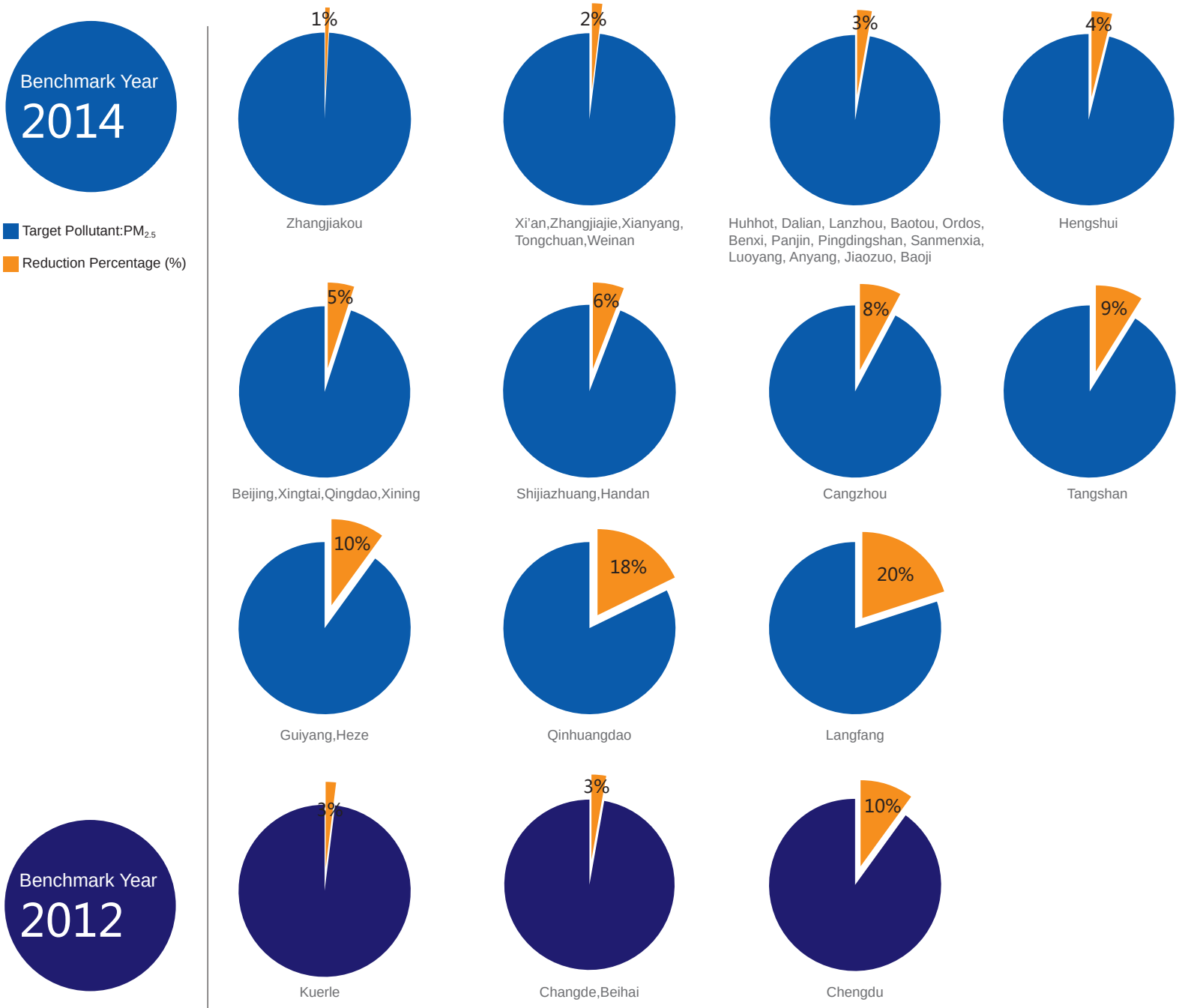


Figure 13-2 City Air Quality Improvement Targets for 2015
(measured by reduction percentage compared with benchmark year)

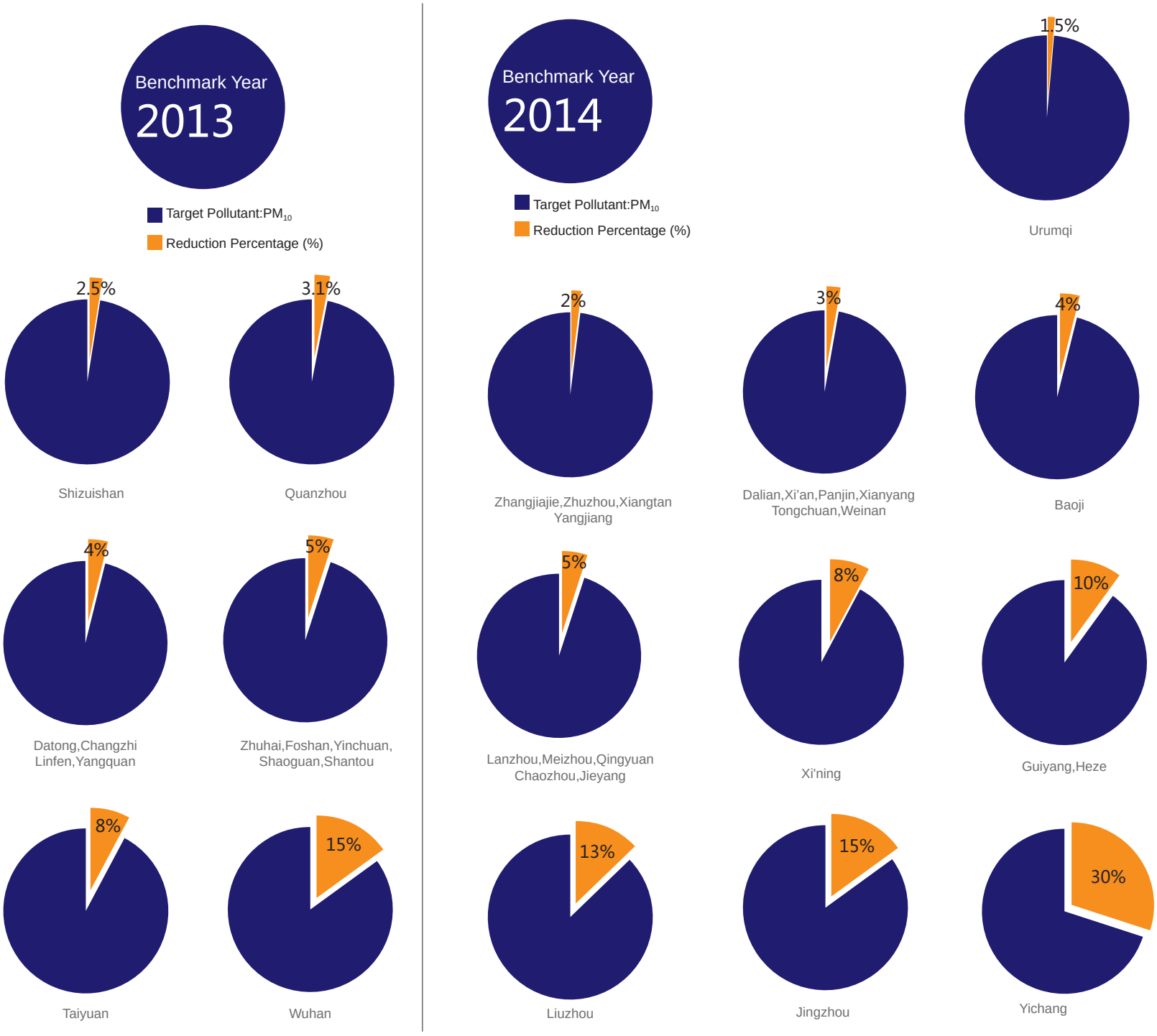


Fig.13: City Air Quality Improvement Targets for 2015 （measured by reduction percentage compared with benchmark year）

In the cities that set PM_{10} as the primary target for air quality improvement (Hefei, Changchun, Harbin, Mudanjiang, Wuhu, Jingzhou, Zhuzhou, Guilin, Liuzhou, Mianyang, Yibin, Luzhou, Zigong, Deyang, Shaoguan, Shantou and Meizhou), they had the highest number of days with $PM_{2.5}$ as the primary pollutant in 2014. Therefore, we recommend that these cities consider including reducing $PM_{2.5}$ levels as an obligatory target in their policies.

Comparison of the Targets for 2015 with the Actual Concentrations in 2015 and the Targets for 2017

By using the published annual mean concentrations of $PM_{2.5}$ and PM_{10} in 2013 and 2014, this report calculates the air quality improvement targets (the concentration of $PM_{2.5}$ or PM_{10}) for cities in 2015. The report compares cities' 2015 targets with their air quality improvement targets for 2017 (see Figure 14-15) and actual annual mean concentrations in 2015 (see Figure 16), and thus we provide information on level of attainment of 2015 target and the remaining gap for each city in terms of achieving their 2017 targets.

- Most cities attained their targets, while those that failed to achieve the targets included: Zhengzhou, Sanmenxia, Jiaozuo, Yingkou, Changchun, and Langfang.

- For some cities, their phased targets for 2015 are already close to the targets they have set for 2017. For example, Wuhan aimed to reduce the annual mean concentration of $PM_{2.5}$ by 13% in 2015 and 20% in 2017 respectively, compared to 2013 levels. In 2015, Wuhan's actual annual mean concentration of $PM_{2.5}$ was 70μg/m^3 (the target was 81.78μg/m^3). Their 2017 goal was already accomplished in 2015, when annual mean concentrations of $PM_{2.5}$ were already 25.5% lower than 2013 (94μg/m^3).

- For some cities, their targets for 2015 had been set close to or the same as their targets for 2017, but failed to attain their 2015 targets. For example, Zhengzhou set the target in 2015 to reduce $PM_{2.5}$ concentrations to 85μg/m^3, which is also its 2018 target. Zhengzhou has also decided to further tighten its target for 2016, aiming to reduce the $PM_{2.5}$ concentration to 79μg/m^3. However, the annual mean concentration in 2015 in Zhengzhou was not reduced but instead increased by 9.1% compared to 2014, making them stray further and further away from the 2017 target.

- Some cities' 2015 targets are far away from their 2017 targets and they must greatly improve their air pollution management efforts. For instance, Pingdingshan's target for 2015 was to reduce the concentration of $PM_{2.5}$ by more than 3% compared to 2014, but it is still far away from achieving its goal of reducing the $PM_{2.5}$ concentrations in the urban districts by more than 15% in 2017 compared to 2014 levels.

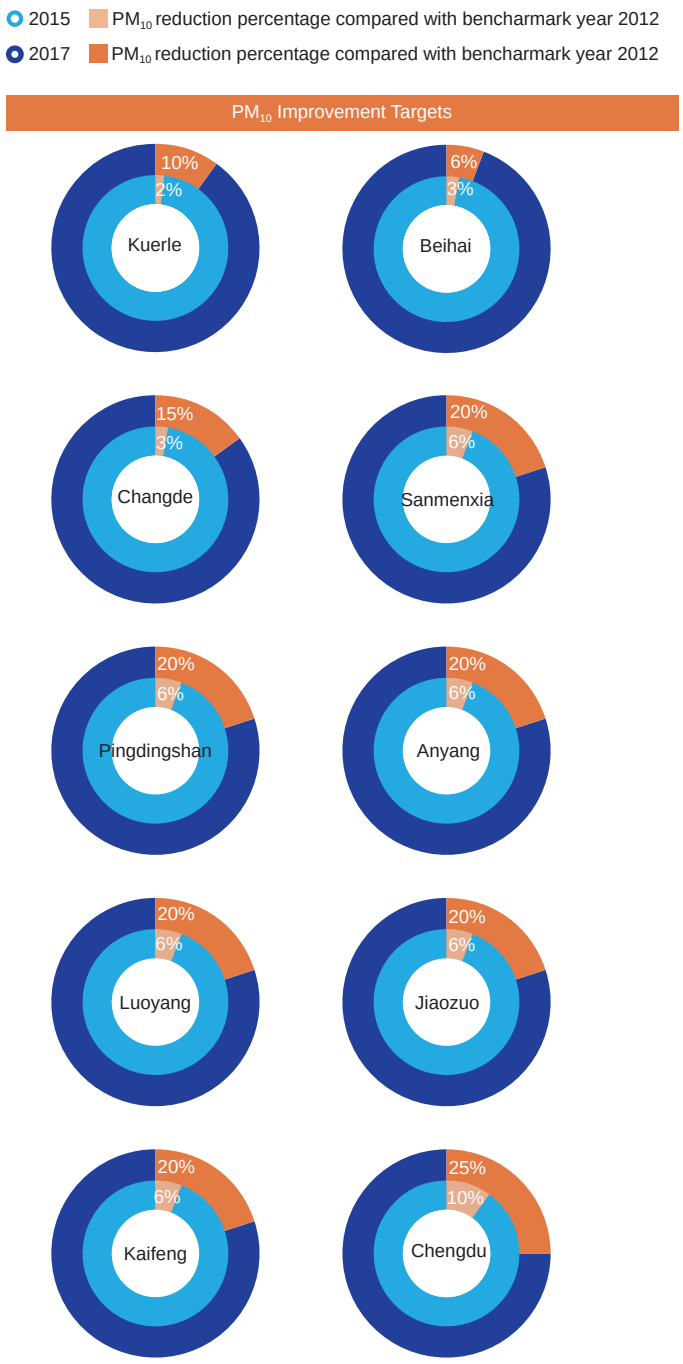


Fig.14: Comparison of Air Quality Improvement Targets for 2015 and 2017

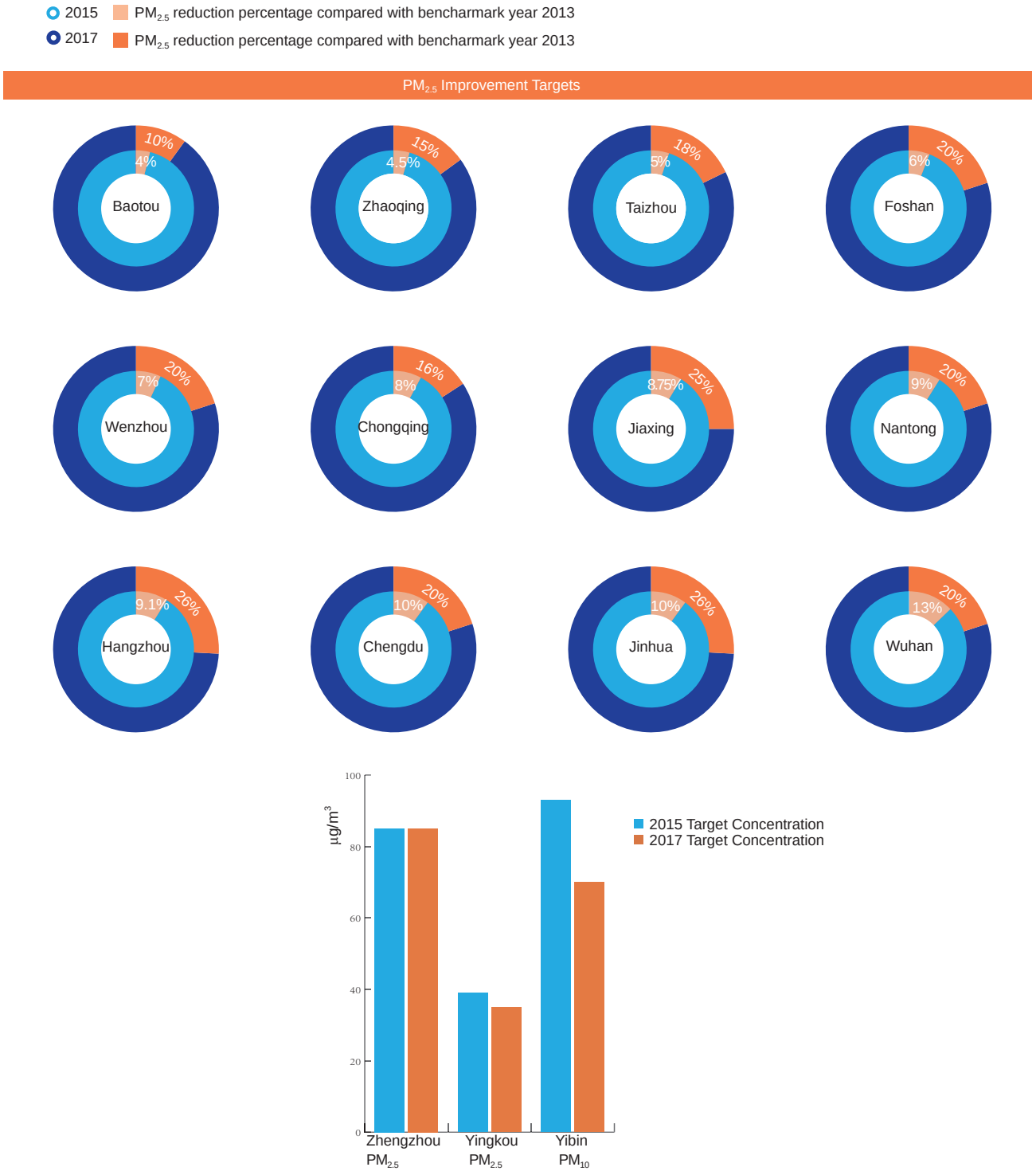


Fig.15: Comparison of Air Quality Improvement Targets for 2015 and 2017

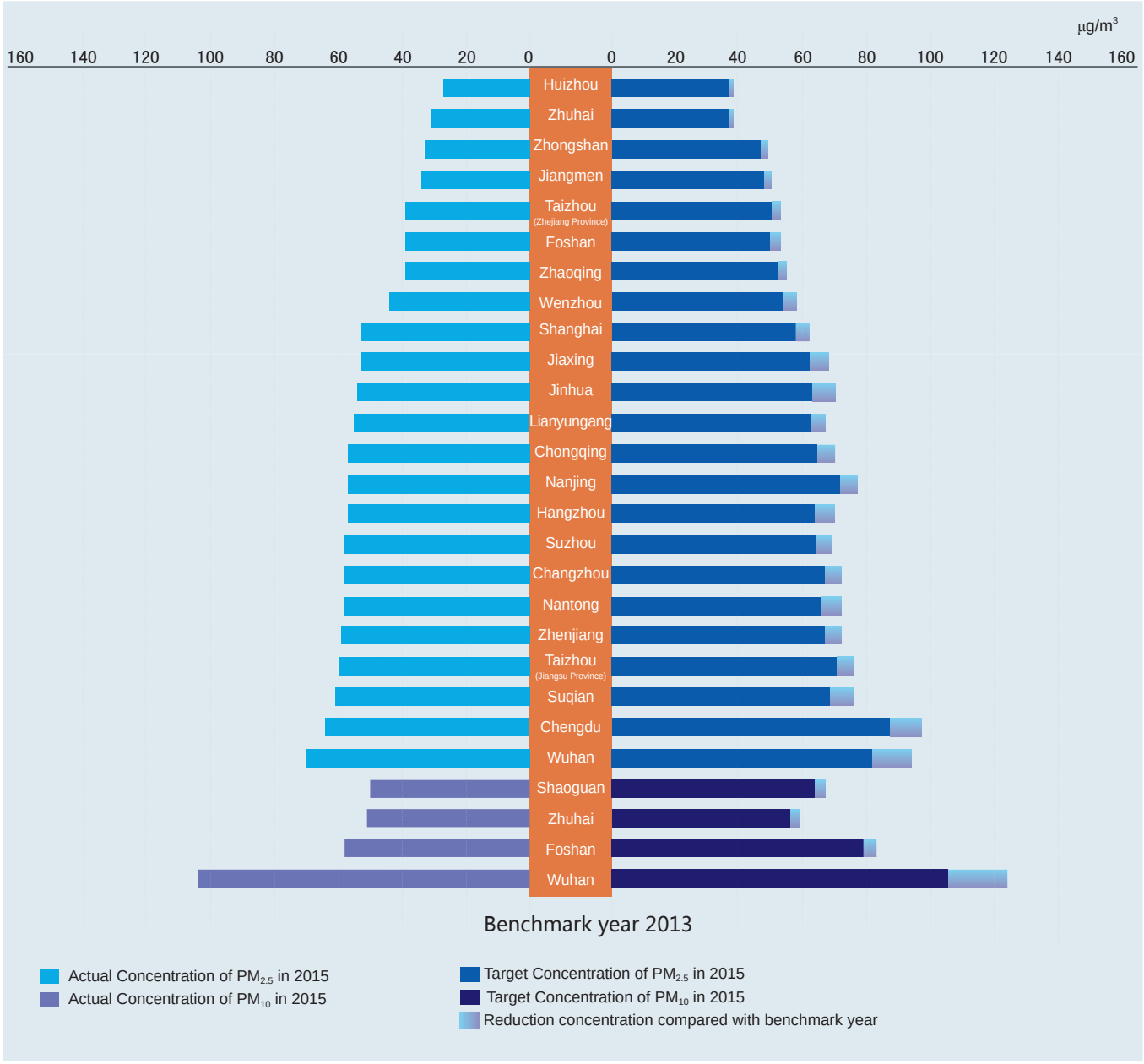


Fig16-1 Attainment Status of Air Quality Targets for Some Cities in 2015

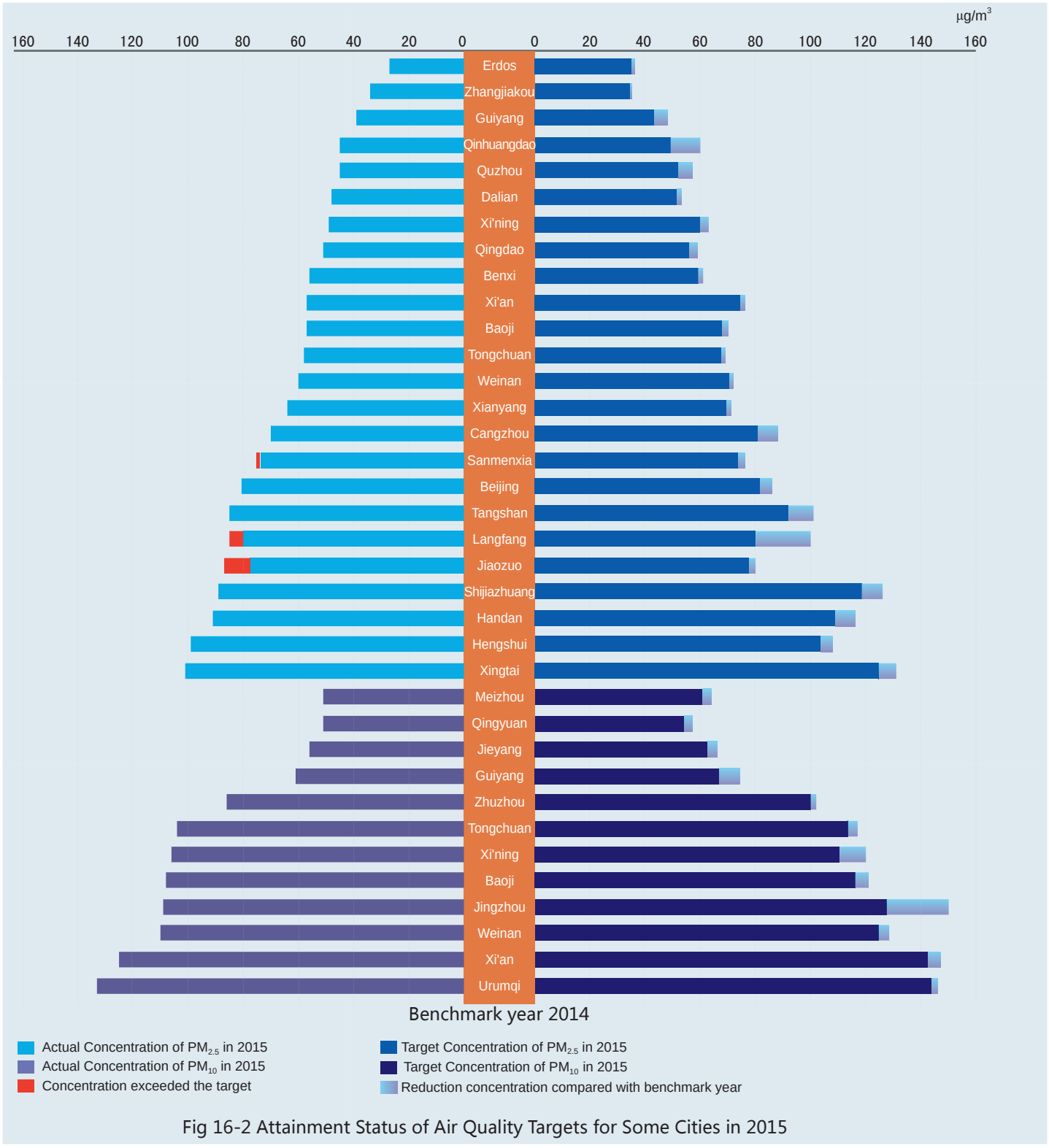


Fig 16-2 Attainment Status of Air Quality Targets for Some Cities in 2015

Fig 16-3 Attainment Status of Air Quality Targets for Some Cities in 2015

Capacity Building

Air Quality Monitoring System Building and Reporting

In 2015, 1,436 state-controlled monitoring sites in 338 prefectural or higher administrative-level cities all started to monitor and report the concentrations of six criteria pollutants and the AQI according to the Ambient Air Quality Standards (GB3095-2012).

Pollution Alerting and Emergency Response

In 2015, the official websites of the Ministry of Environmental Protection (MEP) and the China National Environmental Monitoring Centre published heavy-pollution forecasts for key regions of BTH, YRD, and PRD. The BTH Region and its surrounding areas (Shanxi Province, Shandong Province, Inner Mongolia Autonomous Region, and Henan Province) were subject to frequent heavy pollution. In 2015, 70 prefectural and higher administrative-level cities in this region saw 1,710 heavily polluted or worse days and issued 154 alerts over heavy air pollution.

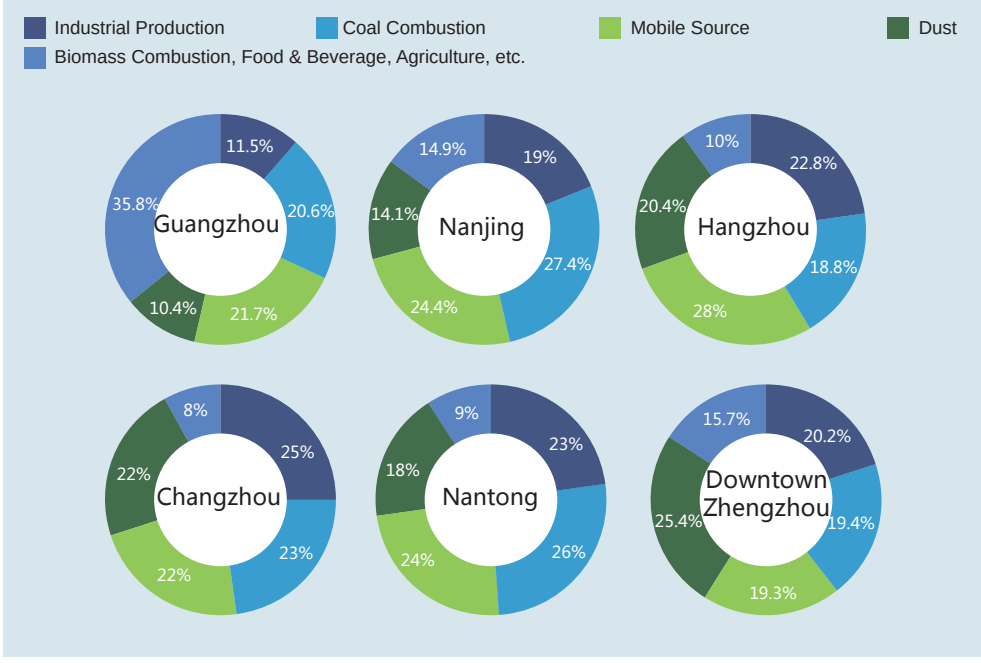


Fig.17: Source Apportionment Results Published by Some Cities in 2015

By the end of 2015, more than 150 cities had issued or revised emergency response plans for heavy-pollution days, and completed the construction of heavy air-pollution monitoring and alerting systems. From December 8 to 10 and December 19-22, Beijing issued red alert because of over heavy air pollution. During the red alert periods, emergency measures such as driving restrictions for vehicles based on license plate numbers and temporary suspension of some construction were implemented. According to an assessment released by the Beijing Municipal Environmental Protection Bureau (EPB), these emergency measures slowed down pollutant accumulation and reduced the peak levels of pollution, achieving a 30% average reduction in the emissions of SO_2, NOx, PM_{10}, $PM_{2.5}$, and VOCs.

Fourteen cities including Tianjin, Handan, Liaocheng, Puyang, Xinxiang, Dezhou, Handan, Xingtai, Langfang, Hengshui, Xinji and Anyang also issued red alerts over heavy air pollution in December 2015, implemented emergency plans, and took similar measures such as driving restrictions and temporary suspension of some manufacturing and construction.

Source Apportionment and Emission Inventory

More than 50 cities included provisions to understand the sources of $PM_{2.5}$ in their 2015 implementation plans. By the end of 2015, 26 cities had carried out air pollutant source apportionment and 22 of them had completed verifying results. Of these 22, six cities (see Figure 17) have published their analysis and data shows that their priorities should still be energy structure adjustment, vehicle pollution management, industrial production, and dust pollution control.

14 cities (Bejing, Tianjin, Shanghai, Nanjing, Fuzhou, Wuhan, Changsha, Guangzhou, Chengdu, Urumqi, Shenzhen, Shijiazhuang, Shenyang and Jinan) have launched air pollutant emission inventory pilots. The preliminary results of some cities have passed MEP's evaluation but have not yet been published. Cities such as Tangshan, Qinhuangdao and Hangzhou have also proposed to carry out vessel pollution research and plan to establish vessel-pollution source inventories.

Emission Reduction Through Energy Structure Adjustment

Total Coal Consumption Control

The Action Plan sets out the national target of coal accounting for less than 65% of total energy consumption in 2017. In 2015, the national total energy consumption was 4.3 billion tons of standard coal, up by 0.9% compared with the previous year, but the percentage of coal consumption was 64.0%, down by 3.7% as against 2014, and the percentage of clean energy consumption was 17.9%, up 1% compared to 2014. Based on these numbers, China accomplished its target of total coal consumption control ahead of schedule. The total coal consumption control targets for cities are summarized in Figure 18.

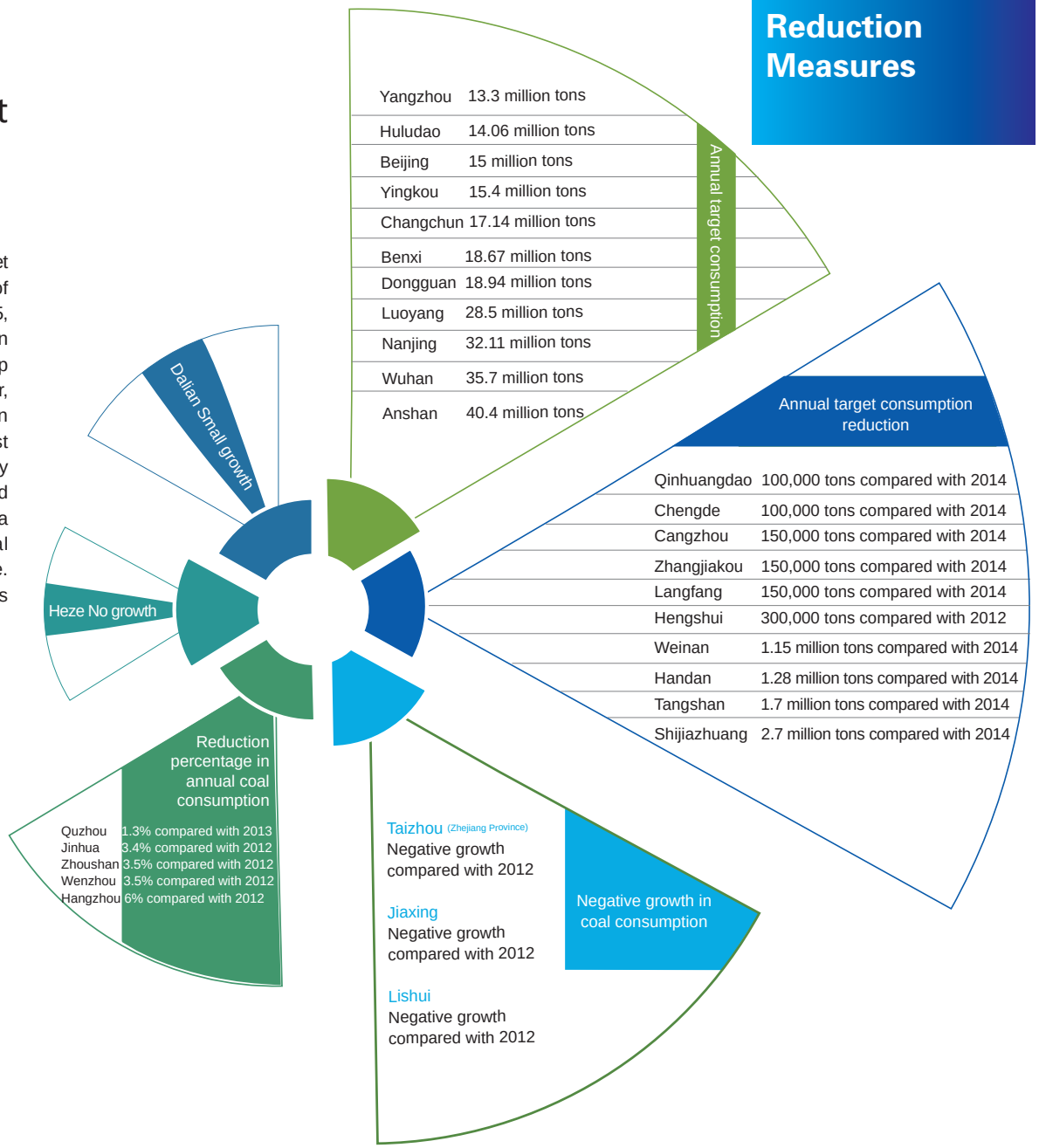


Fig.18: Total Coal Consumption Control Targets for Cities in 2015

At the regional level, BTH and YRD proposed to achieve negative growth in total coal consumption in 2015. Hebei Province expected to achieve a net reduction of 5 million tons in coal consumption compared to 2014 and Beijing expected to control the total coal consumption within 15 million tons. PRD set a specific goal to contain total coal consumption within 160 million tons by the end of 2015.

By the end of 2015, BTH had reduced coal consumption by 16 million tons and achieved negative growth in coal consumption. Four cities (Langfang, Baoding, Tangshan and Cangzhou) in Hebei Province reduced coal consumption by 1.85 million tons and Tianjin reduced 5 million tons. Beijing's coal consumption was down to 12 million tons and had decreased by 11 million tons compared to 2012, which has exceeded their target for 2015.

At municipal level, more than 40 cities including Beijing, Wuhan and Hangzhou have created specific plans for total coal consumption control.

In terms of specific measures for total coal consumption control, the national government, regions and cities continued with many of the measures from the previous year, including eliminating coal-fired boilers and furnaces or retrofitting them to using clean energy; offsetting equal or higher coal consumption for new coal-fired projects; banning the construction of new and phasing out old small coal-fired boilers; prohibiting the construction of self-owned coal-fired power stations for new projects; and incentivizing upgrading of central heating systems to use renewable energy. Public information shows the following targets and progress for 2015 at the national, regional, and municipal level:

(1) Eliminating outdated coal-fired units

Nationwide the electric-power industry planned to eliminate outdated small coal-fired units by 4.234 million kWh in 2015. This target was allocated to provinces shown as Figure 19. For Beijing, Liaoning, Jilin, Gansu, Ningxia, Zhejiang and Anhui, there was no requirement for the elimination of coal-fired units.

By the end of 2015, Hebei, Henan, Fujian, Chongqing and Tianjin all accomplished their goals; in Jiangsu, the electric-power industry eliminated outdated production capacity by 526,250 kWh, achieving most of its goal; for Qinghai, Shandong and Xinjiang, there

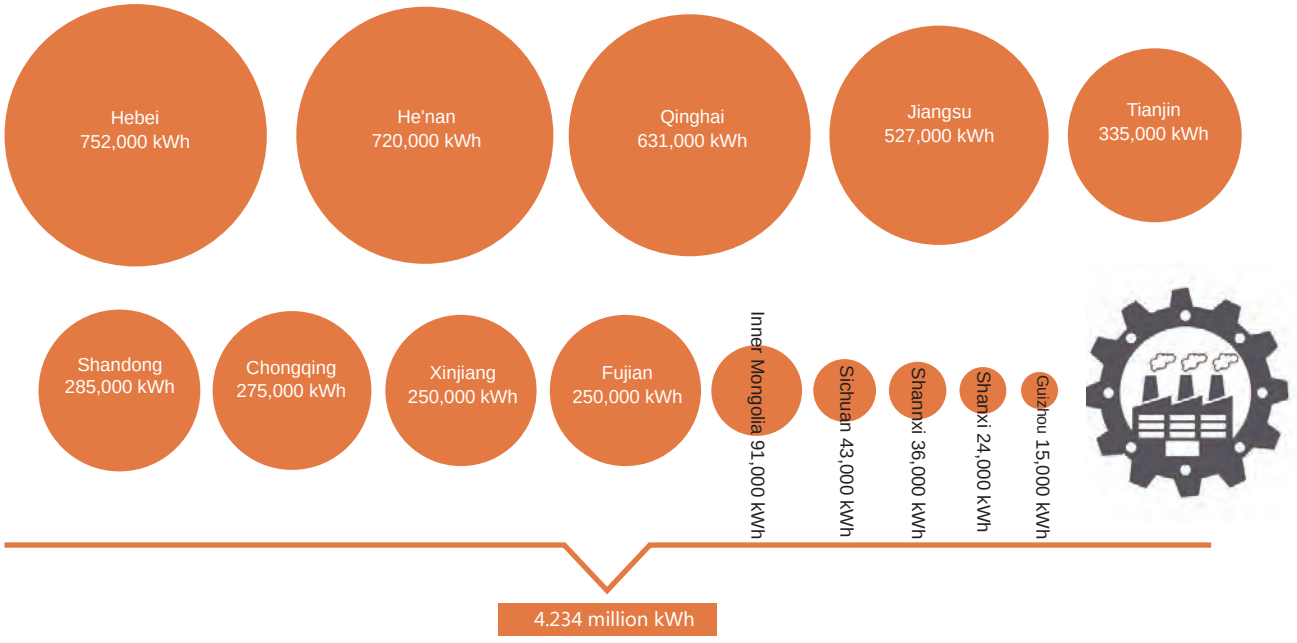


Fig.19: Target of Eliminating Outdated Coal-fired Units in 2015

had been no publicly available information about the progress.

(2) Eliminating and retrofitting coal-fired boilers

In 2015, BTH, YRD and PRD were quite effective in eliminating and retrofitting coal-fired boilers. In 2015, BTH eliminated most small coal-fired boilers under 10t/h for established zones in its cities,YRD eliminated and retrofitted 34,052 coal-fired boilers and furnaces, exceeding the 11,000 target for 2015. Jiangsu eliminated most small coal-fired boilers within the central heating zone, accomplishing the target for 2015 of eliminating 3,100 small coal-fired boilers; Zhejiang achieved 221% of its target.PRD eradicated coal-fired boilers under 4 t/h and eliminated 81% of coal-fired boilers under 10 t/h, In Guangdong, the number of coal-fired boilers reduced from 5,981 in 2010 to 2,597 in 2015, with more than 1,600 coal-fired boilers eliminated. See Figure 20 for the progress to eliminate coal-fired boilers in BTH,YRD and PRD Region.

At the municipal level, progress to eliminate and retrofit coal-fired boilers is shown in Figure 21.

Fig.20: Progress to Eliminate Coal-fired Boilers in BTH,YRD and PRD Region

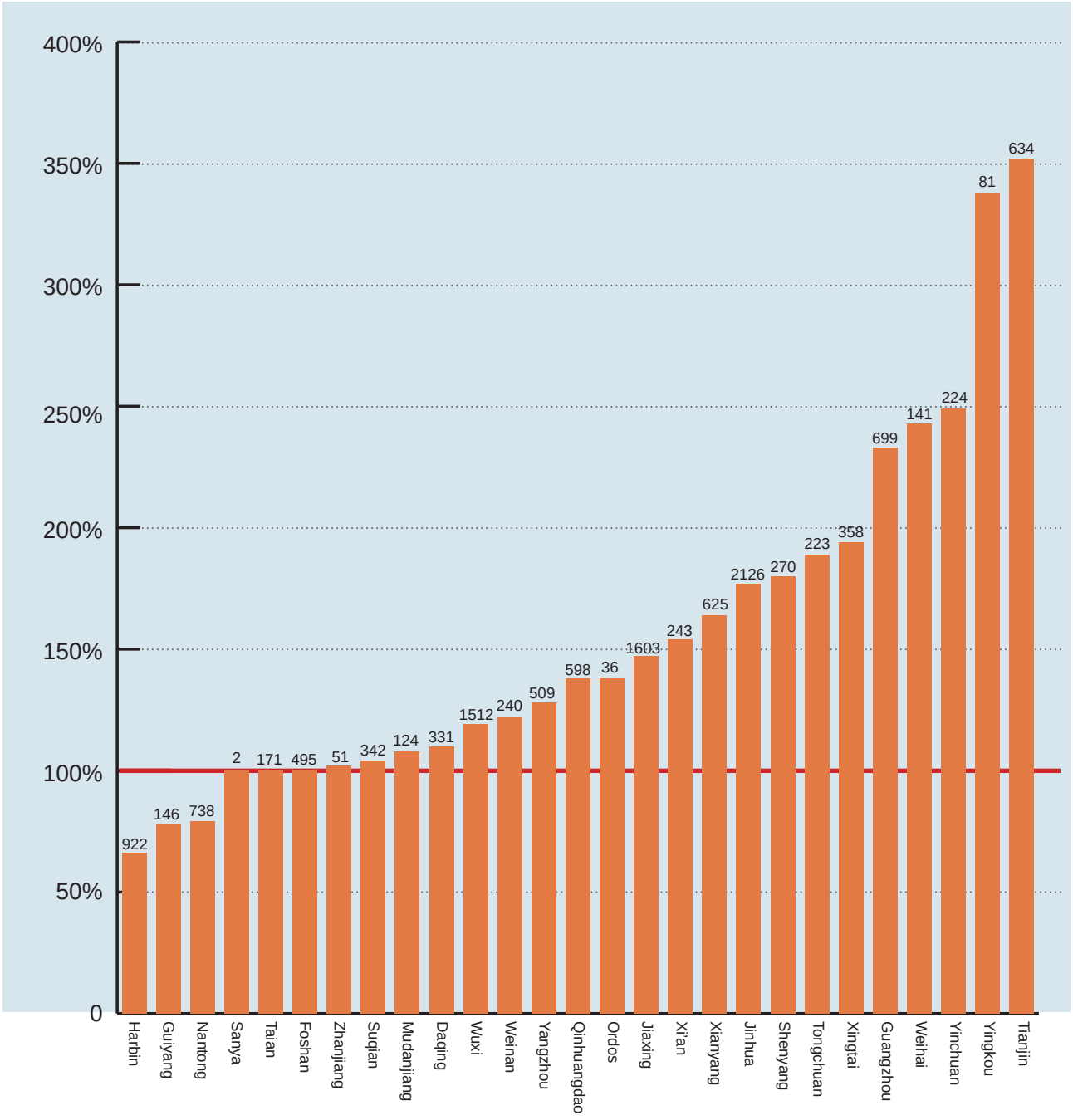


Fig.21: Number of Eliminated and Retrofitted Coal-Fired Boilers for Cities in 2015

(3) Upgrading central heating systems

Cities strengthened their efforts to upgrade central heating systems, increasing coverage rate of central heating. Some cities have already begun to set ambitious targets for 2015 that are comparable to their targets originally set for 2017. See Figure 22.

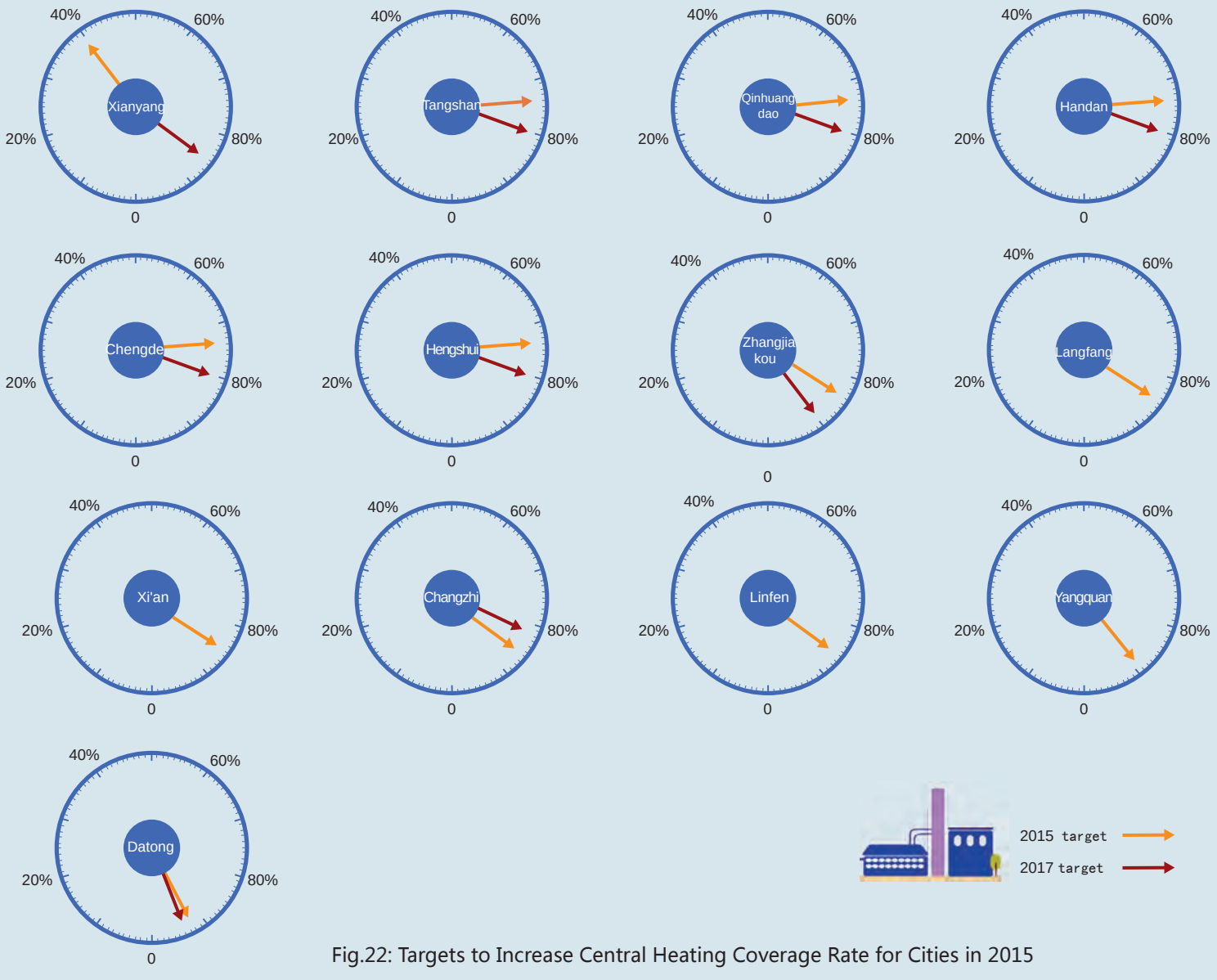


Fig.22: Targets to Increase Central Heating Coverage Rate for Cities in 2015

Elimination of Yellow-Label and Outdated Vehicles

The Action Plan demands that all yellow-label vehicles registered before the end of 2005 be eliminated by 2015. The MEP assigned specific tasks to provinces, see Figure 23 for the detailed information about specific elimination targets for provinces and progress made in key regions.

In 2015, yellow-label vehicles elimination targets were exceeded across the country.

At the regional level, the national government required that BTH, YRD, and PRD eliminate 5 million yellow-label vehicles. BTH planned to basically phase out yellow-label vehicles.

YRD planned to eliminate all yellow-label vehicles in Shanghai, in eight cities along the Yangtze River in Jiangsu Province, and in Hangzhou in Zhejiang Province, while also mostly eliminating yellow-label vehicles in other cities in Jiangsu and Zhejiang Provinces. YRD also proposed to begin information-sharing on yellow-label and outdated vehicles between cities that adopted traffic restrictions by end of September 2015.

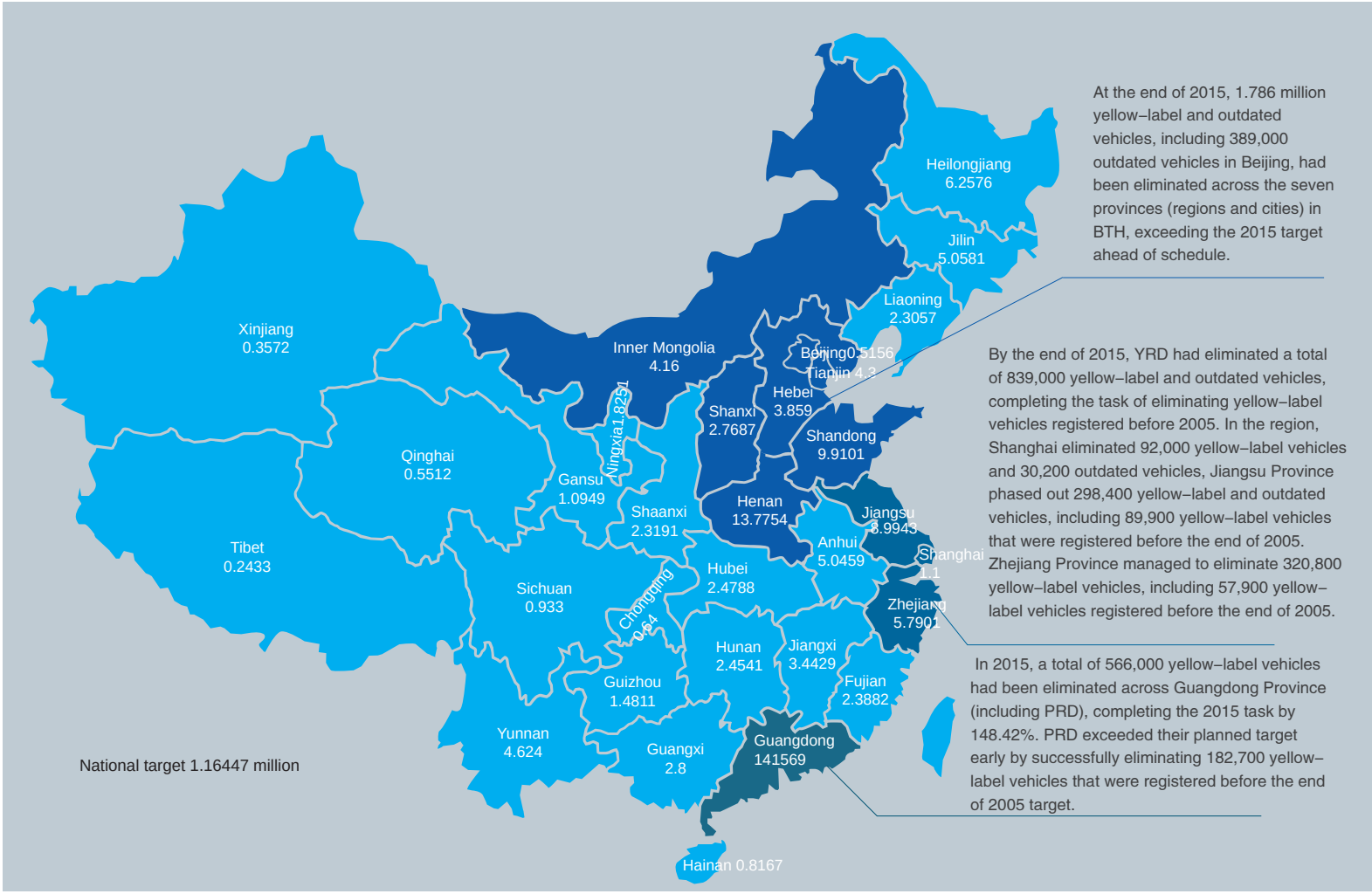


Fig.23: Yellow-Label Vehicle Elimination Tasks for Provinces in 2015 and Progress Made in Three Key Regions

PRD also proposed phasing out yellow-label and outdated vehicles by the end of 2015. Moreover, PRD adopted additional strict measures in 2015 to speed up the elimination of yellow-label and outdated vehicles. Guangdong Province increased the area of their yellow-label vehicle restricted zone to 41,790 km2, which is about 85% of the total urban area, an increase of 36,515 km2 compared to 2014. Measures such as penalty points and fines were also adopted to restrict yellow-label vehicles from entering specified zones. In 2015, a total fine of RMB 160 million was collected from 780,000 violation cases. On December 21, 2015, PRD became the first region in China which uses joint online enforcement to prevent yellow-label vehicles from entering restricted zones.

At the municipal level, efforts to eliminate yellow-label vehicles were also strengthened. Policies such as providing subsidies for early elimination were adopted to phase out yellow-label vehicles registered before the end of 2005. A majority of cities exceeded their annual targets ahead of schedule with just a few exceptions. See Figure 24 for the progress of yellow- label and outdated vehicle elimination in cities in 2015.

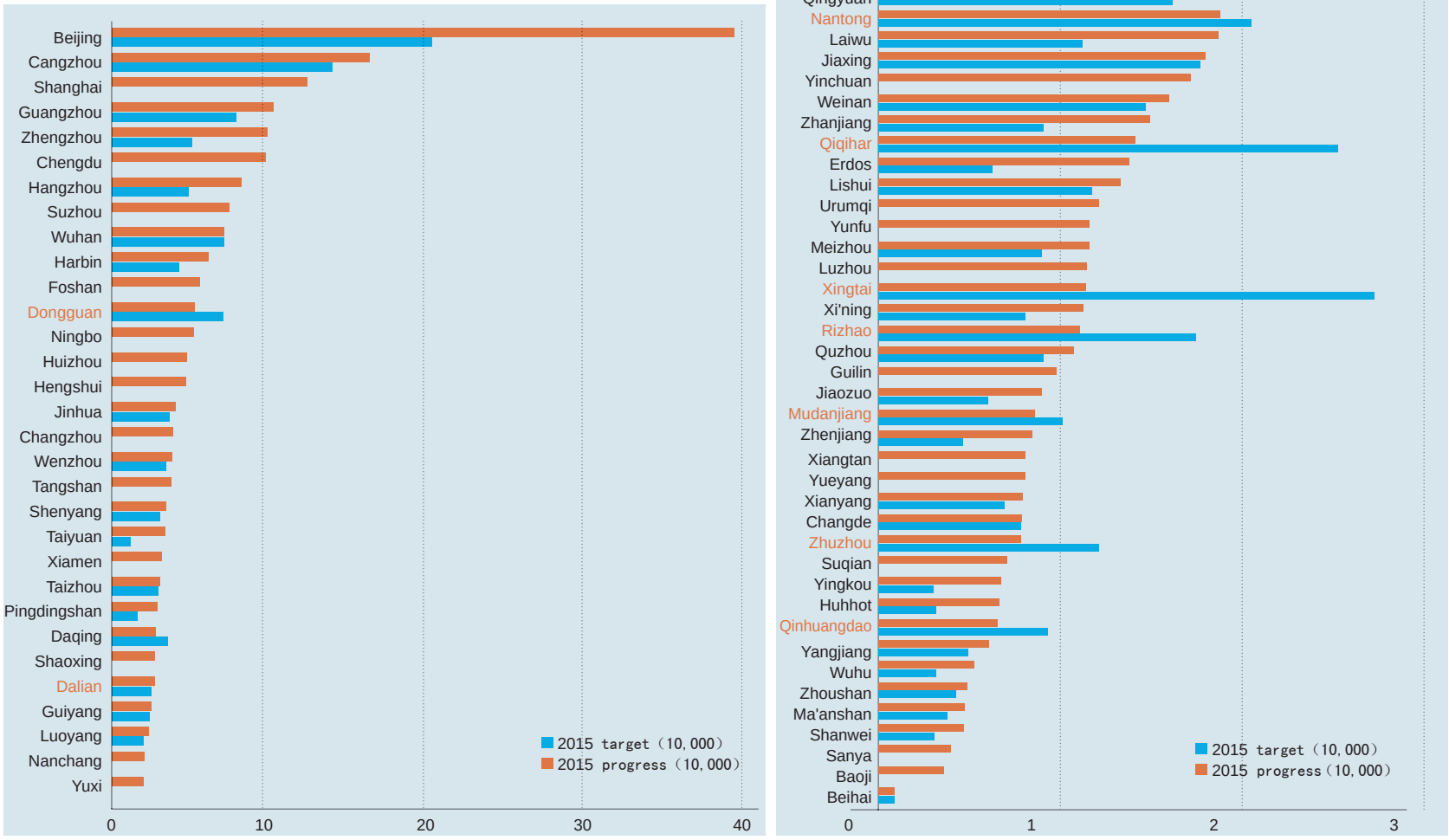


Fig.24: Yellow-Label and Outdated Vehicle Elimination in Cities in 2015

Vehicle Population Control

No targets or policy measures for vehicle population control have been prescribed at the national level. As of the end of 2015, the number of vehicles in China had reached 279 million, an increase of 5.7% compared with 2014.

At the municipal level, besides the vehicle quota imposed by Beijing and Shijiazhuang, proposals of curbing vehicle ownership have also been made by Tangshan, Zhangjiakou, Hengshui, Hangzhou, Foshan and Dongguan. In addition, cities outside the three key regions, such as Changzhi, Linfen, Jinzhou and Quanzhou, also put forward to conduct research on measures to control the increase in number of vehicles.

Encourage Public Transport and Alternative Fuel Vehicles

To encourage public transport and alternative fuel vehicles, the national government adopted policies such as increasing the use of public transport, giving priority to the development of alternative fuel buses and encouraging more electric vehicle charging infrastructure.

To encourage the development of alternative fuel vehicles, various national ministries and commissions introduced a number of policies in 2015, including purchasing tax reduction and exemptions, exemptions from traffic and purchase restrictions, and five national standards for charging ports and internet communication technology for

	Target / Progress	Alternative fuel vehicles	Alternative fuel buses	Centralized charging and battery swapping stations	Distributed charging poles	Alternative fuel vehicles in taxi and urban distribution sectors
Whole country	2020	5 million	200, 000	Add 12, 000 Bus 3850 Taxi 2500 Others 2450	Add 4.8 million	100,000
	2015	583,200	50, 000	3600	49,000	
BTH	2015		16% (percentage in total buses)	112	19,657	
	2015	Beijing 23,500			21,000	
YRD	2015	Shanghai 9,000 Jiangsu 10,000				
	2015 年	Shanghai 44,247 Zhejiang 28,475 Jiangsu 20,000			37,000	
PRD	2013-2015	45,000	15%(percentage in total buses)			
	2013-2015	Guangzhou 14,597				

Fig.25: Development of Alternative Fuel Vehicles in Three Key Regions and the Whole Country

electric vehicles. See Figure 25 for the detailed information about the development of alternative fuel vehicles in three key regions and the whole country.

Municipalities also strengthened their policies to encourage alternative fuel vehicle use and adoption. Several measures, such as financial subsidies, were implemented for encouraging the use of alternative fuel vehicles. Buses in operation will be either be phased out or retrofitted while the number of alternative fuel vehicles for urban public transport systems will be increased on a yearly basis. Public transport, sanitation, and government agencies should take the lead in using alternative fuel vehicles.

In addition to the national subsidy, the following cities provided a subsidy (equal to the national subsidy) to encourage the purchase of alternative fuel vehicles: Beijing, Tianjin, Chongqing, Shijiazhuang, Wuhan, Qingdao, Taiyuan, Xi'an, Changsha, Guangzhou, Huizhou, Ningbo, Hefei, Shaoxing, Shenzhen, Weifang and Luzhou. In Beijing, Chongqing, Shijiazhuang, Wuhan, Xi'an, Changsha, Hefei, Qingdao and Weifang, the ceiling for the subsidy amount is 60% of the total vehicle price, and in Shaoxing the ceiling is 50%. By the end of 2015, Beijing, Shanghai, Chongqing, Shenzhen, and Hebei had a large number of alternative fuel vehicles.

Cities continued to vigorously promote green transportation, speed up developing infrastructure for high-capacity public transport, such as urban rail transit and bus lanes, and increase public transit, cycling, and walking. Increasing efforts were made to have public bicycle systems and establish a transit system centered on cycling and walking. Some cities have set up specific targets to encourage walking and biking that is measured by the ratio of the length of sidewalks and bike lanes to the length of all city roads. See Figure 26.

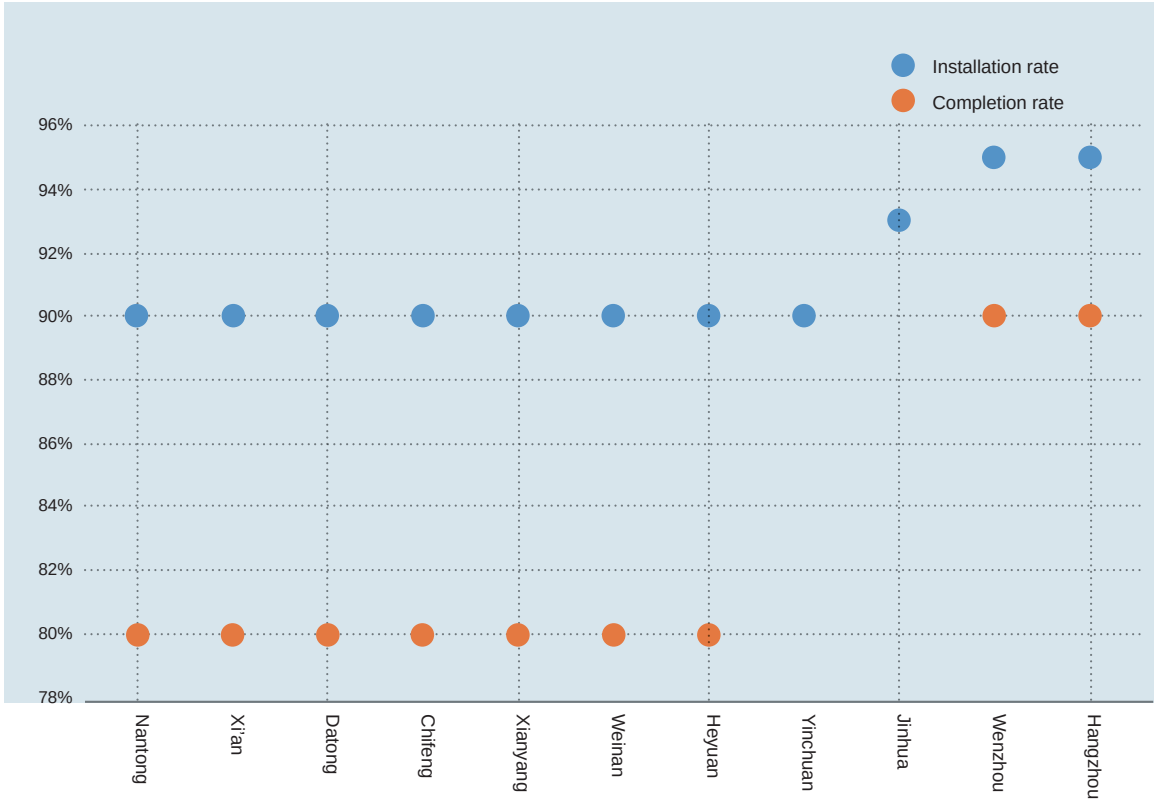


Fig.26: Targets on the Installation and Completion Rates of Sidewalks and Bike Lanes in Cities in 2015

VOCs Control

The national government required Leak Detection and Repair (LDAR) to be carried out in petrochemical industries in China by the end of 2015. Comprehensive control of VOCs in the petrochemical industry was required to be completed in the three key regions (BTH, YRD and PRD) and initiated in the other regions. By 2017, China's petrochemical industry will have completed the comprehensive control of VOCs, built a VOCs monitoring and control system, and ensured a 30% reduction in VOCs emissions (compared with 2014). In addition, the national government required regulations on VOCs emissions discharge fees to be created and implemented in the petrochemical industry.

In 2015, China initiated comprehensive control of VOCs in the petrochemical industry by setting standards for industrial pollutants for three sectors: petroleum refining, petroleum chemicals, and synthetic resin. On October 1, 2015, a pilot for Measures for VOCs Discharge Fees was implemented throughout the country with petrochemical, packaging, and printing industries being the pilot sectors. Immediately afterwards, regulations on charging fees for VOCs emissions were released in five provinces and cities, including Beijing, Shanghai, Jiangsu Province, Anhui Province and Hunan Province.

At regional level, BTH proposed the implementation of a series of VOCs control projects in 2015. Within the region, Beijing, Tianjin and Hebei Province set the following targets:

◎ Beijing should impose pollution control in sectors such as petrochemical and vehicle manufacturing, with the goal of reducing VOCs emissions by 13,500 tons;

◎ Tianjin should complete 20 VOCs control projects in key industries, and carry out LDAR on six enterprises in the petrochemical industry, with the goal of reducing VOCs emissions by 15,000 tons;

◎ Hebei Province, Shanxi Province, Inner Mongolia and Shandong Province should complete LDAR work in the petrochemical industry and instate VOCs control in key sectors, such as pharmacy, chemical engineering, surface coating, and packaging and printing.

At the end of 2015, incentives to spur VOCs control for key pollution sources had successfully been released in BTH, with subsidies reaching as high as 30% of the total control cost. Around 15,000 tons of VOCs emissions had been cut in Beijing's industrial sector, exceeding the 2015 control target.

In YRD, Shanghai aimed to complete VOCs control projects for 71 key and 523 common enterprises in 2015. By the end of the year, 2,893 enterprises in YRD had completed the VOCs control measures. Within the region, Shanghai instated VOCs control in 500 enterprises and completed a full round of LDAR in the petrochemical industry. Jiangsu Province completed 847 VOCs control projects and advanced LDAR technologies in the petrochemical and chemical engineering industries. Zhejiang Province completed the control measures for 999 enterprises (including shutting down 164 of them), accomplishing the target by 134%. Moreover, VOCs were comprehensively controlled in all petrochemical enterprises in the province.

PRD requested oil refineries to complete at least one round of LDAR technology application and also to set up a regulatory system for unorganized emissions by the end of 2015. Major oil refineries and petrochemical enterprises were asked to complete all the measures for VOCs control while all restaurants and canteens in urban built areas were also directed to implement VOCs control measures. Guangdong Province demanded that key enterprises in 13 key industries, including oil refining, petrochemical, surface coating, and furniture manufacturing, complete at least 50% of the assigned VOCs control measures by the end of 2015.

At municipal level, over 20 cities drafted and released VOCs control plans for key industries, and guidelines on control technologies in 2015, to continue VOCs control in such industries as petrochemical, organic chemical and surface coating.

Emission standards on VOCs were released by leading cities. Beijing issued emission standards for the printing industry, industrial coating process, auto maintenance industry and auto manufacturing industry. Shanghai issued such standards for auto manufacturing, printing, coating and ink manufacturing and shipping industries; Shenzhen issued standards for auto maintenance and

architectural decoration industries and Chongqing issued standards for surface coating in vehicle manufacturing.

Cities that had not yet completed oil-vapor recovery in gas stations, oil-storage caverns, and oil-tank trucks by 2014 continued with their recovery work. See Figure 27 for the progress on oil-vapor recovery in relevant cities.

City	Gas Stations under Oil and Gas Control	Oil-storage Caverns under Oil and Gas Control	Oil-tank Trucks under Control
Zhoushan	36	2	6
Wuhu	42		
Changde	62	3	47
Guilin	114	4	22
Xiamen	118	7	
Shaoguan	128	1	
Shantou	135	3	40
Daqing	141		48
Pingdingshan	148	1	203
Baotou	155	2	
Guiyang	179	119	4
Urumqi	191		
Jilin	199	2	66
Huhhot	204		676
Luzhou	207	2	
Deyang	234		
Anyang	244	6	29
Ordos	266	2	
Dalian	317	7	54
Weinan	408	1	90
Quanzhou	447	11	264

Fig.27: Oil-Vapor Recovery Progress in Cities in 2015

Emissions from Non-Road Machinery and Ports and Vessels

In 2015, several government documents explicitly set policies and targets for the prevention and control of vessel and port pollutants for 2015-2020, such policies include setting up emission control areas, developing more stringent standards for vessel fuel, improving vessel emission standards and conducting oil-vapor recovery.

1) Setting up emission control areas. PRD, YRD and Bohai Rim (BTH) were required to set up domestic emission control areas. Between January 1, 2016 and January 1, 2019, vessels entering emission control areas will have to use fuel with no more than 0.5% of sulfur content.

2) Developing more stringent standards for vessel fuel. In May, the government issued the Regular Diesel standard, requiring that China IV and China V regular diesel should be supplied in the nationwide respectively from July 1, 2017 and January 1, 2018, the requirements of which could be applied for inland river vessels. In December, the government released a standard applicable to coastal and ocean vessels for bunker fuel, requiring that starting from July 1, 2016, the sulfur content of distillate fuel oil and residual fuel oil should be respectively controlled within 0.1%~1.5% and 0.1%~3.5%.

In addition, a special inspection on bunker fuel quality was also conducted in 2015 by the Maritime Safety Administration of China, in order to enhance the prevention and control of vessel and port pollutants.

3) Improving vessel emissions standards. Starting on October 1, based on emission standards for non-road mobile machinery, phase-three emission standards of pollutants were enforced on vessel engines with 37 kW power or below. For standards on vessel engines with more than 37 kW, MEP is compiling Limits and Measurement Methods for Exhaust Pollutants from Marine Compression Ignition Engines (China I, II), the issue of which will fill in the gap of emission standards of air pollutants from ships.

4) Conducting oil-vapor recovery. Starting form 2015, oil-vapor recovery experiments at ports would be conducted for three years in key regions, such as Bohai Rim, YRD, PRD, southeast coastal region, and regions alongside the Yangtze River.

At the regional level, BTH and YRD both requested that control of emissions from vessels and ports be done through an air pollution prevention and control coordination mechanism in 2015. In addition, YRD issued the Work Plan for Joint Air Pollution Prevention and Control for Ports and Vessels in the Yangtze River Delta in September 2015. The 2015 policy targets of BTH and YRD are listed in Figure 28.

	BTH	YRD
Regional coordination	Tianjin should take the lead and work with Hebei and Shandong Provinces to conduct investigations on emissions from ports and vessels in the Bohai Rim, and set up a port and vessel emission inventory.	A special working mechanism for regional coordination should be established. Early implementation and early trials should be accelerated to promote the green development of the marine transportation industry with a focus on ports and inland river vessels, and covering new vessels, vessels in operation, and fuel quality.
Vessel emission control	Conduct research on policies and measures that can reduce pollution from vessels burning bunker oil, such as replacing the fuel-generation power with shore power and requesting vessels entering off-shore waters to use clean fuel.	Enhancing the management of vessel air emission standards and upgrading fuel quality standards are the keys. Requiring berthed vessels to use shore power, replacing old vessels with new and clean-energy vessels, developing standards for inland river vessels and eliminating outdated vessels, and regulations on vessel fuels and emissions should also be strengthened.
Port pollution prevention and control	Pilot projects for clean energy use on harbor boats, mobile machineries, engineering vessels and charging facilities in port areas should be carried out.	Promoting new and clean-energy use by harbor machineries is key, while comprehensive pollution control of dust and oil-vapor should be enhanced.

Fig.28: Policy Targets to Prevent and Control Vessel and Port Pollutants in Major Ports of BTH and YRD

Optimization of Industrial Structure and Layout

In 2015, at the regional level, BTH imposed a ban on approving any new production-capacity projects in industries such as iron and steel, cement, electrolytic aluminum, and flat glass. Beijing planned to decrease cement production capacity by 1.5 million tons and shut down Guohua and Shijingshan coal-fired power plants. Hebei Province planned to reduce crude steel production capacity by 5 million tons, pig iron by 5 million tons, cement by 6 million tons, flat glass by 3 million weight boxes, and to eliminate outdated production capacity by 700,000 kW in the electric power industry. Shandong Province planned to reduce the iron and steel production capacity by more than 1 million tons, capping the total to be less than 50 million tons.

By 2015, BTH had reduced the iron production capacity by 10.69 million tons, steel by 17.27 million tons, coke by 3.90 million tons, cement by 23.35 million tons, flat glass by 15.37 million weight boxes, and electric power generation capacity by 3.09 million kW. In March 2015, Beijing shut down 1.28-million-kW coal-fired units at Guohua and Shijingshan power plants, and eliminated 326 polluting enterprises.

At the municipal level, cities continued to phase out outdated production capacities. 1) Based on national government appraisal requirements, cities prohibited the approval and filing of new production-capacity projects in industries with severe excess production capacity. They also adopted new means to properly handle projects under construction even though they lacked permission in industries with excess capacity. 2) Moreover, cities imposed strict bans on the construction of projects with "heavy-pollution and high environmental risks" and strict control over new production-capacity projects for steel smelting. 3) Cities also developed plans to relocate polluting enterprises in urban areas, relocating to outside of urban areas or closing them down completely. See Figure 29 for outdated production capacities eliminated and Figure 30 for companies eliminated and relocated by cities in 2015.

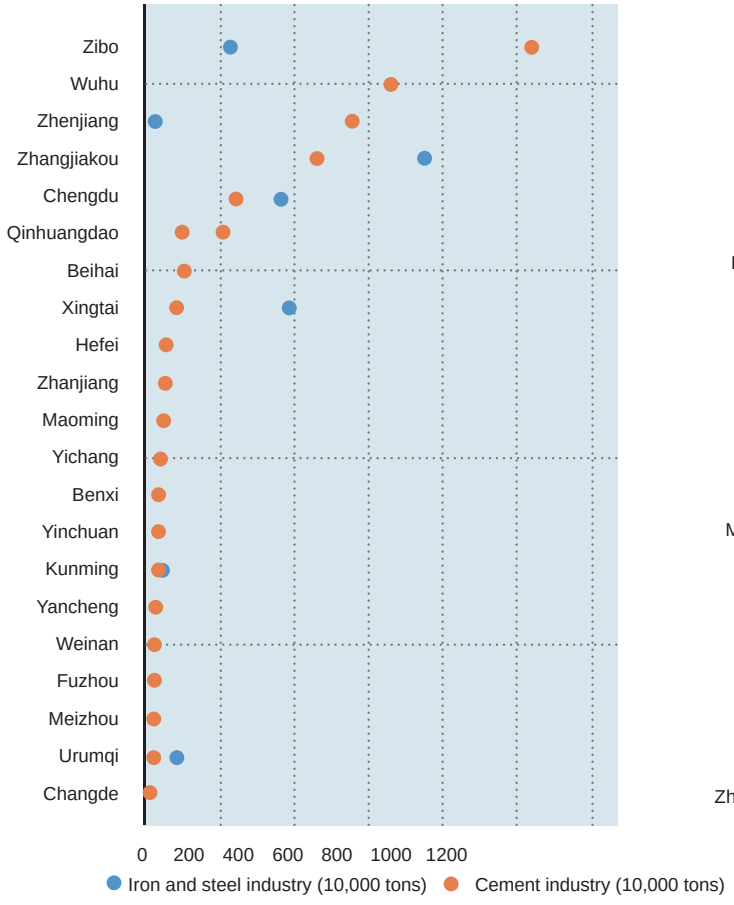


Fig.29: Outdated Production Capacities Eliminated by Cities in 2015

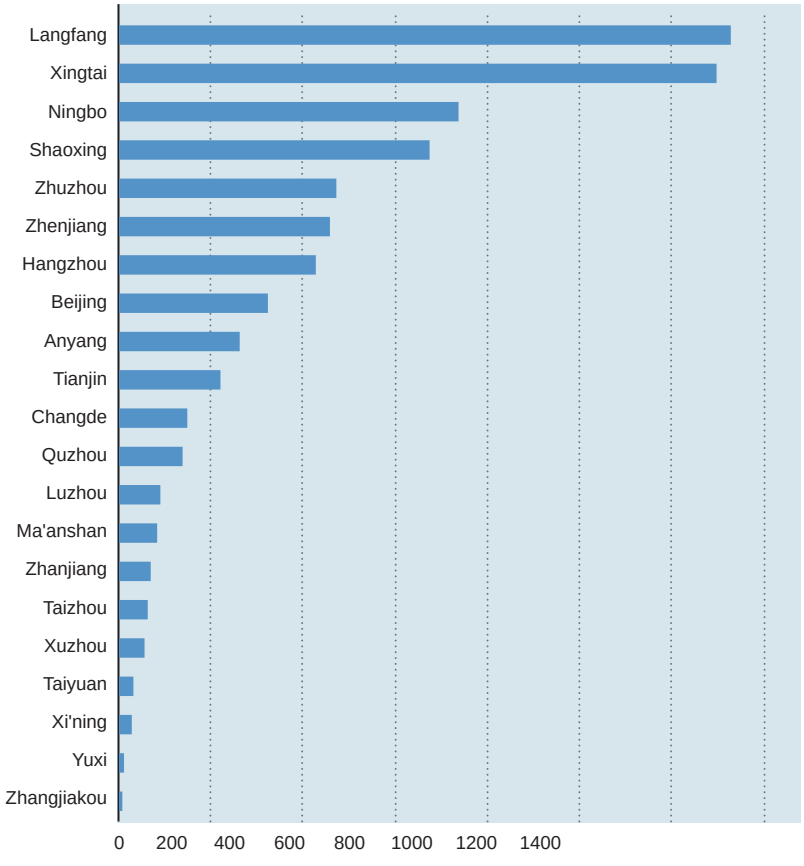


Fig.30: Companies Eliminated and Relocated by Cities in 2015

Emission Reduction in Combustion Processes

Clean Production

In 2015, the national government required the National Development and Reform Commission (NDRC), MEP and Ministry of Infrastructure and Information Technology(MIIT) to develop or revise clean-production assessment indicator systems for key industries such as electric power, papermaking, and PV. These ministries were also required to conduct clean-production audits and technology retrofitting, especially in BTH and YRD and in industries involving high resource consumption and needing more work in terms of pollution prevention and control.

In 2015, the NDRC, MEP and MIIT integrated and adjusted the clean-production assessment indicator systems for key industries such as battery, flat glass, electroplating, lead-zinc mining, yellow phosphorus, electric power, pulping, and papermaking. In addition, they developed similar systems for key industries including Ni-Co, antimony, biopharmaceutical manufacturing and secondary lead.

At the regional level, in BTH, Hebei Province, Beijing and Tianjin completed clean production audits of 490, 204, and 162 key enterprises in 2015, respectively; in YRD, Zhejiang Province completed the clean production audit of 436 enterprises.

At the municipal level, more than 100 cities planned to continue with clean production audits in key industries including iron and steel, cement, chemical engineering, electric power and glass, and complete clean-production technology retrofits in key enterprises.

Upgrading Fuel Quality

In 2015, the NDRC, Ministry of Finance(MOF), and five other ministries issued policy documents, expanding the scope of application of China V vehicle emission standards and advancing the timetable of China V vehicle gasoline and diesel supply. The roadmap of the phased regional upgrading process is shown in Figure 31.

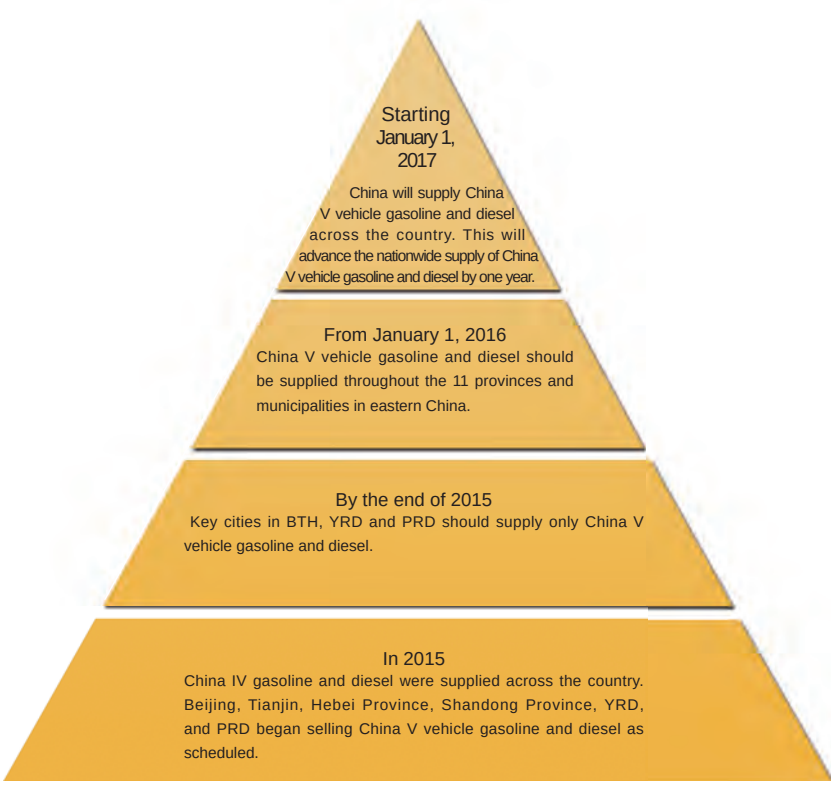


Fig.31: Upgrading Fuel Quality

Clean-Burning Coal

For cleaner and more efficient coal use, the National Energy Administration (NEA) issued policies in 2015 that set the following specific targets: by 2017, the raw coal separation rate should reach 70% and the average operational efficiency of coal-fired industrial boilers should increase by 5% from 2013; by 2020, the raw coal separation rate should reach 80% and the average operational efficiency of coal-fired industrial boilers should increase by 8% from 2013.

By the end of 2015, China's total amount of separated raw coal had reached 2.6 billion tons and the raw coal separation rate had reached 65.9%, increasing by 15% from 2010 and was already close to the 2017 target.

At the regional level, MEP's special supervision efforts in November 2015 revealed that 203 batches of coal samples in BTH had the average sulfur content of 0.41% and the average ash content of 10.23%, revealing satisfactory coal quality control performance overall.

At the municipal level, in 2015, some cities planned to further increase their raw coal seperation rate. In fact, most cities such as Chongqing, Handan, Zhangjiakou, Ordos and Qiqihar had set their 2015 targets close to or above the target for 2017 and had the raw coal separation rates of more than 70%. See Figure 32 for cities' targets.

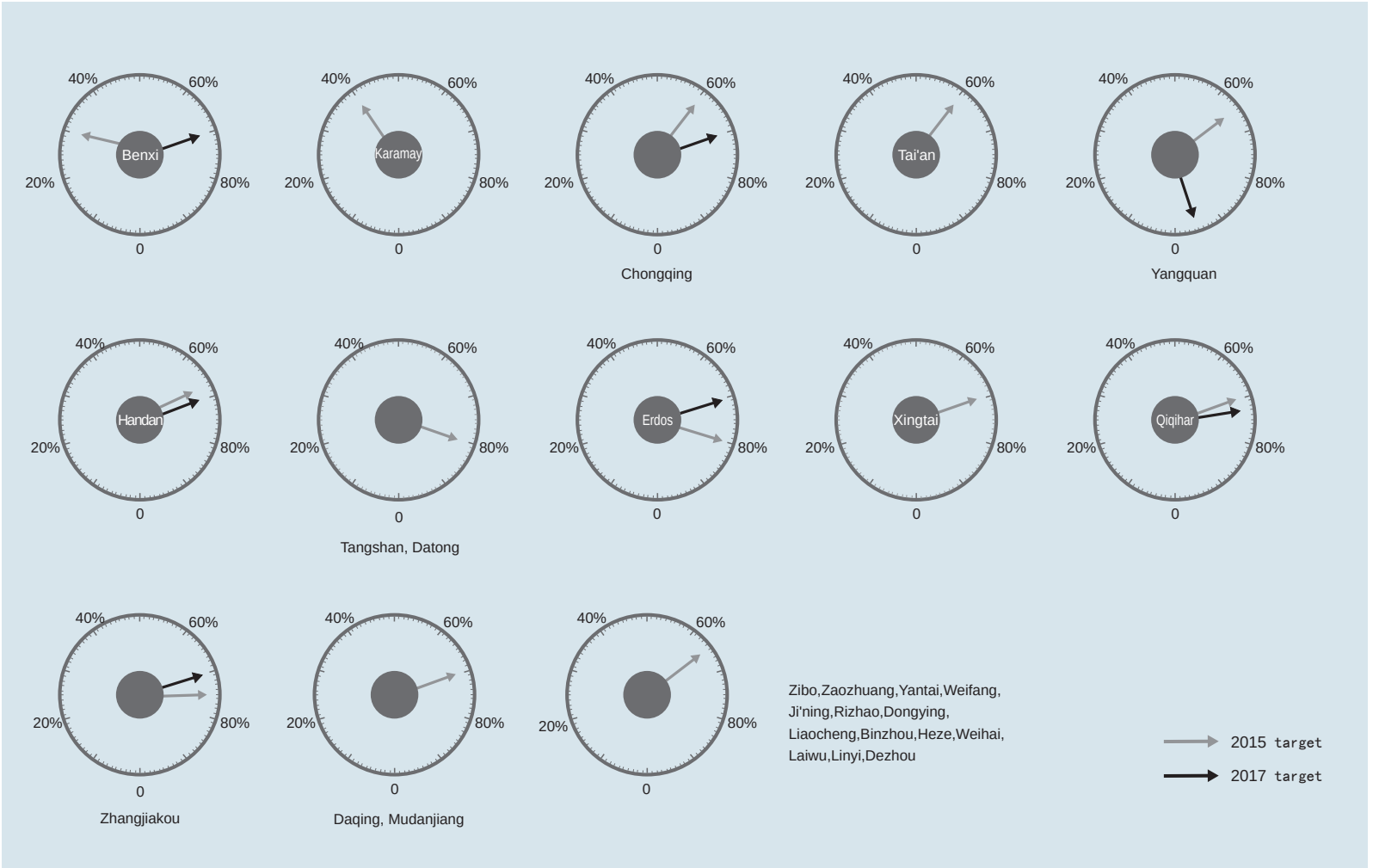


Fig.32: Raw Coal Seperation Target Rates Set by Cities in 2015

Increase Green Space in Urban Areas

Since 2015, urban green space has been listed by many cities as a new measure in their annual implementation plans for the air pollution prevention and control action plan. Increasing green space can reduce the area of bare land and curb dust, which is one of the major emission sources in cities. The cities' specific targets and progresses for the rates of greenery are shown in Figure 33.

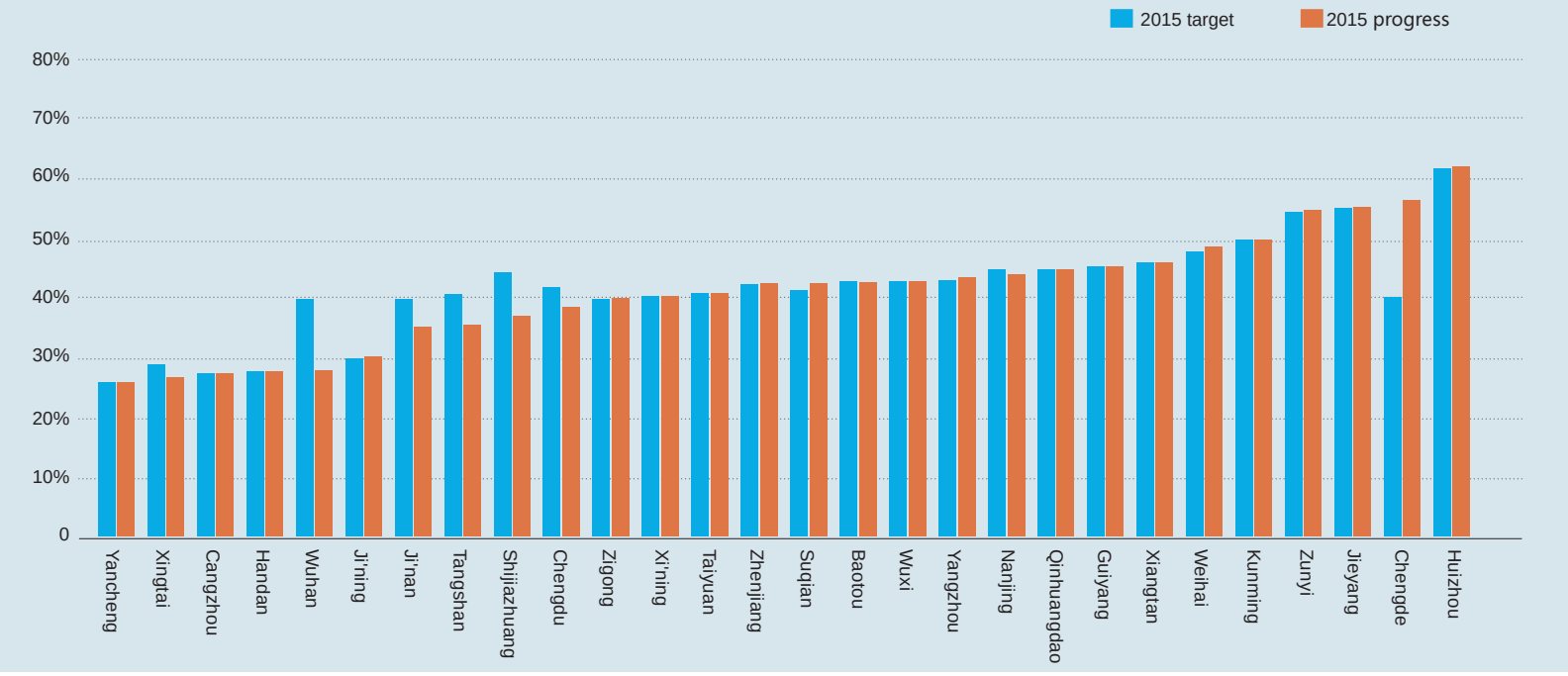


Fig.33: Progress of Increasing Rates of Green Space in Cities in 2015

Area Source Management

In 2015, the national government intensified control over dust pollution and agricultural waste burning.

In terms of preventing and controlling dust pollution, discharge fees for dust from construction-sites was a new measure enacted in 2015. In March and May 2015, Beijing and Tianjin started levying fees for dust emissions from construction-site in accordance with tiered-pricing policies (see details in "Supporting Measures").

In terms of controlling agricultural waste burning, the rate of comprehensive utilization of agricultural wastes from major crops in China was 80.1% in 2015, which met the set target of "higher than 80% by 2015".

At the regional level, BTH and its surrounding areas set 88% as the target for comprehensive utilization rate of agricultural waste. For Beijing, the target was 100%, Tianjin's was 90%, Hebei Province's was 95%, Shanxi Province's was 85%, Inner Mongolia's was 86.5% and Shandong Province's was 85%. All these provinces, autonomous regions and municipalities should have reduced the number of agricultural waste burning points in 2015.

The actual number of agricultural waste burning points in BTH in 2015 decreased by 262 compared to 2014, and BTH had achieved its year-on-year reduction target.

In YRD, the year-on-year reduction of agricultural waste burning points in summer was more than 80% in 2015. Specifically, the number in Anhui Province went down by more than 95% and it decreased in Jiangsu Province by 91.2%. In Zhejiang Province, the comprehensive utilization rate of agricultural waste reached 89.7%.

Emission Reduction in Energy End Use

Desulfurization, Denitration and Dust Elimination

During the 12th Five-Year Plan period, the total capacity of coal-fired units equipped with desulfurization facilities increased from 530 million kW to 890 million kW, with the installation rate of such facilities increasing from 83% to more than 99%; and the total capacity of coal-fired units equipped with denitration facilities increased from 80 million kW to 830 million kW, and the installation rate increased from 12% to 92%.

At the regional level, in 2014, BTH, YRD, and PRD developed their air pollution prevention and control plans for key industries. The plans aimed to complete the construction of desulfurization, denitration and dust elimination facilities in electric power, iron and steel, cement and flat glass industries by the end of 2014 or by July 1, 2015.

In 2015, in addition to the improvement of 1,027 production lines or units of 543 enterprises in the four major industries as indicated in the Air Pollution Prevention and Control Plan for Key Industries in the Yangtze River Delta in a Limited Time Frame, Shanghai added 114 air pollution prevention and control projects in 88 enterprises; Jiangsu Province added 17 projects involving iron and steel sinter machines, petroleum cracking and desulfurization; Zhejiang Province expanded the scope of soot and dust control applied to boilers of more than 20 t/h to include boilers of more than 10 t/h; Anhui Province planned 222 prevention and control projects to be completed within a specific timeframe

In 2015, BTH completed in-depth desulfurization, denitration and dust elimination of 1,530 coal-fired boilers with a total capacity of 51,300 t/h. Guangdong Province covering PRD had completed or was undergoing construction of denitration facilities for 27 flat glass production lines.

In YRD, Jiangsu Province completed retrofitting desulfurization and denitration for coal-fired units with a capacity of 300,000 kW or more, and finished the construction of desulfurization and denitration facilities for all

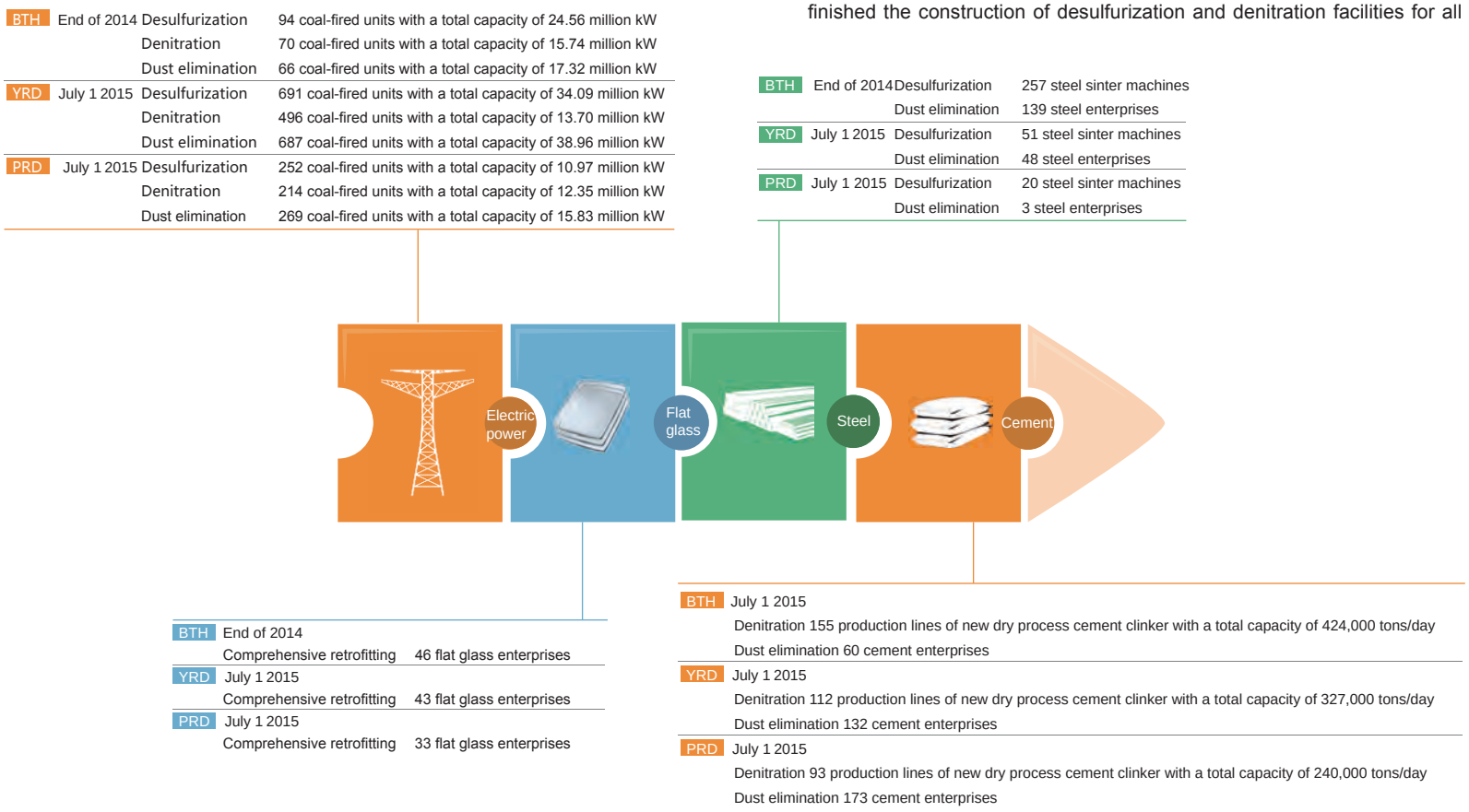


Fig.34: Air Pollution Prevention and Control Plans for Key Industries in BTH, YRD and PRD within a Specific Timeframe

of the 154 iron and steel sinter machines and 45 cement clinker production lines; Zhejiang Province retrofitted all the thermal power units, coal-fired co-generation units and iron and steel production capacities by installing desulfurization facilities, constructed denitration facilities for all thermal power units and cement clinker production lines, completed denitration retrofitting for more than 70% of coal-fired co-generation units, and finished one round of upgrading and retrofitting of dust elimination facilities for enterprises in key industries (such as thermal power, iron and steel, and flat glass) and for coal-fired boilers with a capacity of 10 t/h or above

At the municipal level, cities continued to upgrade and retrofit air pollution prevention and control facilities in key industries such as steel, cement, petrochemicals, nonferrous metals, and chemical engineering. The cities also required advanced and efficient dust elimination, desulfurization, and denitration facilities to be constructed at the same time as coal-fired units in the electric power industry. Moreover, the cities have banned the construction of flue gas bypass passages and required air pollutant concentrations to meet certain emission standards.

Retrofitting for Ultra-Low Emissions

An executive meeting of the State Council set the requirement that all coal-fired power plants in China that can be retrofitted should achieve ultra-low emissions by 2020 (i.e. with the benchmark oxygen content being 6%, smoke and dust, sulfur dioxide and nitrogen oxides emission concentrations should not exceed 10, 35 and 50 mg/m³, respectively). To this end, MEP, NDRC and NEA issued a document that provided the following timeline: by 2017, the country should complete the construction of facilities to achieve ultra-low emissions for public coal-fired units with a capacity of 300,000 kW or above and for private coal-fired units with a capacity of 100,000 kW or above in the eastern part of China; the country should complete the construction of facilities to achieve ultra-low emissions for public coal-fired units with a capacity of 300,000 kW or above in the central (by 2018) and western parts (by 2020) of China. Moreover, the relevant authorities have also prescribed electricity rate subsidies, rewards on generated electricity and emissions fees, and credit and financing support for ultra-low emissions.

In 2015, retrofitting coal-fired power plants for ultra-low emissions was accelerating across the country. In 2015, at the regional level, BTH and its surrounding areas (Shanxi, Shandong, Inner Mongolia, and Henan) completed retrofitting 370 existing coal-fired units (with a total capacity of 88 million kW) for ultra-low emissions. In particular, Hebei Province retrofitted 252 coal-fired units.

YRD (Shanghai, Jiangsu Province, Zhejiang Province and Anhui Province)

Upgrading of Vehicle Emission Standards

As of January 1, 2015, China IV emission standards were enforced on diesel vehicles across the country, and at this point, no diesel vehicles at or below China III standards could be sold or registered.

At the regional level, the government required key cities in BTH, YRD and PRD to fully implement China V emission standards for gasoline and diesel vehicles in 2016. By the end of 2015, key cities in BTH, YRD and PRD (Shanghai, Beijing, Tianjin, and PRD) had taken the lead in implementing China V vehicle emission standards (Figure 35).

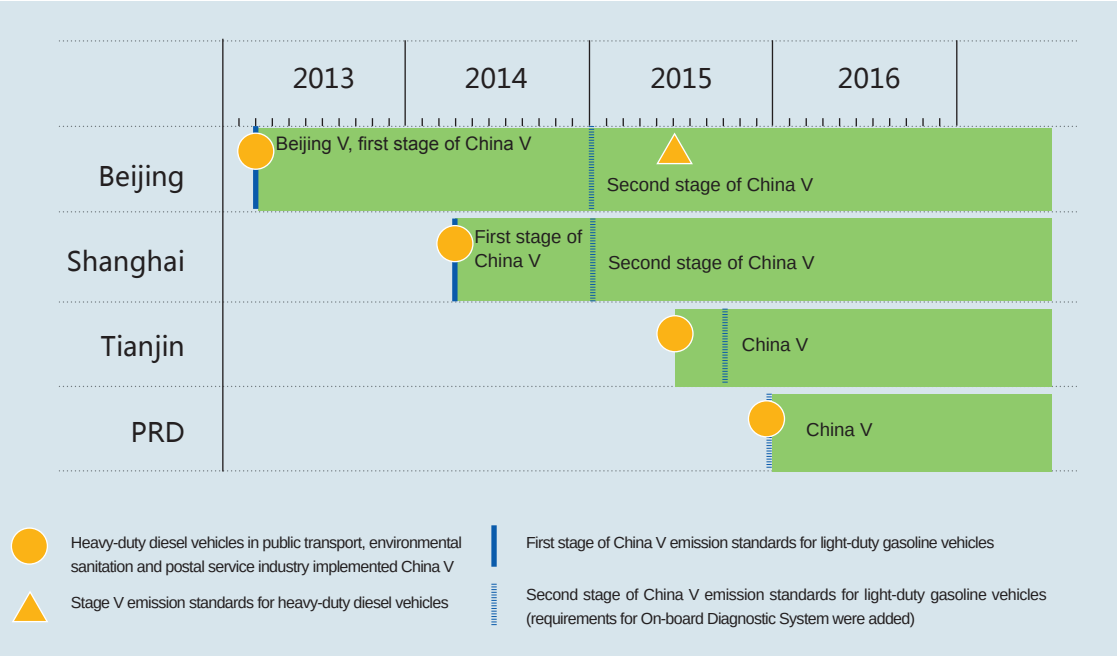


Fig.35: Progress in Upgrading Vehicle Emission Standards

retrofitted ultra-low emissions technology for 80 coal-fired units. Specifically, Jiangsu Province retrofitted 62 large coal-fired units with a total capacity of 30.08 million kW (accounting for 40% of the province's total installed capacity); Zhejiang Province retrofitted 22 coal-fired units for cleaner emissions, achieving cleaner flue gas emissions in 35 thermal power units and 10 coal-fired thermal power units; and Shanghai completed the ultra-low emission retrofitting and gypsum rain control of three public coal-fired units.

Guangdong Province completed the ultra-low emission retrofitting of coal-fired units with a total capacity of 5.69 million kW.

At the municipal level, a growing number of cities retrofitted coal-fired units to have ultra-low emissions. This includes all the cities in BTH, YRD and PRD; Fuzhou and Xiamen of Fujian Province; Jinan, Qingdao, Zibo and Zaozhuang of Shandong Province; Chifeng, Baotou and Ordos of Inner Mongolia; Xi'an and Xianyang of Shaanxi Province; and Shaoguan and Shantou of Guangdong Province. Cities such as Tangshan, Handan, Chengde, Luoyang, and Jiaozuo released work plans or opinions to achieve ultra-low emissions by ensuring that coal-fired units eligible for retrofitting should outperform the national standard for ultra-low emission limits.

Application of Special Emission Limits and Raising of Industrial Emission Standards

In 2015, the national government passed six industrial pollutant emission standards for petroleum refining, petroleum chemistry, synthetic resins, inorganic chemistry, secondary copper, aluminum, lead, zinc industries, and crematoria. At that point, emissions standards had been developed for all of the 25 key industries subject to special air pollutant emission limits as required by the State Council's "Ten Measures."

Regional Collaboration

In 2015, the 4th Meeting of the Air Pollution Prevention and Control Coordination Team for the BTH Region and Surrounding Areas adopted the Key Tasks in 2015 for Joint Prevention and Control of Air Pollution in the BTH Region and its Surrounding Areas. Beijing, Tianjin, and Tangshan, Langfang, Baoding, and Cangzhou were identified as the core areas of air pollution prevention and control in the region to jointly address pollution in six key areas including vehicle pollution control, coal consumption control, management of use and burning of agricultural waste, reducing excessive production capacity, VOCs control, and pollution control of vessels and in ports. Beijing was grouped with Langfang and Baoding, while Tianjin was grouped with Tangshan and Cangzhou to better collaborate on financial and technical issues.

In 2015, the Office of Air Pollution Prevention and Control Coordination Mechanism for the YRD convened its 4th meeting to determine key tasks for collaboration on reducing air pollution. The five key task areas were total coal consumption control and renewable energy integration, upgrading and retrofitting of coal-fired power plants, industrial restructuring for pollution prevention and control, vehicle pollution prevention and control, and agricultural waste burning and dust pollution control. But progresses made by YRD in above-mentioned 5 areas were not available during the compiling of this report.

Besides BTH, YRD and PRD, Qinghai, Sichuan, Shaanxi and Xinjiang also launched or promoted regional cooperation on air pollution control. According to requirements from the Qinghai Provincial Government, the cities of Xining and Haidong further improved their collaboration, and strengthened joint law enforcement, information sharing, and alerting.

The cities of Zigong, Luzhou, Yibin and Neijiang signed a work agreement, which marked a major step forward for collaborative efforts in south Sichuan Province. Together, the four cities in southern Sichuan will create a plan for air quality attainment, establish and implement an emergency response mechanism, and take emissions reduction measures.

Shaanxi Province also established a collaboration mechanism among its central city cluster (Xi'an, Baoji, Xianyang, Tongchuan and Weinan) for information-sharing on atmospheric environment, forecasting and alerting, emergency response actions, law enforcement, and R&D cooperation.

In Karamay and Tacheng of Xinjiang Uygur Autonomous Region, the environmental protection authorities entered into an air pollution prevention and control agreement, and established a joint pollution prevention and control mechanism and a reporting system for major environmental pollution cases. These mechanisms will help Karamay and Tacheng to share information on implementation progress and sources of cross-border pollution.

Supporting Measures

Economic Measures

Discharge Fee

(1) Initiated levying fees for dust emissions from construction-sites

In 2015, Beijing, Tianjin and Jiangsu Province started to levy emissions fee for construction-site dust emissions in accordance with differential charging policies as follows:

On March 1, 2015, Beijing started levying emissions fee for dust emissions from construction-sites and implemented a tiered-pricing policy based on the quality of the dust management for the construction-site: the average charge is RMB 3/kg. If the dust management level at construction sites are at the excellent level, the rate shall be RMB 1.5/kg. If the management quality is at the attainment level, the rate should be RMB 3/kg. If the management level falls short of the attainment level, the rate should be RMB 6/kg.

On May 1, 2015, Tianjin started implementing a charging system for dust emissions, i.e. "double deduction or double penalty" on dust emissions from stockpiling and loading and unloading of bulk materials from construction sites (the concentration of which cannot be monitored). The rate of charge and the amount subject to the emissions fee can be lowered if the emitters adopt dust control measures. In contrast, this rate of charge and amount subject to a fee will be doubled if they take no actions.

Jiangsu Province began charging a fee for construction-site dust emissions, and the charge of some of cities in the province including Wuxi is RMB 1 per square meter per month.

(2) Pilot projects for VOCs emission fee in the petrochemical, packaging, and printing industries

In June 2015, the NDRC, MOF and MEP enacted the Pilots for VOCs Discharge Fees. These required the petrochemical industry and packaging and printing industry to complete pilot projects for VOCs emissions fees from October 1, 2015. In July 2015, Guangzhou took the lead in levying the VOCs emissions fee. By the end of 2015, the city had collected a total of RMB 1,128,900 from 669 enterprises emitting benzene, methylbenzene and dimethylbenzene. Afterwards, Beijing, Shanghai, Jiangsu Province, Anhui Province and Hunan Province issued their local regulations on VOCs emissions fee (Table 1).

Table 1: Policies in Provinces Levying VOCs Emissions Fees

Province/ City	Date of Release	Starting Date	Industry Subject to Emissions Fee	Rate	Tiered-pricing	
Beijing	September 15, 2015	October 1, 2015	Petrochemical, automobile manufacturing, electronics, printing, furniture manufacturing	RMB 20/kg	Enterprises that receive the clean production audit and pass the evaluation; Emission concentration ≤50% of the city's emission limit; Enterprises that are not punished by environmental protection authorities in the same month	RMB 10/kg
					Waste gas treatment facilities are not installed or do not function properly; VOCs emissions exceed the city's standard	RMB 40/kg
Shanghai	December 16, 2015	Stage 1: October 1, 2015 Stage 2:July 1, 2016 Stage 3:January 1, 2017	71 small and medium sub-industries in 12 industries, such as petrochemical, ship building, automobile manufacturing, packaging and printing, furniture manufacturing and electronics	Stage 1: RMB 10/kg Stage 2: RMB 15/kg Stage 3: RMB 20/kg	Enterprises that complete waste gas treatment in accordance with the city's industrial VOCs emissions control plan; Emission concentration ≤ 50% of the city's emission limit; Enterprises that are not punished by environmental protection authorities in the same month	50% of the charging standard
					Enterprises which fail to accomplish the waste gas treatment tasks, whose waste gas treatment facilities do not function properly, whose VOCs emissions exceed the standards, or which are to be eliminated	Twice the charging standard
					Enterprises subject to development restrictions	1.5 times the charging standard
Jiangsu Province	December 28, 2015	January 1, 2016	Pilot industries, such as petrochemical and packaging and printing	January 1, 2016 - December 31, 2017: RMB 3.6 per pollution equivalent; From January 1, 2018: RMB 4.8 per pollution equivalent	Enterprises' pollutant emission concentration is 80% to 100% of the specified emission standard	Benchmark charging standard
					Emission concentration is 50% to 80% of the specified emission standard	80% of the benchmark charging standard
					Emission concentration is less than 50% of the specified emission standard	50% of the benchmark charging standard
Anhui Province	December 30, 2015	October 1, 2015	Pilot industries, such as petrochemical and packaging and printing	RMB 1.2 per pollution equivalent	Enterprise's VOCs emission concentration is higher than the specified emission limit or higher than the specified total emission target	Twice the benchmark charging standard
					Enterprise's VOCs emission concentration is higher than the specified emission limit and higher than the specified total emission target	Three times the charging standard
Hunan Province	December 17, 2015	March 1, 2016	Pilot industries, such as petrochemical and packaging and printing	RMB 1.2 per pollution equivalent	Enterprise's VOCs emission concentration is higher than the emission limit specified by the national government or province or higher than the specified total emission target	Twice the benchmark charging standard
					Enterprise's VOCs emission concentration is higher than the emission limit specified by the national government or province and higher than the specified total emission target	Three times the charging standard

Project Subsidies and Special Funds

(1) Special fund for air pollution prevention and control increasing each year

In 2015, the national government allocated RMB 10.6 billion as a special fund for air pollution prevention and control, an increase of 8.2% compared to 2014. The air pollution prevention and control in Beijing, Tianjin, Hebei Province, Henan Province, Shandong Province, Inner Mongolia, Shanxi Province, Jiangsu Province, Zhejiang Province, Anhui Province and Shanghai was financially supported by the national government.

The national government planned to grant more special funds for air pollution prevention and control to regions that achieve good energy conservation and emission reduction results for coal-fired power plants. China Development Bank was also planning to grant preferential credits to such regions in support of ultra-low emissions and energy efficiency retrofitting.

At the municipal level, Beijing, Wenzhou, Qingdao and other cities continued to allocate the following (Figure 36) special funds for air pollution prevention and control.

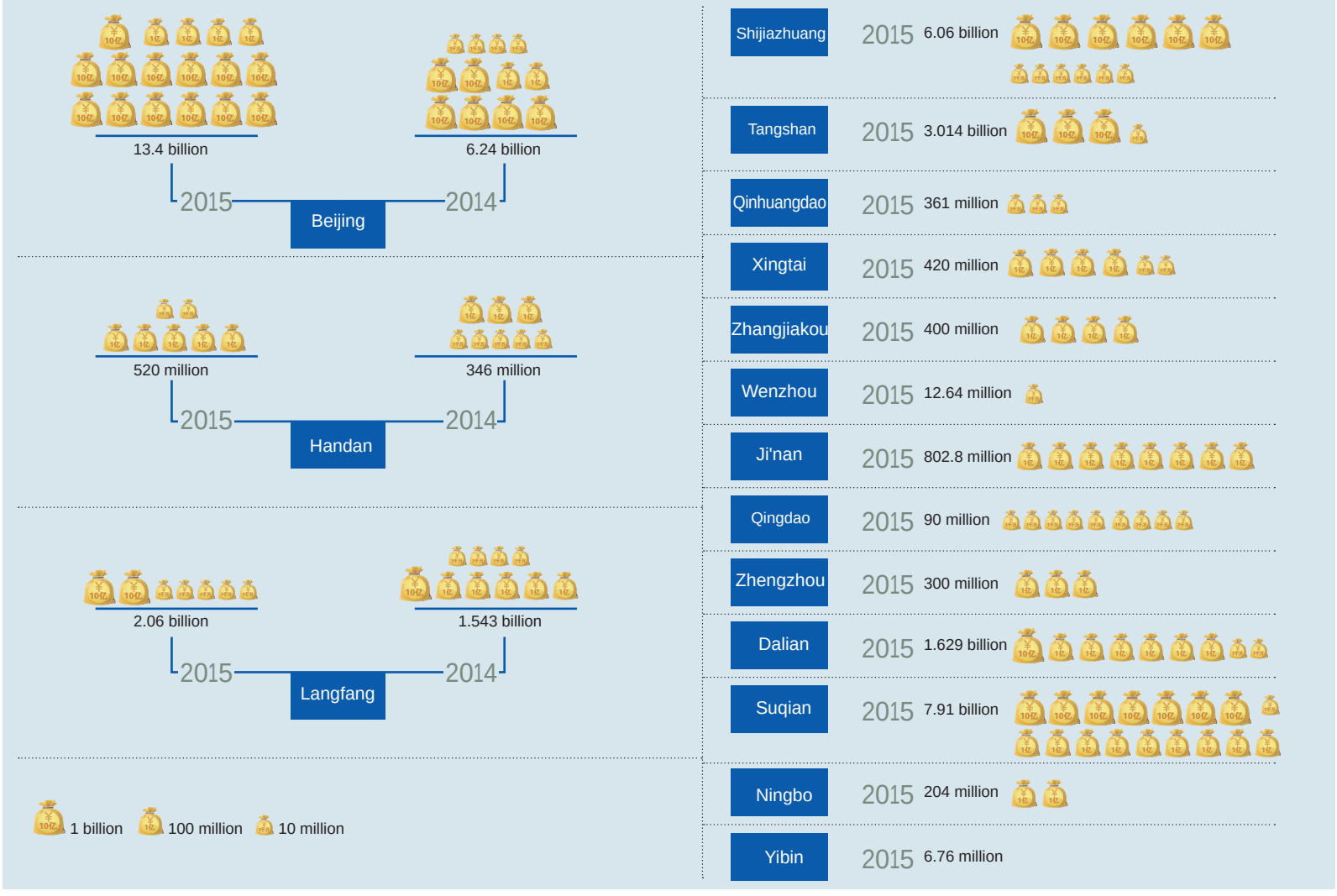


Fig.36: Special Funds Allocated by Cities in 2015

(2) Increased subsidies for alternative fuel buses

In 2015, the national government granted a subsidy of RMB 47.85 billion for energy conservation and emissions reduction, an increase of 40.4% year-on-year. The subsidy, which was originally intended for diesel buses, was changed to fund alternative fuel buses.

Cities also increased their financial support and established special funds to relocate and shut down enterprises, eliminate yellow-label vehicles, scrap outdated vehicles, promote alternative fuel vehicles, implement coal-to-gas switching, promote clean coal and energy-efficient environment-friendly stoves, and conduct scientific research on air pollution prevention and control. They began to encourage and guide non-governmental investments while establishing diverse mechanisms for investments by governments, enterprises and other investors to provide necessary financial guarantees for air pollution prevention and control.

Administrative Measures

Admonition and Comprehensive Supervision

In 2015, The MEP had admonitory talks with top leaders of local governments which were disclosed to the public. This measure incited more attention to air pollution. The MEP held public admonitory talks with the main government leaders of 15 cities (Changchun, Cangzhou, Linyi, Chengde, Zhumadian, Baoding, Lvliang, Ziyang, Wuxi, Ma'anshan, Zhengzhou, Nanyang, Baise, Zhangye, and Haixi Prefecture) on air pollution. This number is double that of 2014, when only 7 municipal governments were requested for such talks.

In 2015, the MEP established an environmental protection supervision mechanism, shifting the focus from "supervising enterprises" to "supervising governments" and intensified comprehensive supervision. By the end of 2015, the MEP carried out comprehensive supervision on 33 cities.

In addition, the Central Leading Team for Comprehensively Deepening Reform required provincial environmental protection authorities to conduct comprehensive supervision of work on environmental protection done by local governments for more than 30% of prefecture-level cities in their administrative regions. In 2015, the environmental protection departments (bureaus) of all provinces, autonomous regions, and municipalities directly under the national government carried out comprehensive supervision of country (district) governments of 163 cities with districts, autonomous prefectures and municipalities, accounting for 39.5% of the local governments in China.

Through the supervision, 31 cities were admonished, 20 cities (counties) had restrictions on approval of regional environmental impact assessments imposed on them, and local governments were required to address 176 problems within specified time frames. In the administrative region of the Northern China Environment Supervision Center alone, 57 responsible persons (29 from Cangzhou, 7 from Zhumadian, 3 from Baoding, and 18 from Chengde) were criticized, warned or dismissed following the admonitory talks on environmental improvements, but the MEP did not disclose how many cases were from air pollution violations.

At present, there is still insufficient publicized information on the effects of of pollution control after the admonitory talks, with only a few cities including Linyi and Zhumadian having disclosed the results following the talks. Linyi of Shandong Province shut down 57 polluting enterprises after being admonished. Zhumadian of Henan Province demoted four major officials who failed to complete their environmental management duties to satisfaction and shut down or rectified enterprises that were not in compliance with industrial policies and polluted.

Air Quality Ranking

Since January 2013, the China National Environmental Monitoring Center has issued monthly air quality rankings of 74 key cities. However, it has not ranked the other 264 cities that have published real-time air quality information.

Legislative Measures

Implementation of the Environmental Protection Law and Amendment to the Law on Prevention and Control of Atmospheric Pollution

The newly amended Environmental Protection Law became

effective on January 1, 2015, providing legal basis for environmental law enforcement. In 2015, 1,685 criminal cases for suspected environmental pollution across China were taken to courts for trial; 715 environmental violations were fined RMB 569 million; 4,191 cases involved seizure, and 3,106 cases involved production restriction or suspension. Environmental protection authorities at all levels made more than 97,000 administrative punishment decisions and imposed a total penalty of RMB 4.25 billion, an increase of 34% compared with 2014. However, the MEP did not disclose data about penalties related to air pollution.

At the regional level, BTH and its surrounding areas filed and investigated 16,800 air pollution cases, imposed a total of RMB 1.41 billion in penalties and shut down or restricted more than 5,700 illegal enterprises. Specifically, Beijing tried 1,937 air pollution cases and imposed a total penalty of RMB 44,042,300. Throughout 2015, Chongqing Municipal EPB accepted 57,116 environmental pollution petition letters and complaints, 18,375 (32%) of which were about air pollution.

During the countrywide environmental protection inspection in 2015, the MEP inspected a total of 1.77 million enterprises, investigated 191,000 illegal enterprises, closed down or restricted 20,000 enterprises, ordered 34,000 enterprises to suspend production, and required 89,000 enterprises to make rectifications within a specific time frame. However, it did not disclose the number of enterprises which were investigated due to air pollution.

2015 was the first year of environmental public interest lawsuits following the implementation of the new Environmental Protection Law. In 2015, Chinese courts at all levels accepted 53 environmental public interest lawsuits, including 47 civil cases and 6 administrative cases. However, the relevant departments did not disclose statistical data and information regarding air pollution-related cases.

Furthermore, the Law of the People's Republic of China on Prevention and Control of Atmospheric Pollution was amended in August 2015 and became effective on January 1, 2016. It contains the provisions on the standards, the schedules for attaining standards, requirements for supervision and management, measures for air pollution prevention and control, joint air pollution prevention and control mechanisms in key regions, and emergency response.

Information Disclosure and Alerts for Heavy Air Pollution

In 2015, the MEP stepped up efforts for environmental information disclosure. The MEP strongly promoted disclosing air quality information, regional environmental quality information, and timely air quality forecasts and alerts for key regions. Since December 28, 2014, the MEP has been publishing air quality forecasts and heavy pollution weather forecasts for BTH, YRD and PRD on its website and the website of the China Environmental Monitoring Center.

At the municipal level, all the 161 cities have established public platforms disclosing major pollution source monitoring information on the websites of their EPBs to promote public supervision and information transparency. The cities expand the scope of online monitoring of pollution sources and disclose the pollution source information provided by authorities' supervisory monitoring and enterprises' self-monitoring. EPBs provide supervisory monitoring information through monthly or quarterly reports, and the public can get access to the latest information from enterprises' self-monitoring on EPBs' public platforms.

City Case Study

Coal-Fired Boiler Retrofitting

Shanghai

I. Background

As a megacity in Eastern China, the Shanghai Municipal Government has significantly emphasized reducing air pollutant emissions and improving air quality. As a leading voice in China's efforts to improve air quality, Shanghai is one of the first Chinese cities to retrofit coal-fired boilers. The city government started researching and piloting relevant projects as early as 2000. The following information provides background on this work:

(1) Total energy consumption continues to rise with overly high proportion of coal use: Since 1995, Shanghai's total coal consumption has been increasing while the proportion of coal usage in energy consumption has also steadily increased. Shanghai's total energy consumption in 2000 was 54.995 million tons of standard coal.

(2) Extensive use of coal-fired boilers: In 2000, more than 3,800 industrial boilers were in operation in Shanghai. Specifically, there were 621 boilers within the Inner Ring Road, 1,056 between the Inner and Outer Ring Roads, and 2,149 in communities located outside the Outer Ring Road. The citywide average boiler density was 0.6 unit/km2, while the density in the downtown areas within the Inner Ring Road was as high as 6.2 unit/km2 .

(3) High air pollutant emissions require appropriate and effective environmental measures: In 1998, the State Council listed Shanghai as one of China's key regions that would be required to reduce SO_2 emissions in a plan aimed at controlling acid rain and SO_2 pollution. In 2000, Shanghai's total emissions was significant – the city emitted 464,900 tons of SO_2 and 141,200 tons of smoke and dust from industrial sources. In April 2000, the National People's Congress amended the Law on Prevention and Control of Atmospheric Pollution, intensifying efforts to reduce air pollution while providing strong legal support for the replacement of coal-fired boilers with clean energy boilers. Consequently, the Shanghai Municipal Government developed a number of policy measures for SO_2 emissions control, including implementing a total emission control and the licensing system, establishing "coal-forbidden zones," switching to clean energy, and shutting down small thermal power units.

(4) The West-East gas transmission pipeline project guarantees natural gas supply: Improving supply of natural gas is one of the most important steps to replacing coal-fired boilers with clean energy boilers. In 1999, the Shanghai Municipal Government began using natural gas from the Pinghu Oil and Gas Fields located in the East China Sea. In 2000, the West-East Gas Transmission Pipeline Project was officially launched. Finally, the Jingbian-Shanghai section was put into trial operation successfully in 2003. On January 1, 2004, the West-East Gas Transmission Pipeline officially started supplying natural gas to Shanghai. The West-East Gas Transmission Pipeline Project was a vital opportunity for Shanghai to re-adjust its energy structure to make replacing coal with clean energy in Shanghai a reality.

II. History of Shanghai's Policies to Retrofit Coal-Fired Boilers

1. Early Efforts in Shanghai to Promote Coal-Fired Boiler Retrofitting

(1) In 1999, Shanghai piloted a program to replace small coal-fired boilers with clean energy boilers in Luwan District and Huangpu District. This program was then expanded to cover the entire downtown area.

(2) In 2001, the effort to increase the use of clean energy boilers was launched with the release of the "Notice on the Measures for the Implementation of the Replacement of Coal-Fired Boilers and Industrial Stoves in Shanghai with Clean Energy" by the Shanghai Economy and Information Technology Commission and the Shanghai Environmental Protection Bureau (Hu Jing Jie [2001] No. 407). That same year, the Shanghai Environmental Protection Bureau also published the "Notice on Granting the Special Fund for the Replacement of Coal-fired Boilers with Clean Energy Units in 2001" (Hu Huan Bao Kong [2001] No. 361), which specified standards for subsidies and conditions for replacement.

(3) In 2002, the Shanghai Environmental Protection Bureau issued the "Demarcation and Implementation Plan of Mostly Coal-Free Zones in Shanghai", specifying the zones that would need to replace coal-fired boilers with clean energy boilers (see Figure 37).

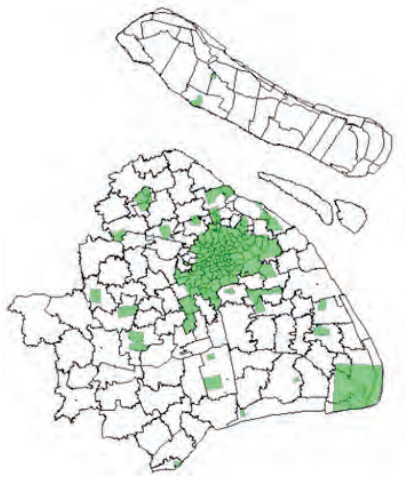


Fig.37: "Mostly Coal-Free Zones" in Shanghai

2. Full Implementation of Retrofitting Coal-Fired Boilers in Shanghai

Although Shanghai had been continuously replacing coal-fired boilers with clean energy boilers since 2000, progress was relatively slow. During the initial stages of the "12th Five-year Plan," Shanghai's worsening haze strengthened the public's call for cleaner air and industrial pollution became an even more important priority. At that time, there were still a large number of boilers in Shanghai, but clean energy boilers began to increase with the following conditions in place:

(1) Energy structure re-adjustment intensified. According to Shanghai's Energy Development Plan for the "12th Five-year Plan," Shanghai planned to optimize the primary energy structure, controlling the use of coal while increasing natural gas use, supporting top-performing and new enterprises, and significantly increasing the supply of clean and low-carbon energy (such as electricity, natural gas and new energy from other locations).

Moreover, Shanghai planned to optimize the layout and structure of power sources and grids (including sources and grids for natural gas), improve the grid's ability to integrate energy from multiple sources, and increase generation capacity for natural gas. Furthermore, the plan outlined proactive steps to develop regional co-generation and distribute systems and install large generator sets and suppress small generator sets to form a multi-faceted electric power supply system where small, medium and large energy production systems could be complementary.

(2) Increasing supply of natural gas. In 2009, Shanghai accelerated the construction of the Phase 2 of the Shanghai Section of the Natural Gas Backbone Network and the terminal station of Sinopec Sichuan-East Gas Transmission Project. This enabled Shanghai to obtain natural gas from Sichuan Province. The citywide supply of natural gas throughout 2009 was 3.35 billion m^3, an increase of 11.7% compared with 2008. The Shanghai Municipal Government also continued to accelerate the construction of the natural gas pipeline network and the citywide natural gas transmission pipeline is now 21,153 km.

During this period, the Shanghai Municipal Government and the relevant authorities pushed forth a series of policies to promote and guarantee replacement of coal-fired boilers with clean energy units. These policy documents include:

(1) In 2012, the Shanghai Municipal Government completed the "Work Plan of Shanghai Municipality for the Replacement of Coal (Heavy Oil)-Fired Boilers with Clean Energy Boilers" and the "Measures of Shanghai Municipality for the Special Fund Support for the Replacement of Coal (Heavy Oil)-Fired Boilers with Clean Energy Boilers" (Hu Fu Ban Fa [2012] No. 36, hereinafter referred to as "No. 36 Document"), developed by Shanghai's Development and Reform Commission, Environmental Protection Bureau and four other authorities. This marked the initiation of a new round of efforts to replace old coal-fired units with clean energy boilers. That same year, the Shanghai Municipal Government passed Shanghai's "Coal-Free Areas and Mostly Coal-Free Areas and Implementation Plan (2011-2015)" (Hu Fu [2012] No. 40), providing the legal support to replace coal-fired boilers with clean energy boilers.

(2) Over one month after the State Council issued the Action Plan for Air Pollution Prevention and Control, the city government released the "Clean Air Action Plan of Shanghai Municipality (2013-2017)" in November 2013, which established these goals: "By 2015, Shanghai shall have completed the replacement, adjustment or shutdown of more than 2,500 boilers and more than 300 furnaces fired by high-polluting fuels such as coal (heavy oil), and have closed most scattered facilities fired by coal or other high-polluting fuels, such as commercial small drinking water boilers and small stoves. By 2017, Shanghai shall have retrofitted all coal-fired facilities, such as co-generation units and central heating boilers, into clean energy ones, and shall have shutdown scattered coal-fired facilities."

(3) In December 2013, the Shanghai Municipal Government issued the "Suggestions on Further Intensification of Efforts to Promote the Replacement of Coal (Heavy Oil)-Fired Boilers and Furnaces with Clean Energy Ones" (Hu Fu Ban Fa [2013] No. 66, (hereinafter referred to as "No. 66 Document"), further clarifying the city's objectives and supporting policies to replace coal-fired boilers in Shanghai.

(4) At the outset of the "13th Five-year Plan" period, Shanghai's Development and Reform Commission and six other agencies issued the "Work Plan of Shanghai Municipality for Coal Reduction and Replacement (2015-2017)." The document explicitly requires: "By the end of 2015, Shanghai should have completed the clean energy replacement or shutdown of nearly 3,000 scattered coal-fired boilers and furnaces. By the end of 2016, Shanghai should have closed commercial small stoves and other scattered coal-fired facilities. By the end of 2017, Shanghai should have completed the clean energy replacement of central heating and co-generation boilers."

III. Major Policy Measures and Technical Options

1. Policy Measures

Since Shanghai started replacing coal-fired boilers, the government has published a number of policy documents, of which the two most important are No. 36 Document and No. 66 Document. Specifically, No. 66 Document deepened and strengthened No. 36 Document. Compared with No. 36 Document, No. 66 Document contained key adjustments to make the policy measures more scientific and feasible:

(1) The goal to increase clean energy boilers was expanded. According to No. 36 Document, by the end of 2015, more than 1,300 coal (heavy oil)-fired boilers (with the total heating capacity of 4,000 t/h) in the "coal-free zones" and "mostly coal-free zones" should have been replaced with clean energy boilers. According to No. 66 Document, the entire Shanghai metropolitan region should be "coal-free" and by the end of 2015, 2,898 coal (heavy oil)-fired boilers and furnaces across Shanghai should be replaced with clean energy units.

(2) Incentive policies were adopted with an increase in subsidies. Compared with No. 36 Document, No. 66 Document adopted subsidies that increased based on specific tiers. If enterprises completed replacement in 2013 and 2014, they would receive more subsidies. The specific subsidy standards are listed in Table 2.

Table 2: Shanghai's Subsidy Standards for the Replacement of Coal-Fired Boilers with Clean-Energy Ones (Unit: 10,000 Yuan)

		No. 36 Document	No. 66 Document Subsidy Standard	
Districts	Project	Subsidy Standard	Completed in 2013-2014	Completed in 2015
Huangpu, Xuhui, Changning, Putuo, Zhabei, Hongkou, Yangpu	Municipal level	8	12	8
	District/county level	12	12	12
	Total	20	24	20
Pudong, Baoshan, Minhang,Jiading, Songjiang	Municipal level	12	16	12
	District/county level	12	12	12
	Total	24	28	24
Jinshan, Qingpu, Fengxian, Chongming	Municipal level	20	26	20
	District/county level	10	10	10
	Total	30	36	30

(3) An increase in the upper bound for subsidies to retrofit boilers. No. 36 Document notes that one independent legal entity can receive the municipal-level subsidy of up to RMB 5 million and the district/county-level subsidy of up to RMB 2.5 million. In contrast, No. 66 Document increases the upper bound and specifies that one independent legal entity may receive the municipality-level subsidy of up to RMB 10 million and that the district/county governments may increase the maximum district/county-level subsidies based on each situation.

(4) Application and approval process for subsidies was simplified. According to No. 36 Document, the following steps comprise the application and approval process of fiscal subsidies for the replacement of coal-fired boilers with clean energy boilers:

1) Users apply to the district/county competent authority for this special subsidy after signing a "project retrofitting contract".

2) The relevant district/county authority completes a preliminary examination of the materials.

3) After the completion of the project, the user submits the designated application documents (five documents, including the invoice and the equipment purchasing contract).

4)The relevant district/county authority organizes the relevant authorities of the district/county to complete a preliminary check on the replacement project.

5) The Municipal Office to Promote Clean Energy Replacement submits the review to the Municipal Office of Energy Conservation and Emission Reduction and also submits the review and the subsidy appropriation application to the Municipal Finance Bureau.

6) The Municipal Finance Bureau then appropriates the subsidy to the Finance Bureau of the relevant district/county.

Under No. 66 Document, the subsidy application and approval process was simplified. An enterprise simply completes the subsidy application by submitting the proof of the methods to shut down original coal (heavy oil)-fired boilers and furnaces, and provides information about the retrofitting or the repurchasing of the equipment or facilities (methods).

(5) Increased support for gas and power supplies and other supporting projects and facilities. To reduce the economic burden of replacing boilers for enterprises, under No. 36 Document, if a "boiler-using" enterprise is not included in the plan for natural gas development and retrofitting would require the construction of a special pipeline (or a feeder) for the enterprise, the gas supplier should collect the pipeline construction charge at 50% of the Budget Quota of Shanghai Municipality for Public Pipeline Projects (2000) (the agreement between the supplier and the pipeline user, if any, would apply).

Under No. 66 Document, 50% (40%) of the cost to lay the pipeline (outside the enterprise's red line) in the natural gas pipeline network should be equally shared by the district/county government and the enterprise. The 0.4 kV business expansion project for replacement with electric boilers shall be charged at the "real" cost. Moreover, the power supply company will pay the cost to upgrade the power grid, and this will be labeled as a project that supports business expansion. The power supply capacity for electric boilers in 10 kV business expansion projects for replacement with electric boilers shall be charged at a tariff lower than the quota standard for non-residential business expansion projects.

(6) Clarified and expanded the scope and increased the number of parties that would receive support. In addition to the adjustments mentioned above, No. 66 Document expanded the scope and increased support for the

receivers of the subsidy. On the precondition that the facilities maintain their original functions, the facilities can obtain one-off subsidies from the municipal finance and the district/county finance departments to replace boilers, furnaces and other facilities powered by high-polluting fuels (such as coal, heavy oil, coal water slurry or wood) with equipment that is powered by clean energy sources (such as natural gas, electricity, heat pumps, heating power, including central power).

The municipal government will also encourage gas and power supply enterprises to lower the tariffs on natural gas or electricity for enterprises that have installed clean energy replacements. The local government will also encourage gas, electricity or other energy supply enterprises to lower their energy tariffs for livelihood service enterprises replacing units with clean energy options.

2. Technical Options

Shanghai's menu of technical options to replace coal-fired boilers with clean energy ones mainly includes coal-to-gas and coal-to-electricity switching, supplemented by distributed energy supply and heat pumps.

(1) Coal-to-Gas Switching

Coal-to-gas switching means switching from coal to gas-fired boilers. Gas-fired boilers have the benefits of good combustibility, rapid ignition, fast heat-up, flexibility, efficient combustion and low levels of pollution. The maintenance cost of a gas-fired boiler is low because it has a simple system, little ancillary equipment, and a high level of automation.

As gas-fired boilers can produce hot water or steam, they are widely used in the facilities needing steam, heating, and hot water such as factories, hospitals, schools, restaurants and hotels. In addition, as gas-fired boilers take up a smaller area and provide operational flexibility, they are very suitable for the heating needs of civil or public buildings, such as business hotels, offices, schools, residential quarters and entertainment venues. Some production enterprises also use steam from gas-fired boilers to process or disinfect products, dry semi-finished products or anneal intermediate products.

In order to guarantee the smooth implementation of coal-to-gas switching, the Shanghai Municipal Government requires the gas supply enterprises to bear 50% (60%) of the cost to lay the natural gas pipeline (outside the enterprise's red line), in line with the requirements of No. 36 Document and No. 66 Document. The district/county governments and the gas-using enterprises should then each bear 25% (20%) of the cost.

(2) Coal-to-Electricity Switching

Coal-to-electricity switching means switching from coal-fired boilers to electric boilers. Electric boilers are clean, simple to operate, and take up a smaller area. Specifically, electric boilers are more energy efficient as they are very conducive for load-shifting in the power grid. They can reduce peak loads, reduce equipment capacity, and save infrastructural investment, so as to reduce line losses in the grid and save electricity.

With a broader coverage area than natural gas, electricity has become one of the most convenient, reliable and clean energy resources for enterprises, public institutions and residents across Shanghai. In addition, there are variations in electric boilers, which can meet the heating needs for different environments and conditions. Users can choose direct heating or storage heating, based on the actual amount of heat needed. Therefore, electric boilers are suitable for hotels, villas, factories, office buildings, government agencies, higher education institutions, hospitals, military units and other facilities.

According to Shanghai's "Work Plan to Accelerate the Replacement of Central Heating and Cogeneration Coal (Heavy Oil)-Fired Boilers in Shanghai with Clean Energy Boilers" issued in 2015, power grid companies should enhance the coordination and communication with power grid planning, municipal road and other authorities at the district/county-level to include gas-fired co-generation with regional grid planning, accelerate the construction of the power grid, and invest in and construct a user's external (outside the user's booster station) grid-connection facilities to be suitable for gas-fired cogeneration and other relevant grid upgrades. The plan also specifies that companies that are retrofitting for gas-fired co-generation will be exempt from reserve capacity charges due to the principle of "determining power generation based on heat generation".

IV. Participating Departments and Responsibilities

Most of Shanghai's coal-fired boilers were replaced with clean energy boilers. To ensure smooth implementation, Shanghai created the Office to Promote Clean Energy Replacement of Coal-fired Boilers ("Municipal Promotion Office") to be responsible for the overall implementation. Other relevant parties include the Municipal Finance Bureau, the Municipal Office of Energy Conservation and Emission Reduction, district/county governments and relevant project enterprises. Under No. 36 Document, the participants' responsibilities were:

(1) The Municipal Promotion Office shall gather and submit annual work plans and subsidy budgets of districts/county responsible for installing new clean energy boilers. This office will also review subsidies for clean energy boilers based on the designated application procedures.

(2) The Municipal Finance Bureau shall appropriate special funds to replace coal (heavy oil)-fired boilers with clean energy boilers, supervise the use of these funds, and also assess the performance.

(3) The Municipal Office of Energy Conservation and Emission Reduction shall review, manage and balance the special subsidy plan and budgets. This office shall also perform random inspection to assess the implementation of any subsidized projects.

(4) The District/county governments shall manage the subsidies. The relevant authority of a district/county will prepare the implementation plan and the subsidy budget; accept, examine, gather and submit project subsidy applications for approval in the district/county; promote, implement, supervise and inspect the replacement projects and finally, verify the completion of the replacement projects; develop the relevant measures for the implementation of the subsidies at the district/county-level; and allocate the municipal-level and the district/county-level subsidies in a timely manner.

(5) The Members of Municipal Promotion Office shall supervise and manage the replacement projects according to their respective division of work.

(6) The enterprises replacing their boilers shall submit applications, ensure the authenticity of the application materials, complete the implementation of projects as planned, and coordinate with relevant municipal authorities in the supervision, inspection and acceptance process.

In addition to the clear division of responsibilities in No. 36 Document, No. 66 Document contains the division of responsibilities of additional relevant authorities:

(1) The Municipal Development and Reform Commission shall coordinate the cogeneration retrofitting and electric power access of central heating companies, speed up project approvals, and intensify coordination for increasing access to electric power.

(2) As the main municipal authority responsible for increasing the use of clean energy boilers, the Municipal Economy and Information Technology Commission (Municipal Office of Clean Energy Replacement Promotion) shall: 1) Refine the work plan and optimize the fund application process; 2) Improve the public promotion of and technical services for clean energy replacement projects; 3) Prepare brochures of technologies, cases, equipment, and facilities; and 4) Set up and maintain hotlines, and further enhance the management of projects.

(3) The Municipal Environmental Protection Bureau shall accelerate revising Shanghai's boiler and furnace emission standards, conduct and enhance environmental regulation, supervision and monitoring, strengthen law enforcement, and strictly punish violators. If an emitter does not attain the standards, the local government will have the authority to order the emitter to make adequate rectifications within a specific time frame. If the emitter fails to do so, the local government will have the authority to suspend (or shut down) the offender's business.

(4) The Municipal Construction and Traffic Commission shall work with the Municipal Development and Reform Commission to plan the citywide gas distribution and development process. Additionally, the commission shall also ensure that gas supply companies are constructing natural gas pipelines as planned, guide gas supply companies to offer preferential prices, enhance the supervision of natural gas supply, construction, pricing and other aspects, coordinate with non-pipeline transmission enterprises and gas supply companies, and develop measures and procedures for the management of non-pipeline transmission applications.

(5) The Municipal Finance Bureau shall manage the availability of funds for the districts/counties, and organize and guide performance assessment.

(6) The Municipal Quality and Technical Supervision Bureau shall supervise and manage boiler energy conservation based on regulations and coordinate with relevant authorities in the legal inspection process. This bureau shall provide enterprises with relevant certificates of boiler dis-use/scrapping and analyze relevant inspection measures for boiler and energy conservation.

(7) The Municipal Planning and Land Resources Bureau shall guide and coordinate with land resources authorities of the districts/counties in the planning and approval process for natural gas and heat supply pipeline networks. This bureau will also assist with the planning, approval and land use elements in the project construction process.

(8) Shanghai Gas Group and gas supply enterprises of the districts/counties shall accelerate laying down the natural gas pipeline based on the natural gas pipeline network plan of Shanghai Municipality, districts and counties. These organizations shall ensure the implementation of preferential gas price policies and provide technical services and construction for supporting facilities when replacing old boilers and furnaces with clean energy ones.

(9) Shanghai Municipal Electric Power Company shall accelerate grid construction, ensure power supply, provide technical services, and guarantee electricity supply and relevant preferential policies.

No. 66 Document also highlighted the coordination and cooperation among the relevant authorities and emphasized that district/county governments are primarily responsible. It specifies that:

1) The relevant local district/county governments, with assistance from relevant authorities (including Municipal Economy and Information Technology Commission, Municipal State-Owned Assets Supervision and Administration Commission) will help coordinate and advance boiler and furnace replacement for municipally-administered industrial enterprises and zones.

2) The replacement process of other municipally-administered enterprises shall be coordinated and promoted by the relevant local district/county governments, with the assistance of relevant authorities for industry.

3) The replacement process of state-owned enterprises in Shanghai shall be coordinated and promoted by enterprises' local district/county governments, with the assistance of the Municipal Economy and Information Technology Commission.

As the primary entity responsible for clean energy replacement of coal-fired boilers, the district/county governments shall sign liability statements with the municipal government to specify the annual targets and indicators. District/county governments shall designate specific authorities to promote clean energy replacement. Therefore, district/county governments shall track and monitor the progress in their administrative regions. The main regulation method is on-site inspection – the implementation of clean energy replacement by enterprises on the list shall be inspected on the site and monitored one-by-one until all replacement clean energy units are installed. In addition, the on-site inspection for retrofits, when enterprises apply for government subsidies, is also an important part of regulation.

The supervision responsibilities of the relevant authorities are as follows:

1) Supervision shall focus on investigating and punishing high energy-consuming coal-fired boilers and furnaces and aim to control coal consumption from the source.

2) The environmental protection authority shall focus on the regulation of improperly managed facilities, emissions standards violations and other issues, and impose punishments on a daily basis.

3) The districts/counties and sub-districts/towns shall address illegal coal-fired boilers through structural adjustment, crackdown on illegal production and illegal building demolition, and troubleshooting safety issues.

For each implementation process, if some users are unwilling to replace old units with clean energy units, environmental protection authorities shall impose strict, fast and heavy penalties for illegal construction, black-smoke boilers, improperly-functioning facilities, emissions standards violations, and other violations in accordance with the Environmental Protection Law of the People's Republic China and the Regulations of Shanghai Municipality on Air Pollution Prevention and Control. The environmental protection authority shall strictly enforce the laws and impose punishments, punishments on a daily basis, detention, and other punishments.

In law enforcement, if enterprises are found to have environmental violations related to coal-fired boilers and furnaces, they shall be ordered to suspend production and rectify problems within a limited time frame. In addition, if enterprises continue to use high-polluting small and medium-sized coal (heavy oil)-fired boilers and furnaces after January 1, 2016, the environmental protection authority can order enterprises to dismantle or it will confiscate the facilities still powered by high-polluting fuels.

V. Policy Effects

From 2001 to 2005, Shanghai completed the retrofitting of more than 2,000 coal-fired boilers for and furnaces. The area for "mostly coal-free zones" in Shanghai reached 321 square kilometers, which is double the original goal of 150 square kilometers. All the remaining 621 coal-fired boilers within the Inner Ring Road had been replaced with clean energy ones or their use had been discontinued, and the Inner Ring Road became "coal-free". Detailed results are shown in Table 3.

Since 2010, the boiler replacement progress has been boosted with the promotion of a new round of clean energy replacement. By the end of 2015, Shanghai had fully completed the replacement of small- and medium-sized coal-fired boiler, including 2,442 small- and medium-sized coal (heavy oil)-fired boilers and furnaces, in addition to outlawing 3,626 commercial small boilers and stoves. Shanghai has also completed the retrofitting of other scattered coal-fired boilers except central heating boilers.

After completing this round of replacements, Shanghai can annually reduce scattered coal consumption by 1.8 million tons standard coal, carbon dioxide consumption by 2.882 million tons, sulfur dioxide emission by 24,000 tons, nitrogen oxide emission by 14,000 tons, and smoke and dust by 8,000 tons. Comprehensive boiler energy efficiency was increased by 28%, which is equivalent to saving 550,000 tons of standard coal.

Table 3: Completion of Clean Energy Replacement of Coal-Fired Boilers in Shanghai (2001-2005)

Area	Number of boilers replaced	Quantity of coal reduced (1,000 tons)
Within the Inner Ring Road	621	485
Between the Inner Ring Road and the Outer Ring Road	717	789
Outside the Outer Ring Road	728	680
Total	2066	1954

VI. Experience and Challenges in the Management of Coal-fired Boilers

Thus far, Shanghai has achieved significant results in the replacing coal-fired boilers with clean energy ones. The main experience is summarized as follows:

(1) Establishing a Coordination System for Enhancing Collaboration among Multiple Authorities

Local governments were primarily responsible for replacing coal-fired boilers in Shanghai. The participants included: the Development and Reform Commissions, the Economy and Information Technology Commissions, environmental protection bureaus, finance bureaus and gas and electric power companies. To ensure smooth progress, Shanghai authorities set up the Municipal Promotion Office to regularly hold liaison meetings, gather the authorities' relevant work requirements and replacement progress, and prepare quarterly work briefs.

In the replacement process, the vice-mayor in charge also held a number of special coordination meetings for addressing any challenges. The coordinated guidance of local governments and the collaboration among authorities effectively guaranteed that coal-fired boiler retrofitting was smoothly implemented.

(2) Combining Incentives and Regulation

First, the relevant authorities in Shanghai developed a policy for financial subsidies to guide enterprises on replacing their coal-fired boilers. Also, subsidies were tier-based in a way which encouraged enterprises to retrofit facilities as early as possible. Subsidies varied based on the date of retrofit; the earlier the retrofitting, the greater the subsidy.

Second, upgrading of the boiler emission standards compelled enterprises to complete replacements as early as possible. In August 2014, Shanghai released the Emission Standard of Air Pollutants for Boiler (DB31/387-2014), which came into force on October 1, 2014 and superseded the original standard, the Emission Standard of Air Pollutants for Boiler (DB31/387-2007). Under the new standard, the limit for emitting smoke and dust, sulphur dioxide, nitrogen oxides, mercury and its compounds by coal-fired boilers in Shanghai is 20 mg/m^3, 100 mg/m^3, 150 mg/m^3 and 0.03 mg/m^3 respectively, more than 25% higher than the national special emissions limits.

Third, Shanghai raised the fees for pollutant emissions to further incentivize enterprises to complete replacements. The increase in charges further drove enterprises to replace coal-fired facilities with clean energy ones.

(3) Districts/Counties Providing Support

As replacing coal (heavy oil)-fired boilers would involve high investments and high operating costs, the municipal-level and the district-level finance bureaus granted one-off equipment investment subsidies for replacement projects. As they were primarily responsible for the promotion of clean energy boilers, district/county governments also developed subsidy policies to encourage retrofits of coal-fired boilers.

(4) Enhancement of Law Enforcement

The quality supervision authority focused on controlling coal consumption from the source by investigating and punishing companies for using the highest energy-consuming coal-fired boilers and furnaces. The environmental protection authority focused on the regulation of improperly functioning facilities, emissions standards violations and other issues, and imposed penalties on a daily basis, increasing control of end-of-pipe emissions. The district/county and sub-district/town governments accomplished tasks that addressed illegal coal-fired facilities through structural adjustment, crackdown on illegal production, demolition of illegal buildings, troubleshooting for safety measures, and other work.

Shanghai has completed its coal-fired boiler retrofitting goals ahead of schedule. With the exception of retrofitting central heating boilers, which is expected to be completed by 2017, other small- and medium-sized coal-fired boilers are now all running on clean energy. Therefore, the future challenge is mainly replacing old central heating boilers with ones powered by clean energy.

For this reason, on July 30, 2015, the Shanghai Municipal Development and Reform Commission, the Economy and Information Technology Commission, the Environmental Protection Bureau, and the Finance Bureau issued the Implementation Plan for Accelerating the Clean Energy Replacement of Coal-Fired Boilers in Shanghai, setting clearer requirements for replacing central heating boilers. Enterprises retrofitting for gas-fired co-generation must make clear technical project plans and initiate work by the end of 2015, and project implementation and construction must begin no later than 2016. Construction of gas supply, connecting to electric power, and other supporting projects will also begin at the same time, to ensure that retrofitting is completed by the end of 2017.

Urban VOCs Control

Shenzhen

I. Background

In 2009, in the southern Chinese city of Shenzhen, the volatile organic compounds (VOCs) emissions were as high as 190,544.8 tons, and the sectors generating VOCs emissions were highly concentrated, with the top five responsible for 80% of total emissions in Shenzhen. According to the 2008 Shenzhen ambient air pollutant emission inventory, the top five sectors of VOCs emissions were: road mobile sources, furniture manufacturing, plastics painting, architectural coating, and electronics manufacturing, with emissions amounting to 59,460.1, 42,500, 21,799, 18,108.7 and 10,229 tons respectively (Table 4).

II. History of VOCs Control Policies in Shenzhen

1. The Beginning of VOCs Emission Control

With a steady increase in complaints against VOCs emissions and more complaints from the public on air pollution, the Shenzhen Municipal Government had sacrifice some short-term economic benefits for long-term urban development. The city government saw improving air quality as a way to enhance the competitiveness of the city and create green welfare benefits for the local citizens. As the host city of the 26th Summer Universiade in 2011, Shenzhen began its efforts on VOCs control in the furniture manufacturing industry.

On January 24, 2011, the Human Settlements and Environment Commission of Shenzhen Municipality (HSECSM, a municipal environmental protection authority of Shenzhen) officially issued the Notice of Carrying out VOCs Control of Furniture Manufacturers, which requires that:

(1) Source control and end-of-pipe emissions control must be done simultaneously. A departure from previous requirements, this Notice stated the importance of source control while also providing favorable policies on using low-VOC coating, such as water-based paint or UC paint.

(2) Supervision and management should be strengthened by creating an inventory of raw and supplementary materials. This Notice requires enterprises to establish an inventory of raw and supplementary materials, improve the records of operations of emission control facilities and ensure that the removal rate of VOCs in exhaust gas processing facilities reaches 90%.

Table 4: 2008 Shenzhen Ambient Air Pollutant Emission Inventory

Emission Sources	SO_2(t)	NOx(t)	CO(t)	PM_{10}(t)	$PM_{2.5}$(t)	VOCs (t)
Coal-fired plants	39,371.8	44,281.6	20,073.8	5,851.5	4,961.9	1,914.2
Industrial sources	2,857.9	3,779.3	321.2	441.9	353.7	13,089.8
Printing	41.4	15.6	1.6	2.7	1.8	1,427
Electronics manufacturing	683.1	575.8	49.5	32.1	31.1	10,229
Road mobile sources	10,100.9	86,756.1	571,759.7	16,500.3	13,672.6	59,460.1
Non-road mobile sources	14,723.2	24,331.7	4,725.5	679.7	625.2	579
Dust sources				24,997.1	7,499.1	
VOCs-containing products						103,245.1
Use of household solvents						4,307.8
Dry laundry						116
Furniture manufacturing						42,500
Painting on plastic						21,799
Footwear manufacturing						6,691
Bicycle manufacturing						2,769
Painting and architectural Coating production						1,454.2
Printing ink production						2,035.8
Use of architectural coating						18,108.7
Vehicle maintenance						431
Gas stations						3,032.6
Natural sources						12,088
Other emission sources	1,186.3	938.6	4,107.7	596.1	389.2	168.6
Total	68,240	160,087.4	600,987.9	49,066.6	27,501.7	190,544.8

(3) The Notice also requires that every facility sets a timeline and mandates strict rejection of false reporting. According to this Notice, "Each furniture manufacturer should report to its local environmental department on the air pollutant type, quantity and concentration of coating production line emissions before April 30, 2011." Moreover, "The environmental department should issue pollutant discharge permits to qualified manufacturers before July 31, 2011, and issue applications for pollutant discharge permits based on these pollutant discharge reports." After the Notice came into effect, the HSECSM and the environmental departments at the district level perform special legal inspections to reduce emissions from furniture manufacturers.

Meanwhile, on April 12, 2011, the Environmental Protection Department of Guangdong Province released the Plan for Joint Prevention and Control for the Air Quality Assurance during the 26th Summer Universiade in 2011 to strengthen the comprehensive prevention and control of air pollution in Shenzhen and its surrounding cities, carry out air pollution control in multiple sectors, and ensure that the air quality in Shenzhen met specific standards. This Plan set forth the requirements as follows:

1) Each city in the main control area should, by July 31, 2011, establish a registration and reporting system for the use of organic solvents and VOCs control by key VOCs emission enterprises.

Table 5: Shenzhen VOCs Control Tasks for the Summer Universiade

City	Key Control Sectors	Main Control Measures
Shenzhen	Printing, furniture manufacturing, footwear manufacturing, surface coating (automobile manufacturing) industries	Reform use of water-based raw and supplementary materials and set up organic solvents recycling and emissions processing facilities. By July 31, 2011, key enterprises monitored at the provincial-level should have completed 100% of the reform tasks.
	Petroleum processing industry	Use mandatory measures to reduce VOCs emissions and strictly control emissions of fugitive organic gas during production.
	Basic chemicals, coating, ink, pigment, container, artificial board and plastic products manufacturing industries	1. Promote production technologies of low VOCs emissions and encourage coating, printing ink and adhesives production enterprises to apply for environmental labels and phase out painting and coating products of high VOCs content. 2. By July 31, 2011, Shenzhen, Dongguan and Huizhou should have fully banned the use of non-water-based interior wall paint.

2) There are mandatory measures for petroleum processing enterprises to reduce VOCs emissions by strictly controlling the emissions of fugitive organic gas during production and fully implement production technologies with low VOC emissions levels.

3) Coating, printing ink, and adhesives production enterprises have been encouraged to apply for environmental labels and phase out painting and coating products with high content of VOCs.

4) Printing, footwear, furniture and automobile manufacturing enterprises' compliance on air quality standards have been reinforced.

5) Moreover, there have been additional efforts to accelerate the pollutant control of other sectors generating VOCs emissions in the production process.

6) By July 31, 2011, Shenzhen should have finished relevant tasks concerning key provincial and municipal-level enterprises that were monitored. Dongguan and Huizhou should have completed more than 80% of the tasks while other cities had completed over 30% of the tasks.

7) By July 31, 2011, Shenzhen, Dongguan and Huizhou should have completely banned the use of non-water-based interior wall paint.

After measures were implemented in 2011, the VOCs emissions, to some extent, are under control. The total amount of emissions was decreasing, but some industries did not meet their targets. The 2012 ambient air pollutant emission inventory shows the the total VOCs emissions in Shenzhen were 151,628 tons, down by 20% compared to 2008, whereas VOCs emissions of the furniture manufacturing industry increased by 5,385 tons, 12.7% higher than that of 2008 (Table 6).

2. Comprehensive Advancement

Learning the Summer Universiade experience, the Department of Environmental Protection of Guangdong Province released the Suggestions on Strictly Controlling Volatile Organic Compounds (VOCs) Emissions of Industrial Enterprises in the Pearl River Delta Region in 2012, showing that comprehensive prevention and control of VOCs in the region was not only an important measure for addressing the serious haze in the PRD, but also a way to effectively improve the regional air quality and visibility. The Suggestions require Guangzhou, Shenzhen, Dongguan, Foshan and Zhongshan, as pilot cities, to carry out regional prevention and control to strengthen control of VOCs emissions in industries such as printing, furniture, footwear, and automobile manufacturing.

On February 8, 2013, the Guangdong Provincial Government issued the Clean Air Action Plan in Guangdong PRD–Implementation Plan on Continuing to Improve Air Quality: Phase II (2013–2015). Also in 2013, the Shenzhen Municipal Government issued the Plan on Air Quality Improvement in Shenzhen on September 30. On

Table 6: 2012 Shenzhen Ambient Air Pollutant Emission Inventory

Emission sources	SO_2(t)	NOx(t)	CO(t)	PM_{10}(t)	$PM_{2.5}$(t)	VOCs(t)
Coal-fired plants	3,076	27,273	14,078	2,691	2,237	1,528
Industrial sources	4,548	2,832	17,577	5,966	3,860	1,961
Road mobile sources	1,055	66,029	193,837	7,365	7,365	23,968
Non-road mobile sources	17,848	38,527	8,240	2,925	2,282	2,121
Dust sources				41,237	11,921	
VOCs sources						110,044
Furniture manufacturing						47,885
Footwear manufacturing						9,406
Printing						3,573
Automobile manufacturing						776
Bicycle manufacturing						2,309
Vehicle maintenance						675
PWC manufacturing						4,797
Plastics manufacturing						17,226
Electronics manufacturing						2,664
Oil & Gas Vapor at gas stations						1,584
Use of household solvents						5,274
Use of architectural coating						13,875
Other emission sources	196	1012	304	116	83	12,006
Total	26,723	135,674	234,035	60,300	27,748	151,628

July 16, 2014, HSECSM released the 2014 Work Plan on VOCs Pollution Control in Shenzhen, with a list of key enterprises that are required to take actions in line with the Work Plan. The four documents have further clarified the requirements for comprehensive control of VOCs.

III. Main Policy Measures and Technical Options

1. Rigorous Environmental Impact Assessment and Approval of New, Renovated and Expanded VOCs Projects

The furniture manufacturing industry is required to use 100% water-based or UV-curable coatings. The proportion of water-based, alcoholic, or soy inks used in the printing industry should not be lower than 90%, while water-based coating used in the automobile manufacturing and maintenance industry should be at least 80%. For other industries, the proportion of water-based (or low VOC) paint, cleaning agents and adhesives should not be lower than 60%.

2. Emission Control Requirements for Enterprises

(1) Enterprises that have failed to complete emissions control or whose organic emission collection and purification rate was below 90% as of July 2014 were asked to modify their production lines and use raw and supplementary materials with low VOCs. The furniture manufacturing industry is required to increase the proportion of water-based or UV-curable coatings to 90% or higher. The proportion of water-based, alcoholic, or soy inks used in the printing industry should not be lower than 90%, while water-based coating used in the automobile manufacturing and maintenance industry should be at least 80%. For other industries, the proportion of water-based (or low VOCs) paint, cleaning agents, and adhesives should not be lower than 60%.

(2) Enterprises should adopt standard exhaust outlets. Any production process that generates VOCs and any coating and cleaning operation that uses high-VOCs materials should be conducted in a closed environment. Any production line unable to operate in a closed environment should be completed with an exhaust collection system that is composed of hoods and exhaust pipes. The design of the exhaust collection system should be based on the Specifications for Design of Heating Ventilation and Air Conditioning (GB 50019-2003), which ensures that the concentrated exhaust fumes can be channeled to the emissions

processing facilities at an exhaust collection rate of 90% or higher. All exhaust pipes must meet the requirements set forth in the Technical Specifications for Emission Monitoring of Stationary Sources (HJ / T397-2007). The emission exhaust system should be equipped with a sampling operation deck, and enterprises should also integrate the exhaust pipes within the same plant.

(3) Enterprises should set up emissions control facilities and entrust a qualified organization to design and install these facilities. There should be an expert review before the design is implemented to ensure that the emissions purification rate is not lower than 90%. The VOCs levels in all raw and supplementary materials, the amount of VOCs emitted through the exhaust pipes, and the height and exhaust rate of the pipes should also meet industry standards.

(4) Enterprises should monitor emissions and entrust a qualified testing organization to monitor their VOCs emissions. Furniture, printing, footwear and automobile manufacturing industries are required to conduct monitoring once every six months, and other sectors should monitor once per year. Any enterprises that cannot be monitored from lacking standard exhaust outlets will be deemed “non-attainment enterprises”.

(5) All coating production lines that do not have a permit or license or have not completed an environmental impact assessment will be shut down.

3. Carrying out Inspections on the Enterprises Rectifying VOCs Emissions Issues

(1) HSECSM should organize experts to conduct assessments on the rectification or control effects of major consumers of VOC-containing raw and supplementary materials, such as Southern CIMC, BYD, CSOT, Foxconn and Youlian Ship Factory.

(2) HSECSM should complete spot checks on the VOCs emissions enterprises rectifying any issues in environmentally sensitive areas.

(3) HSECSM should carry out inspections on VOCs emissions enterprises that have finished rectification or control work. HSECSM should also fill out the on-site inspection form.

4. Improving VOCs Control through Economic and Administrative Measures

(1) Increase subsidies for enterprises conducting retrofitting or control for VOCs. Based on the Regulations on Subsidies for Air Quality Improvement in Shenzhen, released by HSECSM in coordination with the Finance Commission of Shenzhen Municipality, VOCs control subsidies have been moderately increased. Enterprises that have received subsidies based on the old standard will be paid the difference. Moreover, subsidies to enterprises for VOCs control are provided by financial bureaus at district levels in addition to the subsidies from the municipal level government.

(2) Environmental departments at the district level should complete VOCs control demonstration projects based on the specific characteristics of their local industries. They should also encourage enterprises to apply for special funds to support advanced VOCs processing technology development, product R&D, and equipment production.

(3) HSECSM, in coordination with the municipal and district level procurement departments, should set a designated procurement access threshold. Policy requires government-designated suppliers for office equipment, furniture, printing and vehicle maintenance to use raw and supplementary materials with low VOCs content.

(4) HSECSM should formulate a directory of Hong Kong-owned VOCs emissions enterprises in Shenzhen. With the Environmental Protection Department of Hong Kong SAR and through the Clean Production Partnership Program, Hong Kong-owned enterprises in Shenzhen are urged to complete VOCs emissions controls.

5. Increasing Public Attention and Awareness of VOCs

(1) Provide training sessions for sales representatives from large-scale furniture manufacturers to understand the environmental labelling system and also encourage their respective enterprises to apply for the environmental labels.

(2) Ask major furniture shops to organize promotional events for environmental labelling system. These events should focus on explaining the health hazard of solvent coating products, recommend furniture that have environmental labels, and encourage consumers to choose environmentally friendly furniture.

(3) Work with news or online media to conduct surveys on in-car air quality. Owners of vehicles with less than one year of service time, regardless of the brand or model, are encouraged to participate in an event to detect formaldehyde content in cars. This detection process is conducted on about 100 vehicles of more than 30 brands. Detection reports are provided to the owners. When it comes to painting, repair and maintenance, car owners are encouraged to select vehicle maintenance factories where water-based paint is used.

6. Publishing Technical Specifications and Guidelines on VOCs Control

Requirements for VOCs control in key industries in Shenzhen are shown in the figure below. Technical guidelines and manuals on low VOCs coating adoption and VOCs treatment in furniture manufacturing, vehicle maintenance, electromechanical manufacturing, and printing industries have also been released. Technologies and processes of VOCs control in automobile manufacturing, bicycle manufacturing,

metalwork, plastics and rubber, and PWB manufacturing industries have also been analyzed so that the government can provide targeted technical guidance for different production processes.

Fig.38: Requirements of VOCs Control in Key Areas in Shenzhen

Table 7: Technical Specifications on VOCs Control in Shenzhen

No.	Title of Technical Specifications	Date of Implementation
1	Standard for Hazardous Substance in Architectural Coating and Adhesive Products	03/01/2015
2	Standard for VOCs in Paints and Emissions of the Vehicle Maintenance Industry	08/01/2015
3	Standard for Hazardous Substance in Furniture and Furniture Materials	To be released
4	Standard for VOCs in Industrial and Household Products	To be released

IV. Participating Departments and Responsibilities

Shenzhen has focused on both the source and end-of-pipe control for VOCs emissions. The Office of the Prevention and Control of Air Pollution (re-named the Air Pollution Integrated Management Division in 2015) was set up by HSECSM, and they also issued the 2014 Work Plan on VOCs Pollution Control in Shenzhen to confirm the responsibilities of relevant parties. Evaluation platforms such as Pollution Control and Blue Sky Project were also used to advance the work, while "Shenzhen-Dongguan-Huizhou", "Shenzhen-Hong Kong" and other regional cooperation platforms are also working to improve regional air quality. Major responsibilities of relevant parties are as follows:

1)The Office of the Prevention and Control of Air Pollution is in charge of coordinating work on VOCs control in Shenzhen. Its major responsibilities include developing VOCs control plans, formulating technical specifications and guidelines, publishing a directory of enterprises emitting VOCs, conducting inspections on VOCs emissions enterprises that have finished rectification or control, writing the Regulations on Subsidies for Air Quality Improvement in Shenzhen, developing air pollutant emission inventories, and conducting general investigations into VOCs emission sources in Shenzhen.

2)Shenzhen's municipal Reform and Development Commission should create an industry restructuring and elimination catalogue for production processes of high VOCs emissions in industries such as furniture manufacturing, plastics, and footwear manufacturing.

3)The Finance Commission should publish regulations on subsidies for improving air quality to ensure the effective implementation of VOCs control.

4)The Transport Commission should enhance the supervision and management of vehicle maintenance enterprises, urge vehicle maintenance enterprises to adopt water-based paint, and improve end-of-pipe emission control measures.

5)The Market and Quality Supervision Commission should strictly control the sales of architectural coating and adhesive products while discontinuing the sale of paints that do not meet local technical specifications.

6)The Housing and Construction Bureau should strengthen the management and control of the architectural decoration industry, conduct spot checks on architectural sites, impose penalties on architectural enterprises that use improper paints (solvent paints), and record violation cases in a credibility system for architectural construction.

7)District-level environmental departments should strengthen their supervision on enterprises emitting VOCs and encourage enterprises to use water-based paint, improve measures of emissions control, and set up a system that can monitor raw and supplementary materials. The department should also conduct inspections and impose penalties on enterprises that fail to carry out proper control measures. The district environmental departments should also assist HSECSM in conducting general investigations into VOCs emission sources and ensure the effective implementation of technical specifications.

V. Policy Effects

After years of work, Shenzhen has made significant improvement in controlling VOCs. Shenzhen has seen a considerable reduction of VOCs emissions in key industries. According to the 2014 ambient air pollutant emission inventory, the total volume of VOCs emissions was 143,581 tons, a decrease of 5.3% as compared with 2012. There was a 77% reduction in the furniture manufacturing industry. Starting from 2010, 565 out of more than 800 furniture enterprises in Shenzhen have removed or relocated their coating lines, and 112 unlicensed coating lines have also been shut down. Currently, all furniture enterprises in Shenzhen have completed the clean production retrofitting on their painting processes, reducing VOCs emissions by over 30,000 tons each year.

At the end of 2015, Shenzhen had issued technical specifications on furniture manufacturing, architectural decoration material and vehicle maintenance industries, developed technical guidelines for VOCs control in the PWB, footwear, bicycle, metalwork and plastics manufacturing industries, and mandated the completion of control tasks in more than 10 key enterprises including Southern CIMC, CIMC Vehicles, CSOT, and BYD. Water-based paints have been adopted by 594 industrial and 263 vehicle maintenance companies, 101 furniture manufacturers have been put on the directory of enterprises that have to go through oil-to-water reform, and 48 enterprises have been penalized for failing to meet emission standards. Since the promotion of environmental labels began, a total of 20 enterprises have obtained furniture environmental labels.

Table 8: 2014 Shenzhen Ambient Air Pollutant Emission Inventory

Emission sources	SO_2(t)	NOx(t)	NH_3(t)	PM_{10}(t)	$PM_{2.5}$(t)	VOCs(t)
Stationary sources of fossil fuel combustion	1,708.7	10,811.5	116.2	2,510.3	1,363.5	606
Industrial sources	53.3	97.6		48.1	13.4	7,085.5
Mobile sources	16,792.9	114,379.3	1,542	5,204.5	4,548.9	31,565.1
Solvent-use sources						63,474.7
Plastics manufacturing Industry						7,035
Furniture manufacturing Industry						11,001
Footwear and leather manufacturing industry						1,131
Printing industry						8,811
PWC manufacturing industry						2,414
Container manufacturing industry						4,778
Automobile manufacturing industry						1,292
Bicycle manufacturing industry						418
Vehicle maintenance industry						1,833
Electronics manufacturing industry						7,874
Metalware industry						4,231
Electrical machinery manufacturing industry						1,276
Other industries with solvent use						625
Dry laundry industry						96
Household and commercial use of solvents						5,368.7
Use of architectural coatings						5,291
Storage and transport sources						4,768.3
Waste-disposal sources	1,627.5	3,877.4	2,087.3	95.9	95.9	3,585.9
Other emission sources						13,306.5
Total	20,574	130,656.7	5,821.3	35,887.5	12,105.5	124,392

VI. Experiences and Challenges of VOCs Control

Through years of experimentation, Shenzhen has developed an effective system of VOCs control:

First, priority is given to control over sources, followed by control over emissions. While authorities carried out VOCs control tasks on industrial enterprises, unorganized emissions, inactive emission control equipment, and delayed transfer of secondary pollutants are often found, making control efforts from enterprises ineffective. Thus, the Shenzhen Municipal Government required industrial coating enterprises to use low VOC coating to reduce organic solvents and VOCs emissions. Also, to improve the quality of inspections by the environmental department, the government has required enterprises to create inventories for raw and supplementary material use, the operation status of emission control facilities, and joint transfer of dangerous wastes.

Second, the government has released laws and regulations in conjunction with technical specifications. When authorities enforced VOCs control tasks on enterprises, problems of insufficient legal basis and loose emission standards were common. To address this issue, HSECSM has been working actively to formulate technical specifications for key industries. Documents such as the Standard for Hazardous Substance in Architectural Coating and Adhesive Products, Standard for VOCs in Paints and Emissions of the Vehicle Maintenance Industry, and Standard for Hazardous Substance in Furniture and Furniture Materials have been released. HSECSM also called on industry associations to adopt the Joint Action Plan on Environmental Protection, which features “collective commitment, collective action, unified standards, oil-to-water reform, district-based implementation within time limit, simultaneous implementation, self-discipline, and supervision and penalties when there are violations”, thus achieving a mass reduction in VOCs emissions during the process of container production.

Third, control work is being carried out by industries to prevent a “wait-and-see” approach. Different enterprises in one industry with similar production processes and costs often take a “wait-and-see” approach. Therefore, while conducting VOCs control in furniture manufacturing, electronics manufacturing, vehicle maintenance, bicycle manufacturing, packaging and printing and other industries, HSECSM adopted the principle of overall advancement addressing individual enterprises. Action is first taken by enterprises that are above the industry average, and then spread rapidly to the whole industry after the effects have been demonstrated. In this way, slow and stagnant progress caused by the “wait-and-see” phenomenon can be mostly avoided.

Fourth, the government has strengthened regulations on key enterprises under supervision. On top of general industry VOCs control, some sectors have only a few enterprises but also have very high per unit emissions. For example, VOCs emissions from Shenzhen Southern CIMC Eastern Logistics Equipment Manufacture Co. Ltd. accounts for 52.5% of the total emissions in Pingshan New District, Shenzhen China Star Optoelectronics Technology Co., Ltd. accounts for 40.4% of Guangming New District's emissions, Southsea Oils & Fats Industrial (Chiwan) Limited accounts for 34.2% of Nanshan District's emissions, and Boen

Optical (Shenzhen) Co. Ltd. has much higher emissions than other enterprises in Longgang District. By focusing on these key enterprises for rectification, progress can be expedited.

Fifth, law enforcement has been enhanced. Stringent enforcement is a basic precursor for VOCs control. To encourage enterprises to complete reforms on time, environmental departments conduct multiple legal inspections. To ensure the effective implementation of different measures, penalties are imposed on enterprises that fail to finish on time. Moreover, there are crack downs on secret emissions, more inspections are carried out on enterprises with the most public reports, and daily penalties are imposed on enterprises that refuse to conduct mandatory reforms.

To understand the impacts of VOCs control in Shenzhen and provide guidance to future control efforts, Shenzhen conducted general investigations into VOCs emission sources for the first time in 2014 and updated the data in 2015. This provides a more objective perspective on the progress of VOCs control. According to the report, as of the end of 2014, a total of 122,000 tons of VOCs had been emitted in Shenzhen. Solvent use is the biggest VOCs emissions' source in Shenzhen, accounting for 53.9% of the total emissions. Road mobile source is second, accounting for 21% of the total emissions (Figure 39). In terms of regional distribution of VOCs emissions from industrial sources (including organic solvent and production process sources), there is a downward trend in the northwestern and southeastern parts of the city.

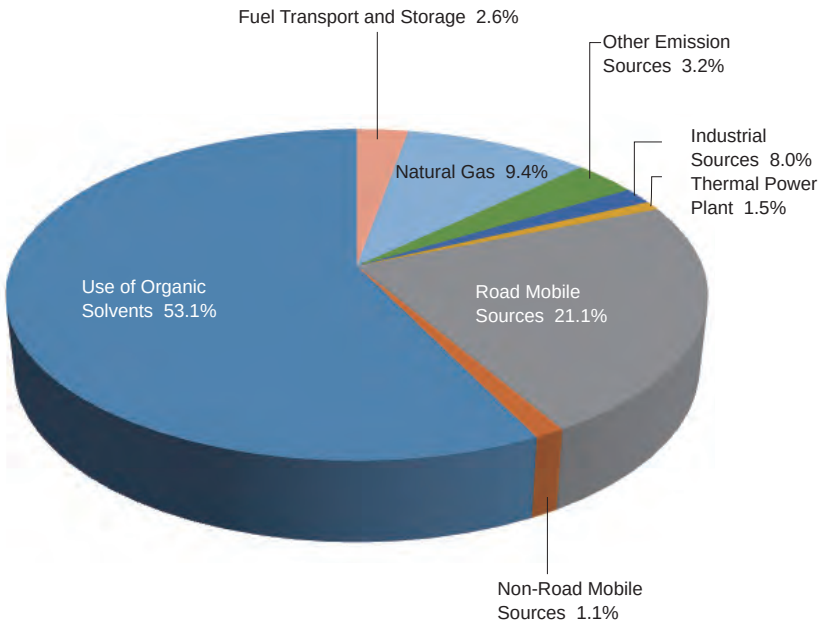


Fig.39: Distribution of VOCs Contribution in Shenzhen

There are still a number of difficulties to achieve successful control of VOCs. First, sectors generating VOCs emissions are not concentrated, making VOCs controls more difficult. VOCs emissions are evenly distributed across a number of sectors and there is no prominent industry. The furniture manufacturing industry was previously responsible for 50% of the total VOCs emissions in Shenzhen, but the industry has seen a dramatic reduction after strict controls and restructuring. Although the furniture manufacturing industry is still the biggest organic solvent consumer, its emissions level is very close to that of the plastics manufacturing, printing, electronics manufacturing, and metalwork industries. Therefore, control work must be carried out based on analyzing VOCs-generating production processes.

Second, the collection and removal rate of VOCs from industrial sources is still insufficient. According to surveys, only 25% of the enterprises in Shenzhen have installed VOCs control facilities. In terms of collection facilities, external ones are the majority with a collection rate of 60% or below. Water spray, with no more than 5% of removal rate, is still the major emissions processing technology used by enterprises, taking up more than 40% of the total. Approximately 35% of the enterprises adopt water spray and activated carbon combined processing facilities, but the VOCs removal rate is still below 25% and operation is highly unstable. Only a small number of enterprises adopt technologies with high VOCs removal rates, such as photo-oxidation, direct combustion, and catalytic combustion.

Lastly, laws and regulations on the control of VOCs pollution from industrial sources are still incomplete, making enforcement more difficult. The reduction of VOCs emissions from industrial sources is heavily dependent on supervision. However, relevant laws and regulations are not robust, posing law enforcement challenges to the environmental departments. Currently, there are only a few laws and regulations on VOCs prevention and control in China. VOCs emissions standards for furniture manufacturing, surface coating (automobile manufacturing), footwear manufacturing, packaging and printing and container manufacturing industries have been released in Guangdong Province. However, for sectors without such standards, VOCs emissions control can only be completed based on the Standards on Comprehensive Ambient Air Pollutant Emission, which has rather lax requirements for VOCs emissions. This has created difficult conditions to achieve VOCs emissions standards.

Conclusions and Recommendations

Air Quality

As of 2015, Chinese cities have monitored air quality and released real-time data on a large scale for three years and there has been continuous improvement in air quality in most of the cities. However, it is still common for $PM_{2.5}$ concentrations to exceed relevant standards by large margins, while some regions are also confronted with O_3 pollution.

Air quality improved as a whole, but non-attainment was still widespread

The air quality of Chinese cities improved in 2015 compared with the previous year. Of the six pollutants, the annual mean concentration of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 was generally on the decline in 74 cities as compared with 2014, decreasing by 14.1%, 11.4%, 21.9% and 7.1% on average, respectively. In the meanwhile, the annual mean concentration of CO was about the same as levels in 2014. The figures in respect of SO_2, NO_2, CO and O_3 all attained the National Secondary Standard under the Ambient Air Quality Standards (GB3095-2012) (the National Secondary Standard).

Nevertheless, it is still common for Chinese cities to not meet standards, especially in the winter when heavy pollution was more frequent. In 2015, the number of non-attainment days in the 161 cities covered by the report averaged 99, with that of the 74 key cities being 105. BTH and its surrounding areas (Shanxi, Shandong, Inner Mongolia and Henan) was still the region with the poorest air quality and highest frequency of heavy pollution in the country. Among the 161 cities, the top 20 with the most days of not meeting standards were all concentrated in the BTH region. Furthermore, 70 cities at or above the prefecture level in the region had a total of 1,710 days of heavy or higher-level pollution and issued 154 alerts on heavy pollution.

Fine particulate matter continued to be a serious issue, with O_3 pollution worsening in key regions

$PM_{2.5}$ was still the primary problem for most of the cities, especially the 74 key cities that were among the first to conduct air quality monitoring. The annual mean concentration of $PM_{2.5}$ in these cities was relatively high, at 1.5 times the National Secondary Standard (35 μg/m^3).

Moreover, the issue of O_3 pollution surfaced in 2014 and continues to worsen. The annual mean concentration of O_3 in the 74 key cities continued to rise at a rate of 3.4%, whereas the proportion of cities that achieved standards continued to fall at a rate of 5.4%. In BTH, the days that saw O_3 as the primary pollutant already outnumbered PM_{10}, making it second only to $PM_{2.5}$. In YRD, O_3 became the only pollutant whose concentration rose instead of dropping.

Eight cities failed to lower the concentration of particulate matter, with PM pollution worsening in several cities

Particulate matter was assessed as a key indicator in the 161 cities based on their air-quality improvement targets. Of these cities, 90% attained their targets. PRD did the best among all the key regions, and was the first to achieve its target. Some cities in Central and Western China and Hebei Province did fairly well, with the annual mean concentration of $PM_{2.5}$ decreasing by over 20%, including Jingzhou, Yichang, Liuzhou, Guilin, Xining, Zhuzhou, Xi'an, Hefei, Panzhihua, Qinhuangdao, Cangzhou, Shijiazhuang, Handan and Xingtai.

Cities that failed to attain their PM improvement targets in 2015 were Zhengzhou, Sanmenxia, Jiaozuo, Zaozhuang, Rizhao, Yingkou, Changchun and Langfang. Among these, Zhengzhou and Jiaozuo even saw a 9% higher annual mean concentration of $PM_{2.5}$ compared with 2014 levels, while the concentration in Yingkou increased significantly at 23%. Cities with relatively poor air quality that decreased concentrations by less than less than 5% included Sanmenxia, Zaozhuang, Jinan, Dezhou, Harbin, Shenyang, Changchun and Zigong.

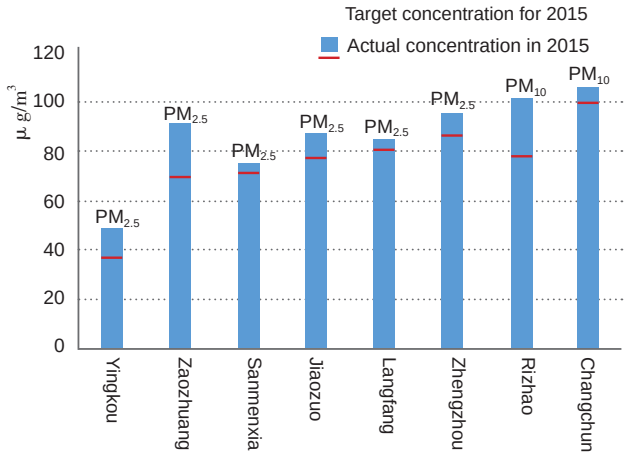


Fig.Cities that failed to achieve PM reduction target in 2015

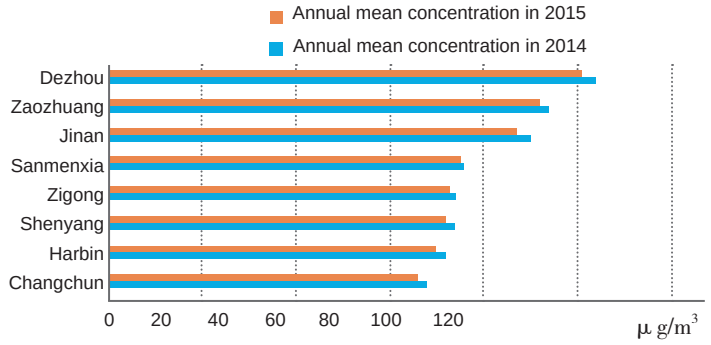


Fig.Cities that had poor air quality and realized less than 5% $PM_{2.5}$ concentration reduction in 2015

Policy Measures

Improvement in air quality relies heavily on sustained efforts towards air pollution prevention and control. In 2015, significant improvements were seen in many aspects, including coal control, VOCs control, control of emissions from ports and vessels, and regional collaboration.

Total Coal Consumption Control Achieving "Ten Measures" Target Ahead of Schedule and Comprehensive Efforts Towards Using Clean Coal

Due to China's energy availability and use patterns, pollution from coal-burning is an inevitable challenge. In 2015, both total consumption control and using clean coal were adopted to alleviate pollution from burning coal. Measures like eliminating industrial coal-fired boilers were also implemented in cities such as Beijing and Shanghai to phase out coal consumption.

The national total energy consumption saw a minor increase (up by 0.9%) in 2015, but the percentage of coal of total energy consumption was 64.0%, down by 3.7% compared to 2014. The target to reduce the percentage of coal of total energy consumption to 65% or lower by 2017 from the Action Plan was accomplished ahead of schedule.

The raw coal separation rate reached 65.9%, which is close to the target of 70% or above for 2017. During the 12th Five-Year Plan period, the total capacity of coal-fired units with desulfurization increased from 530 million kW to 890 million kW, with the installation rate of desulfurization facilities increasing from 83% to more than 99%. The total capacity of coal-fired units equipped with denitration facilities increased from 80 million kW to 830 million kW, with the installation rate increasing from 12% to 92%.

An executive meeting of the State Council set the requirement that all coal-fired power plants that can be retrofitted in China should achieve ultra-low emissions by 2020. For this goal, MEP, National Development and Reform Commission and National Energy Administration issued relevant documents to specify the schedule, electricity rate subsidies, rewards on generated electricity and discharge fees along with credit and financing support.

Initiating VOCs Discharge Fees and Comprehensive Control Measures in Major Cities

VOCs are precursors to ozone and fine particulate matters - controlling them is a key task for air pollution prevention and control. However, since the problem was identified late, there are great technical difficulties involved with the management and control of VOCs from complicated sources. In 2015, China initiated comprehensive control of VOCs in the petrochemical industry by setting industrial emission standards of pollutants for three sectors, petroleum refining, petroleum chemistry, and synthetic resin. Such standards served as policy basis for VOCs control in key industries.

A pilot for Measures for VOCs Discharge Fees was also implemented throughout the country with petrochemical, packaging, and printing industries being the pilot sectors. Shortly after, regulations on charging VOCs emissions were released in five provinces and cities, including Beijing, Shanghai, Jiangsu Province, Anhui Province, and Hunan Province.

Major cities have taken a leadership role and accumulated experience in the comprehensive control of VOCs. Beijing and Shanghai exceeded the 2015 control target. Shenzhen conducted investigations to identify VOCs emission sources and update relevant data. Shenzhen prioritized controlling the sources through regulations and technical specifications. They also had industries carry out detailed control measures, strengthened regulations on key enterprises under supervision, and enhanced law enforcement.

Emission Control Areas for Vessels Addressing the Blind Spots

China's east coast has some of the world's biggest ports. Of the top ten ports in terms of handling capacity in 2014, seven were in China. With the relatively stagnant pollution control policies, pollutants discharged from ports and vessels have become a major source of air pollution in cities like Shanghai, Guangzhou and Shenzhen.

To address the issue, the national government issued a policy document to set policies and targets for the prevention and control of vessel and port pollution in 2015 for 2015-2020. PRD, YRD and Bohai Rim were required to set up emissions control areas for vessels in their water areas. At the regional level, BTH and YRD both required that emissions from vessels and ports be managed through air pollution prevention and control coordination mechanism in 2015.

Regional Prevention and Control Measures Implemented in BTH, and YRD Efforts Relatively Slower

As air pollution usually has regional impacts, regional collaboration that involves all cities is important, and strategies must be coordinated and focused on integrating social, economic, and environmental considerations. In 2015, regional collaboration deepened on the prevention and control of air pollution in key regions, particularly in the BTH region. A joint mechanism for environmental law enforcement and control of motor vehicle emissions was initiated. Guidelines for an integrated approach were enacted through creating a cooperation framework agreement and coordinated development plan. Beijing was matched with Langfang and Baoding, while Tianjin with Tangshan and Cangzhou, so that these cities could provide mutual support for

air pollution control funds and technologies.

YRD identified key tasks for air pollution prevention and control, including total coal consumption control and replacing with clean-energy, upgrading and retrofitting of coal-fired power plants for energy conservation and emission reductions, industrial restructuring and pollution prevention and control, vehicle pollution prevention and control, and agricultural waste burning and dust pollution control. However, from the publicly available information, it seems that YRD has yet to formulate policy documents and action measures through joint control beyond the measures for prevention and control of pollution from vehicles and vessels.

Government Monitoring and Supervision yet Publicly Available Data on Progress Insufficient

In 2015, the MEP held more admonitory talks and established a working mechanism for environmental protection supervision. Through “government supervision”, local governments were urged to take responsibility for local environmental quality and ensure effective implementation of the Action Plan. In 2015, the MEP held admonitory talks on air pollution with key government officials from 15 cities, doubling the number of cities that were involved in 2014.

The environmental protection supervision mechanism established by the MEP in 2015 shifted the focus from "supervising enterprises" to "supervising governments". By the end of 2015, the MEP had conducted comprehensive supervision of 33 cities on environmental issues such as air pollution. Through the comprehensive supervision, 31 cities were admonished, regional environmental impact assessments were not approved in 20 cities (counties), and local governments were required to address 176 problems within specified time frames. However, there is still insufficient publicized information on the assessment of pollution control effects after the admonitory talks, with only a few cities including Linyi and Zhumadian having publicly disclosed results after the talks.

Recommendations

Since the Action Plan was enacted in 2013, experience has accumulated at the national, regional and municipal level from implementing a variety of measures. Such experience is crucial for cities to be able to accomplish their air quality improvement targets for 2017 and restore air quality. As this report was being drafted, the Chinese Academy of Engineering published the interim review on the Action Plan. According to the review, in the next few years, China needs to further use energy structure adjustment to reduce pollution, establish a more effective haze treatment system, enhance capacity in dealing with heavy pollution days, and ensure the long-term improvement of air quality. As an independent third-party, Clean Air Asia provides the following recommendations on air pollution prevention and control in Chinese cities for the short and long-term:

Set up a timeline and roadmap for air quality attainment

For most cities in China, the 2017 target for particulate matter ($PM_{2.5}$ and PM_{10}) set in the Action Plan is still far behind the national standard and WHO guidelines. Moreover, as a document aimed at reducing particulate matter level, the Action Plan does not sufficiently deal with combined pollution, such as the increase of ozone concentration in recent years.

A clear timeline and roadmap is key to formulating mid- to long-term air quality improvement strategies at the national and local level with step-by-step actions. Experience from many developed countries and cities prove this is an effective strategy. However, this has not been done in China’s current policies, laws and regulations. To protect public health, the MEP should provide clear timelines and roadmaps for air-quality attainment in regions and cities during the 13th Five Year Plan period. Relevant attainment plans, technical methods, assessment methods, and incentive mechanisms should also be enacted。

Create a science-based system for pre-evaluation, tracking, and post-implementation evaluation of policies

After the State Council’s release of the Action Plan, governments at all levels introduced a series of policy measures. However, as is often the case, local governments are unsure if the measures will work under local conditions and often lack understanding of the actual impacts of

the measures. This creates a lack of confidence in achieving the relevant targets on time.

Setting up a science-based system for the pre-evaluation, tracking, and post-implementation evaluation of policies will help governments choose the most effective measures, adjust their control plans during the implementation process, and improve the precision of control measures. This is essential to air quality management. The 13th Five Year Plan period is an ideal time for setting up such a system. Governments at all levels, especially those at the municipal level, should incorporate it in their air quality management work plans.

Enhance capacity support in air quality management for local governments

In 2015, the focus of the environmental protection supervision mechanism was shifted from "supervising enterprises" to "supervising governments". In conjunction with measures like city ranking, public admonitory talks, and liability statements, the national government put significant pressure on local governments to implement the Action Plan. However, cities still need technical capacity and resources in order to achieve air quality improvement.

This report finds that cities that failed to attain the 2015 air quality target and suffered from poor air quality and slow progress were concentrated in Henan Province, Shandong Province, and Northeast China. Compared with the more developed regions, these cities had less experience and insufficient capacity in air pollution prevention and control. In addition to using direct pressure, the national government should also provide comprehensive capacity-building for local policymakers with relatively weak management capacity.

Continue to release information on air pollution prevention and control

By implementing the “three-step” plan on air quality monitoring system building and reporting, China has achieved a major accomplishment towards publicizing information related to air quality. It is now the third year for the Action Plan implementation and CAA has still found it difficult to acquire data and information on the actual progress for the air pollution prevention and control measures, law enforcement results for air pollution cases, and the results from admonitory talks and environmental protection supervision.

This report recommends that local governments should disclose the above mentioned information to help organizations, including research institutes, NGOs, media, and the public, develop a better understanding of the progress in air pollution prevention and control in China. This will help these organizations monitor policy implementation and conduct relevant research to provide effective support to improve air quality in China.

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