China Air 2020

Air Pollution Prevention and Control Progress in Chinese Cities

Clean Air Asia

About Clean Air Asia

Clean Air Asia (CAA) is an international non-profit organization which seeks to improve air quality and build livable cities in Asia. Founded in 2001, CAA is a recognized partner of the United Nations.

CAA's headquarters are located in Manila, Philippines, with offices in Beijing and Delhi. The organization has 261 partners around the world, and its operations cover six country networks including the Philippines, Indonesia, Malaysia, Nepal, Sri Lanka, and Vietnam.

CAA has been working in China since 2002, where it continues to focus on air quality management and green transportation. CAA was issued its "Representative Office of an Overseas Non-Governmental Organization Registration Certificate" by the Beijing Municipal Public Security Bureau on March 12, 2018 and set up the Clean Air Asia (Philippines) Beijing Representative Office. Subject to the supervision and guidance of the Ministry of Public Security and the Ministry of Ecology and Environment (MEE), CAA undertakes capacity building, research, public education initiatives in the field of air pollution prevention and control across China.

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Abstract

China Air, the annual flagship report series by CAA, collects information and data from government sources to record and analyze the progress China has made in air pollution prevention and control. The series has tracked national efforts since the Action Plan for Air Pollution Prevention and Control was released in 2013. We hope these reports will encourage society as a whole to support and contribute to policy implementation, promote mutual learning among Chinese cities, and help the international community better understand the progress China has made on improving air quality.

The first four editions in the report series recorded and analyzed changes in air quality across China nationally, as well as within key regions and in 338 cities (later changed to 337). The reports also tracked policies and measures for air pollution prevention and control. From the fifth edition onwards (China Air 2019), we began conducting a comprehensive assessment and ranking of air quality management in over 160 key cities. This assessment method is markedly different from traditional air quality rankings and enables a more thorough evaluation of cities' efforts and achievements in air pollution control. Additionally, the rankings can motivate cities to strive for continual improvements in air quality.

Content and scope

As the sixth edition in the series China Air: Air Pollution Prevention and Control Progress in Chinese Cities, this report records and analyzes air quality data from 337 cities at and above the prefecture level in 2019. It also provides a recap of China's policies and measures and implementation progress in air pollution prevention and control over the past year, as well as a comprehensive evaluation and ranking of 168 key cities on air quality management.

The integrated planning and implementation of policies for air pollution control and climate change mitigation can effectively yield co-benefits for both domains. In 2018, following an institutional reform, climate change mitigation efforts were incorporated as a responsibility of the new MEE, allowing for integrated planning and coordinated control. Accordingly, this report extends the scope of analysis to include policies that promote co-benefits of climate change mitigation in addition to those which support air pollution prevention and control.

Methodology

Every report in this series adheres to the core principle of objectivity. This report is based on air quality data and policy information released by the government, which has been systematically collected to ensure accuracy and comprehensiveness. Specific sources include: air quality data from environmental quality reports and official news releases issued by the Ministry of Ecology and Environment (MEE) and its provincial and municipal bureaus; and policy information from government documents, speeches by officials, meeting notes, and news reports by mainstream media citing official sources.

This report considers two indicators in its assessment of air quality management in cities: actual improvements in air quality, and the policies and measures that have been put in place. This approach emphasizes that both the efforts made, and the actual outcomes achieved are equally important for air pollution control. Improvements in air quality are assessed using a three-year moving average of the improvement range in $PM_{2.5}$ concentrations (i.e., the range of improvement from the average concentration for 2017-2019 compared to 2016-2018) and a three-year moving average of the improvement range in attainment days. Policies and measures assessed include control and reduction measures for emissions from stationary sources, mobile sources, and area sources, as well as capacity building and safeguarding measures.

Conclusions

Air quality

2019 marked the second year of the Three-year Action Plan for Winning the Blue Sky Defense Battle ("Three-year Action Plan"), and the 337 Chinese cities surveyed largely maintained the momentum in air quality improvement seen over the previous six years. However, the extent of this improvement has declined, while some cities have even regressed. Across the 337 cities, the average proportion of attainment days rose from 79.3% to 82.0%. A total of 157 cities met the National Ambient Air Quality Standard (GB3095-2012) for annual mean concentrations of all six criteria pollutants, up by 36 cities year-on-year. For the first time, over half of the 337 cities met the standard for annual mean concentration of $PM_{2.5}$. As for variations in the concentrations of the six criteria pollutants, the concentrations of $PM_{2.5}$, NO_2 and CO remained unchanged compared to 2018 levels, while those of PM_{10} and SO_2 improved slightly. Meanwhile, O_3 pollution continued to worsen.

The number of attainment cities continued to rise, but the average concentration of $PM_{2.5}$ showed no improvement

In 2019, 157 cities met the national standard for annual mean concentrations of all six criteria pollutants, an increase of 36 cities from the previous year. This accounts for more than 46% of the 337 cities. The number of cities meeting the standard for each of the six criteria pollutants also increased. All 337 cities met the standards for SO_2 and CO, while the number of attainment cities for $PM_{2.5}$ exceeded 50% of the total for the first time, as shown in Figure 1.

When considering the annual mean concentration of pollutants, the pace of improvement has declined noticeably compared to the past several years. From 2014 to 2019, the number of criteria pollutants which saw year-on-year declines in average concentrations dropped from five to just two by 2019. Those two pollutants were PM_{10} and SO_2, whose average annual mean concentrations declined by 1 μg/m^3 and 2 μg/m^3 respectively. Concentrations for the remaining four pollutants either remained stable or increased compared to 2018 levels. Notably, the national average concentration of $PM_{2.5}$ remained unchanged for the first time following five consecutive yearly declines since 2013, as shown in Figure 2.

With regards to provincial changes in annual mean $PM_{2.5}$ concentrations, the Fen-wei Plains region recorded a 1.9% rise following the launch of the Three-year Action Plan and represents the only key region to experience a regression. 14 cities in Liaoning Province and most cities in the provinces of Shandong and Shaanxi also recorded poorer performances, with a maximum concentration increase of 29.6%. Out of the 168 key cities, 63 saw a decrease in their number of attainment days compared with 2018, while most of the cities recording losses of over 20 attainment days are in key regions. At present, the situation in Shandong Province is the most concerning.

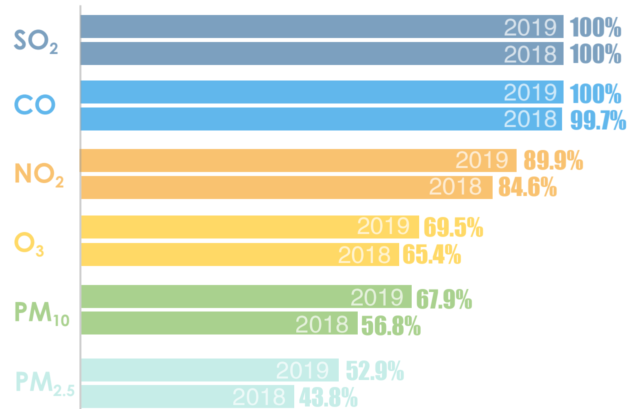

Fig. 1 Percentage of attainment cities for six pollutants in 2018 and 2019

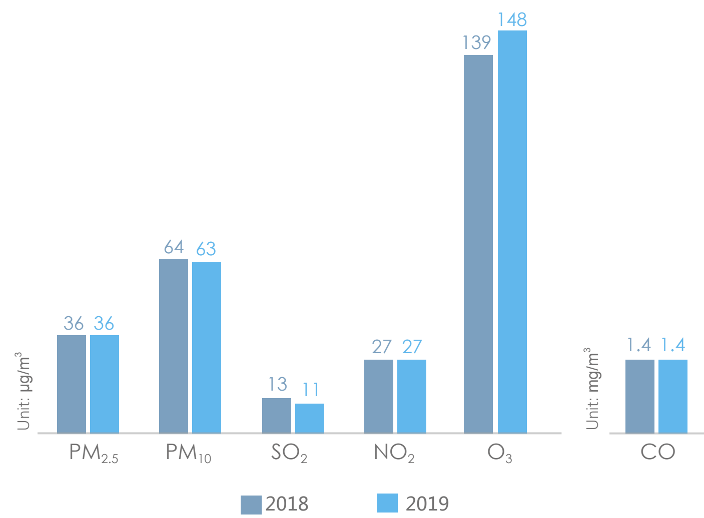

Fig. 2 Average annual mean concentration of six pollutants of 337 cities in 2018 and 2019

O_3 pollution continued to worsen, especially in key cities and regions

Since the release of O_3 data commenced in 2013, the average annual mean concentration of the pollutant has continuously followed a rising trend. However, the rate at which concentrations increased in key regions has been particularly severe. In 2019, the average concentration of O_3 across 337 cities was 148 μg/m^3, an increase of 6.5% year-on-year. The average annual mean O_3 concentrations and yearly increase rate across 168 key cities, the Beijing-Tianjin-Hebei (BTH) region and surrounding areas, the Yangtze River Delta (YRD) and the Pearl River Delta (PRD) all exceeded the national average respectively, and concentration levels were all above set standards. Only the rate of increase in the Fen-wei Plains remained slightly below the national average. However, its annual mean concentration still exceeded the standard, reaching 171 μg/m^3 as shown in Figure 3. In the BTH region and surrounding areas as well as in the YRD, the number of non-attainment days where O_3 was the primary pollutant made up nearly half of all non-attainment days.

Polices and measures

New upgrades to monitoring networks were made, with additional stations established and functions enhanced

In 2019, the number of cities monitoring components of ambient PM increased to 93. O_3 attainment areas were distinguished from non-

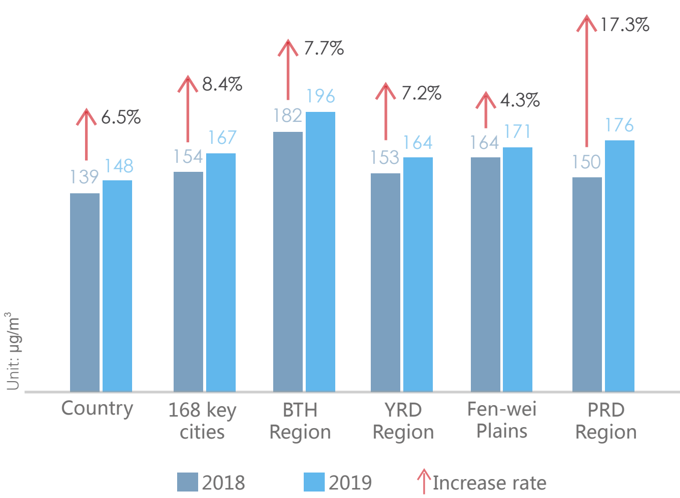

Fig. 3 Average annual mean concentrations of O_3 of key regions in 2018 and 2019

attainment areas, and the monitoring of non-methane hydrocarbon (NMHC) and VOC components was likewise differentiated. Collectively, these developments aimed to provide a more solid scientific and technological foundation upon which comprehensive analytical support for air pollution prevention and control can be formulated and delivered in regions and cities. In addition, cities in key regions took the initiative to establish new ambient air quality monitoring stations in state-level new areas, high-tech zones, key industrial parks and airports, with the objective to increase the coverage of hotspot regions and improve the representativeness of monitoring networks.

Energy restructuring goals set by the 13th Five-Year Plan were met ahead of schedule, but coal consumption still rose

In 2019, China's total energy consumption rose by 3.3% year-on-year to reach 4.86 billion tons of standard coal equivalent (tce). This increase in consumption accounted for three quarters of global growth, making China a key driver for rising global energy consumption. Meanwhile, the share of coal in China's primary energy consumption fell to 57.7%, down by 1.5% year-on-year. This indicates that the overall target set by the 13th Five-Year Plan for Energy Development and the Three-year Action Plan to "reduce the share of coal consumption below 58%" was achieved one year in advance. In their autumn and winter action plans for air pollution prevention and control, the BTH region and surrounding areas and the YRD both clearly stipulated the implementation of controls on total coal consumption. The Three-year Action Plan also mandated that the Fen-wei Plains achieve negative growth in coal consumption. However, despite the positive progress made in energy restructuring, overall levels of coal consumption still saw a slight increase.

Ultra-low emission retrofitting was extended to the iron and steel industry

The iron and steel industry has replaced the thermal power industry as the largest source of industrial pollution. In 2019, China issued its Opinions on Promoting the Implementation of Ultra-low Emissions in the Iron and Steel Industry, marking the beginning for ultra-low emission retrofitting outside the power industry. This policy included tightening emissions standards for the iron and steel industry to spur the upgrade and renovation of pollution control facilities, as well as requirements for fugitive emissions control and clean transportation. It set a target for 60% of iron and steel companies in key regions to complete ultra-low emissions retrofitting by the end of 2020, and 80% by 2025. Furthermore, this policy set out a system of rewards and penalties to help reduce the burden on enterprises that already have ultra-low emissions, while encouraging iron and steel enterprises to further improve their performance in environmental protection and meet emissions limits. These initiatives enabled enterprises in the industry to make headway in their control of organized emissions. However, they have yet to make progress on fugitive emissions control and clean transportation.

Gradual progress was made in VOCs pollution management, while fugitive emissions began to come under control

To promote the control of VOCs, in 2019 the MEE issued three new standards which sought to advance the precise management and control of fugitive emissions among key industries emitting VOCs. The standards set out clear control requirements for fugitive emissions during material storage, transfer, transport, and processing. Additionally, June 2019 saw the implementation of the Plan for the Integrated Control of Volatile Organic Compounds in Key Industries, which for the first time advocated for a cost-benefit analysis of emissions reduction measures. The Plan urged all regions to aid enterprises by providing technical support and expertise to measure investment costs and emission reduction benefits, in order to help them embed the concept of sustainable investment in environmental protection and reduce their economic costs.

The emergence of new technologies strengthened the oversight of mobile sources and helped identify excess emissions

As technologies for supervision became more sophisticated, Chinese cities increased investments and the application of these technologies in the oversight of mobile sources. The technologies become an effective means to identify violations by motor vehicles and acted as a deterrent for other potentially illegal behaviors. Monitoring via remote sensing has also been widely used to detect excessive emissions from vehicles and vessels and facilitate subsequent law enforcement.

For example, in 2019, most cities established remote sensing monitoring systems for exhaust and snatching systems for black smoke. Shanghai and Jiangsu Province utilized these new technologies to investigate and penalize vessels responsible for illegal emissions. In addition, the penetration rate of OBD remote monitoring in vehicles and non-road mobile machineries also increased. In some cities in key regions, more than half of heavy-duty diesel vehicles were required to install remote online monitoring equipment and connect with the department of ecology and environment. Non-road mobile machineries were also required to install remote monitoring devices.

Assessment of Air Quality Management in Cities

No cities were added to the rank of “underperforming” cities in terms of effect scores, but the rankings of cities in Shandong Province fell significantly

The assessment framework for air quality management in cities includes an “effect score” indicating improvements in air quality, an “effort score” for the policies and measures put in place, and a comprehensive score combining the two. Compared with the assessment results published in China Air 2019, the number of cities gaining “excellent” and “good” scores remains the same, while the overall scores of the poorest performers have risen significantly. No new cities were added to the rank of “underperforming” cities. These results indicate that cities which achieved noticeable improvements in air quality generally maintained their condition, while cities with limited improvements strove to advance, thereby achieving positive progress among the poorest performers. Unfortunately, as most cities in Shandong Province showed a rebound in annual mean concentrations of $PM_{2.5}$ in 2019, they scored poorly in the assessment of air quality management. Specifically, Jinan, Liaocheng, Dezhou, Zaozhuang, and Zibo all dropped sharply in the ranking of effect scores compared to the previous year.

Yinchuan ranked highest in comprehensive scores, while Linfen continued to rank the lowest

A total of 14 cities scored higher than the full score of 100, placing them on the list of cities ranked as “excellent”. These cities are namely Yinchuan, Lhasa, Luzhou, Beijing, Meishan, Lanzhou, Chengdu, Shanghai, Taizhou, Chongqing, Hangzhou, Guangzhou, Neijiang and Qingdao, in order from highest to lowest scores. Among them, Yinchuan made considerable gains with regards to its three-year moving average improvement range of $PM_{2.5}$ and attainment days, hence topping the ranking list for comprehensive scores. Beijing and Chengdu were rated as “excellent” in the rankings for both air quality improvement and policies and measures. Collectively, these cities represent strong examples where substantial efforts led to significant improvements in air quality. Meanwhile, the provinces of Shanxi, Henan, and Anhui each had 3 cities on the “poor” list, while Linfen continued to lag behind other cities due to its high $PM_{2.5}$ concentration and worsening air quality from 2016-2019.

Suggestions

Continue to improve $PM_{2.5}$ concentration levels and curb rising concentrations of O_3 in the 14th Five-year Plan period

Given overall improvements in air quality, continued reductions in concentrations of major air pollutants across China will become ever more challenging. This report suggests that the MEE formulate targets and action plan for the coordinated control of $PM_{2.5}$ and O_3 in the 14th Five-Year Plan period. This aims to continually reduce $PM_{2.5}$ pollution, while effectively curbing the increase of O_3 concentration. The coordinated control of $PM_{2.5}$ and O_3 requires scientific and technological support to optimize emission reduction methods and policy packages, ensuring the "double control and double reduction" of precursors - NOx and VOCs - in the medium and long term. In addition, comprehensive assessments should be conducted for emission reduction potentials, control costs, impacts of air quality improvement and the health benefits of policies and measures to enhance public benefit and social well-being.

Formulate differentiated air quality management objectives and strategies for attainment and non-attainment cities

In order to carry forward the momentum of air quality improvement, this report suggests that the MEE set ambitious objectives during the 14th Five-Year Plan period for attainment cities and those demonstrating evident improvements in air quality, as well as clear improvement targets for non-attainment cities in terms of $PM_{2.5}$. This will encourage attainment cities to make further improvements, avoid $PM_{2.5}$ concentration rebounds and declines in attainment days, while also urging cities with good air quality to set more challenging goals. For non-attainment cities, the MEE needs to urge them to formulate and publicize their attainment plans within a specified period, laying out timetables and roadmaps for attainment, and conducting quantitative evaluations to ensure plans' effectiveness.

Deepen structural adjustment and reduce air pollutants and greenhouse gas emissions in a coordinated manner

Total coal consumption in China has grown annually since 2017 and saw a year-on-year increase of 1% in 2019. However, the target for carbon emissions per unit of GDP, one of the obligatory targets outlined in the 13th Five-Year Plan, has yet to be achieved. Collectively, these realities place pressures on both air quality improvement and climate change mitigation. China has not made fundamental changes to its heavy industrial structure and coal-dominated energy structure. In 2019, air quality indicators recorded different degrees of deterioration in the cities of the Fen-wei Plains and Shandong Province. Structural adjustments should be deepened and the control of coal consumption strengthened, to sustain steady improvements in air quality and maintain sharp declines of the intensity of greenhouse gas emissions.

This report suggests that in the drafting of the 14th Five Year Plan, MEE should encourage cities to focus on structural adjustment and energy structure optimization. Cities should also be urged to formulate coordinated action plans to reduce emissions of air pollutants and greenhouse gasses. Furthermore, under their attainment plans, cities should vigorously advance the implementation of structural emissions reduction measures which support a "double decrease". Such measures include controlling total coal consumption, eliminating outdated capacity, adopting clean heating, and shifting modes of transportation, such as road-to-railway.

Increase enterprises' responsibility in reducing mobile emissions

In recent years, considerable results have been made for the pollution control of mobile sources in the context of enhanced measures implementation and enforcement. To continuously reduce emissions from mobile sources, which is indispensable to air quality improvement, it is necessary to strengthen the sense of responsibility and actions of enterprises at the production side, sales side, and user side. This report suggests that the relevant ministries formulate or amend laws and regulations to specify enterprises' responsibilities in reducing air pollution and increase the costs of violations. For example, the measures can include: to formally establish the vehicle emission recall system; to require ports to develop clean air action plans; to supervise fuel quality in full lifecycle. The measures can enable vehicle manufacturers, port enterprises, and fuel enterprises to undertake their respective responsibilities.

Meanwhile, the relevant ministries should develop policy incentives such as taxes and other fiscal measures, as well as encourage sectoral self-regulation agreements, to provide motivation for enterprises to adopt emission reduction actions in a cost-effective manner. The measures can include: to sign environment commitment letter for clean transportation with large enterprises in the iron and steel industry, cement industry; to provide subsidy for onshore power and clean energy use to shipping enterprises.

Share air quality data from cities across the board and urge under-performing cities to strengthen information disclosure

Since 2015, when all cities at prefecture level and above released their air quality data across the board, the availability of air quality information in cities has improved significantly. However, the release was limited to real-time data and regular reports, which prevented the public from fully understanding changes in air quality. This report suggests that air quality data across all monitoring stations and time scales be made publicly available during the 14th Five-year Plan Period so that the public, research teams and other relevant stakeholders can search for and download such data. This will encourage a wider understanding of the current situation and provide a strong basis for scientific research and education to improve air quality.

In addition, it is suggested that the MEE require all key cities to publicly disclose their air quality status on a regular basis and communicate any observed changes through annual environmental bulletins or equivalent reports. Low-ranking cities that have not released reports, such as Baotou, Kaifeng and Zhoukou, should be urged to disclose information.

Chapter I.

Current Air Quality Status

2019 marked the second year of implementation of the Three-year Action Plan for Winning the Blue Sky Defense Battle ("the Three-year Action Plan"). In general, 337 cities in China maintained the momentum of air quality improvement over the previous six years. The average percentage of attainment days across the 337 cities increased from 79.3% to 82.0%, and 215 cities saw their share of average attainment days rise above 80%, registering a year-on-year increase of 22 cities. 157 cities met national ambient air quality standards for all six criteria pollutants, marking an increase of 36 cities year-on-year.

Although the number of non-attainment days with $PM_{2.5}$ as the primary pollutant remained higher than that of other pollutants, the number of $PM_{2.5}$ attainment cities increased. 178 cities met the national standard for annual mean $PM_{2.5}$ concentration, reaching over half of the total number of cities for the first time. Looking at year-on-year variations in concentrations of the six pollutants, $PM_{2.5}$, NO_2 and CO remained unchanged from 2018 levels while PM_{10} and SO_2 improved slightly, declining by 1 μg/m^3 and 2 μg/m^3 respectively compared to the previous year. Meanwhile, O_3 pollution continued to worsen.

In 2018, China issued an amendment to the Ambient Air Quality Standard GB3095-2012. From January 1, 2019 onwards, both actual and reference state data was used to assess ambient air quality in cities. This indicates that the current data available provides a much more accurate reflection of real ambient air quality. However, this adjustment also resulted in a significant change whereby concentrations of major gaseous pollutants become lower compared with data obtained using previous approaches. To ensure comparability between datasets, the 2019 Report on the State of Ecology and Environment issued by the government correspondingly adjusted 2018 concentrations in its interannual comparison. The analysis of various cities' annual changes in pollutant concentrations contained in this report is consistent with the Report on the State of Ecology and Environment.

$PM_{2.5}$

In 2019, the average annual mean concentration of $PM_{2.5}$ across the 337 cities was the same as that in 2018, at 36μg/m^3. Although this concentration was 1 μg/m^3 higher than the national standard, it is approaching the standard.

The proportion of attainment cities increased from 43.8% to 52.9%, reaching over half the total number of cities for the first time.

The average annual mean concentration of $PM_{2.5}$ in key regions recorded little change. Fen-wei Plains was the only key region where pollution deteriorated following the launch of the Blue Sky Defense Battle, recording a rise of 1.9% to 55 μg/m^3. Meanwhile, the BTH region and surrounding areas saw a decline of 1.7% to 57 μg/m^3, and the concentration of the YRD region declined by 2.4% year on year, reaching 41 μg/m^3.

Key Regions

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Zhangjiakou	40	35	34	32	31	29	25
	Chengde	50	52	43	40	35	32	29
	Qinhuangdao	65	60	45	46	44	38	41
	Langfang	110	100	85	66	60	52	46
	Tianjin	96	83	70	69	62	52	51
	Cangzhou	102	88	70	69	66	59	49.7
	Beijing	89.5	85.9	80.6	73	58	51	42
	Tangshan	115	101	85	74	66	60	53.9
	Handan	138	116	91	82	86	69	66
	Hengshui	122	108	99	87	77	62	56
	Xingtai	160	131	101	87	80	69	65
	Baoding	135	129	107	93	84	67	
	Shijiazhuang	156	126	89	99	86	72	66
Fen-wei Plains	Lvliang					55	52	39
	Jinzhong				62	59	55	45
	Linfen			59	74	83	70	62
	Yuncheng					73	60	61
	Sanmenxia			75	66	57	57	55
	Luoyang				79	73	59	62
	Xi'an	105	76	57	71	73	63	57
	Xianyang			64	82		71	66
	Baoji			57	59		54	51
	Tongchuan			58	59	54	49	47
	Weinan			60	76	71	71	57

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Zhoushan	33	30	30	25	25	22	20
	Lishui	49	39	38	33	33	28	25
	Taizhou	53	43	39	36	33	29	25
	Wenzhou	58	46	44	38	38	30	28
	Ningbo	54	46	45	39	37	33	29
	Quzhou	57	57	45	43	42	33	33
	Yancheng	65	57.5	49	43	43	43	39
	Jiaxing	68	57	53	44	42	37	35
	Shanghai	62	52	53	45	39	36	35
	Shaoxing	71	63	56	45	41	37	38
	Jinhua	70	64	54	46	42	34	31
	Suzhou	69	66	58	46	43	42	36
	Nantong	72	62	58	46	39	41	37
	Lianyungang	67	61.2	55	46	45	44	43
	Huzhou	74		57	47	42	36	32
	Nanjing	77	73.8	57	47.9	40	43	40
	Changzhou	72	67	59	49	47	50	44
	Hangzhou	70	64.6	57	49	45	40	38
	Zhenjiang	72	68	59	50	56	54	45
	Yangzhou	70	65.2	55	51	54	49	43
	Taizhou	76	68	60	51	48	47	44.1
	Wuxi	75.1	68	61	53	45	43	39
	Huai'an	79	68	58	53	50	45.2	42
	Suqian	76	67.5	61	56	55	53	47
	Xuzhou	76	67.3	65	60	66	62	57

National Standard 35 μg/m^3 — Min 10 — Max 160

Fig. 4 Annual mean concentrations of $PM_{2.5}$ in 337 cities in 2013-2019

North China

Province	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Erdos			27	24	25	27	23
	Chifeng			41	37	34	31	23
	Hohhot	56		43	41	44	36	38
	Wuhai				46	44	39	32
	Baotou				47	46	42	40
	Ulanqab					29	28	24
	Xilingol					15	16	10
	Hulun Buir					20	17	17
	Tongliao					35	33	33
	Bayannur					36	35	33
	Hinggan League					20	21	25
	Alxa League					35	38	27
Henan	Xinyang				58	54	53	48
	Nanyang				63	58	60	60
	Sanmenxia			75	66	57	57	55
	Xuchang				68	59		60
	Zhoukou				68	56	58	56
	Zhumadian				68	59	62	52
	Puyang				69	64	63	63
	Kaifeng				72	62		62
	Hebi				73	65	55	61
	Pingdingshan				75	63	65	60
	Luohe				77	64	61	59
	Shangqiu				77	75	62	55
	Zhengzhou	108	88	96	78	66	63	58
	Luoyang				79	73	59	62
	Xinxiang				84	66	61	56
	Jiaozuo			87	85	77	67	63
	Anyang				86	85	74	71

Province	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Xinzhou				56	58	53	41
	Jincheng				62	62	60	54
	Jinzhong				62	59	55	45
	Taiyuan	81	72	62	66	66	59	56
	Linfen			59	74	83	70	62
	Datong					36	36	32
	Changzhi					60	54	47
	Yangquan					61	59	47
	Shuozhou					48	46	45
	Yuncheng					73	60	61
	Lvliang					55	52	39

East China

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Weihai			38	35	32	25	29
	Yantai			45	39	35	29	35
	Qingdao	66	59	51	45	37	34	37
	Rizhao			57	55	48	42	45
	Tai'an			69	63	56	51	53
	Binzhou			77	70	64	54	53
	Ji'nan	108	90	87	73	63	52	53
	Zaozhuang			92	81	66	56	59
	Dezhou			101	81	68	58.7	53
	Heze			94	82	70	58	57
	Liaocheng			101	86	71	61	60
	Ji'ning			82		61	52	54
	Dongying			79		57	49	48

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Zibo					63	55	56
	Weifang					58	51.2	54
	Linyi					60	54	57
Fujian	Longyan				24	24	26	
	Nanping				25	24	24	
	Sanming				26	27	26	
	Fuzhou	36		29	27	27	25	24
	Ningde				27	24	25	19
	Xiamen	36	37	29	28	27	25	24
	Quanzhou				28	28	27	
	Putian				29	28	27	25
	Zhangzhou				33	35	33	
Anhui	Huangshan				28	26	24	24
	Lu'an				46	47	45	41
	Maanshan			61	49	50	45	42.8
	Tongling				50.9	58.2	49	47
	Xuancheng				51	50	44	41
	Wuhu			58	53	49	49	39
	Anqing				54	56	46	45
	Huai'nan				56	62	56.3	53.4
	Hefei	88	83	66	57	56	48	44
	Bozhou				58	63	58.6	52.9
	Chuzhou				59	56	50	48
	Bengbu					60	54.7	50.9
	Huaibei					64	57	54
	Fuyang					68	55	51
	Suzhou					70	58.3	50.2
	Chizhou				44	60	44	42

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Yingtan				41	41	36	40
	Fuzhou				41	47	36.6	
	Shangrao				41	44	36	
	Nanchang	69	52	43	44	41	30	35
	Ganzhou				45	47	39	32
	Jiujiang				50	48	43	46
	Jingdezhen					40	31.25	
	Pingxiang					51	43	40
	Xinyu				43	48	39.2	35
	Ji'an					53	40.2	
	Yichun					51	40	36

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Xiaogan			72	45	49	42	43
	Xianning			55	48	47	37	36
	Enshi			54	48	36	38	32
	Huanggang			59	51	49	42	40
	Shiyan			56	51	41	43	39
	Suizhou			66	56	51	45	42
	Wuhan	94	82	70	57	53	49	45
	Huangshi			68	57	55	43	40
	Jingmen		88	71	58	50	57	56
	Jingzhou			70	60	56	49	46
	Ezhou			68	60	56	46	42
	Yichang		93	70	62	58	53	52
	Xiangyang			76	64	66	61	60

Province	City	2013	2014	2015	2016	2017	2018	2019
Hunan	Chenzhou				41	38	31	30
	Huaihua				42	39	31	29
	Yiyang				44	41	35	54
	Xiangxi Prefecture				44	40	35	30
	Yongzhou				45	45	48	39
	Loudi				46	41	34	40
	Zhangjiajie			53	48	42	32	31
	Yueyang				49	49	45	43
	Zhuzhou			55	51	52	45	47
	Xiangtan			56	51	51	49	48
	Hengyang				52	49	43	37
	Changsha	83	74	61	53	52	48	47
	Shaoyang				54	55	47	43
	Changd			52	56	54	44	48
Guangxi	Fangchenggang				29	30	30	29
	Hechi				34	35	31	30
	Nanning	57	49	41	36	35	34	33
	Qinzhou				37	35	32	
	Guigang				38	42	40	
	Liuzhou			50	44	45	41	38
	Guilin			51	47	44	38	37
	Beihai					28	27	
	Wuzhou					41	37	
	Yulin					40	39	
	Baise					42	37	
	Hezhou					42	37.95	33
	Laibin					48	40	
	Chongzuo					32	31	32

Province	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shanwei			28	24	27		21
	Zhanjiang			28	26	29	27	
	Meizhou			35	28	30	30	26
	Shantou			33	30	29	27	
	Heyuan			34	32	29		
	Chaozhou			38	33.4	30		
	Qingyuan			33	36	32	31	32
	Jieyang			39	39	34		31
	Shaoguan			34	33	38		29
	Maoming			32	30	32		
	Yangjiang			32	31	33		
	Yunfu			34	34	37	33	29
	Zhuhai	38		31	26	30	27	25
	Shenzhen	39.6	34	30	27	28	26	24
	Huizhou	38		27	27	29	28	25
	Zhongshan	49	38	33	30	33	30	27
	Jiangmen	50	44	34	34	37	31	27
	Dongguan	48	45	36	35	37	36	32
	Guangzhou	53	49	39	36	35	35	30
	Zhaoqing	54.7	52	39	37	37	33	32
	Foshan	53	45	39	38	40	35	30
Hainan	Sanya			17	14	15		14
	Haikou			22	21	20	18	17

Province	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Guangyuan				27.9	23.1	27.1	27.6
Sichuan	Panzhihua			32	32	34	36	35
Sichuan	Ya'an				42	49	40.8	41.7
Sichuan	Suining				44	38	36	31.2
Sichuan	Guang'an				46	37	40.3	33.8
Sichuan	Mianyang			47	49	47.8	45	37.6
Sichuan	Ziyang				49	36	35.7	34.7
Sichuan	Neijiang				54	48	38	35
Sichuan	Deyang			53	55	54	49	40.2
Sichuan	Dazhou				56	50	47.1	45.8
Sichuan	Chengdu	97	77	64	63	56	51	43
Sichuan	Leshan				63.3	55.3	47	39.1
Sichuan	Luzhou			61	64	52.6	39	41
Sichuan	Zigong			73	73	66	54.1	44.9
Sichuan	Yibin			58		56	51.9	47
Sichuan	Nanchong					46	47.9	42.3
Sichuan	Meishan					49.2	35.4	36.4
Sichuan	Bazhong					32.7	30.3	35
Sichuan	Aba Prefecture					17	15	13
Sichuan	Ganzi Prefecture					19	19.8	11.3
Sichuan	Liangshan Prefecture					22	23.7	20.4
Tibet	Lhasa	26		26	28	20	17	12
Tibet	Changdu Prefecture							
Tibet	Shannan Prefecture							
Tibet	Shigatse Prefecture							
Tibet	Naqu Prefecture							
Tibet	Ali Prefecture							
Tibet	Linzhi Prefecture							

Province	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	70	65	57	54	45	40	38
Yunnan	Chuxiong Prefecture				22	22	24	
Yunnan	Kunming	42		30	28	29	28	26
Yunnan	Lincang				28	24		
Yunnan	Qujing					28	30	
Yunnan	Yuxi					23		
Yunnan	Zhaotong					31		
Yunnan	Lijiang					14		
Yunnan	Honghe Prefecture					34		
Yunnan	Diqing Prefecture					10		
Yunnan	Baoshan					25	21	20
Yunnan	Puer					28		
Yunnan	Wenshan Prefecture					23		
Yunnan	Xishuangbanna					26	26	20
Yunnan	Dali Prefecture					23	17	14
Yunnan	Dehong Prefecture					30		
Yunnan	Nujiang Prefecture					20		
Guizhou	Tongren				25	24	26	31
Guizhou	Anshun				27	30	32	23
Guizhou	Qiandongnan Prefecture				28	32		26
Guizhou	Bijie				30	30	31	26
Guizhou	Guiyang	53	48	39	37	32	32	27
Guizhou	Liupanshui				39	40	35	24
Guizhou	Zunyi			42	44	33	28	21
Guizhou	Qianxi'nan Prefecture							20
Guizhou	Qiannan Prefecture							19

	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Jinchang				32	29	22	20
	Jiayuguan				33	23	23	22
	Dingxi				36	36	40	26
	Zhangye				38	29	32	28
	Gannan				38		32	22
	Baiyin				39	33	34	27
	Wuwei				39	38	36	29
	Pingliang				41	30	37	24
	Tianshui				42		40	30
	Lanzhou	67.1		52	54	49	47	36
	Jiuquan					28	32	25
	Qingyang							30
	Longnan					31	34	19
	Linxia Prefecture						46	29
Qinghai	Yushu Prefecture				17	19	18	10
	Haixi Prefecture				27	24	20	14
	Hainan Prefecture				31	27	20	20
	Haibei Prefecture				32	28	25	18
	Guoluo Prefecture				37	27	24	15
	Huangnan Prefecture				45	33	30	22
	Haidong Prefecture				46	47	45	36
	Xi'ning	70	63	49	49	39	45	34
Ningxia	Shizuishan				47		39	34
	Wuzhong				48		31	28
	Yinchuan	51		51	56	49	38	31
	Guyuan						34	24
	Zhongwei					34	33	29

	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Karamay			31	30		28	
	Urumqi	87	61	66	74	70		50
	Korla						50	
	Turpan							
	Changli Prefecture					48		
	Ili Prefecture					51		
	Hami Prefecture					31		
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture							
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi						60	
Shaanxi	Shangluo				39	36		32
	Tongchuan			58	59	54	49	47
	Baoji			57	59		54	51
	Xi'an	105	76	57	71	73	63	57
	Weinan			60	76	71	71	57
	Xianyang			64	82		71	66
	Yan'an							31
	Hanzhong					53	49	46
	Yulin					34	35	35
	Ankang							39

Province	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Jixi			29	28	43	34	31
	Shuangyashan			43	34	40	28	29
	Qiqihar			38	36	38	28	28
	Mudanjiang		59	48	37	36	30	33
	Harbin	81	72	70	52	58	39	42
	Daqing			45	38	35	28	29
	Hegang			48	38	35	27	24
	Yichun			30	19	23	21	22
	Jiamusi			31	33	38	29	28
	Qitaihe			56	47	47	32	34
	Heihe			29	23	23	19	16
	Suihua			36	33	36	35	36
	Great Khingan			24	22	19	19	20
Jilin	Yanbian				31	31	27	26
	Songyuan				35	35	27	29
	Jilin			59	42	52	37	38
	Tonghua				42	35	28	29
	Changchun	73	68	66	46	46	33	38
	Siping				46	46	38	36
	Liaoyuan				46	44	34	36
	Baicheng				48	31	28	26
	Baishan				50	44	32	29

Province	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Dalian	52	53	48	39	34	30	35
	Zhaoyang				39	42	39	37
	Panjin				40	39	36	39
	Dandong			46	42	35	29	32
	Fushun			53	44	47	43	45
	Yingkou			49	44	43	40	43
	Benxi			56	45	40	34	37
	Huludao			54	47	47	42.8	47
	Liaoyang				47	47	39	41
	Tieling				48	50	40	41
	Shenyang	78	74	72	54	51	41	43
	Jinzhou			60	55	48	46	47
	Anshan			72		48	41	43
	Fuxin					41	37	37

PM_{10}

The average annual mean concentration of PM_{10} across the 337 cities declined to 63 μg/m^3 in 2019, registering a year-on-year decline of 1.6% and remaining lower than the national standard for concentration levels.

The proportion of attainment cities rose from 56.8% to 67.9%.

Among the key regions, the BTH region and surrounding areas saw a decline to 100 μg/m^3, down by 3.8% year-on-year. The Fen-wei Plains region experienced a decline to 94 μg/m^3, down by 3.1%, while the YRD saw its concentration drop to 65 μg/m^3, down by 3% year-on-year and remaining lower than the national standard.

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Chengde	104	111	92	81	82	78	63
	Qinhuangdao	124	114	99	87		77	80
	Beijing	108.1	115.8	101.5	92	84	78	68
	Tianjin	150	133	116	103	94	82	76
	Langfang	184	159	137	112	102	97	85
	Tangshan	184	163	141	127	119	110	101
	Hengshui	217	192	174	143	137	101	94
	Baoding	220	224	174	147	135	114	
	Shijiazhuang	309	216	147	164	154	131	122
	Handan	238	187	166		155	133	124
	Cangzhou	130	138	121		105	102	89
	Xingtai	294	235	172	144	148	131	115
	Zhangjiakou	91	78	78		70	69	56
Fen-wei Plains	Lvliang					112	95	87
	Jinzhong				109	112	110	86
	Linfen			89			117	103
	Yuncheng					125	108	100
	Sanmenxia			134	127	98	99	90
	Luoyang				130	123	104	107
	Xi'an	190	147	125	137	130	122	96
	Xianyang				149		134	101
	Baoji			108	111		105	82
	Tongchuan			104	104	97	89	80
	Weinan			110	139	135	134	101

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Shanghai	82	71	69	59	55	51	45
	Ningbo	86	73	69	62	60		48
	Shaoxing	98		79	68	63	59	
	Nantong	108	96	88	70	65	63	55
	Suzhou	95	86	80	72	66	65	62
	Zhenjiang	124	107	82	80	90	76	72
	Changzhou	102	104		81	73	73	69
	Wuxi	112.1	105	94	82	79	75	69
	Nanjing	137	123	96	85.2	76	75	69
	Yangzhou			101	87	95	90	71
	Taizhou	110	107	101	87	79	74	
	Lianyungang	119	111	94	87	75		66
	Huai'an	114	105	96	92	89	69.5	73
	Xuzhou	123	119	122	118	119	104	96
	Taizhou	75	71	66		59		44
	Huzhou	109		76		64		
	Yancheng	103	92	85		79	81	68
	Hangzhou		98	85		72	68	66
	Jiaxing		81			67		
	Lishui	65	62			50	46	
	Wenzhou	95	75			65	58	53
	Suqian	126	113			78	76	78
	Jinhua	99				58	55	52
	Zhoushan					45		
	Quzhou					64	54	51

National Standard 70 μg/m³ — Min 26.6 — Max 309

Figure 5 2013-2018 Annual Mean Concentration of PM_{10} in 337 Cities

North China

Province	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Erdos			69	63	72	90	65
	Chifeng			88	76	73	76	60
	Baotou				105	99	103	82
	Wuhai				111	113	99	92
	Hohhot	145		103		99	86	77
	Ulanqab					53	63	42
	Xilingol					46	68	36
	Hulun Buir					42	31	33
	Tongliao					69	65	71
	Bayannur					96	99	78
	Hinggan League					45	39	43
	Alxa Leagure					76	94	56
Henan	Xinyang				96	90	86	76
	Zhoukou				113	98	103	94
	Nanyang				119	109	96	92
	Zhumadian				120	106	111	86
	Kaifeng				122	103		
	Xuchang				122	96		88
	Pingdingshan				125	106	101	93
	Sanmenxia			134	127	98	99	90
	Shangqiu				127	131	103	90
	Hebi				128	120	108	99
	Luoyang				130	123	104	107
	Luohe				130	116	103	94
	Puyang				137	107	102	102
	Jiaozuo			150	142	134	116	114
	Zhengzhou	171	158		143	118	106	98
	Xinxiang				144	116	105	101
	Anyang				155	132	123	115

Province	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Xinzhou				103	112	96	79
	Jinzhong				109	112	110	86
	Jincheng				111	117	118	111
	Taiyuan	157	138	114	125	131	135	107
	Linfen			89			117	103
	Datong					73	82	73
	Changzhi					103	98	84
	Yangquan					116	108	84
	Shuozhou					99	112	86
	Yuncheng					125	108	100
	Lvliang					112	95	87

East China

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Weihai			65	63	62	50	56
	Yantai			77	76	69	66	70
	Qingdao	107	107	94	85	76	72	74
	Rizhao			102	101	87	79	85
	Tai'an			126	112	103	102	97
	Binzhou			126	123	110	98	91
	Ji'nan	191	172	157	141	130	112	103
	Zaozhuang			159	141	126	115	113
	Dezhou				141	122	113.6	103
	Heze			155	143	131	119	112
	Liaocheng			164	151	136	123	116
	Ji'ning			140		103	99	
	Dongying			136		110	94	

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Zibo					119	106	104
	Weifang					103	94	104
	Linyi					114	106	106
Fujian	Nanping				37	37	35	
	Putian				43	44	44	43
	Longyan				44	42	46	
	Sanming				46	44	42	
	Ningde				46	44	42	35
	Xiamen	62	59	48	47	48	46	40
	Quanzhou				48	53	53	
	Fuzhou	64			50	51	48	42
	Zhangzhou				65	59	60	
Anhui	Huangshan				45	51	42	39
	Chizhou				66	89	67	61
	Xuancheng				68	76	64	56
	Anqing				71	80	65	62
	Lu'an				73	80	78	72
	Wuhu			81	75	82	67	62
	Maanshan			87	75	83	75	68
	Chuzhou				77	83	80	72
	Tongling				77.8	88.4	75	75
	Hefei	115	113	91.9	83	80	73	68
	Bozhou				83	103	98.3	
	Huai'nan				85	107	88.9	91.3
	Huaibei				87	100	90	84
	Bengbu					98	87.3	
	Fuyang					108	90	84
	Suzhou					97	90.1	

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Yingtan				59	59	52	52
	Fuzhou				63	64	59	
	Ganzhou				68	72	63	56
	Shangrao				70	75	63	
	Jiujiang				74	70	68	
	Nanchang	116	85	75	78	76	64	
	Jingdezhen					67	56	
	Pingxiang					84	71	
	Xinyu				76	82	70.5	64
	Ji'an					75	66.7	
	Yichun					76	65.8	

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Enshi Prefecture		79	76	69	54	60	58
	Huanggang		102	85	75	84	74	73
	Xianning		94	90	77	62	56	56
	Xiaogan		103	110	78	80	72	73
	Shiyan		98	90	81	64	71	68
	Suizhou		108	103	88	75	73	69
	Huangshi		103	102	89	86	70	71
	Wuhan	124	113	104	92	88	73	71
	Xiangyang		113	108	93	90	89	84
	Yichang		136	107	97	88	77	73
	Jingmen		110	114	99	84	79	75
	Jingzhou		150	109	100	92	86	83
	Ezhou		110	104	100	85	73	74

Province	City	2013	2014	2015	2016	2017	2018	2019
Hunan	Chenzhou				70	70	61	52
	Yongzhou				70	67	69	56
	Loudi				71	66	66	66
	Yueyang				72	71	72	68
	Zhangjiajie			78	72	67	58	50
	Changsha		84	76	73	70	61	57
	Hengyang				76	70	66	59
	Shaoyang				77	78	65	59
	Xiangxi Prefecture				78	75	59	49
	Huaihua				79	83	50	46
	Changde			82	80	77	62	60
	Yiyang				82	78	69	72
	Zhuzhou			86	83	82	71	66
	Xiangtan				85	81	68	63
Guangxi	Fangchenggang				45	46	47	51
	Guigang				55	66	63	
	Hechi				55	60	59	53
	Nanning	90	84	72	62	56	57	58
	Guilin			70	64	60	55	54
	Liuzhou			70	66	66	62	57
	Beihai			48		45	46	
	Wuzhou					60	61	
	Qinzhou					55	53	
	Yulin					59		
	Baise					63	60	
	Hezhou					66	57	53
	Laibin					70	65	
	Chongzuo					47	52	58

Province	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shanwei			41	38	43		37
	Zhanjiang			45	39	42	39	
	Yangjiang			48	44	48		
	Meizhou			51	46	50	49	42
	Heyuan			49	46	48		
	Maoming			48	47	50		
	Shantou			52	48	49	44	
	Shaoguan			50	51	52		43
	Yunfu			54	51	57	53	50
	Chaozhou			58	51.2	50		
	Qingyuan			51	52	47	46	52
	Jieyang			56	60	55		52
	Zhuhai	59		51	41	43	43	41
	Shenzhen	62	53	49	42	45	44	42
	Zhongshan	66	57	49	44	49	45	43
	Huizhou			50	45	51	47	
	Dongguan	65	60	51	49	51	50	38
	Foshan	83	66	58	55	63	60	56
	Jiangmen	76	64	50	55	60	56	49
	Zhaoqing		74	56	55	56	51	48
	Guangzhou	72	67	59	56	56	54	53
Hainan	Sanya			32	28	28		27
	Haikou			40	39	37	35	32

	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Panzhihua			64	65	66	64	70
	Suining				68	63	61	49
	Ya'an				68	67	55.8	30.5
	Guangyuan				69.6	59.2	56.5	49.1
	Neijiang				76	70	58	51
	Mianyang			72	78	71.4	72	58.6
	Guang'an				78	74	70.3	55.5
	Dazhou				86	77	74.6	73.2
	Luzhou			89	86.8	80	59	54
	Deyang			75	91	87	78	66.6
	Leshan				92.9	83.7	70.1	61.7
	Ziyang				95	82	69.5	54
	Zigong			103	99	89	77.8	67.1
	Chengdu	150	123	108	105	88	81	68
	Yibin			82		80	75	62
	Nanchong					72	72.9	63.4
	Meishan					80.1	60.6	60.5
	Bazhong					53.6	51.4	59
	Aba Prefecture					34	26.6	25
	Ganzi Prefecture					31	31.5	18.6
	Liangshan Prefecture					45	37.6	34.3
Tibet	Lhasa			59	80	54		
	Changdu Prefecture							
	Shannan Prefecture							
	Shigatse Prefecture							
	Naqu Prefecture							
	Ali Prefecture							
	Linzhi Prefecture							

	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	106	98	87	77	72	64	60
Yunnan	Chuxiong Prefecture				35	40	40	
	Lincang				43.5	40		
	Kunming	82		56	55	58	51	45
	Qujing					54	53	
	Yuxi							
	Zhaotong					56		
	Lijiang					27		
	Honghe Prefecture					51		
	Diqing Prefecture					36		
	Baoshan					39	40	30
	Puer					44		
	Wenshan Prefecture					39.7		
	Xishuangbanna					48		54
	Dali Prefecture					33	38	28
	Dehong Prefecture					46		
	Nujiang Prefecture					43		
Guizhou	Anshun				38	44	47	30
	Bijie				44	47	52	38
	Qiandongnan Prefecture				45	46		36
	Tongren				50	66	57	52
	Guiyang	86	73	61	63	53	57	47
	Liupanshui				68	66	57	39
	Zunyi			71	69	54	47	38
	Qianxi'nan Prefecture							31
	Qiannan Prefecture							31

Province	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Gannan				70		63	44
	Dingxi				75	69	81	57
	Tianshui				80		79	56
	Pingliang				80	73	75	56
	Zhangye				90	81	66	55
	Baiyin				95	85	82	62
	Wuwei				97	81	80	61
	Jiayuguan			98	98	97	79	61
	Jinchang				104	101	76	58
	Lanzhou	153	126	120	132	111	103	79
	Jiuquan					89	90.7	65
	Qingyang							58
	Longnan					62	58	38
	Linxia Prefecture						81	59
Qinghai	Yushu Prefecture				40	46	49	26
	Haixi Prefecture				65	62	45	39
	Hainan Prefecture				69	57	51	39
	Guoluo Prefecture				72	56	47	32
	Haibei Prefecture				76	55	49	34
	Huangnan Prefecture				86	56	60	44
	Xi'ning	163	120	106	113	99	89	59
	Haidong Prefecture				114	104	85	60
Ningxia	Wuzhong				98		75	64
	Shizuishan				114		89	76
	Yinchuan	119		112	111	117	87	68
	Guyuan						82	59
	Zhongwei					81	75	61

Province	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Karamay			64	55		60	
	Urumqi	146	146	133	115	106		86
	Korla						177	
	Turpan							
	Changli Prefecture					77		
	Ili Prefecture					83		
	Hami Prefecture					78		
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture							
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi							
Shaanxi	Shangluo				72	65		54
	Tongchuan			104	104	97	89	80
	Baoji			108	111		105	82
	Xi'an	190	147	125	137	130	122	96
	Weinan			110	139	135	134	101
	Xianyang				149		134	101
	Yan'an							67
	Hanzhong					86	81	71
	Yulin						78	66
	Ankang							64

Province	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Jixi			61	53	75	57	54
	Shuangyashan			69	55	61	49	50
	Qiqihar			63	61	65	53	52
	Mudanjiang		91	78	68	65	58	61
	Harbin	119	111	103	74	87	65	67
	Daqing			62	59	59	46	48
	Hegang			78	67	65	61	46
	Yichun			51	33	36	38	35
	Jiamusi			53	48	57	47	44
	Qitaihe			85	74	84	80	63
	Heihe			50	37	41	40	34
	Suihua			60	58	65	53	56
	Great Khingan			55	43	33	34	30
Jilin	Yanbian				49	46	45	44
	Liaoyuan				63	59	48	51
	Jilin			98	69	79	63	63
	Songyuan				69	71	61	58
	Baicheng				75	55	50	49
	Tonghua				76	62	54	51
	Siping				77	80	68	69
	Changchun	129	118	107	78	78	61	64
	Baishan				81	71	59	56

Province	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Dalian	66	74	81	67	59	56	60
	Panjin				67	66	59	56
	Zhaoyang				69	76	76	68
	Dandong			76	71	61	50	55
	Yingkou			77	73	69	69	69
	Benxi			89	74	71	65	66
	Fushun			93	78	81	73	78
	Jinzhou			92	81	78	78	77
	Fuxin				83	81	69	67
	Liaoyang				83	82	69	74
	Tieling				83	85	74	76
	Huludao			99	87	80	74.25	77
	Shenyang	129	124	115	94	88	75	77
	Anshan			115		95	77	81

SO_2

The average annual mean concentration of SO_2 across the 337 cities declined to 11 μg/m^3 in 2019, registering a year-on-year drop of 15.4%, substantially lower than the national standard.

The concentrations of SO_2 in all cities met the national standard in 2018 and maintained the momentum in 2019.

Among the key regions, the Fen-wei Plains saw the largest decline of 31.8% to 15 μg/m^3. The same concentration was achieved by the BTH region and surrounding areas, with a decline of 16.7%. Meanwhile, the YRD saw its concentration drop to 9 μg/m^3, declining by 10.0%.

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Beijing	26.5	21.8	13.5	10	8	6	4
	Tianjin	59	49	29	21	16	12	11
	Shijiazhuang	106	64	47	41		23	18
	Tangshan	114	73	49	46	40	34	22
	Qinhuangdao	60	54	38	28		21	19
	Handan	97	57	45			22	15
	Baoding	69	67	55	39	29	21	
	Chengde	37	40	22	17	17	13	14
	Cangzhou	54	40	40			24	18
	Hengshui	68	42	36			15	13
	Xingtai	113	75	60	52		26	19
	Zhangjiakou	51	53	31			14	11
	Langfang	46	36	24	18	14	11	8
Fen-wei Plains	Lvliang						40	29
	Jinzhong				88	84	37	26
	Linfen						46	28
	Yuncheng					51	30	15
	Sanmenxia				33			
	Luoyang				39	25	17	10
	Xi'an	46	32	24	20	19	15	9
	Xianyang			24	20		16	9
	Baoji			15	13		10	8
	Tongchuan			25	22	20	21	12
	Weinan			23	22	18	13	10

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Shanghai	24	18	17	15	12	10	7
	Jiaxing		26					
	Shaoxing	37		21	12	9	7	
	Zhoushan							
	Wenzhou	24	17			12	9	8
	Jinhua	32					8	7
	Quzhou						8	7
	Taizhou	18	12	9				4
	Lishui	16	13				7	
	Nanjing	37	25	19	18.2	16	10	10
	Suzhou	31	24	21	17	14	8	9
	Wuxi	40	29	26	18	13	12	8
	Changzhou	41	36		19	17	14	10
	Yangzhou			24	23	18	13	10
	Zhenjiang	30	24	25	24	15	10	9
	Nantong	28	26	30	25	21	17	10
	Taizhou	32						
	Xuzhou	52	38	38	35	22	17	11
	Lianyungang	34	30		25	18		13
	Huai'an	34	32	21	18		9.25	10
	Yancheng	29	20	19			9	4
	Suqian	33						8
	Hangzhou		21	16		11	10	7
	Ningbo	22	17	15	13			
	Huzhou	26		17				

National Standard 60 μg/m³ — Min 2 — Max 114

Figure 6 2013-2019 Annual Mean Concentration of SO_2 in 337 Cities

North China

	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Hohhot	56		34		29	20	15
	Chifeng			49		23	20	19
	Baotou				31	28	24	22
	Erdos			20	15	14	13	13
	Ulanqab					27	23	20
	Xilingol					18	19	15
	Wuhai				56	51	35	32
	Hulun Buir					4	3	3
	Tongliao					14	14	11
	Bayannur					24	14	14
	Hinggan League					8	8	7
	Alxa League					11	10	9
Henan	Zhengzhou				29		15	9
	Pingdingshan				30			
	Sanmenxia				33			
	Luoyang				39	25	17	10
	Anyang				52			
	Kaifeng				28			
	Jiaozuo			49	40	25	18	13
	Xuchang				28			
	Nanyang				24			7
	Xinyang				14			7
	Zhoukou				21			
	Hebi				43		19	13
	Xinxiang				40	28	19	16
	Puyang				29		16	
	Luohe				28	15	12	10
	Shangqiu				23			
	Zhumadian				31	16		

	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Taiyuan	80	73		69		29	22
	Datong						31	30
	Changzhi					43	22	16
	Linfen						46	28
	Yangquan						32	16
	Jincheng				70	47	25	16
	Shuozhou						40	26
	Jinzhong				88	84	37	26
	Yuncheng					51	30	15
	Xinzhou				49		34	29
	Lvliang						40	29

East China

	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Ji'nan	93	72	50	38	25	17	15
	Qingdao	54	37	28	20	14	10	8
	Zibo			83		38	24	20
	Zaozhuang			63	38	29	19	17
	Yantai			21	21	15	10	8
	Weifang					26	19.9	13
	Ji'ning			56		24	18	
	Tai'an			39	35.2	25	18	15
	Rizhao			27	23	16	12	9
	Dongying			54			18	
	Liaocheng				31	18	14	14
	Binzhou			58	39	32	22	19
	Heze			42	35		14	14
	Weihai			17	15	10	7	6

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Linyi					23	18	15
	Dezhou				34		25.5	15
Fujian	Fuzhou	10			6		7	5
	Xiamen	20	16	10	11		9	6
	Quanzhou				11		10	
	Putian				7		9	6
	Sanming				15		13	
	Zhangzhou				15		8	
	Nanping				11		9	
	Longyan				10		10	
	Ningde				6	9	8	8
Anhui	Hefei			16	15	12	7	6
	Wuhu			20	21	15	11.5	11
	Maanshan			24	20		15.3	12
	Bengbu						16.1	
	Huai'nan				19	18	15.4	14
	Huaibei					21	17	11
	Tongling				43	27	18	15
	Anqing				19	15	11	9
	Huangshan				15		10	9
	Chuzhou				18	13	11	10
	Fuyang					13	9	6
	Suzhou						16.2	
	Lu'an				13	11	7	6
	Bozhou				27		12.7	
	Chizhou				20	15	12	
	Xuancheng				21	21	11	8

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Nanchang	40		19	17	15	11	
	Jiujiang				21	20	13	
	Jingdezhen						12.7	
	Pingxiang						19	
	Xinyu						20.75	19
	Yingtan				32	30	21	18
	Ganzhou				26		18	13
	Ji'an						20.2	
	Yichun						18.25	
	Fuzhou						13.8	
	Shangrao						22.6	

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Wuhan	33	21	18	11	10	9	9
	Yichang			20	14	12	11	7
	Jingzhou			26	23	18	15	9
	Huangshi				19	18	14	14
	Ezhou				23	15	11	12
	Xiaogan				11	11	9	7
	Huanggang				9	11	9	10
	Xianning				8	7	5	7
	Shiyan				17	14	15	9
	Xiangyang				15	16	14	11
	Jingmen				21	18	15	9
	Suizhou				10	9	7	7
	Enshi Prefecture				10	9	7	4

	City	2013	2014	2015	2016	2017	2018	2019
Hunan	长沙		24	18	16	13	10	7
	岳阳				21	14	10	9
	常德			25	19	12	11	8
	张家界			10	7	8	7	4
	株洲			25	25	19	18	11
	湘潭				25	20	16	10
	衡阳				16	16	16	14
	邵阳				31	29	18	15
	益阳				27	13	9	7
	郴州				16	15	15	11
	永州				19	12	11	9
	怀化				19	11	10	8
	娄底				22	17	11	10
	湘西州				10	4	4	6
Guangxi	南宁	19	15	13	12	11	11	10
	桂林			21	17	15	12	13
	北海							
	柳州			24	21	19	15	14
	梧州					12		
	防城港				9		11	
	钦州							
	贵港							
	玉林							
	百色							
	贺州							11
	河池				12	9		
	来宾							
	崇左							7

	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shaoguan			19				10
	Shantou			13	14	12	12	
	Zhanjiang			10	10		9	
	Maoming			14				
	Meizhou			9	7	8	7	8
	Shanwei			10				8
	Heyuan			10	7			
	Yangjiang							
	Qingyuan				14	11	10	9
	Chaozhou							
	Jieyang			17	15	15		11
	Yunfu						15	15
	Guangzhou	20	17	13	12	12	10	7
	Shenzhen	11	9	8	8	8	7	5
	Zhuhai	13		9	9		7	5
	Foshan	32	25	17	14	13	11	9
	Jiangmen	27	24	16	12	12	9	7
	Dongguan	23	19		11	12	10	10
	Zhongshan	19	16		11	10	9	6
	Huizhou							
	Zhaoqing		25	20	16	13	11	
Hainan	Haikou			6	6	6	5	5
	Sanya			3		2		4

	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Chengdu	31	19	14	14	11	9	6
	Mianyang			13	11	9	6.4	9
	Yibin			24		18	16	10
	Panzhihua			34	38	35	40	31
	Luzhou			22	18	17	15	11
	Zigong			17	15	15	13.3	
	Deyang			22	15	14	12	
	Nanchong						9.4	
	Suining				13		10	9.3
	Neijiang				18		10	7
	Leshan				19.4	16.2	7.7	12.9
	Meishan						9.8	
	Guang'an				18	13	9	
	Dazhou				12	11	10.2	
	Ziyang				17	10	8.1	
	Guangyuan				18.9	21.1	19.7	11
	Ya'an				15	11	14.5	
	Bazhong					42	4.2	4.3
	Aba Prefecture					11	7.8	9
	Ganzi Prefecture						10.4	
	Liangshan Prefecture					12	16.4	
Tibet	Lhasa			10	8			
	Changdu Prefecture							
	Shannan Prefecture							
	Shigatse Prefecture							
	Naqu Prefecture							
	Ali Prefecture							
	Linzhi Prefecture							

	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	32	24	16	13	12	9	7
Yunnan	Kunming	28		17	17	15	13	12
	Qujing						14	
	Yuxi							
	Zhaotong							
	Lijiang							
	Chuxiong Prefecture				22	19	15	
	Honghe Prefecture							
	Diqing Prefecture							5
	Baoshan						7	
	Puer							
	Lincang				11.5	12		
	Wenshan Prefecture					9.7		6
	Xishuangbanna							10
	Dali Prefecture						5	
	Dehong Prefecture							
	Nujiang Prefecture							
Guizhou	Guiyang	31	24	17	13	13	11	10
	Zunyi			16	11	12	12	12
	Liupanshui				17	18	17	12
	Bijie				17	13	11	9
	Anshun				22	20	17	14
	Tongren				12	10	4	4
	Qianxi'nan Prefecture							5
	Qiandongnan Prefecture				13	8		18
	Qiannan Prefecture							10

	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Lanzhou	33	29		19	20	21	18
	Jiayuguan			25	21	17	14	11
	Jinchang				37	27	21	17
	Baiyin				42		46	42
	Tianshui				27		17	12
	Wuwei				23	14	8	8
	Zhangye				25	13	10	12
	Pingliang				19		11	9
	Jiuquan					14	9.4	10
	Qingyang							11
	Dingxi				25	22	17	11
	Longnan					20	17	16
	Linxia Prefecture						23	13
	Gannan				19		14	11
Qinghai	Xi'ning	48	41	31	31	24	20	17
	Haidong Prefecture				22	20	18	14
	Haibei Prefecture				19	14	16	14
	Huangnan Prefecture				17	15	17	15
	Hainan Prefecture				13	18	9	10
	Guoluo Prefecture				25	27	23	19
	Yushu Prefecture				13	20	15	9
	Haixi Prefecture				21	20	17	9
Ningxia	Yinchuan	77		64		48	27	15
	Shizuishan						17	30
	Wuzhong				41		17	16
	Guyuan						27	10
	Zhongwei					24	41	14

	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Urumqi	29	25	15	14	13		
	Karamay							
	Korla						7	
	Turpan							
	Changli Prefecture					15		
	Ili Prefecture					23		
	Hami Prefecture							
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture					35		
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi							
Shaanxi	Xi'an	46	32	24	20	19	15	9
	Xianyang			24	20		16	9
	Tongchuan			25	22	20	21	12
	Yan'an							10
	Baoji			15	13		10	8
	Weinan			23	22	18	13	10
	Hanzhong					15	11	13
	Yulin							15
	Ankang							12
	Shangluo				20			13

Province	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Harbin	44	57	40	28		20	17
	Qiqihar			26	23	22	15	
	Daqing			18		13	13	9
	Mudanjiang		25	20	18	10		
	Jixi				20			8
	Hegang							
	Shuangyashan				18	13	9	8
	Yichun							
	Jiamusi							
	Qitaihe							
	Heihe					16		
	Suihua							
	Great Khingan							19
Jilin	Changchun	44	41	36	28	26	16	11
	Jilin			30	23	18	15	12
	Siping				22	26	14	11
	Liaoyuan				25	18	13	15
	Tonghua				29	26	16	11
	Baishan				35	29	21	14
	Songyuan				15	14	7	6
	Baicheng				12	11	10	8
	Yanbian				14	15	11	9

Province	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Shenyang	90	82	66	47	37	26	21
	Dalian	31	29		26	17	12	
	Anshan			49			22	
	Fushun			31	27			
	Benxi			43	36	27	21	
	Jinzhou			59	52	45	39	
	Dandong							
	Yingkou			29	23		12	
	Panjin							
	Huludao			47			38.3	
	Fuxin				39			
	Liaoyang				27			
	Tieling				30	20		
	Zhaoyang				34			

NO_2

In 2019, the average annual mean concentration of NO_2 across the 337 cities remained stable at 27 μg/m^3, level with that of 2018, meeting the national standard.

The proportion of attainment cities rose from 84.6% to 89.9% as a percentage of total cities.

Among the key regions, the average annual mean concentration of NO_2 in the BTH region and surrounding areas increased by 2.6% to 40 μg/m^3, equivalent to the national standard. Meanwhile, the concentration in the Fen-wei Plains region dropped by 2.5% to 39 μg/m^3, while that of the YRD decreased to 32 μg/m^3, on par with 2018 levels.

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Beijing	56	56.7	50	48	46	42	37
	Tianjin	54	54	42	48	50	47	42
	Shijiazhuang	69	54	51	58		50	40
	Tangshan	69	60	61	58	59	56	51
	Qinhuangdao	47	49	45	48		45	42
	Handan	58	52	47			43	38
	Baoding	56	55	54	58	50	47	
	Chengde	36	39	35	35	35	34	32
	Cangzhou	31	33	41			43	38
	Hengshui	46	43	44			34	33
	Xingtai	69	62	60	61		50	45
	Zhangjiakou	32	29	26			23	22
	Langfang	48	49	47	52	48	47	39
Fen-wei Plains	Lvliang						45	45
	Jinzhong				36	44	45	41
	Linfen						40	39
	Yuncheng					35	31	28
	Sanmenxia				39			
	Luoyang				47	42	40	40
	Xi'an	57	47	44	53	59	55	48
	Xianyang			39	50		50	43
	Baoji			36	39		41	34
	Tongchuan			36	35	35	37	36
	Weinan			29	47	56	51	42

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Shanghai	48	45	46	43	44	42	42
	Jiaxing		44					
	Shaoxing	42		37	31	31	29	
	Zhoushan							
	Wenzhou	52	50			41	37	34
	Jinhua	38					29	27
	Quzhou						32	31
	Taizhou	39	25	23				19
	Lishui	26	23				23	
	Nanjing	55	54	50	44.3	47	44	42
	Suzhou	53	53	54	51	48	48	37
	Wuxi	47	45	41	47	46	43	40
	Changzhou	48	40		37	41	44	37
	Yangzhou			30	30.5	40	38	35
	Zhenjiang	42	46	42	38	43	38	33
	Nantong	36	40	38	36	38	36	32
	Taizhou	31						
	Xuzhou	47	37	39	42	44	42	37
	Lianyungang	36	35		30	33		30
	Huai'an	32	27	22	25		31	26
	Yancheng	29	27	23			27	24
	Suqian	35						29
	Hangzhou		50	49		45	43	41
	Ningbo	44	41	43	39			
	Huzhou	41		40				

National Standard 40 μg/m³ — Min 9.5 — Max 69

Figure 7 2013-2019 Annual Mean Concentration of NO_2 in 337 Cities

North China

Province	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Hohhot	40		39		45	41	39
	Chifeng			25		20	27	26
	Baotou				39	42	39	39
	Erdos			24	23	27	26	26
	Ulanqab					28	25	25
	Xilingol					19	12	11
	Wuhai				28	31	30	29
	Hulun Buir					18	14	12
	Tongliao					22	20	20
	Bayannur					27	22	21
	Hinggan League					16	13	15
	Alxa Leagure					11	11	10
Henan	Zhengzhou				56		50	45
	Pingdingshan				43			
	Sanmenxia				39			
	Luoyang				47	42	40	40
	Anyang				51			
	Kaifeng				40			
	Jiaozuo			50	48	44	41	37
	Xuchang				47			
	Nanyang				29			29
	Xinyang				28			24
	Zhoukou				29			
	Hebi				52		44	38
	Xinxiang				49	50	49	44
	Puyang				42		36	
	Luohe				39	36	35	29
	Shangqiu				32			
	Zhumadian				38	36		

Province	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Taiyuan	43	36		46		52	50
	Datong						29	34
	Changzhi					41	31	34
	Linfen						40	39
	Yangquan						45	34
	Jincheng				40	45	40	38
	Shuozhou						31	41
	Jinzhong				36	44	45	41
	Yuncheng					35	31	28
	Xinzhou				39		44	43
	Lvliang						45	45

East China

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Ji'nan	59	53	48	45	46	45	41
	Qingdao	40	43	33	32	33	31	32
	Zibo			61		47	43	42
	Zaozhuang			36	31	31	35	34
	Yantai			33	33	30	27	27
	Weifang					36	34.6	37
	Ji'ning			43		38	34	
	Tai'an			42		39	36	34
	Rizhao			34	35	36	35	35
	Dongying			41			36	
	Liaocheng				41	40	38	39
	Binzhou			41	39	40	39	39
	Heze			42	36		39	33
	Weihai			23	20	23	17	20

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Linyi					45	42	38
	Dezhou				40		36.8	34
Fujian	Fuzhou	43			30		26	22
	Xiamen	44	37	31	31		31	23
	Quanzhou				27		25	
	Putian				18		20	18
	Sanming				27		26	
	Zhangzhou				31		30	
	Nanping				18		17	
	Longyan				25		24	
	Ningde				26	22	20	13
Anhui	Hefei			33	45	52	41	42
	Wuhu			36	45	49	41.8	26
	Maanshan			35	34		37.25	36
	Bengbu						37.9	
	Huai'nan				35	31	28.75	28
	Huaibei					35	33	29
	Tongling				43	50	41	37
	Anqing				39	36	31	30
	Huangshan				21		16	18
	Chuzhou				39	40	40	35
	Fuyang					36	28	31
	Suzhou						42.5	
	Lu'an				35	38	34	31
	Bozhou				36		28.75	
	Chizhou				33	35	35	
	Xuancheng				38	32	34	29

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Nanchang	40		31	33	37	36	
	Jiujiang				30	29	29	
	Jingdezhen						16	
	Pingxiang						26	
	Xinyu						28.7	26
	Yingtan				24	26	24	24
	Ganzhou				24		25	24
	Ji'an						19.8	
	Yichun						24.2	
	Fuzhou						17.9	
	Shangrao						22.5	

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Wuhan	60	55	52	46	50	47	44
	Yichang			35	35	35	34	29
	Jingzhou			36	34	36	34	32
	Huangshi				31	37	36	33
	Ezhou				34	36	34	34
	Xiaogan				25	26	20	21
	Huanggang				25	27	24	25
	Xianning				19	18	23	21
	Shiyan				28	22	29	26
	Xiangyang				32	35	34	32
	Jingmen				35	38	34	27
	Suizhou				25	24	24	24
	Enshi Prefecture				19	23	24	22

Province	City	2013	2014	2015	2016	2017	2018	2019
Hunan	Changsha		42	38	38	40	34	33
	Yueyang				25	25	23	27
	Changde			24	23	22	25	23
	Zhangjiajie			18	21	22	22	20
	Zhuzhou			35	35	36	33	34
	Xiangtan				37	37	35	33
	Hengyang				30	28	30	27
	Shaoyang				22	24	23	23
	Yiyang				29	29	25	23
	Chenzhou				27	26	26	24
	Yongzhou				24	22	25	27
	Huaihua				17	18	13	12
	Loudi				23	22	22	22
	Xiangxi Prefecture				19	19	19	16
Guangxi	Nanning	38	37	33	32	35	35	32
	Guilin			26	27	25	23	25
	Beihai							
	Liuzhou			24	24	26	24	25
	Wuzhou					26		
	Fangchenggang				17		19	
	Qinzhou							
	Guigang							
	Yulin							
	Baise							
	Hezhou							21
	Hechi				27	25		
	Laibin							
	Chongzuo							19

Province	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shaoguan			25				24
	Shantou			20	21	21	19	
	Zhanjiang			15	14		14	
	Maoming			15				
	Meizhou			23	25	28	28	25
	Shanwei			13				11
	Heyuan			23	19			
	Yangjiang							
	Qingyuan				37	23	22	33
	Chaozhou							
	Jieyang			21	25	25		22
	Yunfu						31	29
	Guangzhou	52	48	47	46	52	50	45
	Shenzhen	40	35	33	33	30	29	25
	Zhuhai	37		29	32		30	27
	Foshan	53	48	41	41	44	41	41
	Jiangmen	33	32	31	34	38	35	32
	Dongguan	45	42		34	41	39	37
	Zhongshan	43	32		34	36	32	32
	Huizhou							
	Zhaoqing		37	31	33	27	25	33
Hainan	Haikou			14	16	12	5	13
	Sanya			13		12		9

Province	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Chengdu	63	59	53	54	53	48	42
	Mianyang			34	36	32	31.5	53
	Yibin			29		34	35	30
	Panzhihua			32	34	36	38	40
	Luzhou			33	29	35	35	30
	Zigong			31	33	37	30.9	
	Deyang			29	25	28	29	
	Nanchong						32.8	
	Suining				24		29	23.1
	Neijiang				28		26	25
	Leshan				24.8	24.6	32.8	24
	Meishan						34.9	
	Guang'an				24	27	27	
	Dazhou				41	39	40.2	
	Ziyang				20	27	27.2	
	Guangyuan				35.5	38.2	34.5	31
	Ya'an				27	28	20.8	
	Bazhong					26.5	23.8	24.5
	Aba Prefecture					11	9.5	11
	Ganzi Prefecture						15.9	
	Liangshan Prefecture					14	20.5	
Tibet	Lhasa			21	24			
	Changdu Prefecture							
	Shannan Prefecture							
	Shigatse Prefecture							
	Naqu Prefecture							
	Ali Prefecture							
	Linzhi Prefecture							

Province	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	38	39	45	46	46	44	40
Yunnan	Kunming	40		30	28	32	33	31
	Qujing						19	
	Yuxi							
	Zhaotong							
	Lijiang							
	Chuxiong Prefecture				21	21	20	
	Honghe Prefecture							
	Diqing Prefecture							
	Baoshan						12	12
	Puer							
	Lincang				12	20		
	Wenshan Prefecture					14.6		
	Xishuangbanna							20
	Dali Prefecture						16	11
	Dehong Prefecture							
	Nujiang Prefecture							
Guizhou	Guiyang	33	31	28	29	27	25	21
	Zunyi			29	32	29	27	26
	Liupanshui				25	23	23	26
	Bijie				23	22	20	17
	Anshun				16	15	15	12
	Tongren				16	22	19	21
	Qianxi'nan Prefecture							14
	Qiandongnan Prefecture				11	21		23
	Qiannan Prefecture							14

Province	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Lanzhou	35	48		57	57	55	50
	Jiayuguan			27	26	25	26	22
	Jinchang				17		16	15
	Baiyin				27		26	27
	Tianshui				36		34	31
	Wuwei				27	28	26	25
	Zhangye				22	21	18	20
	Pingliang				39		35	35
	Jiuquan					27	12.3	22
	Qingyang							18
	Dingxi				31	30	27	25
	Longnan					26	25	23
	Linxia Prefecture						21	21
	Gannan				22		23	21
Qinghai	Xi'ning	41	38	38	42	40	39	37
	Haidong Prefecture				41	36	39	40
	Haibei Prefecture				13	14	16	15
	Huangnan Prefecture				11	16	13	12
	Hainan Prefecture				16	15	20	16
	Guoluo Prefecture				17	16	16	13
	Yushu Prefecture				13	15	15	13
	Haixi Prefecture				13	15	13	14
Ningxia	Yinchuan	43		39		42	37	37
	Shizuishan						25	29
	Wuzhong				28		24	28
	Guyuan						37	28
	Zhongwei					26	32	26

Province	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Urumqi	60	56	52	53	49		
	Karamay							
	Korla						21	
	Turpan							
	Changli Prefecture					23		
	Ili Prefecture					38		
	Hami Prefecture							
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture					26		
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi							
Shaanxi	Xi'an	57	47	44	53	59	55	48
	Xianyang			39	50		50	43
	Tongchuan			36	35	35	37	36
	Yan'an							41
	Baoji			36	39		41	34
	Weinan			29	47	56	51	42
	Hanzhong					32	29	26
	Yulin							42
	Ankang							25
	Shangluo				26			23

Province	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Harbin	56	52	51	44		37	33
	Qiqihar			24	23	22	18	
	Daqing			25		26	23	20
	Mudanjiang		32	25	26	26		
	Jixi				20			20
	Hegang							
	Shuangyashan				22	21	19	15
	Yichun							
	Jiamusi							
	Qitaihe							
	Heihe					15		
	Suihua							
	Great Khingan							14
Jilin	Changchun	44	47	45	40	40	35	34
	Jilin			37	30	29	27	24
	Siping				32	33	28	27
	Liaoyuan				28	30	27	23
	Tonghua				31	32	26	26
	Baishan				27	26	22	19
	Songyuan				23	20	16	17
	Baicheng				20	22	16	15
	Yanbian				23	22	21	18

Province	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Shenyang	43	52	48	40	40	39	36
	Dalian	24	27		30	28	27	
	Anshan			38			34	
	Fushun			34	33			
	Benxi			41	33	31	31	
	Jinzhou			38		38	35	
	Dandong							
	Yingkou			31	28		29	
	Panjin							
	Huludao			37			33	
	Fuxin				26			
	Liaoyang				29			
	Tieling				23	32		
	Zhaoyang				22			

CO

In 2019, the average annual mean concentration of CO across the 337 cities was 1.4 mg/m^3, on par with 2018 levels, meeting the national standard.

The annual mean concentration across all cities met the standard, making CO the second pollutant after SO_2 to have met standards across all cities.

Among the key regions, only the Fen-wei Plains region saw an improvement in annual mean concentration after registering a year-on-year decline of 9.5% to 1.9 mg/m^3. Concentrations in the BTH region and surrounding areas and in the YRD remained similar to the previous year, at 2 mg/m^3 and 1.2 mg/m^3 respectively.

Key Regions

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Beijing	3.4	3.2	3.6	3.2	2.1	1.7	1.4
	Tianjin	3.7	2.9	3.1	2.7	2.8	1.9	1.8
	Shijiazhuang	6	4.3	4.3	3.9		2.6	
	Tangshan	5.4	2.4	4.2	2.3	2	3.3	2.9
	Qinhuangdao	4	3.5	3.6	2.9		2.5	2.6
	Handan	4.8	3.9	3.8			2.8	2.6
	Baoding	5.5	5.4	5.8	4.4	3.6	2.4	
	Chengde	2.1	2.3	2.3	2.4	2.1	1.9	1.8
	Cangzhou	3.5	2.9	3.2			1.8	1.8
	Hengshui	3.8	3	3.7			1.8	1.8
	Xingtai	5.5	3.8	5.1	1.8		2.8	2.4
	Zhangjiakou	1.7	2.2	1.6			1.4	1.1
	Langfang	4.4	3.6	3.4	3.5	2.9	2	1.7
Fen-wei Plains	Lvliang						2.4	1.6
	Jinzhong				4.1	2.8	2.1	1.6
	Linfen						3.6	3.1
	Yuncheng						3.3	2.7
	Sanmenxia				3			
	Luoyang				3.38	2.4	2	1.5
	Xi'an	4.4	4.3	4.3	3.1	2.8	2.2	1.7
	Xianyang						2.1	1.6
	Baoji			2.7	2.2		1.5	1.6
	Tongchuan			2.5	2.16	2.2	2	1.7
	Weinan						1.9	1.9

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Shanghai	0.85	0.77	0.86	0.79	0.76	0.67	0.66
	Jiaxing		0.9					
	Shaoxing			0.9	0.8	0.8	1.2	
	Zhoushan							
	Wenzhou		1.7			1	1	1
	Jinhua	1.03					1.1	0.7
	Quzhou							1.1
	Taizhou		1	0.8				0.9
	Lishui	1.2	1.2				1	
	Nanjing	1.04	0.95	1	1	1.5	1.4	1.3
	Suzhou		0.92	0.92	1.5	1.4	1.2	1.2
	Wuxi			1.0	1.1	1.5	1.6	1.4
	Changzhou					1.5	1.6	1.2
	Yangzhou			1.4			0.84	0.6
	Zhenjiang				0.9	0.9	0.7	0.7
	Nantong							1.1
	Taizhou	1.4						
	Xuzhou					1	0.9	0.8
	Lianyungang		2		1.6	1.5		1.5
	Huai'an		1.3	1.1	1		0.9	1.2
	Yancheng						1.26	
	Suqian	1.3						1.2
	Hangzhou			1.5				
	Ningbo	1	0.9	1.4	1.2			
	Huzhou			0.9				

National Standard 4 mg/m³ — Min 0.6 — Max 6

Figure 8 2013-2019 Annual Mean Concentration of CO in 337 Cities

North China

Province	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Hohhot	4.9					2.2	2.2
	Chifeng			1.0			0.8	1.3
	Baotou						2.3	2.6
	Erdos			0.7	0.7		1.1	1.1
	Ulanqab						1	1
	Xilingol						0.8	0.4
	Wuhai				2		1.8	1.6
	Hulun Buir						0.6	0.6
	Tongliao						1	0.9
	Bayannur						1.2	1.4
	Hinggan League						1	1
	Alxa League						0.9	0.8
Henan	Zhengzhou				2.8		1.8	1.6
	Pingdingshan				2.1			
	Sanmenxia				3			
	Luoyang				3.38	2.4	2	1.5
	Anyang				4.7			
	Kaifeng				2.7			
	Jiaozuo			3.9	1.9			
	Xuchang				2.9			
	Nanyang				2.1			1.6
	Xinyang				1.6			
	Zhoukou				2.7			
	Hebi				4.1		2.5	2
	Xinxiang				1.5	3	2.3	2.08
	Puyang				2.9		1.1	
	Luohe				2.1	1	0.84	0.71
	Shangqiu				1.7			
	Zhumadian				1.8	1		

Province	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Taiyuan	3.4	3.2		3.3		1.9	1.9
	Datong						3.1	3
	Changzhi					3.1	2.4	2.1
	Linfen						3.6	3.1
	Yangquan						2.2	2.1
	Jincheng				4.1	4.3	2.9	2.6
	Shuozhou						1.9	1.6
	Jinzhong				4.1	2.8	2.1	1.6
	Yuncheng						3.3	2.7
	Xinzhou				3.5		2	1.9
	Lvliang						2.4	1.6

East China

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Ji'nan						1.7	1.6
	Qingdao					1.3	1.4	1.5
	Zibo					2.6	2.1	1.9
	Zaozhuang							
	Yantai			0.8	0.8	0.7	1.3	
	Weifang							1.7
	Ji'ning							
	Tai'an							
	Rizhao							
	Dongying						1.5	
	Liaocheng						1.9	1
	Binzhou							
	Heze							
	Weihai				1.1			1.1

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Linyi					2	1.9	1.6
	Dezhou							1.6
Fujian	Fuzhou				1.1		0.9	0.9
	Xiamen		1	0.9	0.9		0.9	0.8
	Quanzhou				1		0.8	
	Putian				0.9		0.8	1
	Sanming				2.1		1.7	
	Zhangzhou				1.2		1	
	Nanping				1.4		1	
	Longyan				1.2		1	
	Ningde				1.6	1.1	1.2	1.2
Anhui	Hefei			1.06	1	1.4	1.5	1.2
	Wuhu							1.2
	Maanshan			1.5	2.1		1.7	1.4
	Bengbu						1.2	
	Huai'nan				1	0.8	1.2	1.1
	Huaibei					1.5	1.4	1.3
	Tongling				1.31	1.1	1	0.9
	Anqing				1.3	1.1	1.1	1.1
	Huangshan				0.5		1.1	1
	Chuzhou				0.9	0.8	0.7	0.8
	Fuyang					0.9	0.75	0.7
	Suzhou						1.3	
	Lu'an				1.3	1.2	1.1	1.1
	Bozhou				1.12		1.3	
	Chizhou				1.6	1.6	1.4	
	Xuancheng				1.2	1.3	1.2	1.1

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Nanchang				1.6	1.6	1.5	
	Jiujiang						1.6	
	Jingdezhen						1.1	
	Pingxiang						2.2	
	Xinyu						1.5	1.4
	Yingtan				1.1	1	1	0.9
	Ganzhou				1.8		2	1.9
	Ji'an						1.0	
	Yichun						1.4	
	Fuzhou						1.05	
	Shangrao						1.2	

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Wuhan	1.1	1.1	1.1	1.7	1.1	1	1.5
	Yichang			1.7	1.7	1.7	1.6	1.4
	Jingzhou			1.8	1.8	1.7	1.8	1.5
	Huangshi				2.5	1.7	1.7	1.5
	Ezhou				1.8	1.6	1.7	1.6
	Xiaogan				2.8	3	1.6	1.6
	Huanggang				1.7	1.5	1.4	1.2
	Xianning				1.4	1.6	1.5	1.2
	Shiyan				1.9	1.7	1.4	1.4
	Xiangyang				2	1.8	1.6	1.4
	Jingmen				1.6	1.4	1.5	1.2
	Suizhou				2	2.6	1.5	1.4
	Enshi Prefecture				1.5	1.6	1.5	1.3

	City	2013	2014	2015	2016	2017	2018	2019
Hunan	Changsha				1.4	1.3	1.3	1.3
	Yueyang				1.4	1.4	1.4	1.4
	Changde			1.4	1.8	1.8	1.4	1.5
	Zhangjiajie			1.6	2.2	1.9	1.4	1.3
	Zhuzhou			0.9	1.4	1.4	1.4	1.2
	Xiangtan				1.4	1.3	1.3	1.3
	Hengyang				1.8	1.7	1.6	1.6
	Shaoyang				1.5	1.5	1.4	1.4
	Yiyang				1.7	1.8	1.8	1.6
	Chenzhou				1.8	1.9	1.8	1.2
	Yongzhou				1.1	1	1.1	1.2
	Huaihua				1.6	1.4	1.5	1.2
	Loudi				2.5	2.6	2.3	1.6
	Xiangxi Prefecture				1	1.8	1.2	1.2
Guangxi	Nanning	1.7	1.6		1.3		1.3	1.4
	Guilin			1.8	1.7	1.3	1.3	1.4
	Beihai							
	Liuzhou				1.6	1.5	1.4	1.6
	Wuzhou					1.5		
	Fangchenggang						1.3	
	Qinzhou							
	Guigang							
	Yulin							
	Baise							
	Hezhou							0.8
	Hechi				1.6	1.3		
	Laibin							
	Chongzuo							1.2

	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shaoguan			1				1.3
	Shantou			1.2	1.2	1.1	1	
	Zhanjiang			1.4	1.2		0.9	
	Maoming			0.9				
	Meizhou			1.3	1.3	1.3	1.2	1.1
	Shanwei			0.8				0.9
	Heyuan			1.3	1.2			
	Yangjiang							
	Qingyuan				1.6	1.5	1.3	1.4
	Chaozhou							
	Jieyang			1.5	1.5	1.3		1.2
	Yunfu						1.2	1.2
	Guangzhou	1		1	1.3	1.2	1.2	1.2
	Shenzhen	1.2	1.1	0.9	0.8	0.8	0.6	0.6
	Zhuhai	1		1.6	1.1		1	1.2
	Foshan	1.6	1.6	1.4	1.3	1.2	1.2	1.3
	Jiangmen	2.1		1.5	1.3	1.3	1.2	1.3
	Dongguan	0.9	1.4		1.3	1.2		1.1
	Zhongshan	1.5	1.7		1.4	1.3	1.1	1.2
	Huizhou							
	Zhaoqing		1.8	1.5	1.4	1.3	1.2	1.3
Hainan	Haikou			0.9	0.9	0.8	0.8	0.9
	Sanya			0.8		0.8		0.7

Province	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Chengdu	2.6	2	2	1.8	1.7	1.4	1.1
	Mianyang			1.4	1.6	1.4	1.1	1
	Yibin			0.9		1.2	0.9	0.8
	Panzhihua			2.7	2.2	2.2	2.5	2.3
	Luzhou			0.9	0.9	1	1	1
	Zigong			1.5	1.5	1.6	1.4	
	Deyang			1.4	1.4	1.5	1.3	
	Nanchong						1.2	
	Suining				1.4		1.1	0.9
	Neijiang				1.4		1.2	1.2
	Leshan				1.1	1.4	1.2	1.4
	Meishan						1.1	
	Guang'an				1.4	1.5	1.3	
	Dazhou				1.9	1.9	1.9	
	Ziyang				1.2	1.2	1	
	Guangyuan				0.8	1.5	1.3	1.4
	Ya'an				1.6	1.2	1.1	
	Bazhong					1.5	1.1	1.1
	Aba Prefecture					1.3	0.8	1.2
	Ganzi Prefecture						0.7	
	Liangshan Prefecture					1	1.2	
Tibet	Lhasa			1.1	1			
	Changdu Prefecture							
	Shannan Prefecture							
	Shigatse Prefecture							
	Naqu Prefecture							
	Ali Prefecture							
	Linzhi Prefecture							

Province	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	1.5	1.8	1.5	1.4	1.4	1.3	1
Yunnan	Kunming			1.0	1.0	0.9	1.2	
	Qujing						1.4	
	Yuxi							
	Zhaotong							
	Lijiang							
	Chuxiong Prefecture				0.8	0.9	0.7	
	Honghe Prefecture							
	Diqing Prefecture							0.5
	Baoshan						0.6	
	Puer							
	Lincang				1.0	0.9		
	Wenshan Prefecture					0.7		0.7
	Xishuangbanna							
	Dali Prefecture						0.7	
	Dehong Prefecture							
	Nujiang Prefecture							
Guizhou	Guiyang	1.3	1.3	1.1	1.1	1.1	1	0.9
	Zunyi			1.2	1.2	1.1	1.1	0.9
	Liupanshui				1.3	1.1	1.2	1.1
	Bijie				1.6	1.7	1.3	1
	Anshun				1.1	0.9	1	0.9
	Tongren				1.2	1.3	1.4	1.4
	Qianxi'nan Prefecture							0.8
	Qiandongnan Prefecture				1.3	1.2		1
	Qiannan Prefecture							0.7

Province	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Lanzhou				2.9	2.8	2.7	2.5
	Jiayuguan				1	1	1	0.9
	Jinchang				1.9		0.9	0.9
	Baiyin				1.4		1.6	1.4
	Tianshui				2		1.6	1.6
	Wuwei				2.7	1.8	1.6	1.2
	Zhangye						1	0.9
	Pingliang							1
	Jiuquan					1	1.6	1
	Qingyang							1.2
	Dingxi					1.6	1.4	1.2
	Longnan					2	0.8	1.5
	Linxia							1.8
	Gannan				2.2		1.5	1.2
Qinghai	Xi'ning	1.8	1.3		3.2	2.8	2.8	2.3
	Haidong Prefecture				2.3	2.5	1.6	1.3
	Haibei Prefecture				1	0.9	1.1	0.9
	Huangnan Prefecture				1.6	1.4	1.5	1.4
	Hainan Prefecture				0.8	1.4	1.3	0.9
	Guoluo Prefecture				1.2	1.3	1.2	1.3
	Yushu Prefecture				1.2	1.1	1.1	0.9
	Haixi Prefecture				1.3	1	1.1	0.9
Ningxia	Yinchuan	1.2		2.5		2.5	2.1	2
	Shizuishan						1.2	1.6
	Wuzhong				1.6		1.2	1
	Guyuan						2.1	1.4
	Zhongwei					1.4	1.7	1

Province	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Urumqi	5.7	1.4		1.5			
	Karamay							
	Korla							
	Turpan							
	Changli Prefecture					1.1		
	Ili Prefecture					1.8		
	Hami Prefecture							
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture					1.3		
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi							
Shaanxi	Xi'an	4.4	4.3	4.3	3.1	2.8	2.2	1.7
	Xianyang						2.1	1.6
	Tongchuan			2.5	2.16	2.2	2	1.7
	Yan'an							1.9
	Baoji			2.7	2.2		1.5	1.6
	Weinan						1.9	1.9
	Hanzhong					2.4	2.1	2
	Yulin							1.8
	Ankang							1.4
	Shangluo				1.2			1.2

	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Harbin				2			
	Qiqihar			1.5	1.5	1.5	1.1	
	Daqing			0.6		1.3	1	0.9
	Mudanjiang							
	Jixi							
	Hegang							
	Shuangyashan				0.81	0.75	0.7	1.4
	Yichun							
	Jiamusi							
	Qitaihe							
	Heihe					1		
	Suihua							
	Great Khingan							0.6
Jilin	Changchun	2.1	1.5	1.8	1.6	1.9	1.3	1.3
	Jilin			1.9	1.5	1.8	1.5	1.3
	Siping				1.5	1.8	1.5	1.2
	Liaoyuan				1.9	1.8	1.6	1.4
	Tonghua				2.3	2	1.8	1.6
	Baishan				1.9	1.6	1.6	1.8
	Songyuan				1.4	1.6	1.2	1
	Baicheng				1.1	1.1	1.2	0.9
	Yanbian				1.4	1.4	1.2	1

	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Shenyang			1	1.7	1.7	1.8	1.9
	Dalian					1.4	1.3	
	Anshan			2.7			2.2	
	Fushun			2.5	2.1			
	Benxi			2.9	2.1	2.3	2.2	
	Jinzhou			2.3		2	1.8	
	Dandong							
	Yingkou			1			1.7	
	Panjin							
	Huludao			1.5			1.7	
	Fuxin				1.2			
	Liaoyang							
	Tieling				1.4	1.2		
	Zhaoyang							

O_3

The average annual mean concentration of O_3 continued to increase. In 2019, the average annual mean concentration across 337 cities rose by 6.5% to 148μg/m^3, creeping closer to the national standard (160μg/m^3). This deterioration is a cause for concern.

The proportion of attainment cities rose slightly for the first time from 65.4% to 69.5%, registering an increase of 13 cities year-on-year.

All key regions showed some aspect of deterioration, with average annual mean concentrations exceeding the standard to varying degrees. Specifically, the BTH region and surrounding areas experienced the most severe deterioration, with the figure rising by 7.7% to 196μg/m^3. YRD saw an increase of 7.2% to 164μg/m^3, while in the Fen-wei Plains region the figure increased by 4.3% to 171μg/m^3.

Region	City	2013	2014	2015	2016	2017	2018	2019
Beijing-Tianjin-Hebei	Beijing	183.4	197.2	202.6	160	193	192	191
	Tianjin	151	157		157	192	201	200
	Shijiazhuang	191	159	148	164		211	
	Tangshan	188		182			197	190
	Qinhuangdao	164	114	107	149		164	181
	Handan	199	147	141			201	201
	Baoding	205	177.6	183	174	218	210	
	Chengde	171	167	178	177	162	174	163
	Cangzhou	188	172	169			200	185
	Hengshui	188	188	183			191	192
	Xingtai	190	157	140			203	209
	Zhangjiakou	170	133	159			181	162
	Langfang	159	165	171	182	207	192	196
Fen-wei Plains	Lvliang						163	163
	Jinzhong				142	190	179	192
	Linfen						217	204
	Yuncheng						189	181
	Sanmenxia				162			
	Luoyang				189	204	175	188
	Xi'an	131	176	212	162	185	180	166
	Xianyang						198	162
	Baoji			132	158		150	138
	Tongchuan			132	170	165	168	158
	Weinan						170	169

Region	City	2013	2014	2015	2016	2017	2018	2019
Yangtze River Delta	Shanghai	163	149	161	164	181	160	151
	Jiaxing		109					
	Shaoxing						156	
	Zhoushan							
	Wenzhou		134			145	141	136
	Jinhua						152	86
	Quzhou							140
	Taizhou							125
	Lishui	143	111				135	
	Nanjing							
	Suzhou				167	173	173	166
	Wuxi				186	184	179	180
	Changzhou					170	191	
	Yangzhou			175			109	108
	Zhenjiang				96	108	109	107
	Nantong							157
	Taizhou							
	Xuzhou					114	111	107
	Lianyungang		145		158	153		167
	Huai'an		106	105	101		104.9	165
	Yancheng						166	
	Suqian							180
	Hangzhou			167				
	Ningbo							
	Huzhou			106				

National Standard 160 μg/m^3 Min 71   Max 218

Figure 9 2013-2019 Annual Mean Concentration of O_3 in 337 Cities

North China

Province	City	2013	2014	2015	2016	2017	2018	2019
Inner Mongolia	Hohhot						150	146
	Chifeng			61			86	127
	Baotou						156	143
	Erdos			101	105		163	155
	Ulanqab						155	152
	Xilingol						141	122
	Wuhai				140		165	153
	Hulun Buir						112	108
	Tongliao						148	132
	Bayannur						152	143
	Hinggan League						118	113
	Alxa League						163	146
Henan	Zhengzhou				177		194	194
	Pingdingshan				165			
	Sanmenxia				162			
	Luoyang				189	204	175	188
	Anyang				154			
	Kaifeng				152			
	Jiaozuo			150	166			
	Xuchang				158			
	Nanyang				171			181
	Xinyang				148			
	Zhoukou				158			
	Hebi				154		199	198
	Xinxiang				175	209	202	178
	Puyang				176		117	
	Luohe				161		111	110
	Shangqiu				158			
	Zhumadian				159	108		

Province	City	2013	2014	2015	2016	2017	2018	2019
Shanxi	Taiyuan	147.9	125		140		191	186
	Datong						153	147
	Changzhi					188	189	187
	Linfen						217	204
	Yangquan						184	187
	Jincheng					218	214	201
	Shuozhou						152	192
	Jinzhong				142	190	179	192
	Yuncheng						189	181
	Xinzhou				138		166	171
	Lvliang						163	163

East China

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Ji'nan						202	203
	Qingdao				147	172	154	147
	Zibo					193	201	204
	Zaozhuang						115	
	Yantai			148	142	164	157	
	Weifang						179.1	180
	Ji'ning							
	Tai'an							
	Rizhao							
	Dongying						198	
	Liaocheng						212	114
	Binzhou							
	Heze							
	Weihai				137			160

Province	City	2013	2014	2015	2016	2017	2018	2019
Shandong	Linyi					184	185	187
	Dezhou							201
Fujian	Fuzhou				114		151	138
	Xiamen		128	95	103		127	136
	Quanzhou				109		150	
	Putian				129		156	138
	Sanming				106		124	
	Zhangzhou				114		155	
	Nanping				112		128	
	Longyan				125		129	
	Ningde				120	124	148	123
Anhui	Hefei					170	168	167
	Wuhu							196
	Maanshan				158		183	178
	Bengbu						167.7	
	Huai'nan					109	167	173
	Huaibei					184	183	185
	Tongling				81		89	92
	Anqing				130	136	163	106
	Huangshan				72		95	140
	Chuzhou					115	113	106
	Fuyang						104	110
	Suzhou						171.6	
	Lu'an				146	156	166	145
	Bozhou						170.3	
	Chizhou				130	138	158	
	Xuancheng					142	137	134

Province	City	2013	2014	2015	2016	2017	2018	2019
Jiangxi	Nanchang				138	146	144	
	Jiujiang						153	
	Jingdezhen						118.8	
	Pingxiang						140	
	Xinyu						124	144
	Yingtan				139	151	154	172
	Ganzhou				128		153	170
	Ji'an						136	
	Yichun						122.4	154
	Fuzhou						127.9	
	Shangrao						120.7	

South China

Province	City	2013	2014	2015	2016	2017	2018	2019
Hubei	Wuhan				160	151		183
	Yichang			122	126	137	143	162
	Jingzhou				156	140	157	158
	Huangshi				158	145	164	167
	Ezhou				156	139	165	162
	Xiaogan				160	158	158	171
	Huanggang				176	159	175	167
	Xianning				158	156	163	170
	Shiyan				122	130	145	140
	Xiangyang				152	152	155	162
	Jingmen				130	145	154	161
	Suizhou				152	148	156	160
	Enshi Prefecture				94	121	96	126

Province	City	2013	2014	2015	2016	2017	2018	2019
Hunan	Changsha				150	153	161	171
	Yueyang				158	142	155	164
	Changde				136	147	151	160
	Zhangjiajie				124	129	130	122
	Zhuzhou				142	142	148	162
	Xiangtan				142	142	153	168
	Hengyang				132	141	130	145
	Shaoyang				137	138	134	147
	Yiyang				150	143	140	151
	Chenzhou				126	140	137	140
	Yongzhou				124	129	138	143
	Huaihua				122	122	121	119
	Loudi				139	134	143	150
	Xiangxi Prefecture				120	110	104	115
Guangxi	Nanning	125	126		114		128	138
	Guilin			138	135	139	136	149
	Beihai							
	Liuzhou				123	127	127	145
	Wuzhou					119		
	Fangchenggang						126	
	Qinzhou							
	Guigang							
	Yulin							
	Baise							
	Hezhou							82
	Hechi				119	110		
	Laibin							
	Chongzuo							131

Province	City	2013	2014	2015	2016	2017	2018	2019
Guangdong	Shaoguan							145
	Shantou			141	132	140	152	
	Zhanjiang			137	138		150	
	Maoming							
	Meizhou			118	111	120	123	131
	Shanwei							143
	Heyuan			134	124			
	Yangjiang							
	Qingyuan				144	128	127	152
	Chaozhou			163.2				
	Jieyang			136	130	146		147
	Yunfu						134	138
	Guangzhou				155	162	174	178
	Shenzhen				135		137	156
	Zhuhai			142	144		162	167
	Foshan	169	167	140	160	174	172	185
	Jiangmen	164		146	162	193	184	198
	Dongguan		187	172	166	170	171	191
	Zhongshan	167	152		153	181	165	197
	Huizhou							
	Zhaoqing			147	150	143	145	163
Hainan	Haikou			103	107	127	116	144
	Sanya			113		110		188

Province	City	2013	2014	2015	2016	2017	2018	2019
Sichuan	Chengdu	157	148	183	168	171	167	160
	Mianyang			137	136	134	151.6	137
	Yibin			72			92	83
	Panzhihua			118	112	119	140	140
	Luzhou			121	154	147	149	147
	Zigong			119	116	150	171.6	
	Deyang			156	140	130	158	
	Nanchong						151	
	Suining				150		147	135.2
	Neijiang				157		152	140
	Leshan				143	129.4	128.6	121.4
	Meishan						155	
	Guang'an				147	142	144	
	Dazhou				114	123	143	
	Ziyang				157	150	157.6	
	Guangyuan				134	120.6	126	101
	Ya'an				119	132	124	
	Bazhong					115	106.6	160
	Aba Prefecture					125	118.8	106
	Ganzi Prefecture						126	
	Liangshan Prefecture					108	137	
Tibet	Lhasa			142	151			
	Changdu Prefecture							
	Shannan Prefecture							
	Shigatse Prefecture							
	Naqu Prefecture							
	Ali Prefecture							
	Linzhi Prefecture							

Province	City	2013	2014	2015	2016	2017	2018	2019
	Chongqing	162	146	127	141	163	166	157
Yunnan	Kunming			79	82		130	134
	Qujing						128	
	Yuxi							
	Zhaotong							
	Lijiang							
	Chuxiong Prefecture				76		81	
	Honghe Prefecture							
	Diqing Prefecture							
	Baoshan						91	88
	Puer							
	Lincang				72			
	Wenshan Prefecture					118		
	Xishuangbanna							82
	Dali Prefecture						92	
	Dehong Prefecture							
	Nujiang Prefecture							
Guizhou	Guiyang	109	103	120	130	121	118	125
	Zunyi			108	114	109	124	125
	Liupanshui				96	114	109	110
	Bijie				114	120	124	124
	Anshun				116	122	125	118
	Tongren				71		108	121
	Qianxi'nan Prefecture							116
	Qiandongnan Prefecture				104	83		106
	Qiannan Prefecture							115

	City	2013	2014	2015	2016	2017	2018	2019
Gansu	Lanzhou				144	161	168	151
	Jiayuguan				138	148	140	138
	Jinchang				128		146	134
	Baiyin				112		133	119
	Tianshui				134		134	127
	Wuwei				140	138	143	134
	Zhangye						143	138
	Pingliang							130
	Jiuquan					144	148.4	134
	Qingyang							132
	Dingxi					144	134	129
	Longnan					119	86	120
	Linxia Prefecture							126
	Gannan				146		136	121
Qinghai	Xi'ning				128	136	138	129
	Haidong Prefecture				130	142	153	138
	Haibei Prefecture				154	136	144	131
	Huangnan Prefecture				132	124	118	107
	Hainan Prefecture				149	130	120	144
	Guoluo Prefecture				132	140	142	139
	Yushu Prefecture				87	131	118	115
	Haixi Prefecture				110	128	126	153
Ningxia	Yinchuan			125		169	166	147
	Shizuishan						144	150
	Wuzhong				130		147	145
	Guyuan						166	128
	Zhongwei					157	157	140

	City	2013	2014	2015	2016	2017	2018	2019
Xinjiang	Urumqi	116						
	Karamay							
	Korla							
	Turpan							
	Changli Prefecture							
	Ili Prefecture							
	Hami Prefecture							
	Bortala Prefecture							
	Aksu Prefecture							
	Kizilsu Prefecture							
	Kashi Prefecture							
	Hetian Prefecture							
	Tacheng Prefecture							
	Altay Prefecture							
	Wujiaqu							
	Shihezi							
Shaanxi	Xi'an	131	176	212	162	185	180	166
	Xianyang						198	162
	Tongchuan			132	170	165	168	158
	Yan'an							143
	Baoji			132	158		150	138
	Weinan						170	169
	Hanzhong					145	137	121
	Yulin							159
	Ankang							122
	Shangluo				98			139

Province	City	2013	2014	2015	2016	2017	2018	2019
Heilongjiang	Harbin		198		106			
	Qiqihar			108	98	111	121	
	Daqing					126	127	118
	Mudanjiang							
	Jixi							
	Hegang							
	Shuangyashan				54		79	102
	Yichun							
	Jiamusi						161	
	Qitaihe							
	Heihe					100		
	Suihua							
	Great Khingan							98
Jilin	Changchun	127	132	151	141	142	133	134
	Jilin			154	151	147	149	135
	Siping				130	142	159	150
	Liaoyuan				157	141	154	152
	Tonghua				129	120	140	104
	Baishan				136	126	134	128
	Songyuan				154	144	136	121
	Baicheng				119	123	135	120
	Yanbian				115	126	130	115

Province	City	2013	2014	2015	2016	2017	2018	2019
Liaoning	Shenyang			155	162	166	163	155
	Dalian				155	163	157	
	Anshan							
	Fushun			149	162			
	Benxi			136	137	116	137	
	Jinzhou			165	180	172	151	
	Dandong							
	Yingkou			111			186	
	Panjin							
	Huludao						137.2	
	Fuxin							
	Liaoyang							
	Tieling				160	159		
	Zhaoyang							

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Inner Mongolia				35	32	31	27
	Shanxi		64	56	60	59	55	48
	Tianjin	96	83	70	69	62	52	51
	Hebei	108	95	77	70	65	56	50.2
	Henan				73	62	61	59
	Beijing	89.5	85.9	80.6	73	58	51	42
East China	Fujian				26	27	22	21
	Zhejiang	61	53	43	37	35	33	31
	Shanghai	62	52	53	45	39	36	35
	Jiangxi			45	45	46	38	35
	Jiangsu	73	66	58	51	49	48	43
	Anhui			55	53	56	49	46
	Shandong	98	82	76	66	57	49	50
South China	Hainan			20	18	18	17	16
	Guangdong		41	34	32	33	31	27
	Guangxi			41	37	38	35	34
	Hunan				48	46	41	41
	Hubei			65	54	49	44	42

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				34	36	28	28
	Jilin			55	43	40	32	32
	Liaoning		58	55	46	44	38	40
Northwest China	Qinghai				35	30	29	22
	Gansu				39	37	34	26
	Ningxia		49	47	46	42	35	29
	Xinjiang			53	62	55	41	47
	Shaanxi		67	59	62	57	51	48
Southwest China	Yunnan			28	26	24	25	22
	Guizhou			32	32	29	28	24
	Sichuan			47	47	42	38.6	34.4
	Chongqing	70	65	57	54	45	40	38
	Tibet							

National Standard 35 μg/m^3 Min 16 Max 108

Fig. 10 Annual mean concentrations of $PM_{2.5}$ in provinces, autonomous regions, and municipalities in 2013-2019

PM10

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Inner Mongolia				77	74	80	61
	Beijing	108.1	115.8	101.5	92	84	78	68
	Tianjin	150	133	116	103	94	82	76
	Shanxi		114	98	109	109	107	93
	Hebei	190	165	136	123	117	104	93
	Henan				128	106	103	96
East China	Fujian				46	47	42	39
	Shanghai	82	71	69	59	55	51	45
	Zhejiang	91	78	68	60	57	56	53
	Jiangxi	77	75.8	68	72	73	64	59
	Anhui		95	80	77	88	76	72
	Jiangsu	115	106	96	86	81	76	70
	Shandong	170	142	131	120	106	97	94
South China	Hainan		38	35	31	29	30	28
	Guangdong	60	60	51	48	51	49	46
	Guangxi	62	69	61	56	58	57	56
	Hunan				76	74	66	61
	Hubei		103	99	85	77	72	70

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				56	61	52	49
	Jilin	78	80	88	71	67	57	56
	Liaoning	86	99	93	79	77	69	70
Northwest China	Qinghai		106		79	67	59	42
	Gansu			95	90	93	77	58
	Ningxia		105	106	103	106	82	66
	Shaanxi		128	109	112	103	104	81
	Xinjiang	137	144	129	141	121	99	126
Southwest China	Yunnan		48	45	43	44	46	38
	Guizhou			55	53	50	49	38
	Sichuan	85	80	76	75	67.7	62.6	52.9
	Chongqing	106	98	87	77	72	64	60
	Tibet							

National Standard 70 μg/m³ — Min 28 — Max 190

Fig. 11 Annual mean concentrations of PM_{10} in provinces, autonomous regions, and municipalities in 2013-2019

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Beijing	26.5	21.8	13.5	10	8	6	4
	Tianjin	59	49	29	21	16	12	11
	Henan				33		16	11
	Hebei	74	55	41	34	27	20	15
	Shanxi		65	61	60	56	33	24
	Inner Mongolia				23	21	17	15
East China	Zhejiang	26	21	14	11	9	9	7
	Fujian				12	10	9	8
	Shanghai	24	18	17	15	12	10	7
	Jiangsu	35	29	25	21	16	12	9
	Anhui		26	22	21	17	13	10
	Jiangxi	34	31	27	24	23	17	13
	Shandong	71	59	45	35	24	16	14
South China	Hainan		5	5	5	5	5	5
	Guangdong	19	18	13	12	11	10	9
	Hubei			18	14	13	11	9
	Guangxi	25	21	18	15	14	13	12
	Hunan				20	14	12	9

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				18	15	12	11
	Jilin	32	31	27	23	20	14	11
	Liaoning	42	46	40	34	28	23	19
Northwest China	Xinjiang	18	16	16	14	13	11	9
	Qinghai		29		20	20	17	13
	Shaanxi		32	28	23	20	16	12
	Gansu			31	26	21	18	14
	Ningxia		47	42		33	22	17
Southwest China	Chongqing	32	24	16	13	12	9	7
	Yunnan		25	15	14	12	11	9
	Guizhou			19	15	13	12	10
	Sichuan	34	25	18	17	13.9	12.2	9.4
	Tibet							

National Standard 60 μg/m³ — Min 4 — Max 74

Fig. 12 Annual mean concentrations of SO_2 in provinces, autonomous regions, and municipalities in 2013-2019

NO_2

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Henan				42		39	
	Beijing	56	56.7	50	48	46	42	37
	Tianjin	54	54	42	48	50	47	42
	Hebei	51	48	46	49	47	43	39
	Shanxi		35	34	37	42	40	39
	Inner Mongolia				25	26	23	23
East China	Fujian				19	26	17	15
	Jiangxi	30	27	25	25	26	25	24
	Zhejiang	42	39	28	26	27	32	31
	Jiangsu	41	39	37	37	39	38	34
	Shandong	48	46	41	38	37	36	35
	Anhui		30	31	38	38	35	31
	Shanghai	48	45	46	43	44	42	42
South China	Hainan		10	9	9	9	8	8
	Guangxi	24	24	21	21	23	22	22
	Hubei			28	26	28	28	26
	Hunan				26	26	26	25
	Guangdong	30	30	27	27	29	28	26

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				23	23	21	19
	Jilin	33	30	31	28	28	24	23
	Liaoning	32	36	33	31	31	30	28
Northwest China	Qinghai		24		21	22	21	20
	Xinjiang	35	36	28	29	31	27	27
	Gansu			31	30	29	27	25
	Shaanxi		39	36	38	42	40	36
	Ningxia		29	27		32	29	30
Southwest China	Yunnan		15	17	17	19	18	16
	Guizhou			21	22	21	20	18
	Sichuan	36	32	30	30	31.5	30.1	27.8
	Chongqing	38	39	45	46	46	44	40
	Tibet							

National Standard 40 μg/m³ Min 8 Max 56.7

Fig. 13 Annual mean concentrations of NO_2 of provinces, autonomous regions, and municipalities in 2013-2019

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Tianjin	3.7	2.9	3.1	2.7	2.8	1.9	1.8
	Beijing	3.4	3.2	3.6	3.2	2.1	1.7	1.4
	Hebei	4.3	3.6	3.7	3.3	2.9	2.3	
	Shanxi			3.5		3	2.5	2.2
	Henan						2.1	
	Inner Mongolia					1.6		
East China	Shanghai	0.85	0.77	0.86	0.79	0.76	0.67	0.66
	Fujian				1.1	1.1	1	1
	Zhejiang		1.4	1.4	1.2	1.1	1.2	1
	Anhui			1.8	1.6	1.4	1.4	1.2
	Jiangxi			1.5	1.6	1.4	1.4	1.4
	Jiangsu	2.1	1.7	1.7	1.7	1.5	1.4	1.2
	Shandong							1.5
South China	Hainan			1.1	1.1	1	0.9	0.8
	Guangdong		1.7	1.4	1.3	1.2	1.1	1.2
	Guangxi			1.8	1.4	1.4	1.4	1.4
	Hunan				1.6	1.6	1.5	1.4
	Hubei			1.9	1.8	1.7	1.6	1.4

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				1.5	1.4	1.2	1.1
	Jilin			1.9	1.6	1.7	1.4	1.3
	Liaoning				2	1.8	1.7	1.7
Northwest China	Qinghai				1.76	1.6	1.5	1.2
	Gansu				1.9	1.6	1.5	1.3
	Shaanxi			3	2.7	2.3	2	1.8
	Ningxia		2	1.8		1.8	1.5	1.4
	Xinjiang					2.4	1.1	0.9
Southwest China	Guizhou			1.3	1.2	1.2	1.1	1
	Chongqing	1.5	1.8	1.5	1.4	1.4	1.3	1.2
	Sichuan			1.5	1.5	1.4	1.3	1.1
	Tibet							
	Yunnan							1

National Standard 4 mg/m^3 — Min 0.66 — Max 4.3

Fig. 14 Annual mean concentrations of CO in provinces, autonomous regions, and municipalities in 2013-2019

O_3

Region	Province	2013	2014	2015	2016	2017	2018	2019
North China	Tianjin	151	157	142	157	193	201	200
	Beijing	183.4	197.2	202.6	160	192	192	191
	Hebei	183	159	160	171	193	193	
	Shanxi			134		186	182	180
	Inner Mongolia					143	146	
	Henan							
East China	Fujian				109	137	125	117
	Zhejiang		153	135	132	135	159	154
	Jiangxi			119	132	141	145	151
	Anhui			106	140	160	166	165
	Shanghai	163	149	161	164	181	160	151
	Jiangsu	139	154	167	165	177	177	173
	Shandong							186
South China	Hainan			118	105	107	107	118
	Guangxi			122	120	128	128	140
	Hunan				136	137	140	148
	Guangdong		148	138	138	153	154	158
	Hubei			146	139	139	154	158

Region	Province	2013	2014	2015	2016	2017	2018	2019
Northeast China	Heilongjiang				98	106	120	103
	Jilin			136	137	135	141	129
	Liaoning				155	157	157	151
Northwest China	Qinghai				128	133	132	135
	Gansu			129	133	140	139	131
	Shaanxi			143	158	166	164	151
	Ningxia		139	135		154	151	142
	Xinjiang					124	89	87
Southwest China	Guizhou			106	108	108	116	118
	Sichuan			131	132	140.5	144.4	134.1
	Chongqing	162	146	127	141	163	166	157
	Tibet							
	Yunnan							127

National Standard 160 μg/m^3 — Min 87 — Max 202.6

Fig. 15 Annual mean concentrations of O_3 in provinces, autonomous regions, and municipalities in 2013-2019

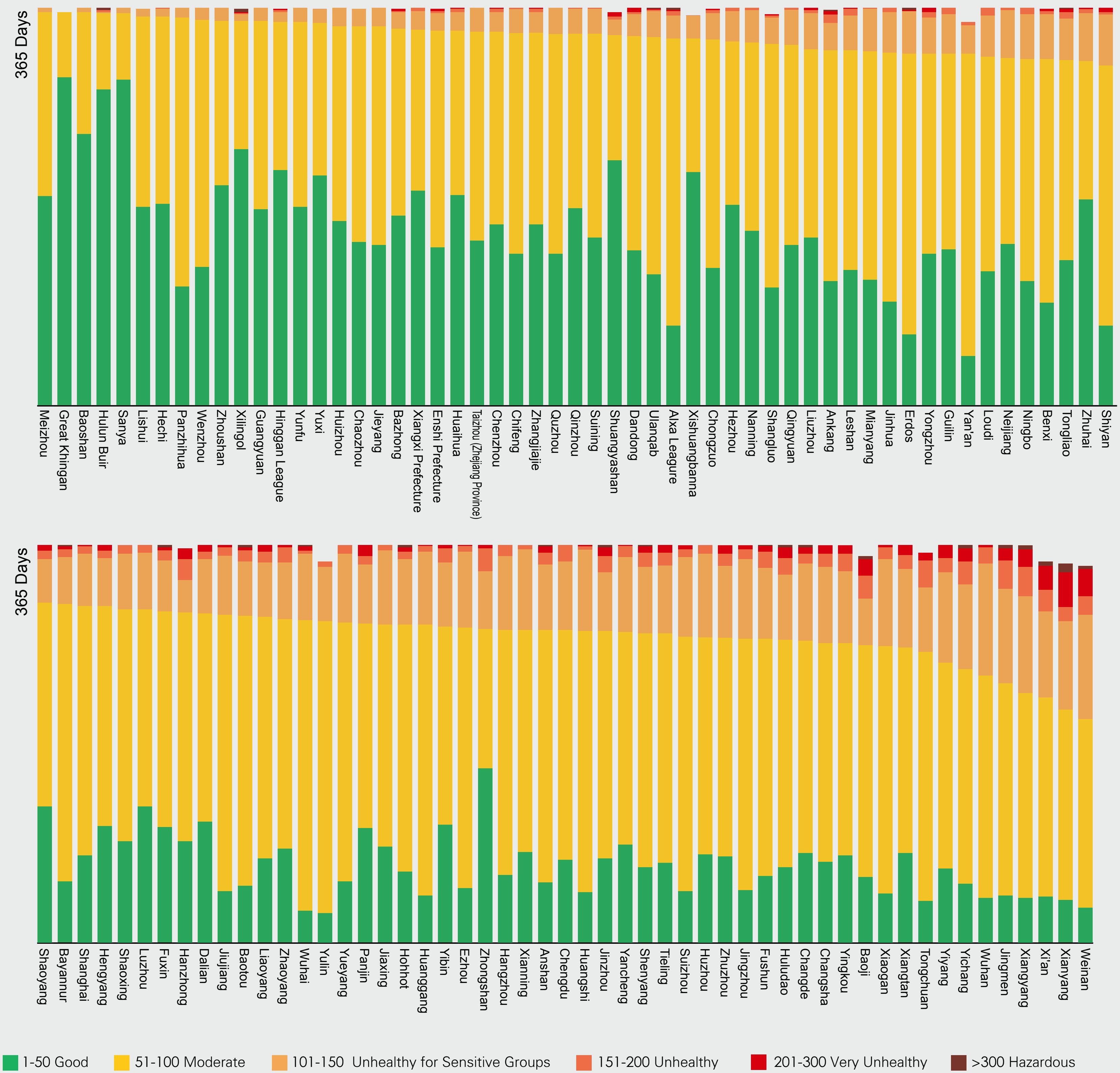

Fig. 16 Distribution of AQI for some cities in 2019

In general, air quality in cities across China in 2019 had the following characteristics:

The number of attainment cities continued to increase, but the average concentration of $PM_{2.5}$ showed no improvement

157 cities attained the National Ambient Air Quality Standard in 2019. This marks an increase of 36 cities compared to the previous year, and accounts for 46.6% of the 337 cities. Likewise, the number of attainment cities for each pollutant also increased. SO_2 and CO were recorded at standard levels in all 337 cities, and the number of $PM_{2.5}$ attainment cities exceeded 50% of the total number of cities for the first time as shown in Figure 17.

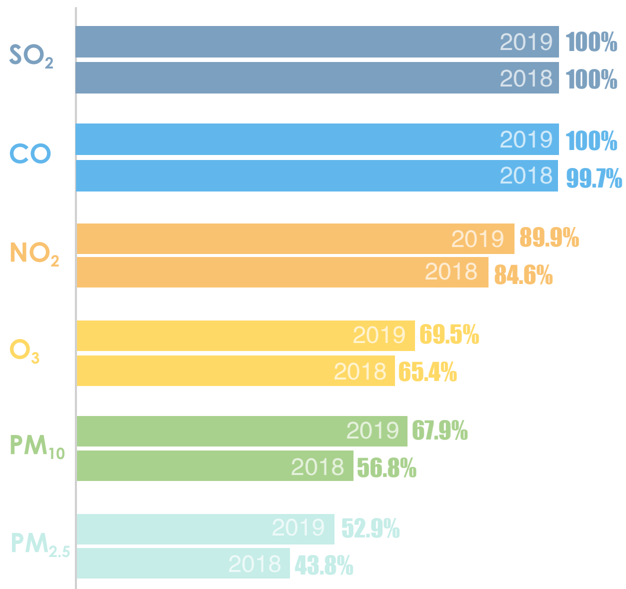

Fig. 17 Percentage of attainment cities for six pollutants in 2018 and 2019

When considering the average annual mean concentration of pollutants, the pace of improvement slowed visibly compared to the past several years. In relation to the period from 2014-2018, the number of pollutants with decreasing average annual mean concentrations fell from five to two. Only the average annual mean concentrations of PM_{10} and SO_2 were down by 1 μg/m^3 and 2 μg/m^3 respectively, while those of the other four pollutants remained the same or increased compared with 2018 levels as shown in Figure 18.

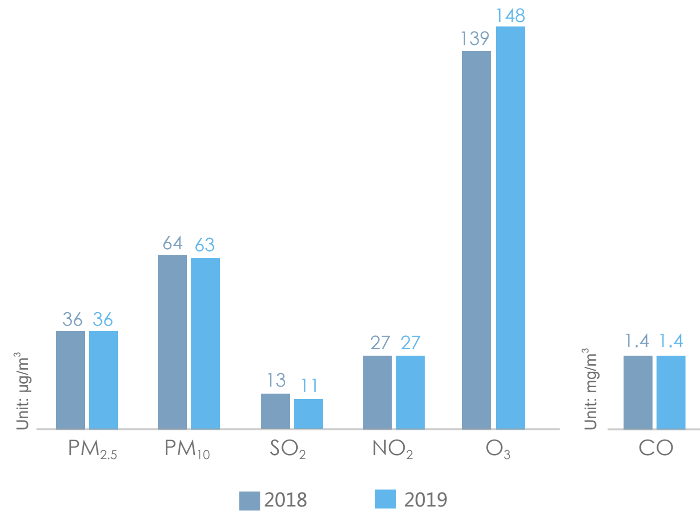

Fig. 18 Average annual mean concentrations of six pollutants of 337 cities in 2018 and 2019

The average annual mean concentration of $PM_{2.5}$ remained unchanged, but concentrations increased in cities in Liaoning, Shaanxi, and Shandong Provinces across the board

In terms of individual pollutants, $PM_{2.5}$ remained the primary pollutant with the highest proportion in the number of non-attainment days. It was also the only pollutant which recorded a national overall concentration exceeding the standard. Notably, the national average concentration of $PM_{2.5}$ remained unchanged for the first time following five consecutive dips from 2013 onwards. Meanwhile, the Fen-wei Plains became the first key region where the concentration of $PM_{2.5}$ rebounded.

Cities that demonstrated poor performance are located in the provinces of Liaoning, Shaanxi and Shandong. Compared with 2018 levels, the annual mean concentration of $PM_{2.5}$ across all 14 cities of Liaoning Province increased, rising anywhere from 2.8% to 20.7%. Besides Dalian and Dandong, all other cities exceeded the standard. Among the 10 cities in Shaanxi Province, only Yan'an recorded a figure which remained level with that of 2018. Meanwhile, the annual mean concentrations of $PM_{2.5}$ in the other 9 cities all rebounded, registering rates of increase ranging from 1.8% to 16.7%. 70% of these cities exceeded the standard. Of the 16 cities in Shandong Province, only Dezhou saw a decrease of 1 μg/m^3 while Liaocheng remained at 2018 levels. The remaining 14 cities all experienced a deteriorating situation, with the rate of increase ranging from 1.8% to 29.6%. Apart from Yantai and Weihai, all other cities in Shandong Province exceeded the standard. In Hubei Province, 6 of the 13 cities (autonomous prefectures) saw a slight rebound, with the rate of increase ranging from 2.4% to 4.0%.

O_3 pollution continued to deteriorate, especially in key cities and regions

Since the release of O_3 data in 2013, the average annual national mean concentration rose continually. The worsening situation across key regions has become even more severe, as shown in Figure 19. In 2019, the average concentration of O_3 across 337 cities was 148 μg/m^3, up by 6.5% year-on-year and coming close to the standard limit value of 160 μg/m^3. The average annual mean concentration and rate of increase across 168 key cities, the BTH region and surrounding areas, the YRD and PRD were all higher than the national average, with concentration levels exceeding the standard. The rate of increase in the Fen-wei Plains region was the sole to remain slightly below the national average, although its average annual mean concentration reached as high as 171 μg/m^3. In the BTH region and surrounding areas as well as the YRD, the number of non-attainment days with O_3 as the primary pollutant approached half of the total number of non-attainment days.

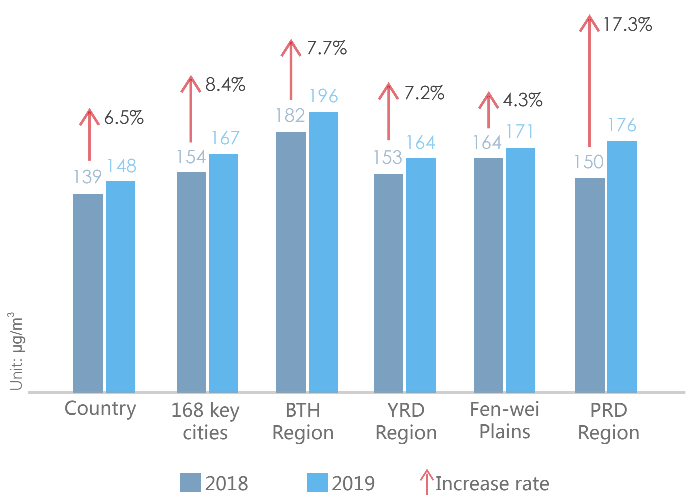

Fig. 19 Average annual mean concentrations of O_3 of key regions in 2018 and 2019

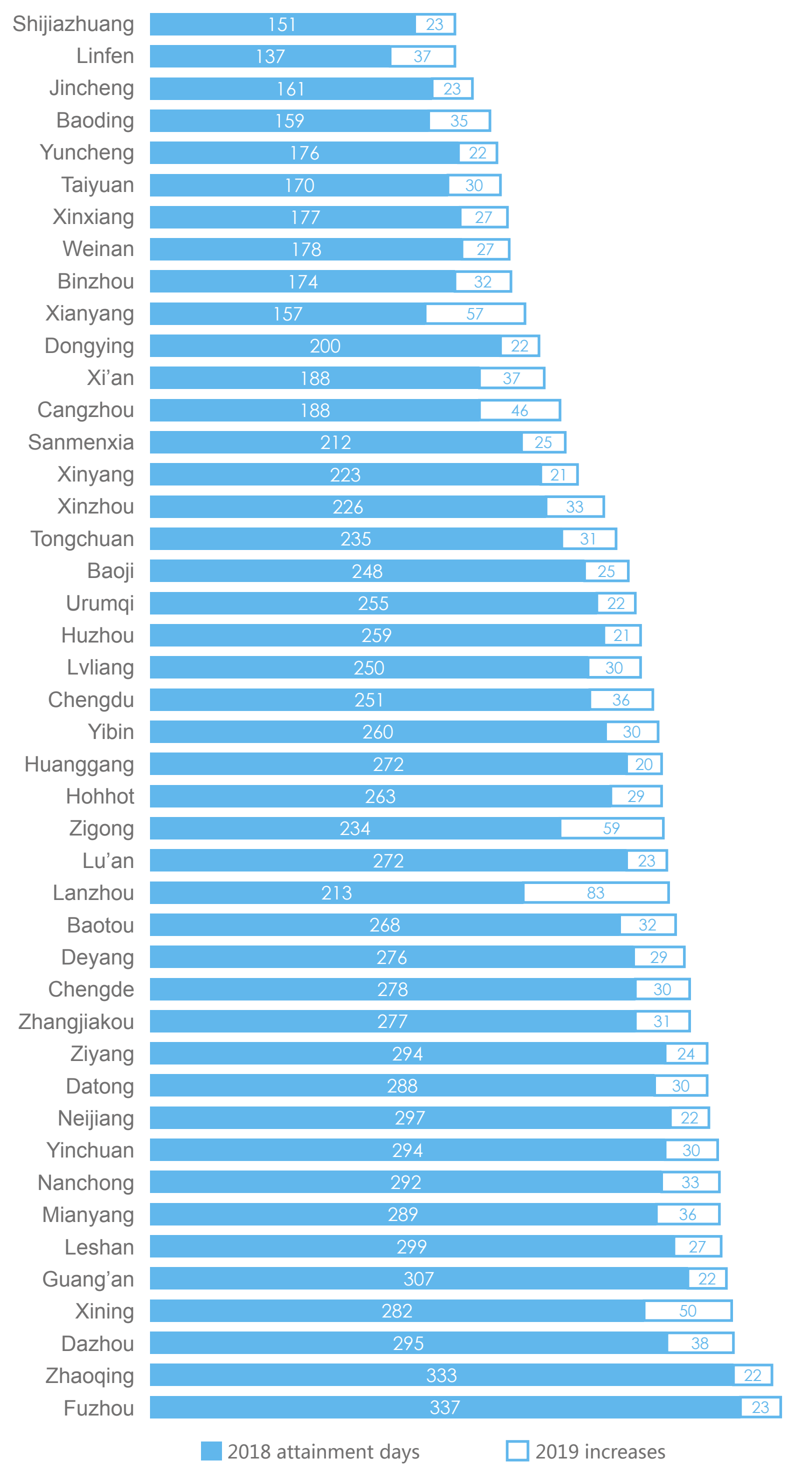

Fig. 20 Cities with large increases in attainment days in 2019

Among the 168 key cities, over 60 saw a fall in the number of attainment days

In 2019, the average proportion of attainment days across 337 cities was 82.0%, marking an increase of 2.7% compared to the previous year. Among the 168 key cities, a total of 44 cities saw the number of attainment days increase by 20 days or more, while Lanzhou, a model city in air pollution prevention and control, obtained the best result with an increase of 83 days. The varying degrees of increase in the number of attainment days across these cities can be attributed to lower concentrations of $PM_{2.5}$.

However, 63 cities located mainly in the provinces of Henan, Shandong, Guangdong, and Anhui saw decreasing numbers of attainment days compared to 2018. Most of the cities with a reduction of over 20 attainment days are located key regions. Yiyang, which had experienced a significant improvement over the past few years, recorded 71 fewer attainment days compared to 2018.

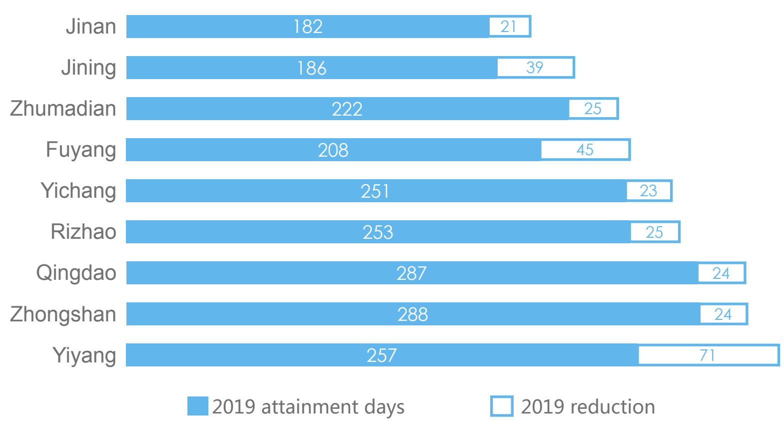

Fig.21 Cities with a large reduction in attainment days in 2019

Chpater II.

Policy Implementation and Progress

In the implementation of the Three-year Action Plan, 2019 represented an intermediate year to build on past successes and further advance progress. It also marked a critical year for achieving the targets set in the Plan. While air quality improved across cities in China during 2013-2018, air pollution prevention and control remained a challenge with over half of the 337 cities exceeding national standards. Meanwhile, the implementation of major emissions reduction projects has narrowed the scope for further reductions and rendered the control of future emissions a more difficult task. As such, achieving success in clean air has also become a greater challenge.

In 2019, air pollution prevention and control measures became more extensive, thorough, and precise. Deep emissions reductions continued to be realized through the optimization of industry, energy, transport, and land use structures. Additionally, scientific breakthroughs made way for more precise measures. Efforts were focused on highly polluted regions and major emissions sources, while city-specific and industry-specific strategies were adopted for more refined management.

Major Milestones for Air Pollution Prevention and Control in 2019

1 Jan.

◆ On January 1, the Plan for the Implementation of Emissions Control Areas for Air Pollution from Vessels was formally implemented, expanding, and upgrading China's emissions control areas.

◆ On January 4, 11 ministries, including the MEE, jointly issued the Action Plan for Prevention and Control of Pollution from Diesel Trucks.

2 Feb.

3 Mar.

◆ On March 16, the exposure draft of the Provisions for the Use of Automatic Monitoring Data from Municipal Waste Incineration Power Plants for Environmental Management (For Trial Implementation) was issued. By stipulating that automatic monitoring data can be used to administer environmental administrative penalties, this document aimed to further regulate the use of automatic monitoring data in the industry and pressure enterprises to meet emissions standards.

4 Apr.

◆ On April 22, Shandong Province was criticized in a circulated notice by the MEE. It was held accountable for its failure to comply with China's requirement to prohibit industries with serious excess capacities, such as iron and steel and electrolytic aluminum, from increasing capacity. There was also a massive increase in the number of coal-fired power generating units in the province, resulting in a significant rise in air pollution emissions.

◆ On April 28, five ministries, including the MEE, jointly issued the Opinions on Promoting the Implementation of Ultra-low Emissions in the Iron and Steel Industry, making the iron and steel industry the first non-power sector to promote ultra-low emissions.

5 May

◆ On May 1, implementation began for the Limits and Measurement Methods for Emissions from Gasoline Vehicles Under Two-speed Idle Conditions and Short Driving Mode and the Limits and Measurement Methods for Emissions from Diesel Vehicles under Free Acceleration and Lugdown Cycle. Collectively, these measures introduced more stringent limits on pollutant emissions from vehicles, increased on-board diagnostics (OBD), and added NOx emissions limits for diesel vehicles.

◆ On May 16, Anhui Jianghuai Automobile Group Corp., Ltd. was ordered to halt production following the unlawful act of selling inferior pollution control devices presented as qualified products for emissions examination. The corporation received a fine from the Beijing Municipal Ecology and Environment Bureau. On May 29, the following three new standards were introduced: Standard for Fugitive Emissions of Volatile Organic Compounds (GB 37822-2019); the Emission Standard of Air Pollutants for the Pharmaceutical Industry (GB 37823-2019); and the Emission Standard of Air Pollutants for the Paint, Ink and Adhesive Industry (GB 37824-2019).

6 Jun.

◆ On June 6, the MEE issued the China Air Quality Improvement Report (2013-2018). In celebration of World Environment Day, the report showcased China's achievements in air quality control and its strenuous efforts to tackle climate change.

◆ On June 26, the Plan for the Integrated Control of Volatile Organic Compounds in Key Industries was issued, marking an upgrade in the pollution control system for key industries emitting VOCs and shifting the focus towards the coordinated control of greenhouse gas emissions.

Fig. 22 Major milestones for air pollution prevention and control in 2019

7 Jul.

◆ On July 1, heavy-duty natural gas vehicles were required to meet China's Stage VI-a emission standards.

◆ On July 3, the National Energy Administration (NEA) issued a notice about problems in the process of "coal-to-gas" and "coal-to-electricity", stipulating that a range of clean heating methods should be developed in adherence with local conditions.

◆ On July 9, the Plan for the Integrated Control of Air Pollution from Industrial Furnaces and Kilns was issued with the aims of: improving the integrated control and management system for air pollution from industrial furnaces and kilns by 2020; comprehensively realizing attainment for emissions across key regions; and controlling greenhouse gas emissions in a coordinated manner.

◆ On July 16, the exposure draft of the Administrative Rules on the Recall of Vehicles for Environmental Protection was issued.

◆ On July 26, the MEE issued the Guidelines on Strengthening Emergency Responses to Heavy Pollution Days and Reinforcing Emission Reduction Measures in a bid to reduce heavy pollution days in the key provinces of BTH region and surrounding areas and the Fen-wei Plains.

◆ On July 31, Mercedes-Benz (China) Ltd. submitted recall plan to the State Administration for Market Regulation (SAMR) and the MEE after a portion of its vehicles failed to meet vehicle emission standards and OBD requirements. This marked the first case of vehicle recall for environmental protection in China.

8 Aug.

9 Sep.

◆ On September 19, the State Council issued the Program of Building National Strength in Transportation. With green development at the core of its approach, the Program specified that pollution prevention and control, energy conservation and emissions reductions should be strengthened for the transportation sector and while its energy structure should also be optimized.

10 Oct.

◆ On October 11, the 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control for the BTH Region and Surrounding Areas in Autumn and Winter was issued.

◆ On October 25, the Ministry of Transport issued the 2020 Plan for the Implementation of Global Marine Fuel Sulphur Limits.

11 Nov.

◆ On November 6, the 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control for Fen-wei Plains in Autumn and Winter and the 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control for the YRD Region in Autumn and Winter were issued.

◆ On November 6, the National Development and Reform Commission (NDRC) issued the Catalogue of Guidance for Industrial Restructuring (2019 Version), aiming to accelerate industrial restructuring and tighten restrictions and standards for the elimination of outdated capacity.

◆ On November 27, China's Policies and Actions for Addressing Climate Change (2019) was released, stating that the country had fulfilled its international commitment to reduce carbon emissions by 2020 ahead of schedule. Furthermore, it stressed that China would continue to step up its efforts to address climate change and prevent and control pollution during the period of the 14th Five-year Plan.

12 Dec.

◆ On December 18, the MEE issued the Technical Guidelines for Ultra-low Emission Assessment and Monitoring in Iron and Steel Companies, guiding companies in the industry which have completed an ultra-low emission retrofit to conduct monitoring for assessment.

◆ On December 20, the Classification Administration List of Pollutant Discharge Permitting for Fixed Pollution Sources (2019 Version) was released, emphasizing the management of fugitive emissions for the VOCs industry and industrial furnaces and kilns.

Scientific Capacity Building

The capacity for scientific decision-making in China's air pollution prevention and control has improved steadily. The number of stations in the monitoring network increased, enabling monitoring for different contributing components. Meanwhile, ambient air quality monitoring has also been deployed for hotspots such as roads, ports and industrial parks. More cities in key regions compiled and updated their emissions inventories and conducted $PM_{2.5}$ source apportionments. Furthermore, the conclusion of the three-year Premier Fund Project on the causes and control of heavy air pollution marked another key milestone. The information gathered through the Project supported scientific decision-making for air pollution prevention and control in the "2+26 cities". More scientific evidence meant greater consensus, helping to promote an in-depth understanding of the complex characteristics of air pollution and facilitate precise policy implementation.

New upgrades to monitoring networks were made, with additional stations established and functions enhanced

China's state-controlled monitoring network, which consists of 1,436 monitoring stations, 16 national air quality background stations and 96 regional stations in 337 cities, has been steadily improving and expanding. In accordance with requirements under the Three-year Action Plan and the 2019 Plan for Monitoring Components of Nationwide Ambient Particulate Matter, the number of cities monitoring components of ambient particulate matter increased to 93. Requirements for key regions are shown in Figure 23. In addition, 11 new monitoring stations were established in Guangzhou, Fuzhou, Xiamen, Chongqing, Chengdu, Wuhan, Shenyang, Harbin, Yinchuan, and Changsha.

By the end of 2019, 83 cities in key regions were covered by a component monitoring network consisting of 94 manual and 74 automatic monitoring sites. Under the network, requirements on operation, quality assurance, quality control, and data submission were unified while the networking of automatic monitoring stations was also realized. It is intended that the system, currently in its preliminary phase, will develop to provide a solid scientific and technological base for the delivery of comprehensive analytical support for regional and local air pollution prevention and control.

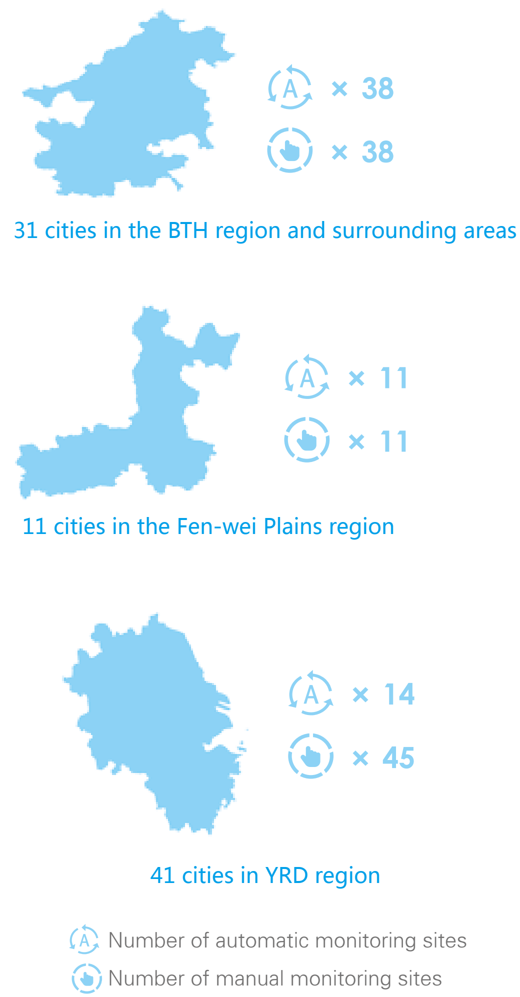

Fig. 23 Number of newly established monitoring stations for $PM_{2.5}$ components in key regions in 2019

In addition, the 2019 Plan for Monitoring Volatile Organic Compounds of Ambient Air in Cities at Prefecture Level and Above was also issued, stipulating that monitoring for non-methane hydrocarbon (NMHC) and VOCs components in ambient air should begin across the 337 cities. The

Plan also proposed differentiated monitoring targets based whether O_3 concentrations exceeded the standard. The monitoring target was NMHC for the 205 O_3-attainment cities in 2018, while the 54 non-attainment cities were additionally required to monitor 57 categories of PAMS and 13 categories of aldehydes and ketones on top of NMHC. Monitoring VOCs will facilitate a better understanding across regions and cities of O_3 generation mechanisms and characteristics of precursors.

In 2019, cities in key regions took the initiative to establish ambient air quality monitoring stations in state-level new areas, high-tech zones, key industrial parks, and airports. From January 2020, provinces (cities) were required to rank places such as high-tech zones and key industrial parks in terms of ambient air quality. For nearly 30 cities in the YRD region, the 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control in Autumn and Winter called for the construction of road air quality monitoring stations in major logistics channels and promoted the establishment of air quality monitoring stations at airports and ports. The 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control for Fen-wei Plains in Autumn and Winter required Jinzhong, Linfen, Jincheng, Lvliang, Luoyang, Xi'an, and the Yangling Demonstration Zone to accelerate the establishment of monitoring stations on roads and at airports. The establishment of monitoring stations on busy road networks and in seaports, airports, industrial parks and other areas with high-intensity emissions will enable the comprehensive evaluation of air quality in cities and increase the understanding of how emission hotspots impact air quality.

According to the Outline Plan for Ecological Environment Monitoring (2020-2035) issued in 2019, alongside the expansion of the local monitoring network, the number of state-controlled air quality monitoring stations will be increased to nearly 1,800 while the optimization and adjustment of the national ambient air monitoring network will be completed in the 14th Five-Year Plan period. Progress made on the local ambient air monitoring network over the past year is shown in Figure 24.

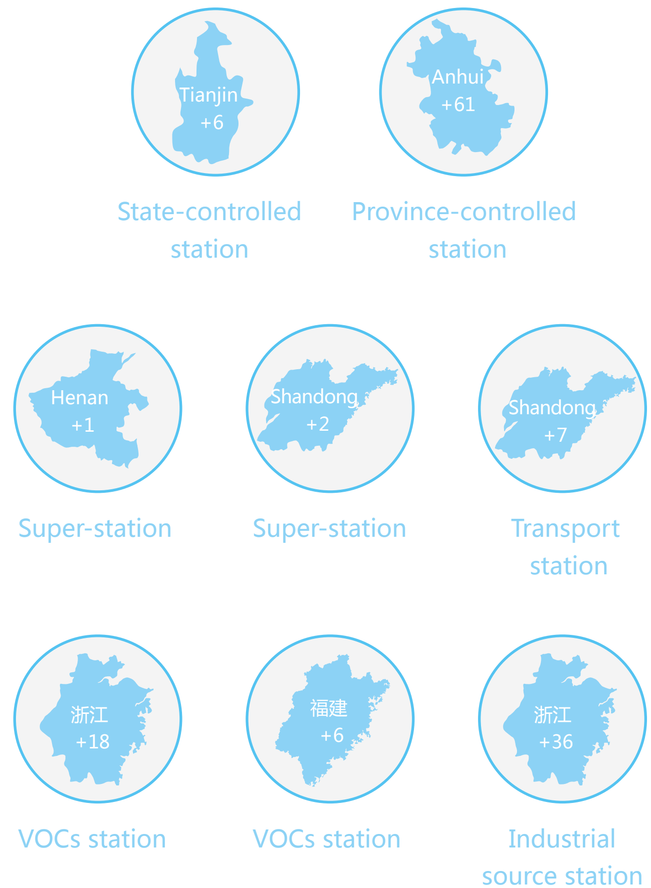

Fig. 24 Number of newly established monitoring stations in some provinces and cities in 2019

Scientific research has been concluded in the "2+26" cities and multiple cities have updated their emissions inventories

The three-year Premier Fund Project examining the causes and control of heavy air pollution was concluded. Over 2,000 participating scientists and researchers employed the approach of "concurrent research, output and applications" while conducting on-site work to formulate city-specific strategies. The research provided scientific support for local governments' environmental management and decision-making processes. According to research outcomes, industries with high levels of pollution and energy consumption in the "2+26" cities from the BTH region and surrounding areas are largely concentrated in Tangshan and the Shanxi-Hebei-Shandong-Henan Border Region. This indicates that industrial restructuring should be accorded top priority. Meanwhile, diesel vehicles and agricultural ammonia emissions were identified as the next focal areas for control. To this end, the Project team offered the best available emissions reduction technologies, developed integrated control plans for the abovementioned key industries, and assessed emissions reduction potentials.

The National Joint Research Center for Tackling Key Problems in Air Pollution Control built China's largest integrated three-dimensional space-air-ground observation network in the BTH region and surrounding areas. This enabled heavy pollution days forecasting to reach an accuracy rate of nearly 100%, giving a timely boost to measures addressing severe air pollution in the region.

The Project compiled the emissions inventories of the "2+26" cities using unified methods and standards for the first time. It also refined control measures to the district and county levels and analyzed sources of major pollutant emissions. Results indicated that about 50% of NOx emissions in this region originated from mobile sources, while the remainder came from industrial sources such as electric power, iron and steel, boilers, and coking. Meanwhile, primary $PM_{2.5}$ emissions largely originated from combustion for civilian use, steel and iron manufacturing, biomass burning and other industrial sources. VOCs originated mainly from industrial sources like the petrochemical and chemical sector, road mobile sources, coking and solvents, while 85% of NH3 emissions came from agricultural sources.

In 2019, Shanghai and Handan completed updates for their emissions inventories, and Zhejiang Province began the updating its own. Meanwhile, Xinyang, Xinzheng, Xingyang, and 17 cities in Shandong Province completed the compilation of their emissions inventories. The Xixian New Area of Shaanxi Province was the first to initiate an emissions inventory compilation in the Fen-wei Plains region and established a system for dynamic updating, control, and decision-making. Anqing, Ezhou, and Huanggang in Anhui Province also progressed in the compilation of their inventories, while Yan'an in Shaanxi Province began the compilation process.

Zhejiang Province issued the Work Plan of Ambient $PM_{2.5}$ Source Apportionment in Zhejiang Province and launched the second round of $PM_{2.5}$ source apportionment in 2019. In addition, in 2019 the six cities of Jinan, Handan, Zhengzhou, Panzhihua, Shantou and Zhaoqing carried out source apportionment projects.

Control of Major Pollution Sources

Stationary sources

Following years of efforts, China has established the world's largest clean coal power generation system and shifted its focus from controlling stationary source pollution from coal power to non-power sectors and the renovation of scattered, unregulated and high-polluting enterprises. In 2019, the iron and steel industry also began ultra-low emission retrofitting. Hebei, China's largest steelmaking province, was the first to revise its emission standards for the iron and steel industry in January. In May, five ministries, including the MEE, jointly issued the Opinions on Promoting the Implementation of Ultra-low Emissions in the Iron and Steel Industry. Under the integrated control of industrial furnaces and kilns and scattered, unregulated and high-polluting enterprises, fugitive emission sources started to be regarded as key control targets. The standard for fugitive emissions of VOCs was also tightened for the first time.

Energy structure adjustment and clean utilization

China is in a critical period of structural transformation in the energy sector. In terms of the fundamental measures related to energy structure which tackle air pollution, the Chinese government focused on the following three aspects in 2019: control of total coal consumption, development of renewable energy, and clean and efficient utilization of fossil energy. At the same time, the control of two indicators, total energy consumption and energy intensity, were also taken into account.

While energy structure adjustment reached the targets set by the 13th Five-Year Plan ahead of schedule, coal consumption still showed growth

In 2019, total energy consumption reached 4.86 billion tce in China, registering an increase of 3.3% from 2018. This increase accounted for three quarters of global growth, making China a major driver of global energy consumption. Meanwhile, the share of coal in primary energy consumption fell to 57.7%, down by 1.5% year-on-year. This indicates that the overall target to "reduce the share of coal consumption to below 58%" set by the 13th Five-Year Plan for Energy Development and the Three-year Action Plan was achieved one year in advance. The Three-year Action Plan also stipulated that the BTH region and surrounding areas and the YRD should implement total coal consumption control, while the Fen-wei Plains region should achieve negative growth in coal consumption. However, despite the progress made in energy structure adjustment, coal consumption still rose slightly by 1.0%.

Although the share of clean energy consumption grew, it still only accounted for a small proportion in the overall energy structure. The consumption of clean energy, including natural gas, hydropower, nuclear power, and wind power, increased by 1.3% year-on-year to reach 23.4%. Within the energy structure, consumption of non-fossil energy accounted for 15.3%, achieving the target set by the 13th Five-Year Plan one year ahead of schedule as shown in Figure 25. In 2019, carbon emissions per unit of GDP fell by 4.1% compared with the previous year.

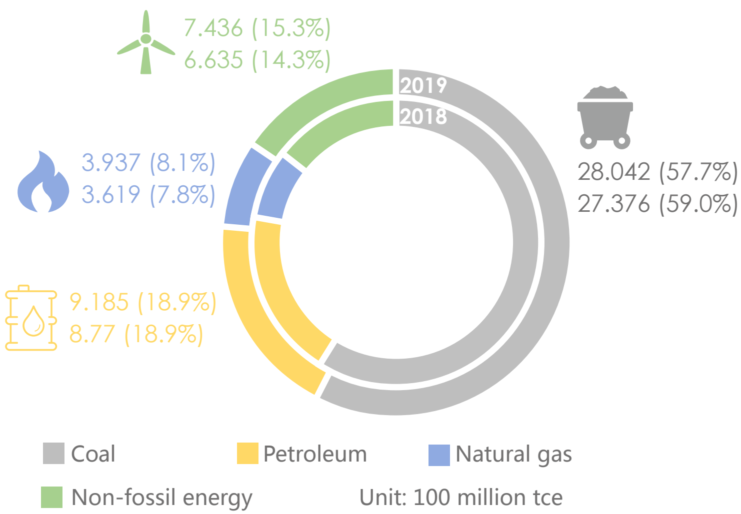

Fig. 25 China' s energy consumption structure in 2018 and 2019

The efficient and clean utilization of coal power was strengthened in the power sector, while the installed power generation capacity and consumption of renewable energy increased

Since 2015, alongside the wide implementation of ultra-low emission retrofitting in the thermal power industry, China built the world's largest clean coal power supply system. By 2019, coal-fired power generating units with ultra-low emission retrofits totaled 890 GW, accounting for 86% of total installed capacity and registering a year-on-year increase of 6%.

To expedite the transformation of the power industry while vigorously promoting clean coal as a basic power supply, China has steadily increased its installed capacity of renewable energy. In recent years, major breakthroughs have been made in the development of renewable energy while large-scale investments resulted in the doubling of new installed capacity. This has rapidly reduced the unit cost of power generation from solar photovoltaic systems and onshore wind, while further expanding the scale of the industry. In 2019, China's installed capacity for power generation exceeded 2,000 GW for the first time, up by 5.8% year-on-year. Specifically, installed capacity of non-fossil energy was 799 GW, accounting for nearly 40%.

Consumption targets for renewable energy were increased in 2019, a move which alleviated the problems of wind and solar power curtailment to some degree. For a long time, low utilization rates and consumption levels of renewable energy have hindered the development of renewable energy and limited its scale of growth. As such, the NDRC and the NEA issued the Notice on Establishing and Improving the Guarantee Mechanism for Renewable Energy Power Consumption in 2019, stressing that accelerating the development and utilization of renewable energy is an important strategic task. The Notice aims to assign the weight of responsibility for renewable energy consumption according to power consumption levels in each provincial-level administrative region, further enhancing the mechanism to guarantee renewable energy consumption while striving to increase energy utilization rates and ensure energy security.

In 2019, the utilization rates of hydropower, photovoltaic power and wind power were raised to 95.9%, 97.8% and 96.2% respectively. The Action Plan for Clean Energy Consumption (2018-2020) set out the following targets: "By 2020, the national average utilization rate of hydropower will be above 95%, that of wind power will be around 95%, and that of the photovoltaic power will be above 95%". All three targets were achieved ahead of schedule, partially allaying the curtailment of hydropower, wind power and solar power. According to the NEA, China's average wind and solar power curtailment rates dropped to 4% and 2% respectively in 2019.

Excess capacity in coal and coal-fired power generating units was eliminated, while the clean utilization of boilers increased

To moderate excessive capacity in coal plants, in 2019 China phased out an additional 100 million tons of outdated coal capacity, adding to the 810 million tons eliminated from 2016 to 2018. Over 450 small backward coal mines were also shut down alongside coal-fired power generating units of

20 million kW, completing the task of reducing excess capacity set in the 13th Five-Year Plan ahead of schedule.

Integrated renovations were carried out for coal-fired boilers and the prioritization of a cogeneration approach to replacing traditional coal-fired boilers was encouraged. In 2019, three key regions completed crucial tasks under the Three-year Action Plan ahead of schedule and came close to realizing the complete elimination of coal-fired boilers with a capacity lower than 35 t/h. To further reduce emissions, provinces and cities carried out low NOx combustion retrofits of gas boilers as well as retrofits of biomass boilers. The progress on low NOx combustion retrofitting of gas boilers in some cities in 2019 is shown in Figure 26.

The iron and steel industry underwent upgrading and technical retrofitting for ultra-low emissions

Excess capacity reduction targets were met in the iron and steel industry, but output continued to grow

Data from the Ministry of Industry and Information Technology shows that since the release of the Plan of Adjustment and Upgrade for the Iron and Steel Industry (2016-2020) in 2016, the capacity of crude steel has been reduced by 150 million tons. This indicates that the target set by the 13th Five-Year Plan – to reduce excess capacity by 100 to 150 million tons of crude steel by 2020 – was met two years ahead of schedule. The Key Points for Reducing Excess Capacity in the Iron and Steel Industry in 2019 focused on encouraging regional and state-owned enterprises that have not yet met reduction targets for excess capacity of crude steel to do so. In Tangshan, the city with the most concentrated iron and steel capacity in China, high-polluting enterprises contribute up to 70% of pollutants in the downtown area. In 2019, 13 iron and steel enterprises were pulled out of Tangshan and relocated, a move that would reduce iron and steel capacity by 51.35 million tons, coal consumption by 1.015 million tons, and CO2 emissions by 20.08 million tons.

However, in 2019, China's crude steel output still approached 1 billion tons and marked a year-on-year growth of 7.2%. The capacity of key regions accounted for 55% of the total crude steel output in China, with Hebei Province having the largest proportion at 24%.

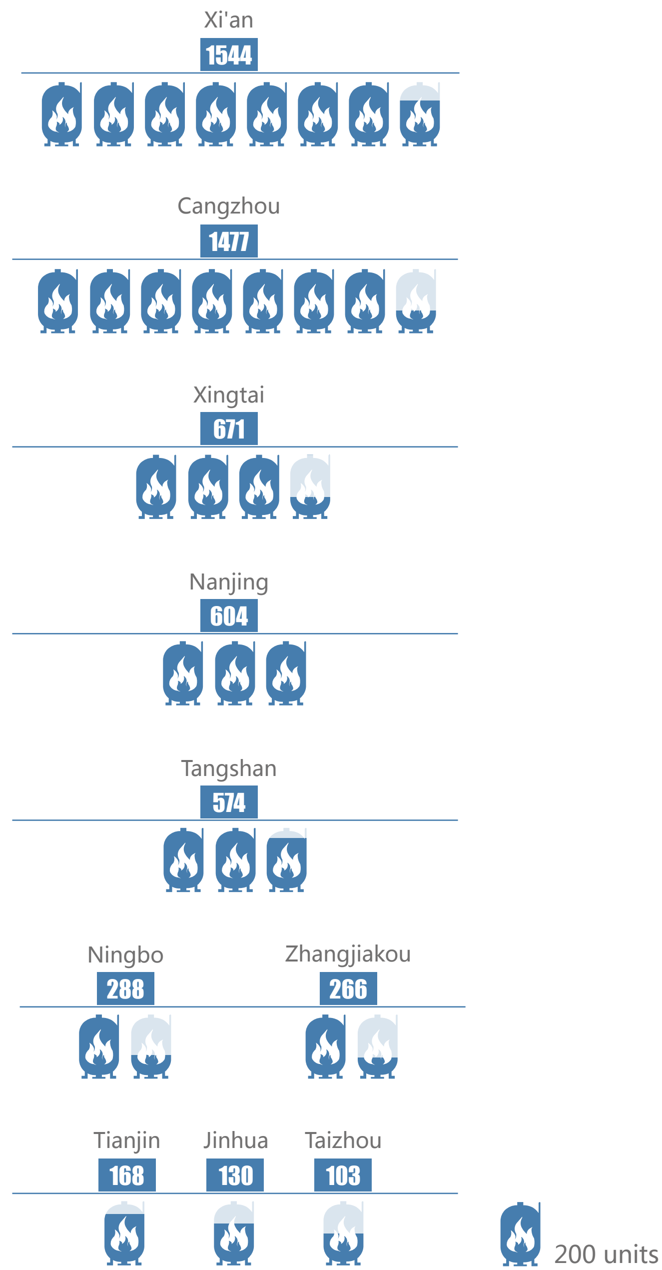

Fig. 26 Number of gas boilers with low NOx combustion retrofitting in some cities in 2019

The iron and steel industry became the first non-power sector to undergo ultra-low emission retrofitting

Since 2017, the iron and steel industry replaced the thermal power industry as the largest source of industrial pollution. In 2019, the Opinions on Promoting the Implementation of Ultra-low Emission in the Iron and Steel Industry marked the official launch of pollution control for stationary sources in non-power industries with the iron and steel industry representing a priority area. A target was set for 60% of iron and steel companies in key regions to complete ultra-low emission retrofitting by the end of 2020, with this proportion rising to over 80% by 2025. The Opinions also specified that iron and steel companies must meet ultra-low emission requirements for organized emissions, fugitive emissions, and clean transportation. The top priority is to tighten standards for organized emissions in the iron and steel industry, necessitating the upgrade and renovation of pollution control facilities as shown in Figure 27. The hourly mean concentrations of PM, SO_2 and NOx stipulated in the Opinions are in line with the ultra-low emission standards issued by Hebei Province in 2018. The provinces of Shandong, Shanxi and Henan also set provincial standards adhering to such limits.

The Opinions further required factory-specific strategies for ultra-low emission retrofitting to be employed in the iron and steel industry. Furthermore, the application of environmental protection and renovation technologies such as efficient flue gas wet desulphurization and de-nitration, low NOx combustion and electrostatic precipitation should be strengthened, while a timetable and roadmap for control should be drawn up to ensure the attainment of emission standards. Enterprises undertaking an ultra-low emission retrofit should implement national or local standards for air pollution emissions, while those in key regions should implement special emission limits. Meanwhile, iron and steel enterprises that do not implement ultra-low emission retrofits should take other measures such as upgrading pollution control facilities and strengthening the management of fugitive emissions.

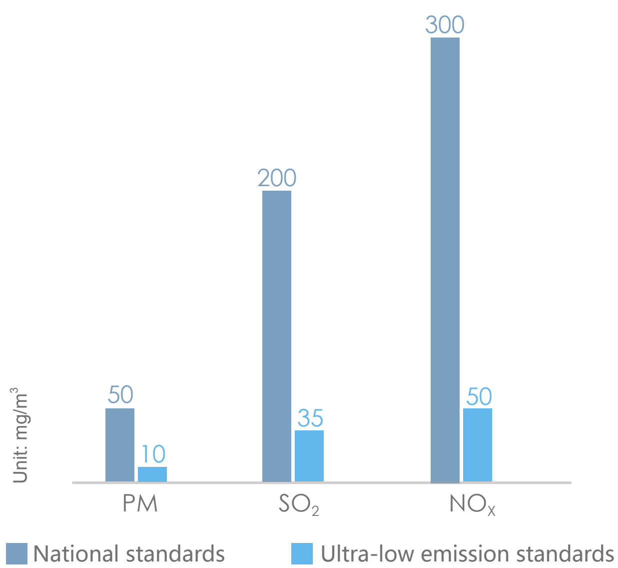

Fig. 27 Limits of flue gas emissions from sintering machine heads and pellet roasting

In 2019, ultra-low emission retrofits were in progress for a total capacity of 550 million tons of crude steel across 222 iron and steel enterprises. 331 ultra-low emission retrofitting projects were initiated in Hebei Province and a steelmaking capacity of 14.0255 million tons was eliminated. Shanxi Province completed retrofits for 15 million tons in total, while Jiangsu Province retrofitted 82 million tons. Shaanxi Province conducted retrofits for seven iron and steel enterprises.

In addition to organized emissions, fugitive emissions and bulk material transportation emissions from the iron and steel industry were also major sources of pollutants. Among this, fugitive emissions accounted for more than 50% of PM emissions. Freight volume in the iron and steel industry accounted for about one tenth of the national total volume, generating 20% of total NOx and PM emissions. However, fugitive emissions of dust in the iron and steel industry originated from multiple sources and were largely scattered, highly intermittent and interactive, rendering progress on control more challenging. Many fugitive emission sources are still not subject to control measures.

Differentiated policies for environmental protection and management

In addition, the iron and steel industry began implementing differentiated management policies for environmental protection, seeking to stimulate its enterprises to control pollution and improve economic benefits. The Opinions emphasized that steel and iron enterprises have a legal responsibility to ensure that special emissions limits for air pollutants are met. However, ultra-low emission retrofitting was not made compulsory. Instead, pioneering enterprises have been encouraged to take the lead in implementation and were guided through the process by differentiated management policies. To this end, the government strengthened its policy support and established a system of incentives comprising both rewards and penalties.

Firstly, a surcharge was added to the electricity price of non-attainment enterprises. In 2019, Shandong Province introduced a gradated surcharge system based on the regular electricity price for non-attainment enterprises. For instance, RMB 0.06 was added per kilowatt-hour for enterprises failing to meet ultra-low emission requirements for organized emissions, fugitive emissions, and clean transportation. Hebei Province has been applying a surcharge since 2018, whereby RMB 0.1 is added per kilowatt-hour for enterprises failing to complete an ultra-low emission retrofit within the time limit.

In addition, during alerting periods for heavy pollution days, enterprises that have not completed an ultra-low emission retrofit were subject to penalty measures, such as production restrictions, production suspensions, and off-peak transportation. With regards to the long-term development of enterprises, such measures are bound to affect regular industrial order and delivery processes and increase operating costs. Therefore, governments can expect differentiated management policies to drive the independent transformation and upgrading of enterprises which have not completed ultra-low emission retrofits.

Moreover, the MEE issued the Guidelines on Strengthening Emergency Responses to Heavy Pollution Days and Reinforcing Emission Reduction Measures, which aimed to strengthen differentiated emission reduction measures for emergency responses. First of all, alerting standards for heavy pollution days were unified, with the 24-hour average value of AQI taken as the indicator while the emission reduction ratios of pollutants – SO_2, NOx, PM and VOCs – are determined in reference to the level of emergency. Secondly, relevant authorities have initiated performance evaluations and differentiated management approaches for the 15 key industries, issuing enterprise grading specifications with a view to rewarding enterprises in key regions which have achieved environmental protection goals (i.e., enterprises with large investments in environmental protection). Reward measures include: exemption from production restrictions and suspensions in heavy pollution days; exclusion of Grade-A enterprises (those that have installed facilities in accordance with the requirements and meet ultra-low emission limits) from key targets of emission reduction controls; and reduced monitoring frequency, in order to encourage enterprises to voluntarily adopt emission reduction measures. This policy will greatly alleviate the burden on enterprises with ultra-low emissions, regulate the market, and eliminate non-compliant enterprises. Jiangsu Province has already introduced a grading incentive system for the iron and steel industry, while Sichuan Province did so for the cement industry.

Strengthened monitoring and supervision of emissions from enterprises in the iron and steel industry

Another key objective for air pollution control in the iron and steel industry is to strengthen pollution emissions monitoring and supervision during the production process. Relevant policies emphasized that data from devices such as automatic monitors should be kept for at least one year, and video data (to strengthen the control of fugitive emissions) for at least three months. The MEE stressed that assessments of emissions from steel mills should be conducted by a third party, the industry association, to prevent data falsification during the retrofit. Penalties would be put in place to limit the enterprise’s steelmaking capacity should any falsification be discovered, directly affecting the economic benefit of enterprises which exceed standards.

At the local level, Hebei Province has built China’s largest ambient air quality monitoring network equipped with a continuous online monitoring system for flue gas emissions. The network covers over 2,000 large enterprises emitting pollutants, including iron and steel enterprises. Monitoring devices in these enterprises automatically record and transmit emissions data to a big data platform for online atmospheric environmental monitoring in Hebei Province. Information from monitoring sites in enterprises is displayed in real time. In the occasion that a monitoring site detects standard-exceeding emissions, Hebei Province has adopted a three-step response which requires: a report from the enterprise in question; verification by the local Environmental Protection Bureau; and handling by the law enforcement department. This process enables an efficient process of supervision and law enforcement.

Comprehensive control of scattered, unregulated, and high-polluting enterprises

Pollution control of industrial furnaces and kilns

Industrial furnaces and kilns are widely used in industries such as iron and steel, coking, nonferrous metals, building materials, chemical engineering, and machinery manufacturing. These industries often involve many scattered, unregulated, and high-polluting enterprises with control measures that fall short. Industrial furnaces and kilns contribute as much as 20% of $PM_{2.5}$ pollution in the BTH region and surrounding areas.

In July 2019, the MEE issued the Plan for Integrated Control of Air Pollution from Industrial Furnaces and Kilns, stating that the formulation of air pollutant emission standards for the casting, domestic glass, fiberglass, mineral wool and calcium carbide sectors should be completed by 2020. At the local level, revisions by Shandong Province and Jiangsu Province have led to more stringent provincial standards for air pollutant emissions from industrial furnaces and kilns. Henan Province also publicized the exposure draft of its revised standard.

Provinces and cities in key regions carried out integrated renovations of industrial furnaces and kilns. In 2019, integrated renovations were completed for 1,874 industrial furnaces and kilns in Hebei Province, over 9,400 in Shandong Province, 267 in Shaanxi Province, and 737 in Zhejiang Province. Regarding the clean utilization of energy in industrial furnaces and kilns, high-sulfur petroleum coke (with a sulfur content greater than 3%) was specifically prohibited from combustion in the glass manufacturing industry across key regions.

Renovation and phasing out of small, scattered, unregulated and high-polluting enterprises

A comprehensive renovation of industrial clusters should be encouraged to optimize the industrial structures of scattered, unregulated and high-polluting enterprises which do not conform to industrial policies and layout planning, fail to install pollution treatment facilities, cause excessive emissions and fail to follow approved environmental protection procedures. These enterprises are often scattered, making it difficult to identify precise numbers. For this reason, many regions released action plans requiring that a list of relevant enterprises in need of renovation be compiled through a comprehensive survey and investigation. To avoid taking a "one size fits all" approach, three types of targeted control measures were implemented, including shutdown and elimination, renovation and upgrading, and integration and relocation.

In 2019, Hebei Province investigated and renovated 4,504 enterprises, while Henan Province renovated 6,681 enterprises, the highest number in China. Shaanxi Province investigated areas within the Guanzhong region where scattered, unregulated, and high-polluting industrial enterprises were located and renovated 4,759 such enterprises, realizing dynamic clearance ahead of schedule. To prevent the resurgence of these enterprises, Xi'an and Xianyang released lists of enterprises that have been penalized and shut down in recent years, promoting supervision through information disclosure. Progress on the renovation of small, scattered, unregulated and high-pollution enterprises is shown in Figure 28.

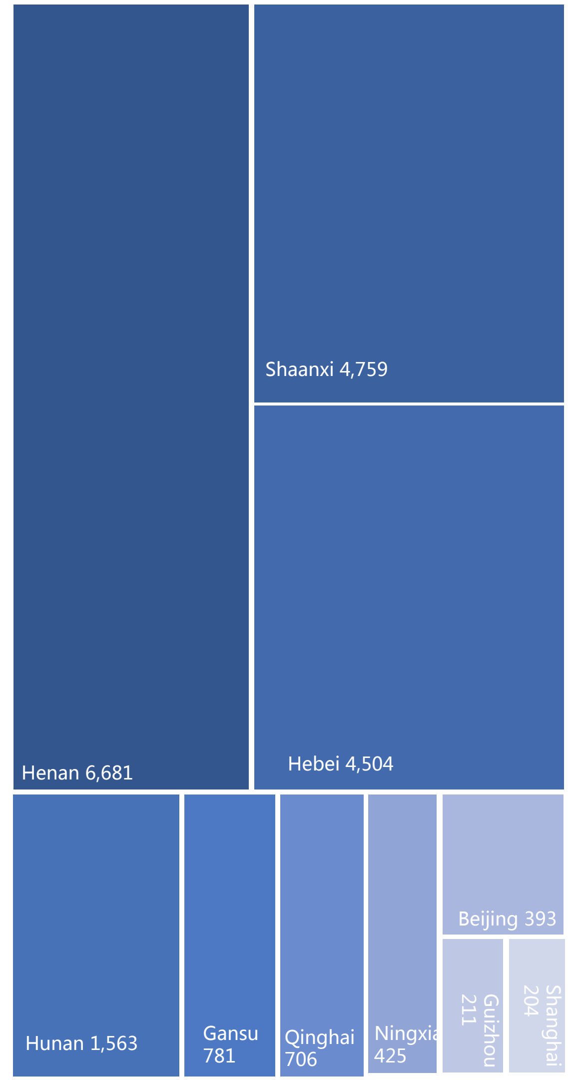

Fig. 28 Number of small, scattered, unregulated and high-polluting enterprises renovated in 2019

Integrated control of VOCs pollution

To promote the control of VOCs, the MEE issued three standards for the first time in May 2019. More specifically, these standards were: the Standard for Fugitive Emissions of Volatile Organic Compounds (GB 37822-2019); the Emission Standard of Air Pollutants for the Pharmaceutical Industry (GB 37823-2019); and the Emission Standard of Air Pollutants for the Paint, Ink and Adhesive Industry (GB 37824-2019). Emissions control standards for VOCs set out clear requirements for fugitive emissions during the material storage, transfer, transportation, and processing stages. In addition, China revised emission limits of NMHC in the Integrated Emission Standard of Air Pollutants (GB16297-1996) (the highest concentration outside the perimeter is 5mg/m^3), as shown in Table 1:

Table 1 Fugitive emission limits for VOCs (GB 37822-2019)

Pollutant	Emission Limits (mg/m^3)	Special Emission Limits (mg/m^3)	Description of Limits	Monitoring Site for Fugitive Emissions
NMHC	10	6	Hourly average concentration at the monitoring site	Monitoring sites set up outside the plants
	30	20	Any concentration value at the monitoring site	

To promote the implementation of standards, the Plan for Integrated Control of Volatile Organic Compounds in Key Industries began to take effect as of June 2019. The Plan aims to further improve the VOCs pollution control system, reduce VOCs emissions by 10% by 2020 (as set in the 13th Five-Year Plan), and strengthen the coordinated control of greenhouse gas emissions. The six key industries and main tasks involved in the Plan are shown in Figure 29.

The Plan also outlined four aspects in the reduction of VOCs emissions. Firstly, three key industries, including chemical engineering, industrial coating, and package printing, should use products with low VOCs content. As such, the application, development, and production of green raw and auxiliary materials such as paint, ink and adhesives with low VOCs content should be encouraged. The action plan on air pollution prevention and control during the autumn and winter seasons for the Fen-wei Plains and YRD regions stipulated that local governments should prioritize the inclusion of products with low VOCs content in their procurement lists, and lead on the promotion and application of these products in municipal projects. In doing so, the government can signal to the market that more enterprises should change their product sourcing, with a view to stimulating greater research and development and the industrialized growth of the industries.

Petrochemical engineering
Petroleum refining, organic chemicals, synthetic resin, synthetic fiber, synthetic rubber

Chemical engineering
Pharmaceuticals, pesticide, paint, ink, adhesive, rubber, plastic products

Industrial coating
Automobiles, furniture, containers, electronic products, engineering machinery

Package printing
Printing for flexible plastic packaging, tinplate printing and tin can making

Fuel products storage, transportation and sales
Gas stations, oil tank trucks, vapor recovery of oil storage tanks, vapor recovery of vessels (gasoline, naphtha, kerosene (including aviation kerosene), crude oil)

Industrial parks and industrial clusters
Coating (home furnishing, machinery manufacturing, electronic products, automobile maintenance), petrochemical and chemical engineering, organic solvents (package printing, textile finishing, synthetic rubber and its products), activated carbon

Fig. 29 Industries and priority areas involved in the Plan for Integrated Control of Volatile Organic Compounds in Key Industries

Secondly, rates of exhaust collection should be improved by strengthening closed-loop management to comprehensively control fugitive emissions. Thirdly, a technical approach should be used to select pollution control facilities suitable for local conditions. The control of exhaust emissions and removal efficiency for key emission sources should be simultaneously coordinated to enhance the efficiency of pollution control measures.

Finally, factory-specific strategies were proposed to support more refined control measures. For the first time, the policy document introduced a cost-benefit analysis for control measures and asked that all regions arrange for experts to provide technical support for high-polluting enterprises in the evaluation of investment costs and emissions reduction benefits. This will help enterprises establish and strengthen investment in sustainable environmental protection and pollution control, such that pollution may be reduced without incurring additional economic burdens. By the end of 2019, 12,000 enterprises across China have completed their control tasks.

Mobile sources

As mobile sources represent major sources of air pollutants in large and medium-sized cities, prevention and control in this area is a priority in the Three-year Action Plan. On December 30, 2018, the MEE issued the Action Plan for Prevention and Control of Pollution from Diesel Trucks, making clear to local governments that the following four aspects would be the focus of control measures in 2019: clean diesel vehicles, clean diesel engines, clean transportation, and clean fuel products.

In 2019, measures for the prevention and control of pollution from mobile sources became more detailed, supervision became more efficient, and relevant laws, regulations and standards were rendered more comprehensive. However, many challenges still remain, including the supervision of institutions for vehicle emission inspections, regulation of gas stations, and optimization of the cargo transportation structure.

While quality supervision of fuel products was strengthened, some cities still need to implement a long-term mechanism

The Action Plan for the Prevention and Control of Pollution from Diesel Trucks states that, by 2019, the illegal production, sale, storage and use of fake, inferior, and non-standard fuel products should be almost completely eliminated. To this end, many cities took action to suppress unlicensed gas stations and illegal mobile refueling trucks while some imposed criminal sanctions. Nanchang in Jiangxi Province, for example, sentenced those responsible for illegally dealing in gasoline to five and a half years' imprisonment and a fine of RMB 200,000.

In May 2019, the MEE, together with the SAMR, the Ministry of Public Security and the Ministry of Commerce, launched enhanced supervision and fixed-point assistance of clean vehicle-use fuel products for the BTH region and surrounding areas. 1,466 unlicensed gas stations were investigated. The problem was the most acute in Hebei Province, which had 40% of the total number of unlicensed gas stations, followed by Shandong and Henan. Regional coordination was also carried out in the Fen-wei Plains. Shaanxi Province took the lead and cooperated with the provinces of Shanxi and Henan to conduct a five-month joint action (from October 2018 to March 2019) to regulate unlicensed gas stations across the region. Nearly 900 unlicensed gas stations were investigated and received penalties in Henan Province and 146 in Shaanxi Province.

While highly frequent inspections and strong accountability kept unlicensed gas stations in check to a certain degree, it did not effectively prevent their resurgence. Despite repeated bans, illegal gas stations continued to operate in many provinces throughout 2019, including in Hebei, Henan, Anhui, and Shandong. These provinces have already established long-term systems overseeing outlets which deal in refined oil products. While the systems clearly focus on supervision, work responsibilities and penalty procedures, none of the provinces mentioned having fully implemented these aspects nor taken tough measures against any illegal activities. These issues affect the effectiveness of efforts to stamp out illegal gas stations.

A multi-pronged approach was implemented to reduce emissions from in-use vehicles

Screening for high emission in-use vehicles was strengthened

Through increasingly sophisticated technology and improved management, major cities in China have gradually established integrated monitoring systems to oversee in-use vehicles. These systems monitor vehicles 24 hours a day throughout their full life cycle via remote sensing, emissions inspections, OBD monitoring, roadside examinations, and household spot checks.

New tools are available for law enforcers to identify high emission vehicles, including remote sensing equipment to monitor exhaust emissions and devices which capture vehicles emitting black smoke. In 2019, various regions collectively made a total of 360 million vehicle inspections through remote sensing (including capturing black smoke emitters) and found 10.8979 million cases of excessive emissions.

Monitoring via remote sensing (including capturing black smoke emitters) was most intensive in the provinces of Guangdong and Henan, with 83.1695 million and 60.3239 million checks conducted on vehicles, respectively.

Regular emission examinations are an effective means to identify vehicles with excessive emissions. In May 2019, implementation began for the newly-revised Limits and Measurement Methods for Emissions from Gasoline Vehicles under Two-speed Idle Conditions and Short Driving Mode Conditions (GB 18285-2018) and the Limits and Measurement Methods for Emissions from Diesel Vehicles under Free Acceleration and Lugdown Cycle (GB3847-2018). These measures apply to checks of new offline vehicles, registration checks and emission examinations of in-use vehicles. The new standards also tightened limits for pollutant emissions from in-use vehicles, increased OBD inspections, and added new limits for NOx emissions from diesel vehicles.

Many regions also sought to stop illegal data falsifications by emissions inspection institutions to make regular examinations a viable means for screening high emission vehicles. Beijing, Tianjin, Zhejiang, Shanxi, and other provinces introduced a points-based system for the administration of emissions inspection institutions. Should any unlawful activities be discovered, the institution would incur a deduction in points. For example, Ningbo imposed two-point penalties on institutions for issuing false emissions inspection reports. Meanwhile, Guangzhou conducted spot checks on motor vehicle emissions inspection institutions with abnormal data, if the institutions had an excessively high level of inspection business for vehicles registered in other cities, or if the qualification rate of their first inspection was too low but that of the second inspection was too high. In 2019, departments of ecology and environment at all levels conducted a total of 14,993 institutional supervisions and examinations and investigated 859 institutions violating regulations.

OBD can remotely monitor vehicles' operation status and pollutant emissions throughout their whole lifecycle. However, for a long period of time, OBD data was not connected to relevant regulatory departments and the potential role of OBD in vehicle emissions monitoring was not fully realized. In 2019, key provinces and cities including Shanxi Province, Hebei Province and Zhengzhou City required over half of their heavy-duty diesel vehicles to install remote online monitoring equipment and connect them with the department of ecology and environment by the end of the year.

The departments of ecology and environment, in conjunction with public security and transportation departments, conducted roadside examinations and household spot checks for vehicle emissions. These checks have become a regular means of pollution control for motor vehicles across various regions. In 2019, China conducted roadside examinations on 11.6183 million vehicles and spot checks for 606,500 vehicles. Collectively, 485,500 vehicles with excessive emissions were found.

Excessive emitters were tracked and managed using an approach combining data-powered tracing and law enforcement

Multiple parties are implicated in excessive emissions from in-use vehicles, including manufacturing enterprises, users, and emission inspection institutions. Therefore, integrated chain management must be strengthened for emissions from motor vehicles. Some cities strengthened the management of vehicle emissions at source by analyzing in-use vehicles with excessive emissions and tracing production enterprises, emission inspection institutions, and transport enterprises.

With regards to manufacturing enterprises, China is improving methods to trace enterprises' responsibilities and relevant legal liabilities. Beijing has integrated data on excessive emissions, new vehicle declarations and regular inspections, targeting vehicle models with "large market volume, low qualification rates in initial annual inspections, and high incidence of exceeding standards during roadside examinations and night inspections." Models falling in this category are designated as key targets for precise spot checks on new vehicles. Beijing's experience has since served as an example for other cities working to trace the responsibility of manufacturing enterprises.

Regarding legal liabilities, in July 2019 the SAMR and the MEE jointly issued the Administrative Rules on the Recall of Vehicles for Environmental Protection (Exposure Draft), preparing to establish a system requiring producers to recall vehicles with defects in environmental performance.

Harbin conducted retroactive investigations into emissions inspection institutions for vehicles confirmed to have discharged black smoke. If any falsification is found in the emissions inspection report, the institution would face a fine of RMB 100,000 or over (no greater than RMB 500,000) and the confiscation of their illegal gains.

Regarding transport enterprises, the Action Plan for Prevention and Control of Pollution from Diesel Trucks requires the departments of transportation, ecology, and environment to blacklist within a year all transport enterprises where vehicles with excessive emissions make up more than 10% of the total fleet. Alternatively, these enterprises may also be regarded as key regulatory targets. Shijiazhuang and Chengde in Hebei Province, Suzhou in Jiangsu Province, and Taiyuan and Jinzhong in Shanxi Province have encouraged large vehicle users to sign a letter of commitment to environmental protection, enabling them to use cleaner transport vehicles and gain a greater awareness of their responsibilities.

A comprehensive I/M system was established to promote the closed-loop management of vehicles with excessive emissions

Screening vehicles with excessive emissions is the first step towards preventing and controlling motor vehicle pollution. The timely maintenance of vehicles is crucial for identifying defects in environmental performance. Therefore, a complete closed-loop management system comprising inspection, maintenance and reinspection should be established for vehicles with excessive emissions identified during regular emission inspection or sample checks.

For vehicles with excessive emissions found during regular emission inspections, the vehicle emissions inspection and maintenance system (I/M system) is an effective form of closed-loop management. The Action Plan for Prevention and Control of Pollution from Diesel Trucks requires the establishment and implementation of the I/M system in all regions by the end of 2019, with key regions expected to complete the requirement ahead of schedule. In 2019, many regions began declaring, evaluating, and publicizing maintenance stations and steadily promoted the implementation of the I/M system.

Vehicles with excessive emissions found via roadside examinations, household spot checks and remote sensing generally incurred a fine of RMB 200 from local traffic management departments in line with the national uniform penalty code for excessive emissions (6063). To promote the timely maintenance and management of these vehicles, different regions have devised a wide range of strategies. Beijing effectively utilized its blacklist to encourage the timely maintenance of vehicles. Any vehicle with excessive emissions found with a license plate from another city would not be eligible for a permit to enter Beijing before it undergoes maintenance and re-inspection, and the certificate of qualification is uploaded online. Likewise, Suzhou retracted its annual traffic permit and issued a temporary paper permit instead. Users now require a “Notification of Completion of Rectification” to regain the annual permit. In Tianjin, vehicles with a record of excessive emissions were incorporated into the pollutant emissions monitoring platform, while those with a bad record were given particular scrutiny during inspections.

The optimization of vehicle structures continued, while the overall structure of the transportation sector was improved

China VI emission standards were implemented for new vehicles in many regions, and the overall structure of in-use vehicles was steadily optimized

In order to expedite the upgrading of emission standards for new vehicles, the Action Plan for Prevention and Control of Pollution from Diesel Trucks required that the designated key regions, PRD and Chengdu-Chongqing regions implement China VI standards ahead of schedule from July 1, 2019 onwards.

In 2019, 15 provinces (municipalities, autonomous regions) implemented China VI standards for light-duty vehicles ahead of other cities. Tianjin, Shanghai, Hebei Province and Guangdong Province directly applied stricter China VI-b standards for Type I light-duty vehicles, while Jiangsu Province, Zhejiang Province, Anhui Province, Shandong Province, Henan Province, Chongqing, Shanxi Province (some cities), Inner Mongolia Autonomous Region (some cities), Sichuan Province (some cities), Shaanxi Province (some cities) and Hainan Province implemented China VI-a standards. Compared to China VI-a standards, the emission limits on CO, total hydrocarbons (THC), non-methane hydrocarbons and NOx were tightened in the China VI-b standards for light-duty vehicles by 28.6%, 50%, 48.5% and 41.7% respectively. Six provinces, including Shanxi, Henan, Chongqing, Sichuan, Shaanxi, and Hainan, required heavy-duty diesel vehicles in the public service sector to implement China VI-a standards from July 1, 2019.

Among in-use fuel vehicles, single vehicle emissions from outdated vehicles are much higher than those from new ones. Eliminating outdated vehicles and upgrading high-emission vehicles are therefore critical measures for local governments to control overall emissions of in-use vehicles. The main methods for eliminating outdated and high-emission vehicles include economic compensations and use restrictions, providing two-way incentive systems for vehicle owners. Taking Dalian of Liaoning Province as an example, China III medium- and heavy-duty diesel trucks equipped with pollution control devices before December 15, 2019 were no longer subject to traffic restrictions if exhaust emissions met the requirements of technical retrofits. In addition, the municipal finance department provided a subsidy of 30% for each vehicle equipped with pollution control devices to encourage the retrofitting of outdated vehicles. In 2019, around 2.295 million scrapped vehicles were recovered nationwide. The current state of elimination of outdated vehicles in some provinces is shown in Figure 30.

Continual optimization of the transport structure

In 2019, the volume of railway and waterway freight registered increases of 7.3% and 6.3% respectively compared to 2018, already meeting 90%

Note: Data for provinces and cities marked with * refers to the number of diesel trucks eliminated

Fig. 30 Status of elimination of outdated vehicles in some provinces in 2019

and 104% of the targets for 2020. The increase in waterway freight surpassed the target ahead of schedule, as shown in Figure 31. The BTH region and surrounding areas saw railway freight increase by more than 26.2% year-on-year. Likewise, railway freight in Hebei Province increased by 36.6%, demonstrating the effect of road-to-railway.

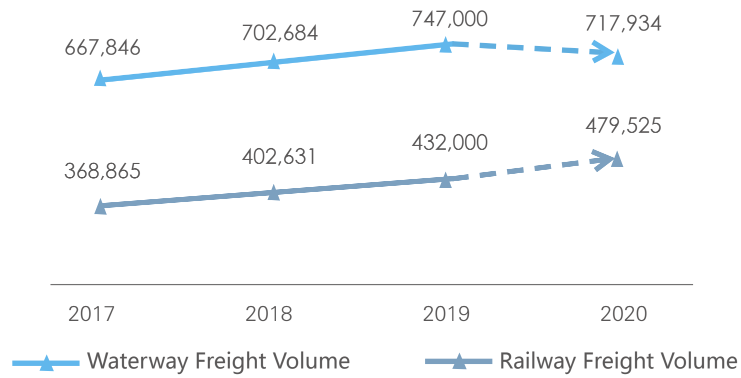

Fig. 31 China' s railway and waterway freight volume in 2017-2019 and targets for 2020

The share of railway transportation increased for three consecutive years within the freightage structure, although road transportation still dominated. The proportion of waterway transportation began to rise, as shown in Figure 32 and Figure 33.

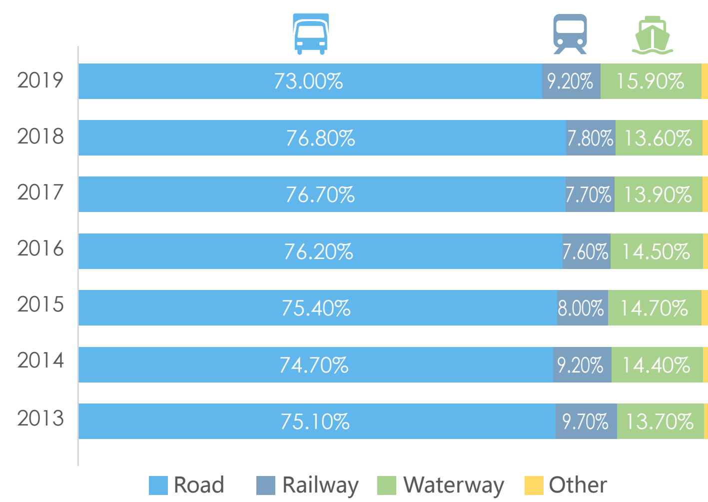

Fig. 32 Share of road, railway, and waterway freight volume in the transport structure from 2013-2019

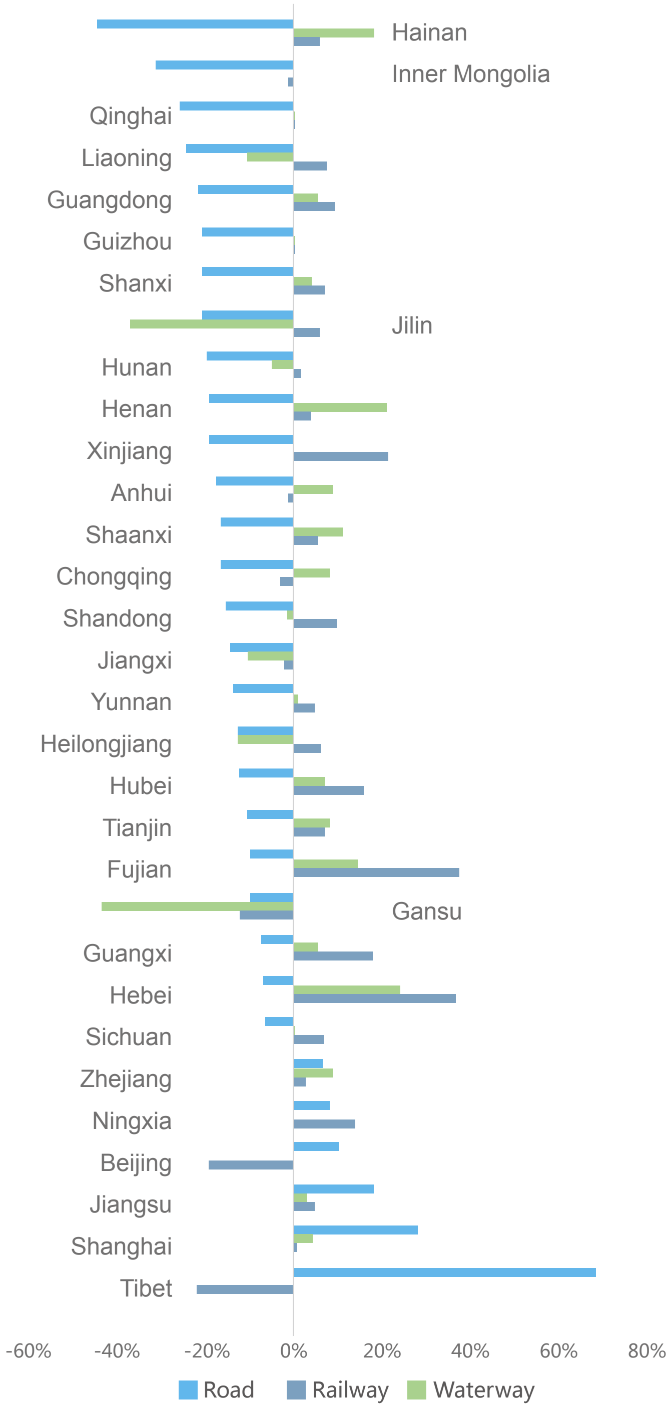

Fig. 33 Changes in waterway, railway and road freight volume in provinces, municipalities, and autonomous regions in 2019 compared with 2018

Production and sales of new energy vehicles declined due to a drop in subsidies

Increasing the proportion of new energy vehicles in total vehicle ownership is a significant method to reduce motor vehicle pollution. From 2013 onwards, new energy vehicles saw breakthrough rates of growth. However, in 2019 both production and sales volumes declined to 1.242 million and 1.206 million, down by 2.3% and 4% respectively from 2018. This decline indicated the impact of a drop in subsidies to buy new energy vehicles. In 2019, the population of new energy vehicles stood at 3.81 million, representing 1.5% of total vehicle ownership.

The management of non-road mobile sources became more precise, while supervision was strengthened

A stronger understanding of non-road mobile machinery usage helped establish a foundation for more precise supervision

Non-road mobile machinery is movable and in use at varying times, thus increasing the difficulty of supervision. Gaining knowledge of the holdings, usage, and emissions of such machinery is therefore the first step towards strengthening management and supervision. In 2019, China's non-road mobile machinery supervision platform and WeChat mini-program were put into use. These measures promoted the registration and coding of non-road mobile machinery in all regions. In addition, different regions successively launched a series of management schemes, including posting environmental protection stickers, installing a Beidou positioning system or monitoring network, and issuing licenses for non-road mobile machinery. By the end of 2019, 730,000 non-road mobile machines were coded and registered across the country.

As more knowledge about the usage of non-road mobile machinery became available, 178 cities announced zones in which the use of high-emission non-road mobile machinery would be prohibited by the end of 2019, in line with the Action Plan for Prevention and Control of Pollution from Diesel Trucks. In these zones, general requirements for emissions from non-road mobile machinery are determined based on actual values of exhaust measured from in-use machinery. The exhaust smoke must meet China III standards set out in the Limits and Measurement Methods for Exhaust Smoke from Non-road Mobile Machinery Equipped with Diesel Engine (GB 36886-2018).

A comprehensive understanding of non-road mobile machinery laid the groundwork for accurate supervision. For example, in 2019 Chengdu investigated the illegal operation of a high-emission non-road mobile machine through early warning information from the "Non-road Mobile Source Emission Supervision Platform" and issued a penalty thereafter.

Vessel emission control areas were expanded and upgraded with enhanced supervision

On January 1, 2019, the Plan for the Implementation of the Emission Control Areas for Air Pollution from Vessels was officially put into action. The original emission control areas of the Circum-Bohai-Sea and the YRD and PRD regions were extended to cover the sea area within 12 nautical miles off China's baseline of territorial sea. Meanwhile, navigable waters of the Yangtze River and Xijiang River trunk lines were also added. The Plan also specified the sulfur content of fuel, emission limits for engines, and the use of shore power for vessels within emission control areas. Since January 1, seagoing vessels within emission control areas must use marine fuel with a sulfur content no higher than 0.5% m/m, while inland vessels must use diesel with a sulfur content no higher than 10 mg/kg.

In 2019, the application of remote sensing for monitoring and unmanned aerial vehicles (UAV) improved the capacity and efficiency of law enforcement officials to monitor vessels within emission control areas. The maritime authority in Jiangsu Province was able to constantly monitor the sulfur content of vessel emissions using a vessel exhaust telemetry system installed on the bridge foundation. Authorities investigated two vessels and issued penalties for the illegal use of high-sulfur fuel. Likewise, the Shanghai Pudong New Area Maritime Safety Administration used UAV for monitoring and tracked down three instances of illegal activity by seagoing vessels. Improvements in capacity for supervision is an essential element in the deterrence of illegal activities.

Area sources

Clean heating in northern rural areas and the comprehensive control of fugitive dust and straw burning are priorities for the control of area source emissions in China. The "2+26" cities have already made rapid progress in clean heating, and in 2019 the percentage of clean heating reached 75%. The Fen-wei Plains will be the next key area for clean heating projects and China has correspondingly improved fiscal incentives and policy support for cities in this region. Meanwhile, Northeast China continues to promote the use of straw fertilizers, straw return-to-field, and straw power generation to reduce straw burning. At present, substantial straw burning still occurs in Northeast China and have become the primary cause of heavy pollution in this region.

Clean heating steadily progressed

In northern rural areas, loose coal burning remains the main method for heating in the winter. The emissions intensity per unit mass of fuel can reach up to 27 times that of ordinary coal-fired power plants, and about 15 times that of ordinary industrial boilers. During the wintertime, it remains one of the main sources of pollution in Northern China. Over the past few years, clean heating has become a significant component of air pollution reduction as well as a major project which concerns the livelihoods of people.

According to the NEA, since the implementation of the Plan of Clean Heating in Winter in Northern China (2017 - 2021), SO_2, NOx, PM and non-chemical organic matters have been reduced by 780,000 tons, 380,000 tons, 1.53 million tons and 140,000 tons respectively by 2019. New clean heating areas increased by about 1.5 billion square meters, with the rate of clean heating reaching 55%. In addition, roughly 100 million tons of loose coal have been replaced. This means Northern China surpassed the overall medium-term target to achieve a clean heating rate of 50%.

Medium-term targets for key regions were overfulfilled, while rural areas will have a heavier task of loose coal control in the future

Across the "2+26" cities in the BTH region and surrounding areas, the number of households using loose coal for heating dropped from 24 million to about 10 million, while the consumption volume of loose coal decreased from 56 million tons to 23 million tons per year. Technical pathways dominated by natural gas and electricity were put in place as a basis for clean heating. In 2019, the clean heating rate across the "2+26" cities reached 75%, while the actual rate in urban areas, county towns and rural areas exceeded medium-term targets as shown in Figure 34. It should be noted that although rural areas have achieved a clean heating rate of 43%, there is still a considerable gap before they can reach the final target of 60% in 2021. Loose coal control in rural areas will be the most difficult challenge in the progress towards clean heating.

According to data reported by local governments in Northern China, over 7 million households were newly renovated with clean heating in 2019. The "2+26" cities in the BTH region and surrounding areas took the lead by enabling loose coal replacement for 5.4496 million households,

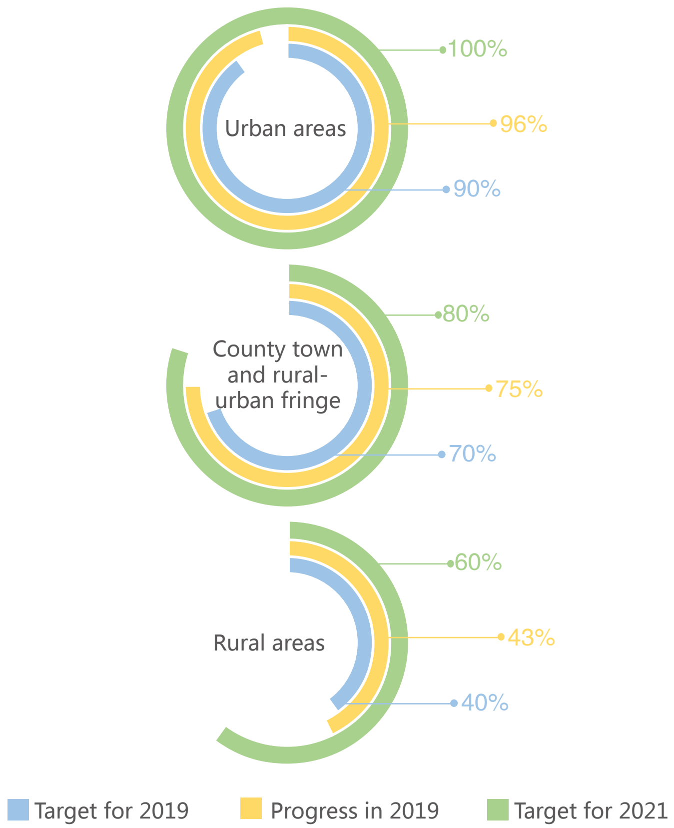

Fig. 34 Progress and targets for clean heating rates in the "2+26" Cities

among which 363,000 households were in Tianjin, 2.2396 million in Hebei Province, 397,000 in Shanxi Province, 1.143 million in Shandong Province and 1.307 million in Henan Province. The Fen-wei Plains region completed loose coal control for 2.058 million households, among which 600,000 households were in Shanxi Province, 300,000 in Henan Province and 1.158 million in Shaanxi Province.

The 2019-2020 Action Plan on Integrated Air Pollution Prevention and Control in Autumn and Winter issued by the key regions – BTH and surrounding areas and the Fen-wei Plains – emphasizes selecting technical pathways to clean heating reform suited to local conditions, which provide a solution to the short supply of natural gas and electric power caused by the mandatory promotion of double replacements launched previously. The Plan clarifies that each region must determine the number of households for reform based on the volume of natural gas in existing signed supply contracts and the actual power supply capacity. In the absence of corresponding support infrastructure (i.e., natural gas pipelines and power grids), outdated heating equipment must not be dismantled without permission. At the same time, the Plan also greatly encourages innovative clean heating systems and advocates for a range of technologies characterized by high one-off upfront investments followed by low operating costs. Options include the utilization of solar energy, centralized utilization of biomass, centralized heating by electric power, thermal-storage electric heaters, and air source heat pumps.

The first batch of pilot cites completed reform tasks while the third batch of cities began the process

In 2019, the first batch of 12 pilot cities completed clean heating reform with fiscal support from the central government. Cities in the provinces of Hebei and Henan were key targets for reform. Financial support from the central government, combined with supporting funds from local governments, encouraged enterprises to enter the clean heating market. A three-year demonstration period was also launched with the aim of providing a model that could be replicated and promoted in other regions. According to statistics from the Ministry of Finance, the 12 pilot cities have completed clean heating reform covering 725 million square meters and involving 6.8391 million households, alongside energy-saving reconstructions of buildings covering 13.18 million square meters and involving 142,000 households. In 2020, the first batch of pilot cities will receive an overall performance evaluation.

Since the launch of the second batch of pilot cities in 2018, China has gradually intensified loose coal replacement and control in the major coal-producing provinces of Shanxi and Shaanxi. Coal-free areas established in these two provinces significantly reduced the use of coal. In 2019, 8 pilot cities were added to the third group, covering five key cities in the Fen-wei Plains. Specifically, Tongchuan became the first city in China to carry out a long-term clean heating plan for the winter season with a duration of eight years. This plan includes a three-year period for pilot implementation followed by a five-year period for consolidation. Tongchuan has committed to delivering a rural clean heating rate of above 65% -- higher than the national target of 60% -- by the conclusion of the pilot scheme in 2021. The number of additional households renovated for clean heating across the three batches of pilot cities is shown in Figure 35.

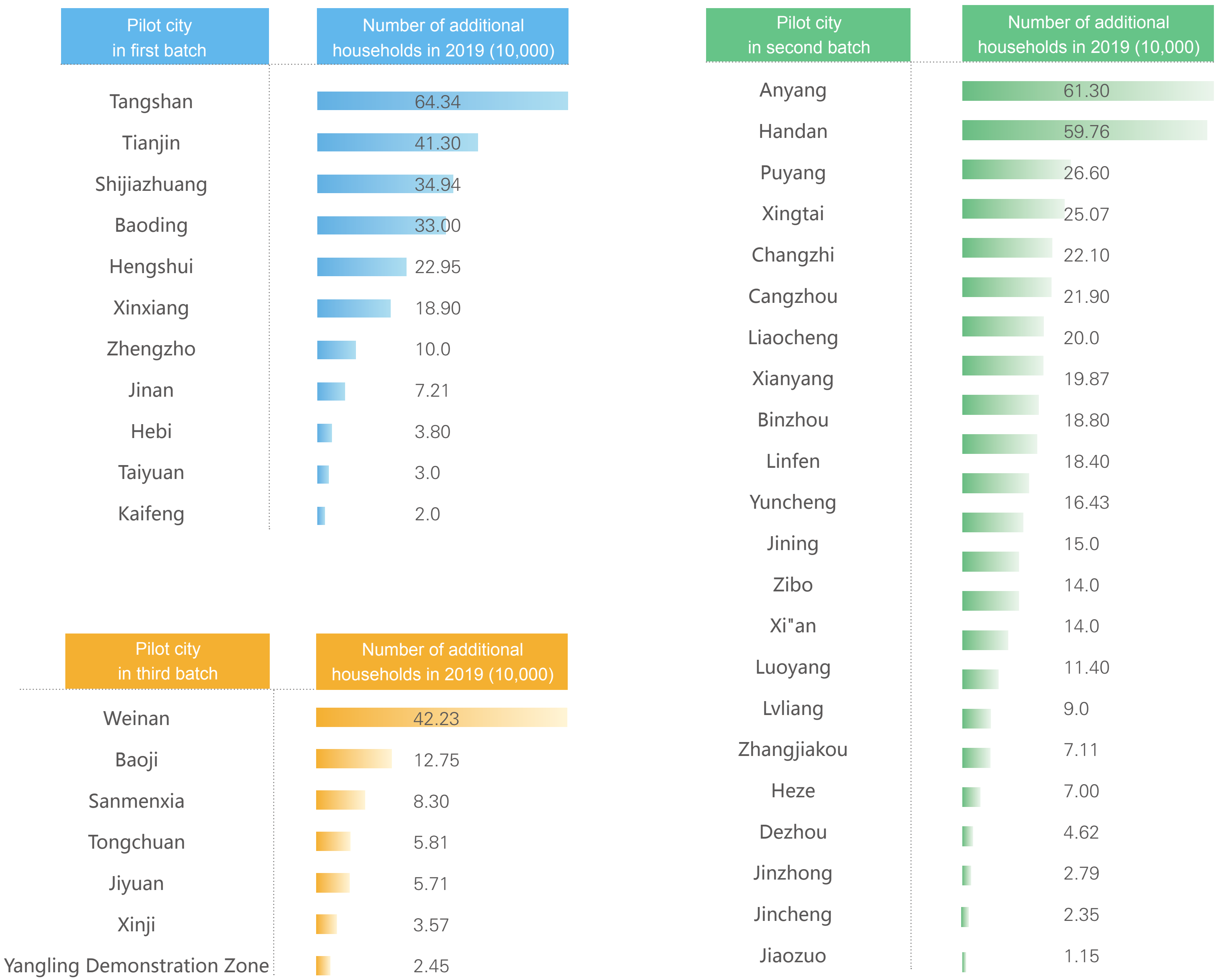

Fig. 35 Number of new households using clean heating in three batches of pilot cities in 2019

Integrated control of fugitive dust

Following the release of dustfall monitoring data for the first time in 2018, three key regions implemented regional dustfall assessment systems in 2019. Cities have adopted a series of control measures for fugitive dust on roads, construction sites, and during coal mining.

The General Office of the Ministry of Housing and Urban-Rural Development issued the Notice on Further Strengthening Fugitive Dust Control on Construction Sites and Roads, with a view to implementing effective dust control measures such as mechanized operations. The rate of road clearance by mechanization is an important factor in reducing fugitive dust on roads. According to the Notice, "by the end of 2020, the rate of road clearance by mechanization in built-up areas of cities at prefecture level and above shall exceed 70%, and the rate in county towns shall exceed 60%, and the rate in key regions such as BTH and surrounding areas, the YRD, and the Fen-wei Plains shall see significant improvements". In terms of completion, the rate of road clearance by mechanization in cities from the Guanzhong region of Shaanxi Province exceeded 95%, while cities in Jiangsu Province reached 87% and other cities reached over 80%.

For most cities among the "2+26" cities of the BTH region and surrounding areas, roads and construction sites are the main contributors of fugitive dust. Following concerted efforts, in 2019 the average dustfall across all cities in Hebei Province dropped by 28% year-on-year. Meanwhile, the dustfall in Beijing was 5.8 t/km^2 per month, down by 22.7% year-on-year. However, this level was still far higher than that in the YRD region.

To promote the integrated control of pollution from open-pit mines, the Ministry of Natural Resources and the MEE jointly issued the Letter of the Opinions on Speeding up the Integrated Improvement of Open-pit Mines. It outlined the following key tasks: thoroughly investigate and check mines for illegal mining practices; carry out integrated control; and strengthen ecological restoration. From 2014 to 2018, Hebei Province completed improvements for 949 open-pit mines, restored and afforested 48.8 km^2 of mine area and reduced the number of mines by 33%, effectively decreasing fugitive dust from mines.

Agricultural area sources

In 2019, satellite remote sensing detected 6,300 straw burning locations across China , 1,347 fewer than in 2018. The locations were found in provinces mainly in Northeast and North China, including Heilongjiang, Inner Mongolia, Jilin, Hebei, Shanxi, Liaoning, Anhui, Shandong, Hubei, and Henan. The provinces of Heilongjiang and Jilin, two major agricultural provinces, prioritised the prohibition of straw burning. Heilongjiang Province issued the Plan of Supervision on Effectively Addressing the Open Burning of Straw in 2019-2020, which established a system prohibiting straw burning and an accountability mechanism to strengthen local supervision. Once a straw burning location is found, the Department of Ecology and Environment, together with the financial department, would take a two-fold approach to deterrence through fines and public exposure via media.

Jilin Province went further to establish ten mechanisms, including a five-level guarantee system for the prohibition of straw burning (detailed to specific units, responsible persons, villages, plots and farmers), a grid-based supervision mechanism, an off-field mechanism, a planned system for burning and others. In particular, Jilin Province took the lead in issuing the Interim Measures of Jilin Province for Incentives to Eliminate Straw Burning which offered subsidies to collectives and individuals demonstrating outstanding performance in off-field practices and straw-burning prohibition.

Promoting the comprehensive utilisation of straw is key to solving the problem of straw burning at a grassroots level. Based on the five methods of straw utilization as defined by the NDRC (i.e., converting straw to fertilizer, energy, feedstuff, raw material, and base stock), the provinces of Heilongjiang and Jilin prioritised the utilization of straw as fertilizer (return-to-field) and vigorously promoted the off-field utilization of straw as biomass feed and fuel. The provincial finance department of Heilongjiang also granted a subsidy of RMB 4.3 billion to support the comprehensive utilization of straw, pushing the utilization rate to 81.9%. With the rate of direct return-to-field at 57.4%, Heilongjiang achieved the annual target of 55% ahead of schedule. Straw return-to-field can also greatly increase the use of organic fertilizer while reducing the volatilization and emission of ammonia in the air.

In addition, Jilin Province issued its Three-year Action Plan for the Comprehensive Utilization of Straw in Jilin Province (2019-2021), setting out a target of 79% for the full utilization rate of straw (i.e., the "five methods of utilization"). At the same time, the Plan stipulates that Jilin will continue to promote the development of industries such as power generation from straw burning, biomass fuel and natural gas (i.e., straw gasification), while striving to ensure that straw utilized as energy will account for 21% of the province's total straw output by 2021. By the end of 2019, the province had built 18 straw-burning power generation projects able to consume 3.8 million tons of straw annually.

Safeguarding Measures

In 2019, a system of enhanced supervision and fixed-point assistance was established based on existing environmental protection supervision. Through investigation, assignment, inspection, interviews, and special supervision, this comprehensive system urged and helped local governments to solve challenges in air pollution prevention and control as soon as possible and fulfill the policy requirements of the Three-year Action Plan. Additionally, in order to provide sufficient support for the Blue Sky Defense Battle, the central authority increased the amount of financial support available for air pollution prevention and control, reaching a total of RMB 25 billion. For the first time, the funding was allocated with clear directions for usage, covering clean heating objectives and priorities in the Blue Sky Defense Battle among other areas. Special funds were also newly allocated to managing the phaseout of ozone-depleting substances (ODS) with a view to achieving co-benefits in air pollution prevention and control and climate change mitigation.

Fixed-point assistance was made available to help local governments overcome difficulties in pollution control

In 2019, the MEE issued the Work Plan for the Enhanced Supervision and Fixed-point Assistance in Key Regions to Win the Blue Sky Defense Battle and the supporting Detailed Rules for the Implementation of Enhanced Supervision and Fixed-point Assistance in Key Regions to Win the Blue Sky Defense Battle. 300 working groups supporting enhanced supervision and fixed-point assistance ("working groups" in short) were dispatched to 39 cities across the BTH region and the Fenwei Plains to carry out a two-year period of assistance on a rolling basis (from May 2019 to March 2021).

Based on the Three-year Action Plan and the key regions' action plans for integrated air pollution prevention and control in autumn and winter, the working groups adopted a five-step approach consisting of "investigation, assignment, inspection, interview and special supervision". They implemented a system under the joint responsibility of the ministry authority (i.e., the dispatching entity), institutions that are directly affiliated, and the provincial departments of ecology and environment. The system is intended to assist local governments in expediting solutions to major challenges in air pollution prevention and control.

The working groups identified core issues related to priority areas, such as the double replacement of loose coal, control of scattered, unregulated and high-polluting enterprises, control of coal-fired boilers, and emergency response plans for heavy pollution days. On this basis, a list of issues was compiled and handed to local governments to facilitate the improvement of reform plans using a targeted, city-specific strategies. Subsequently, the working groups put forth suggestions and measures, before finally verifying progress on the developments. The system was not only oriented to local governments but also extended to enterprises to cover both targeted policy analysis and business training.

By the end of 2019, 24 rounds of fixed-point assistance had been carried out in key regions of China, resulting in the on-site inspection of 925,000 emission points and the assignment of 65,000 air pollution issues to local governments. Shaanxi Province carried out 20 rounds of enhanced supervision and fixed-point assistance for law enforcement authorities to conduct special examinations of enterprises with air pollutant emissions in the Guanzhong region. 569 enterprises were examined, and problems were found in 403 of them. The problems were subsequently addressed in 96.7% of those cases.

Supervision systems were established and improved, stressing the integration of environmental protection and socio-economic development

In June 2019, the General Office of the CPC Central Committee and the General Office of the State Council issued the Regulations of the Supervision on Ecological and Environmental Protection by the Central Government. For the first time, these regulations outlined the basic framework for inspection and the division of duties among each related party in the form of internal party regulations. A two-tier (central and provincial level) supervision system and three supervision methods (routine supervision, special supervision, and retrospective supervision) were also established. The most important improvement in the supervision system was the shift from a singular focus on ecological and environmental protection towards integrated and sustainable development compatible with both the economy and society. On one hand, this system enhanced the competitiveness of environmentally friendly enterprises and accelerated the formation of a green industry layout; on the other hand, the regulatory measures emphasized the prohibition of a "one size fits all" approach, aiming to eradicate the root causes of problems such as perfunctory shutdowns by local governments and rebounds in pollution levels.

In the second round, the first group of 8 ecological and environmental protection supervision teams from the central government were stationed in 6 provinces as well as 2 state-owned enterprises (China Minmetals Corporation and ChemChina) in July 2019. This was the first time that state-owned enterprises were included within the scope of supervision. By end of 2019, supervision teams had handled 198,000 reports from the public, and assigned over 542 major ecological and environmental issues to local governments to address.

Interviews urged non-attainment cities to develop solutions

In 2019, local governments that were interviewed had to submit remediation plans to the MEE within 20 working days and disclose these plans to the public. This indicates that plans must be drawn up as soon as possible to help non-attainment regions meet air quality improvement targets by the end of 2020. Local governments were selected for interview by the MEE and governments at higher levels if they experienced deteriorating air quality, acquired low rankings, or failed to meet targets for improvement.

Failure to achieve targets for air quality improvement

The MEE interviewed the local governments of six cities, Baoding, Langfang, Luoyang, Anyang, Puyang and Jinzhong, because they failed to reach targets for air quality improvement in the autumn and winter seasons of 2018-2019. The main problems included lax supervision over the resumption of loose coal burning, low quality of fuel products, and industrial pollution. The Shaanxi Provincial Department of Ecology and Environment interviewed Xi'an and Xianyang for failing to complete annual evaluation tasks related to $PM_{2.5}$ in 2018. Xianyang ranked lowest in the province in terms of air quality.

Deteriorating level of air quality

The Hebei provincial government interviewed the local governments of Handan, Xingtai and Hengshui due to their year-on-year increases in $PM_{2.5}$ concentration. Shanxi Province interviewed key officials in charge of 11 county (city) governments (Jiexiu, Wenshui County, Pingyao County, Fenyang, Qi County, Lingshi County, Xiaoyi, Jishan County, Xinjiang County and Taigu County). Meanwhile, Shaanxi Province interviewed 8 cities (districts) including Baoji, Tongchuan, Yulin, Ankang, Shangluo, Yangling Demonstration Zone, Xixian New Area and Hancheng. Due to significant rebounds in $PM_{2.5}$ and PM_{10} pollution, officials in charge of the governments of 6 cities, Qingdao, Zaozhuang, Yantai, Tai'an, Dezhou and Liaocheng, were requested to attend interviews and further reinforce their air quality alerting systems.

Low ranking in air quality

The Henan provincial government interviewed the local governments of three cities (Luoyang, Anyang and Puyang) and ten counties (Linzhou, Yuzhou, Neihuang County, Wen County, Tangyin County, Nanle County, Lingbao, Puyang County, Xiangcheng County and Yichuan County) with low rankings in air quality. The government of Tianjin interviewed the local governments of five districts that ranked lower in air pollution control. The Xi'an government collectively interviewed the local governments of 20 districts and townships that ranked among the lowest 20 in terms of comprehensive indicators combining PM_{10}, $PM_{2.5}$ and O_3.

Central government financing for pollution control steadily increased, with the largest proportion of funds allocated to clean heating

In 2019, central government financing for air pollution prevention and control covered 27 provinces and municipalities across China (except Tibet). Funds were allocated to three areas: pilot programs for clean heating, key priorities under the Blue Sky Defense Battle, and the destruction of hydrofluorocarbons. The funds increased to 25 billion, marking a year-on-year increase of RMB 5 billion. The largest proportion of funding went to clean heating pilot programs, totalling RMB 15.2 billion. The provinces receiving the most financial support from central authorities were Hebei Province, Henan Province, Shandong Province, Shanxi Province and Shaanxi Province in order of the amount given. The allocation of funding for Blue Sky Defense Battle priorities across all provinces in 2019 is shown in Figure 36.

In addition, the Ministry of Finance earmarked RMB 206 million for the destruction of hydrofluorocarbons for the first time. It signified that China had fulfilled its international climate commitments as scheduled under the Kigali Amendment to the Montreal Protocol. Coming into force in 2019, this international convention aimed to reduce and phase out HFCs as refrigerants in the refrigeration equipment industry (such as refrigerators and air conditioners). Emission reduction measures led to greater improvements in the management of the ODS phaseout, significant reductions in industrial pollution, and coordinated control of greenhouse gas emissions.

Hebei Province continued to increase financial support at the local level by injecting RMB 8.23 billion – higher than the amount allocated by the central government. The funds mainly aimed to support clean heating, pollution control for open-pit mines, promotion of new energy vehicles, shutdown and phaseout of thermal power plants, and awards and subsidies for natural gas storage facilities. Moreover, an innovative green financing model for multilateral development banks was introduced for clean heating in the BTH region, which improved the quality of project designs and filled the domestic financial gap. In

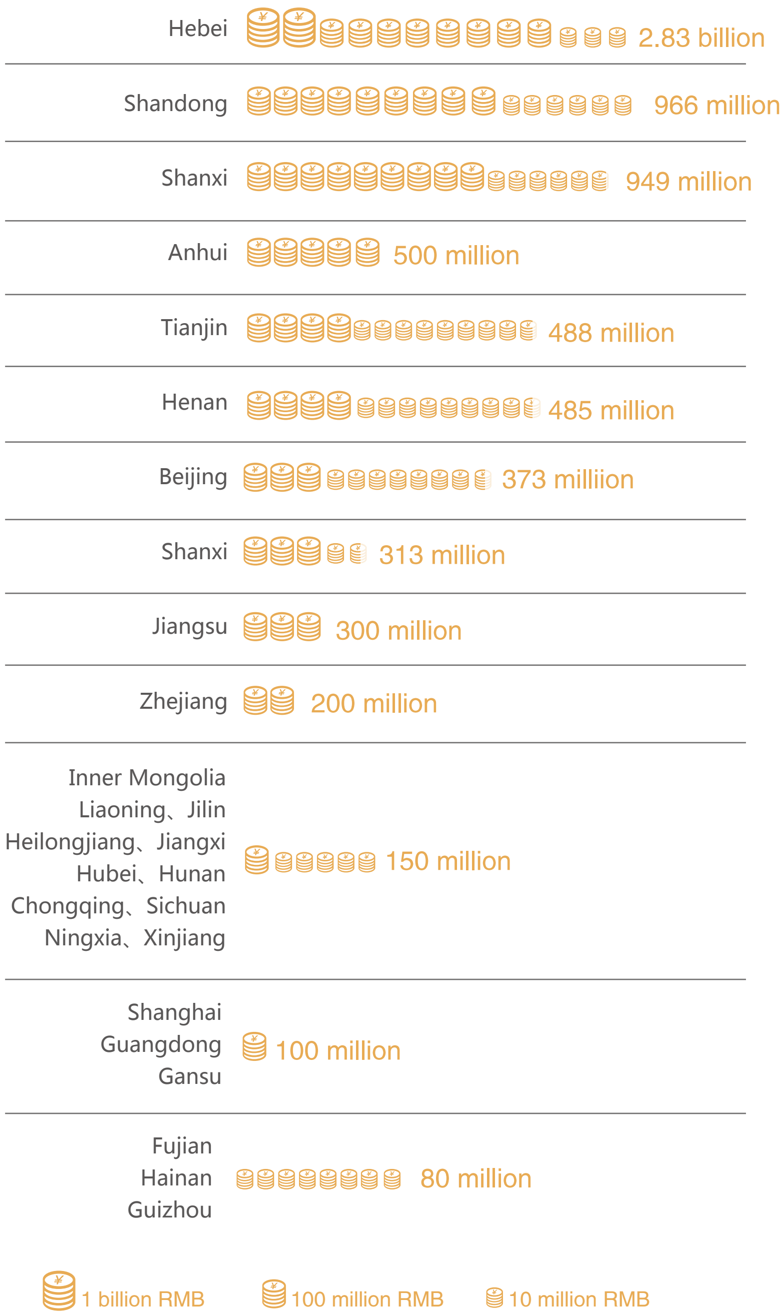

Fig. 36 Allocation of funds from the central government to the Blue Sky Defense Battle in 2019

2019, Beijing Gas cooperated with the Asian Infrastructure Investment Bank once again to successfully obtain a second round of funding, totalling USD 500 million, for air quality improvement projects in the BTH region. This cooperation helped accelerate the construction of coal-to-gas infrastructure and reduced indoor air pollution.

Additionally, in late October 2019, the Ministry of Finance released its 2020 funding arrangement plan for air pollution prevention and control for the first time. Released ahead of schedule, the plan narrowed its scope from the whole of China down to three key regions and reduced the total amount of funds to RMB 21.45 billion. Among this, funding for clean heating pilot programs was cut to RMB 11.95 billion. Specifically, the provinces of Shandong and Shaanxi saw the biggest increase in special funds to deliver key priorities under the Blue Sky Defense Battle, up by around RMB 400 million each.

Various regions have identified their priority areas in pollution prevention and control, and achieved notable results in pollution control during the autumn and winter seasons

Under the framework for regional collaboration on air pollution prevention and control, key regions defined their priorities through annual high-level meetings with a view to better ensuring the effective implementation of actions in autumn and winter. For the BTH region and its surrounding areas, the focus was on clean heating, adjustment of the transport structure and responses to heavy pollution days. The Fen-wei Plains region focused on controlling loose coal and scattered, unregulated and high-polluting enterprises, as well as the control of pollution from motor vehicles and the integrated control of fugitive dust. For the YRD, the focus was on strengthening the control of pollution from mobile sources and continuing to promote ultra-low emission retrofitting in industries like iron and steel.

The collaborative regional accountability-sharing mechanism for emissions reduction was further improved and played an important role in air pollution prevention and control over the autumn and winter seasons. Across all three regions, action plans for air pollution prevention and control in autumn and winter indicated that each city must assign tasks to a specific district, county and relevant department, identify the person responsible at each level, and set a timetable in order to strengthen the participation and responsibility of local governments. Furthermore, a regular dispatch system tracking the completion status of key tasks was established with the aim of regularly carrying out retrospective activities to strengthen supervision. According to the MEE, actions over the autumn and winter seasons have achieved the best results over the past three years. The three key regions surpassed their targets, with the average concentration of $PM_{2.5}$ down by more than 10% year-on-year and the number of heavy pollution days down by more than 30%.

Chapter III.

Assessment of Cities' Air Quality Management

In 2018, CAA developed a method to assess air quality management building upon the air quality management framework. Based on the idea of the Clean Air Scorecard, this method evaluates air quality improvement, assesses the implementation of policies and measures, and ranks cities according to their comprehensive score. Distinct from traditional city rankings for air quality, this report adopts a comprehensive approach to assessment which enables a more extensive evaluation of cities' efforts and achievements in air pollution control.

The Clean Air Scorecard was developed by CAA in 2010 with the support of the Asian Development Bank. It aimed to provide a comprehensive assessment method for air quality management in Asian cities. The tool has since been evaluated and used in many cities across China, Southeast Asia and South Asia, and was further optimized after multiple revisions. Drawing learnings from previous assessments of the tool, China Air redesigned the scoring method to better correspond with the characteristics of China's policy implementation and assessment system for air pollution prevention and control.

Scoring Method

The assessment tool grades cities on two indicators: air quality improvement and policies and measures. The full mark is 100 and each of indicator accounts for 50 points, emphasizing that both efforts and outcomes are equally important in air pollution control. Cities demonstrating significant improvements in air quality and pioneering practices in policies and measures may gain bonus points beyond a perfect mark of 100 points. In this context, pioneering practices refer to more advanced measures and stricter standards which go beyond current national policies and requirements. Meanwhile, cities interviewed by the MEE due to their poor performance in air pollution prevention and control will have points deducted.

The assessment of air quality improvement is based on two sub-indicators: the three-year moving average improvement range of $PM_{2.5}$ (i.e., the improvement range of average $PM_{2.5}$ concentration in 2017-2019 compared with 2016-2018) and the three-year moving average for the improvement range of attainment days. Comparing three-year moving averages can reduce the impact of factors such as meteorological fluctuations in air quality during a certain year, and more objectively reflects air quality improvements by the cities in recent years. This component is deemed as the "effect score" for air quality management.

The indicator for policies and measures includes five sub-indicators: stationary sources, mobile sources, area sources, capacity building, and safeguarding measures. Each sub-indicator also has several sub-items; the score for a sub-indicator is determined by aggregating the scores for its sub-items. This component is deemed the "effort score" for air quality management. The structure of the assessment tool is shown in Figure 37.

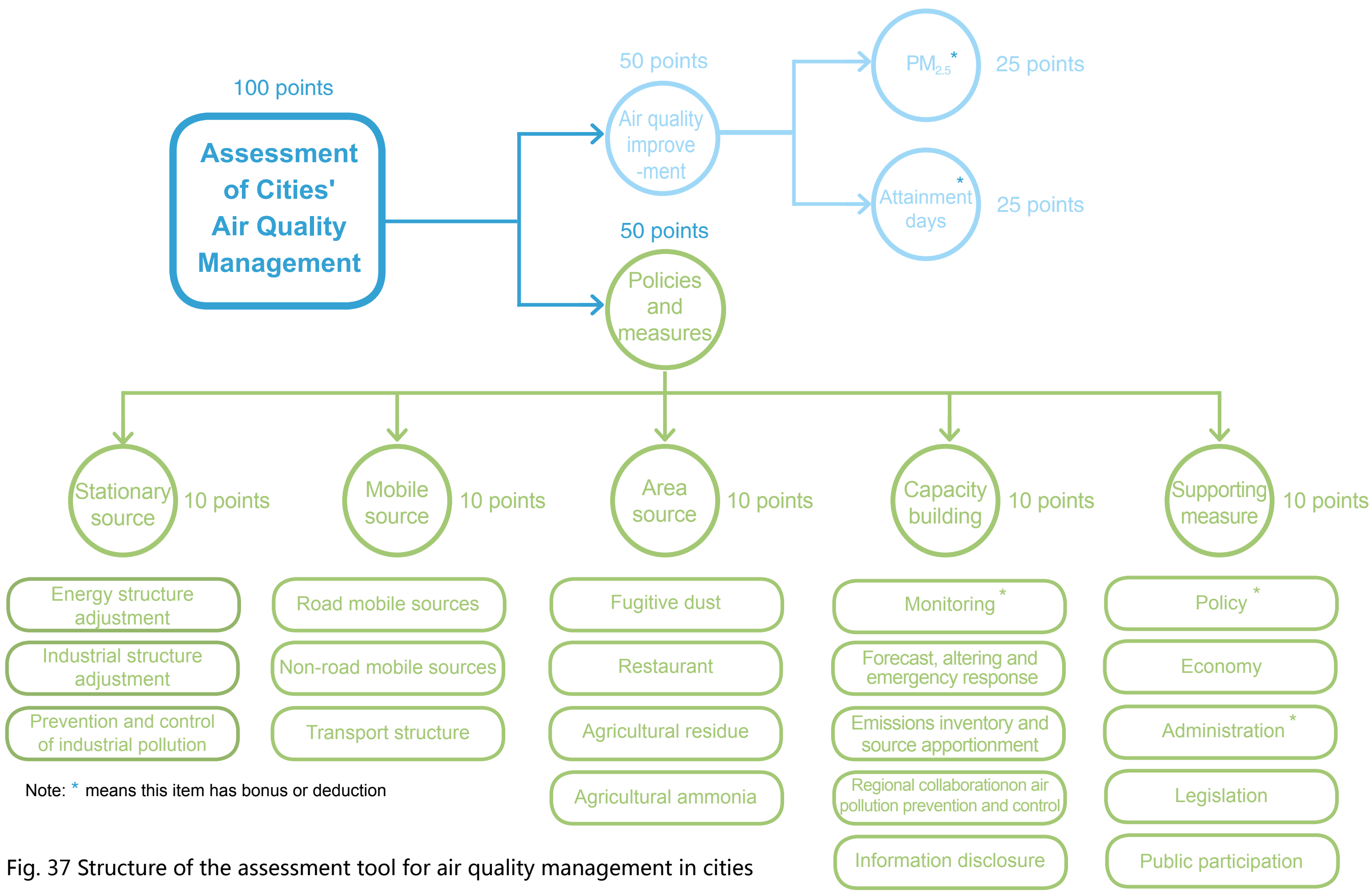

Fig. 37 Structure of the assessment tool for air quality management in cities

A sample graph of the final score is shown in Figure 38.

Fig. 38 Sample graph of final score from the assessment tool

Score analysis and city rankings

Based on the assessment framework, this section of the report ranks and analyzes the two scores for 168 cities: scores on air quality improvement and scores on policies and measures. It seeks to examine the progress and achievements cities have made in air quality improvement as well as the policies and measures they have put in place. Finally, this report ranks the cities based on the comprehensive score across both indicators. The list highlights cities with good scores in both effectiveness and effort in order to encourage other cities to consistently improve air quality by making continuous efforts. Meanwhile, the list also motivates cities which performed poorly in both areas to take proactive action and try to improve their standings.

Air Quality

The scoring criteria for air quality are designed to encourage cities to make constant improvements in air quality. Cities can gain different base scores according to their current air quality status, and either acquire or lose points according to their degree of improvement or decline. This means that cities which have already met air quality standards can obtain a high score if they make ongoing improvements, while cities with poor air quality must make greater improvements to boost their scores. Conversely, cities with excellent air quality that have experienced declines will have their score reduced, while cities with poor air quality which deteriorates further will likely rank among the poorest performers. Scores for air quality improvement in the 168 cities are shown in Table 2.

Table 2 Ranking of air quality improvement scores for 168 cities

Rank	City	Air Quality Improvement Score
1	Lhasa	66.56
2	Yinchuan	61.68
3	Meishan	60.07
4	Luzhou	58.78
5	Taizhou	56.22
6	Neijiang	55.69
7	Lanzhou	54.69
8	Lishui	53.51
9	Xining	53.46
10	Ziyang	52.66
11	Pingxiang	52.63
12	Zhangjiakou	52.61
13	Huzhou	52.33
14	Jinhua	52.3
15	Beijing	52.03
16	Zhoushan	51.94
17	Chongqing	51.51
18	Chengde	51.06
19	Suining	50.85
20	Chengdu	50.43
21	Mianyang	50.33
22	Zigong	50.24
23	Yichun	50.17
24	Haikou	50.09
25	Datong	50
	Rizhao	50
	Baotou	50
	Shenyang	50
	Dalian	50
	Shanghai	50
	Wenzhou	50
	Ningbo	50
	Quzhou	50
	Jiaxing	50
	Shaoxing	50
	Hangzhou	50
	Suzhou	50
	Nantong	50
	Nanjing	50
	Wuxi	50

Rank	City	Air Quality Improvement Score
25	Xuancheng	50
	Leshan	50
	Guang’an	50
	Ezhou	50
	Huanggang	50
	Xianning	50
	Nanchang	50
	Xinyu	50
	Changchun	50
	Guiyang	50
51	Deyang	49.82
	Fuzhou	49.82
53	Xiamen	49.45
	Kunming	49.45
55	Zhaoqing	49.42
56	Huizhou	49.41
57	Nanchong	49.38
58	Langfang	49.19
59	Huangshan	48.81
60	Hengshui	48.72
61	Qingdao	48.65
62	Lu’an	48.62
63	Nanning	48.54
64	Jingzhou	48.48
65	Yancheng	48.15
66	Guangzhou	48.11
67	Qinhuangdao	48.07
68	Shenzhen	47.89
69	Suizhou	47.61
70	Foshan	47.53
71	Hohhot	47.48
72	Tongchuan	47.41
73	Huangshi	47.4
74	Baoding	47.18
75	Zhuhai	46.99
76	Jiangmen	46.85
77	Dazhou	46.66
78	Changzhi	46.59
79	Dongguan	46.31
80	Zhongshan	45.99
81	Xinxiang	45.95
82	Huai’an	45.59
83	Lianyungang	45.44
84	Jinzhou	45.37
85	Ya’an	45.23
86	Jinzhong	45.14
87	Shuozhou	45.11
88	Baoji	44.48
89	Harbin	44.26
90	Weifang	43.97
91	Anqing	43.9
92	Liaocheng	43.83
93	Tianjin	43.75
94	Wuhan	43.7
95	Yibin	43.67
96	Chuzhou	43.48
97	Chaoyang	43.44
98	Hefei	43.21
99	Xinzhou	42.57
100	Changde	41.45
101	Yichang	41.37
102	Urumqi	41.3
103	Yangquan	41.23
104	Luohe	41.13
105	Xianyang	41.02
106	Taizhou	40.97

Rank	City	Air Quality Improvement Score
107	Xinyang	40.65
108	Lvliang	40.51
109	Yueyang	40.44
110	Tongling	40.13
111	Changsha	40.12
112	Wuhu	39.96
113	Weinan	39.72
114	Bengbu	39.69
115	Changzhou	39.65
116	Cangzhou	39.57
117	Jinan	39.28
118	Shijiazhuang	39.26
119	Jiujiang	39.1
120	Yangzhou	39.09
121	Tangshan	38.51
122	Zaozhuang	38.43
123	Zhengzhou	38.31
124	Dezhou	38.24
125	Xi'an	37.65
126	Maanshan	37.49
127	Dongying	37.42
128	Zhuzhou	37.23
129	Sanmenxia	37.14
130	Shangqiu	36.9
131	Suzhou	36.64
132	Huludao	36.5
133	Xiaogan	36.23
134	Suqian	36.04
135	Chizhou	35.7
136	Luoyang	35.18
137	Xiangtan	35.18
138	Zibo	34.92

Rank	City	Air Quality Improvement Score
139	Zhenjiang	34.91
140	Xingtai	34.74
141	Zhumadian	34.11
142	Binzhou	33.86
143	Tai'an	33.45
144	Jingmen	32.9
145	Yiyang	32.57
146	Jiaozuo	32.47
147	Pingdingshan	31.55
148	Puyang	29.93
149	Heze	29.63
150	Zhoukou	28.48
151	Hebi	28.33
152	Linyi	27.75
153	Handan	26.87
154	Fuyang	26.77
155	Jining	26.64
156	Nanyang	25.99
157	Xiangyang	25.52
158	Anyang	25.41
159	Taiyuan	24.69
160	Huaibei	23.44
161	Xuchang	23.3
162	Xuzhou	23.05
163	Kaifeng	20.66
164	Bozhou	20.29
165	Jincheng	20.11
166	Huainan	19.82
167	Yuncheng	17.85
168	Linfen	16.54

Based on the scores for air quality improvement, the following section divides cities into five categories: "excellent", "good", "ordinary", "poor", and "underperforming". The distribution of scores is shown in Table 3 and Figure 39.

Table 3 Distribution of air quality improvement scores for 168 cities

Range of Score	Improvement	Number of cities	Average concentration of $PM_{2.5}$ in 2017–2019	Average improvement rate compared with 2016–2018	Average number of attainment days in 2017–2019	Average improvement rate compared with 2016–2018
>50	Excellent	24	37.19	11.99%	301	5.24%
(45, 50]	Good	63	40.58	7%	290	2.18%
(30, 45]	Ordinary	60	54.43	6.59%	232	0.96%
(15, 30]	Poor	21	61.76	4.78%	195	–5.45%
⩽ 15	Underperforming	0	–	–	–	–

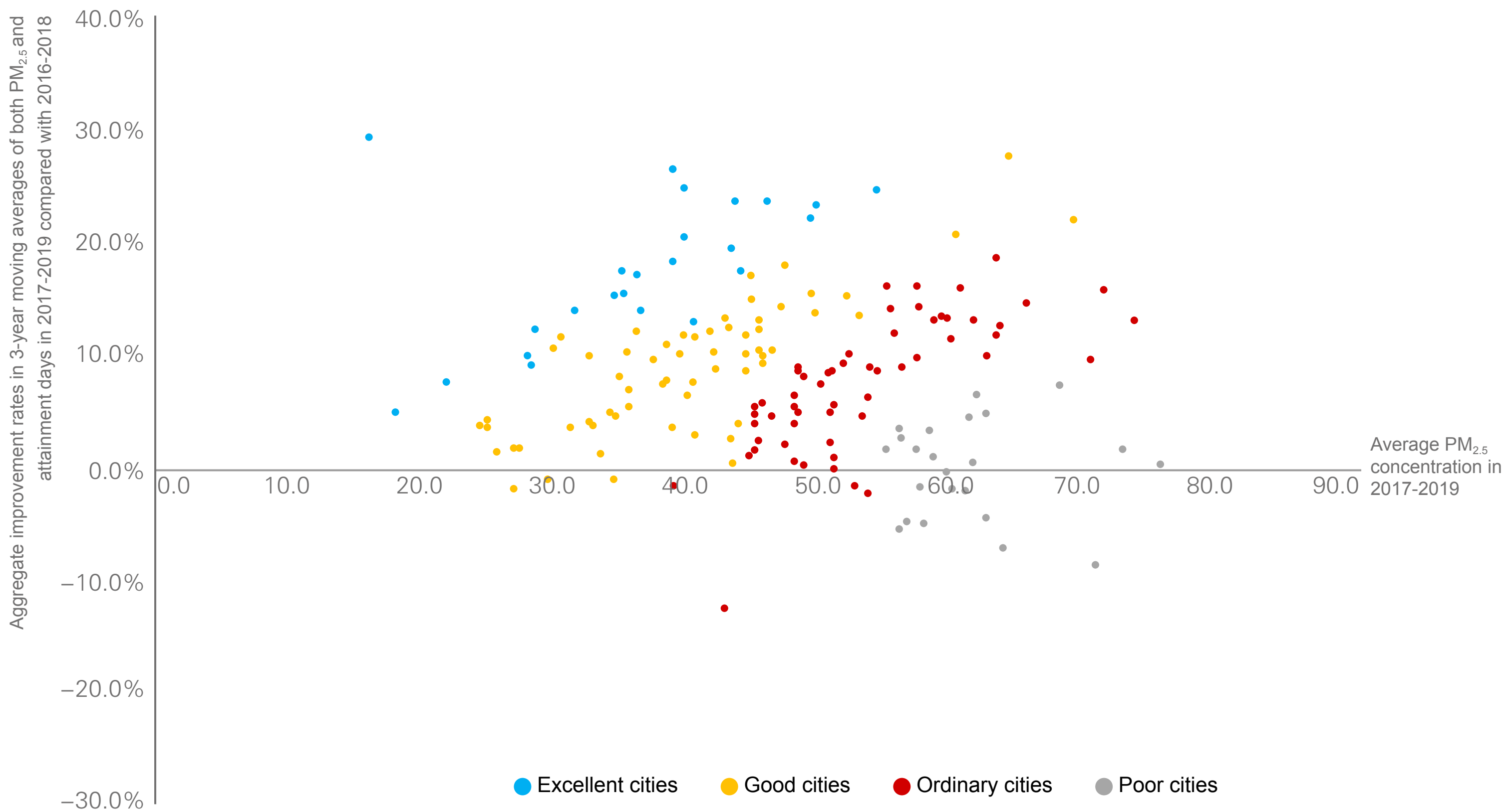

Fig. 39 Improvement rates of three-year averages of $PM_{2.5}$ concentration and attainment days in 2017-2019 compared with 2016-2018

Compared with air quality improvement assessment results in China Air 2019, the number of cities with scores ranked as "excellent" and "good" remain the same as the previous year. Since the overall scores among the poorest performers rose significantly compared to the previous year, no city was added to the rank of "underperforming" cities while the lowest score was 16.54. These results show that cities with noticeable improvements in air quality in China have generally maintained that condition, while cities with minimal improvements strove to progress, thereby raising the average level of the poorest performers.

Cities ranked as "excellent": cities in the provinces of Sichuan and Zhejiang saw the largest degrees of air quality improvement

Cities are ranked as "excellent" (score >50) if they inherently have good air quality and achieve continuous improvements in $PM_{2.5}$ levels and attainment days. Some cities which do not yet meet air quality standards but have shown evident improvements may also be ranked in this category. 24 cities gained bonus points and their scores exceeded the full mark of 50. 13 cities from the provinces of Sichuan and Zhejiang make up half of the cities in the "excellent" rank.

Eight cities in Sichuan Province were ranked as "excellent", including the provincial capital of Chengdu and small and medium-sized cities such as Meishan, Luzhou, Neijiang, Suining, Ziyang, and Mianyang. Among them, Neijiang, Suining and Ziyang met the standard for $PM_{2.5}$ in 2019. Air quality improvement in these cities can be attributed to the effective resolution of a number of long-standing challenges in 2019, including the elimination and renovation of scattered, unregulated and high-polluting enterprises as well as the control of fugitive dust on construction sites. The level of management for the atmospheric environment in key industries such as sand, brick and tile, and commercial concrete also improved significantly. Five cities in Zhejiang Province (i.e., Taizhou, Lishui, Huzhou, Jinhua and Zhoushan) made steady improvements after meeting $PM_{2.5}$ standards and were placed in the "excellent" rank.

Air quality in Lhasa topped the rankings and continued to improve year after year following attainment. In 2019, its $PM_{2.5}$ concentration was close to the level stipulated by WHO guidelines (10 μg/m^3) and exceeded the standard on only one day in the whole year. In 2019, Lhasa was also the first among 168 key cities in the air quality rankings released by the MEE. Zhangjiakou, Chengde and Haikou were also ranked as "excellent" due to good air quality and continuous improvements. Specifically, Zhangjiakou and Chengde saw significant air quality improvements compared to the previous assessment, leading to their large ascent in the rankings.

The list of cities ranked as "excellent" also included three provincial capitals in Northwest China, namely Yinchuan, Lanzhou, and Xining. The three-year moving averages of their improvement range for $PM_{2.5}$ reached over 10% while the number of attainment days rose steadily. The annual mean concentration of $PM_{2.5}$ in Yinchuan and Xining met the standard for the first time in 2019, and the concentration in Lanzhou came close to meeting the standard at 36 μg/m^3. The rest of the cities on the list were those that did not meet air quality standards but have shown evident improvements, including Beijing, Chongqing, Pingxiang and Yichun.

Cities ranked as "good": this list was dominated by cities from three traditional key regions with slower rates of improvement

Cities ranked as "good" (score: 45-50) have achieved either good air quality improvements or have inherently excellent air quality with slight, continuous improvements. This list has 63 cities, including many cities located in the BTH region and surrounding areas, the YRD region, and all cities from the PRD. While cities in the BTH region and surrounding areas had poorer air quality, they maintained the momentum of improvement. Meanwhile, while nine cities in the PRD had inherently good air quality, they failed to make the list of "excellent" cities since they did not make notable improvements and saw declines in attainment days. Other than the cities ranked as "excellent", most cities in the YRD were ranked as "good" because their improvement ranges were relatively small while their air quality remained good and their progress steady.

Some cities which ranked as "excellent" in 2018 dropped to the ranking of "good" in 2019 due to narrowing improvement ranges or even slight deteriorations in $PM_{2.5}$ or the number of attainment days. These cities include Changchun, Huangshan, Dalian, Shenyang, Qingdao, Shanghai, Wenzhou, Jiaxing and Shaoxing.

Cities ranked as "ordinary": Some cities in Shandong Province fell sharply in the rankings due to rising $PM_{2.5}$ concentrations

Cities ranked as "average" (score: 30-45) include 60 cities, most of which had higher three-year average values of $PM_{2.5}$. Two thirds of this cohort had annual mean concentrations of $PM_{2.5}$ above 50 μg/m^3. Although these cities have improved to varying degrees in recent years, the number of attainment days remained low and registered minimal improvements or even deteriorations. Most of the cities in Shandong experiencing worsening $PM_{2.5}$ levels in 2019 ranked as "ordinary". Jinan, Liaocheng, Dezhou, Zaozhuang, and Zibo were among the cities that dropped sharply in effect scores compared to the previous assessment.

In addition, some cities were added to this ranking if they had fair air quality but experienced varying degrees of deterioration or a decreasing number of attainment days. For example, Zhaoyang ranked as "ordinary" since it had annual mean $PM_{2.5}$ concentration below 40 μg/m^3 over the last five years, but made minimal improvements and saw a slight decline in the three-year average of attainment days. Likewise, the annual mean concentration of $PM_{2.5}$ in Yiyang increased from 35 μg/m^3 in 2018 to 54 μg/m^3 in 2019, which was higher than the concentration levels in previous years and increased by 54.3%. This led to a significant deterioration in the three-year moving average of $PM_{2.5}$ and attainment days; as a result, Yiyang's ranking dropped to "ordinary" from its previous rank as "excellent", becoming the city with the biggest reduction in ranking.

Cities ranked as "poor": these cities, which generally saw reductions in attainment days, were mainly located in the provinces of Henan, Anhui, and Shanxi

Cities ranked as "poor" (score: <30) are characterized by inherently poor air quality and a reduction in attainment days over the past few years. 21 cities were put on this list. Their three-year average concentrations of $PM_{2.5}$ ranged from 56.6 μg/m^3 to 73.6 μg/m^3, and their three-year moving average in the number of attainment days generally decreased. Only Puyang saw an increase of 1.87% in the number of attainment days, while other cities' decreases ranged from 0.67% to 13.75%. Most of these cities are in the provinces of Henan, Anhui, and Shanxi, with 9 of the 10 poorest-performing cities also among the bottom 10 in the last assessment in China Air 2019. Huainan, Yuncheng and Linfen all scored fewer than 20 points for air quality improvement, becoming the lowest three cities on the list. Once again, Linfen ranked in the lowest place after taking the same position in the previous year.

Analysis of changes in rankings

As the air quality assessment period changed from 2015-2018 to 2016-2019, three-year moving averages in air quality data were also dynamically altered. This in turn affected the changes in rankings among the cities. More specifically:

Cities that dropped in rankings

Some of the top-ranked cities from 2015 to 2018 were characterized by heavy pollution and great progress: they had high $PM_{2.5}$ concentrations and few attainment days in 2015, but showed steady improvements from 2016 to 2018 and achieved great progress in 2018 compared with 2015 – earning them relatively high scores. However, during the following assessment period from 2016 to 2019, heavy pollution had already been alleviated and subsequent improvements were far less evident than before. For example, while cities like Hengshui, Jingzhou, Yancheng, Zhengzhou, and Pingdingshan still sustained their air quality improvements, their scores and rankings were reduced due to a narrowing margin for improvement. Other cities saw year-on-year deteriorations in 2019 which drove up the three-year moving average value from 2017 to 2019. Consequently, the average concentration showed limited improvements and sometimes even worsened compared with 2016-2018 levels, resulting in lower rankings. Such cities include Lianyungang, Jinzhou, Liaocheng, Wuhan, Jinan, Dezhou, Zibo, Xiaogan, Heze, Linyi, Jining, Xuchang.

Among the top-ranking cities from 2015 to 2018, some were characterized by good air quality and steady progress. They achieved high scores due to good air quality and steadfast improvements over several years. However, in 2019, cities such as Yiyang, Kunming, Huangshan, Qingdao, Shenzhen, Nanning, Dalian, Shenyang, Harbin, Zhuhai, Qinhuangdao and Chaoyang saw worsening $PM_{2.5}$ concentration levels and/or a decreasing number of attainment days, leading to lower rankings. However, generally speaking, the performance of these cities was still satisfactory.

Cities rising in rankings

Evident improvements in air quality was the main reason for the rise in the rankings in 2019. Some cities which were previously in the middle of the overall rankings, including Beijing, Chengdu, Zhangjiakou, Datong, and Xining, received higher rankings after their scores were boosted by significant year-on-year improvements in 2019.

Some cities with poor air quality ranked low on the list after experiencing deteriorations in 2016 compared to 2015. In the assessment period from 2017 to 2019, air quality in these cities improved steadily and they moved up the rankings as a result. These cities include Yinchuan, Lanzhou, Pingxiang, Mianyang, Zigong, Yichun, Xuancheng, Xinyu, Lu'an, Tongchuan, Changzhi, Jinzhong, Yangquan.

Policies and Measures

The indicator for policies and measures covers measures taken by cities to control emissions from stationary sources, mobile sources, and area sources. It also includes capacity building measures to support scientific policy implementation, and safeguarding measures to promote the effective implementation of the policies. The scores for policies and measures in 168 cities are shown in the following table.

Table 4 Ranking of policies and measures scores for 168 cities

Rank	City	Score for Policies and Measures
1	Beijing	53.61
2	Guangzhou	52.66
3	Shanghai	52.31
4	Chengdu	52
5	Tianjin	51.78
6	Qingdao	51.47
7	Shenzhen	51.31
8	Wuhan	51.31
9	Hangzhou	50.88
10	Zhengzhou	50.51
11	Jinan	50.29
12	Chongqing	49.67
13	Nantong	49.63
14	Harbin	49.41
15	Nanjing	49.34
16	Xiamen	49.07
17	Nanning	49.03
18	Ningbo	48.93
19	Foshan	48.91
20	Xuzhou	48.72
21	Jining	48.54
22	Xi’an	48.49
23	Shijiazhuang	48.38
24	Yinchuan	48.29
25	Zhaoqing	48.22
26	Dalian	48.19
27	Fuzhou	48.18
28	Lanzhou	48.12
	Changzhou	48.12
30	Zigong	48.07
31	Taiyuan	48.04
32	Hefei	48.02
33	Luzhou	48.01
34	Nanchang	47.87
35	Changchun	47.79
36	Lianyungang	47.76
37	Changsha	47.62
38	Xiangyang	47.47
39	Suzhou	47.44
40	Jiangmen	47.4
41	Zhongshan	47.1
	Handan	47.1
43	Yangquan	47.04
	Tangshan	47.04
	Binzhou	47.04
46	Yangzhou	47.03
47	Huizhou	47.01
48	Haikou	46.95
49	Dongguan	46.69
50	Zhuhai	46.61

Rank	City	Score for Policies and Measures
51	Dezhou	46.6
52	Wenzhou	46.53
	Zhenjiang	46.53
54	Tongchuan	46.47
	Zibo	46.47
56	Shaoxing	46.46
57	Yancheng	46.39
	Qinhuangdao	46.39
59	Xinxiang	46.31
60	Zaozhuang	46.17
61	Jinhua	46.16
62	Jiaxing	46.1
63	Kaifeng	46.06
64	Xingtai	46.04
65	Taizhou	46.03
66	Guiyang	46.01
67	Huangshi	46
68	Huangshan	45.99
69	Taizhou	45.98
70	Chengde	45.97
	Hengshui	45.97
	Cangzhou	45.97
73	Zhuzhou	45.94
74	Changzhi	45.91
75	Hohhot	45.89
76	Quzhou	45.86
77	Zhoushan	45.85
78	Shenyang	45.83
79	Guang'an	45.82
80	Yueyang	45.8

Rank	City	Score for Policies and Measures
81	Xining	45.77
82	Urumqi	45.76
83	Wuxi	45.75
84	Pingdingshan	45.73
85	Hebi	45.69
86	Zhumadian	45.67
	Jiaozuo	45.67
88	Lishui	45.66
	Huainan	45.66
90	Huai'an	45.55
91	Changde	45.54
92	Ziyang	45.53
93	Fuyang	45.51
94	Huzhou	45.48
	Bengbu	45.48
96	Mianyang	45.47
	Baoding	45.47
98	Deyang	45.46
99	Xianyang	45.37
100	Zhangjiakou	45.23
	Liaocheng	45.23
102	Jingzhou	45.21
103	Shuozhou	45.17
104	Chuzhou	45.16
	Suqian	45.16
106	Xinzhou	45.1
107	Leshan	45.09
108	Anqing	45.07
109	Neijiang	45.06
110	Suining	45.05

Rank	City	Score for Policies and Measures
111	Linyi	45.04
112	Ma'anshan	45.01
	Chizhou	45.01
114	Linfen	44.97
115	Datong	44.89
116	Tai'an	44.8
117	Heze	44.73
118	Nanyang	44.71
119	Lvliang	44.67
120	Huanggang	44.66
	Xiaogan	44.66
122	Shangqiu	44.62
123	Yibin	44.6
124	Jiujiang	44.49
125	Xianning	44.47
126	Yuncheng	44.39
127	Meishan	44.38
128	Dongying	44.36
129	Xinyang	44.32
130	Langfang	44.24
131	Dazhou	44.23
	Yichang	44.23
133	Ezhou	44.16
134	Jincheng	44.15
135	Sanmenxia	44.14
136	Yichun	44.09
137	Xuancheng	44.04
138	Rizhao	43.99
139	Bozhou	43.88
140	Zhoukou	43.85

Rank	City	Score for Policies and Measures
141	Wuhu	43.84
142	Xiangtan	43.79
143	Xuchang	43.76
144	Weinan	43.67
145	Jingmen	43.51
146	Suizhou	43.45
147	Luohe	43.43
148	Yiyang	43.32
149	Huaibei	43.29
150	Suzhou	43.23
151	Kunming	43.18
152	Baoji	43.05
153	Jinzhou	43.02
154	Lu'an	43.01
155	Ya'an	42.95
156	Huludao	42.93
157	Jinzhong	42.92
158	Xinyu	42.86
159	Luoyang	42.86
160	Pingxiang	42.79
161	Tongling	42.79
162	Weifang	42.51
163	Nanchong	42.42
164	Chaoyang	42.05
165	Baotou	41.62
166	Puyang	41.26
167	Anyang	41.03
168	Lhasa	40.64

The distribution of scores for all the cities is shown in Table 5.

Table 5 Distribution of policies and measures scores for 168 cities

Range of Score	Performance	Number of Cities
>50	Excellent	11
(45, 50]	Good	102
(40, 45]	Ordinary	55

Assessments based on publicly available information and data can reflect the degree to which air quality management frameworks are complete, as well as the general comprehensiveness of measures taken by cities. However, the assessment of actual implementation remains relatively limited. Similar to the assessment results from last year, cities' policies are essentially the same, while scores for policies and measures are all above 40 and remain closely aligned. This indicates that major cities have all introduced and implemented comprehensive air pollution prevention and control measures, while the policy system itself did not change much. Therefore, no significant gaps exist between cities.

Cities ranked as "excellent": first-tier cities showed outstanding performance, and continued to secure the top rankings

A total of 11 cities achieved higher scores than the full mark of 50 and demonstrated excellence in implementing policies and measures for air pollution prevention and control. These cities are Beijing, Guangzhou, Shanghai, Chengdu, Tianjin, Qingdao, Shenzhen, Wuhan, Hangzhou, Zhengzhou, and Jinan. The rank of "excellent" cities registered only one change compared to last year, with Jinan joining the list after accruing bonus points for initiating the development of air quality attainment plans in 2019. The other 10 "excellent" cities remain unchanged, with Beijing once again at top of the list.

The 11 cities ranked as "excellent" are traditional and emerging first-tier cities, including 3 municipalities, 6 provincial capitals and 2 municipalities with independent planning status. In 2019, they ranked among the top 20 in GDP. The general characteristics of these cities include strong fiscal capacity, research and development capacity, and advanced planning. These factors enable the cities to allocate more resources to improving air quality compared to others. In addition, these cities also combine the hard power of technology with the soft power of capacity and gained high scores by implementing measures that are more advanced and scientific than those adopted by most other cities. They have also developed leading methods for scientific decision-making and evaluation, including the establishment of air monitoring super-stations to analyze pollutant components and characteristics, the dynamic updating of emissions inventories and source apportionment, and the evaluation of the impact of air pollution prevention and control measures. This cohort of cities carried out the most comprehensive actions to reduce pollutant emissions, with most cities ensuring the sustainability of their air quality improvements.

Jinan, however, stood out as a special case. Despite being ranked as "excellent" in terms of policies and measures, its $PM_{2.5}$ concentration rebounded in 2019 and the number of attainment days fell. This report holds that the cause for the fall was the failure of local authorities to effectively control major sources of pollution in a timely manner. Jinan experienced heavy fugitive dust pollution at the peak of construction; however, its air quality was nearing the lowest ranking in the first half of 2019 before Jinan issued the 20 Regulations on Fugitive Dust Pollution Control and interviewed the individuals in charge of project construction sites. In addition to formulating more comprehensive pollution prevention and control policies, cities must also pay close attention to implementation to improve air quality.

Cities ranked as "good": The number of cities in this category increased year-on-year, demonstrating that small and medium-sized cities have steadily improved their capacity for air pollution prevention and control

A total of 102 cities gained scores ranging from 45 to 50, of which 70% were from the BTH region and surrounding areas, the YRD, and the PRD. Around ten provincial capitals, three municipalities with independent planning status, and over ten small and medium-sized cities from Hubei and Sichuan were also among the 102 cities. While these cities did not match those ranked as "excellent" in benchmarks such as fiscal strength, they made air pollution prevention and control a top priority. They may lack competitiveness in terms of capacity for scientific decision-making and evaluation when compared to "excellent" cities. However, when judged based on other measures, these cities achieved good results.

Encouragingly, the 31 cities ranked as “ordinary” last year rose to the ranking of “good” in 2019. Most of these cities are small and medium-sized cities located in the BTH region and surrounding areas and the YRD. They gained more points after implementing new measures in 2019 according to the Three-year Action Plan released in 2018. These new measures included: the compilation of emissions inventories; control of pollution from diesel vehicles; formulation of air quality attainment plans; and the enhancement of information disclosure for ambient air quality.

At the same time, 11 cities ranking as “good” last year dropped to “ordinary” in 2019. Langfang, Luoyang and Jinzhong were interviewed by the MEE for their poor performance in air pollution prevention and control and subsequent point deductions in 2019. Other cities lost points mainly due to poor disclosure of relevant data and information, which resulted in lower scores.

“The number of cities ranked as “good” increased by 19 from 2018. While more small- and medium-sized cities were improving their capacity for air pollution prevention and control, there was still room for progress in terms of information disclosure, formulation of air quality attainment plans, and the introduction of more stringent emissions reduction policies. With regards to cities receiving unsatisfactory effect scores for air quality improvement, it is necessary to further consolidate foundations for scientific haze control, formulate long-term plans, adopt more stringent emissions reduction measures, and focus on implementation.

Cities ranked as “ordinary”: cities in the BTH region and surrounding areas and the Fen-wei Plains received ordinary scores after experiencing poor air quality

55 cities received scores ranging from 40 to 45. Half of these cities showed very limited improvements in air quality and were ranked among the “ordinary” and “poor” cities in effect scores. Among the cities ranked as “ordinary” in annual mean $PM_{2.5}$ concentrations in 2019, the lowest 20 cities are all located in the BTH region and surrounding areas (Shanxi, Shandong, and Henan) and the Fen-wei Plains region. Cities with annual mean concentrations of $PM_{2.5}$ higher than 60 $\mu g/m^3$ are in Shanxi and Henan. For these cities, poor performance on policy implementation led to poor air quality levels. Langfang and Jinzhong were ranked as “good” in 2018 but were interviewed by the MEE in 2019 because of poor efforts in policy implementation. Consequently, the two cities lost points and dropped into the list of “ordinary” cities.

The list of “ordinary” cities also includes cities that met the air quality standard in 2019, such as Lhasa, Datong, and Kunming. As they are not industrialized cities and did not adopt stricter pollution control measures, they received relatively low scores for effort. However, since these cities had inherent advantages, they generally experienced excellent air quality and gained high basic air quality scores as a result.

Cities ranked as “ordinary” often lacked important pollution control measures such as controls on coal consumption. Some cities had limited information disclosure mechanisms; for example, this may be because the Bureau of Ecology and Environment lacked an official website, a report on the state of ecology and environment was not issued, or pollutant concentrations were not disclosed in such reports.

Analysis of comprehensive air quality management scores for cities

Comprehensive scores for air quality management in cities is the sum of two scores: air quality improvement scores and policies and measures scores. The aggregate reflects both efforts and achievements of cities in a holistic manner. Specifically, the score for policies and measures indicates effort. By evaluating the implementation of measures in the latest assessment period, this score reflects the degree to which pollution prevention and control policies of a specific city are complete. Meanwhile, the score for air quality improvement indicates effect. Influenced by current policies, this score largely depends on the accumulation of measures over the past few years as it evaluates changes in the three-year moving average values. In general, only cities which make sufficient efforts can ensure sustainable improvements in air quality, while cities demonstrating insufficient effort (with the exception of non-industrial cities with inherently good air quality) are bound to receive poor effect scores and rank among the poorest performers in the overall rankings.

Based on the scores for air quality improvement and policies and measures, the comprehensive scores for air quality management of the 168 cities are shown in Table 6.

Table 6 Rankings of comprehensive air quality management scores for 168 cities

Rank	City	Total Score
1	Yinchuan	109.97
2	Lhasa	107.19
3	Luzhou	106.79
4	Beijing	105.64
5	Meishan	104.45
6	Lanzhou	102.81
7	Chengdu	102.43
8	Shanghai	102.31
9	Taizhou	102.25
10	Chongqing	101.18
11	Hangzhou	100.88
12	Guangzhou	100.77
13	Neijiang	100.75
14	Qingdao	100.12
15	Nantong	99.63
16	Nanjing	99.34
17	Xining	99.23
18	Shenzhen	99.2
19	Lishui	99.17
20	Ningbo	98.93
21	Xiamen	98.52
22	Jinhua	98.46
23	Zigong	98.31
24	Dalian	98.19
	Ziyang	98.19
26	Fuzhou	98
27	Nanchang	97.87
28	Zhangjiakou	97.84
29	Huzhou	97.81
30	Changchun	97.79
	Zhoushan	97.79
32	Zhaoqing	97.64
33	Nanning	97.57
34	Suzhou	97.44
35	Haikou	97.04
36	Chengde	97.03
37	Wenzhou	96.53
38	Shaoxing	96.46
39	Foshan	96.44
40	Huizhou	96.42
41	Jiaxing	96.1
42	Guiyang	96.01
43	Suining	95.9
44	Quzhou	95.86
45	Shenyang	95.83
46	Guang’an	95.82
47	Mianyang	95.8
48	Wuxi	95.75
49	Tianjin	95.53
50	Pingxiang	95.42
51	Deyang	95.28
52	Leshan	95.09
53	Wuhan	95.01
54	Datong	94.89
55	Huangshan	94.8
56	Hengshui	94.69
57	Huanggang	94.66
58	Yancheng	94.54

Rank	City	Total Score
59	Xianning	94.47
60	Qinhuangdao	94.46
61	Yichun	94.26
62	Jiangmen	94.25
63	Ezhou	94.16
64	Xuancheng	94.04
65	Rizhao	93.99
66	Tongchuan	93.88
67	Jingzhou	93.69
68	Harbin	93.67
69	Zhuhai	93.6
70	Langfang	93.43
71	Huangshi	93.4
72	Hohhot	93.37
73	Lianyungang	93.2
74	Zhongshan	93.09
75	Dongguan	93
76	Xinyu	92.86
77	Baoding	92.65
78	Kunming	92.63
79	Changzhi	92.5
80	Xinxiang	92.26
81	Nanchong	91.8
82	Lu’an	91.63
83	Baotou	91.62
84	Hefei	91.23
85	Huai’an	91.14
86	Suizhou	91.06
87	Dazhou	90.89

Rank	City	Total Score
88	Shuozhou	90.28
89	Jinan	89.57
90	Liaocheng	89.06
91	Anqing	88.97
92	Chuzhou	88.64
93	Jinzhou	88.39
94	Yangquan	88.27
	Yibin	88.27
96	Ya’an	88.18
97	Zhengzhou	88.82
98	Jinzhong	88.06
99	Changzhou	87.77
100	Changsha	87.74
101	Xinzhou	87.67
102	Shijiazhuang	87.64
103	Baoji	87.53
104	Urumqi	87.06
105	Changde	86.99
106	Taizhou	86.95
107	Weifang	86.48
108	Xianyang	86.39
109	Yueyang	86.24
110	Xi’an	86.14
111	Yangzhou	86.12
112	Yichang	85.6
113	Tangshan	85.55
114	Cangzhou	85.54
115	Chaoyang	85.49
116	Lvliang	85.18

Rank	City	Total Score
117	Bengbu	85.17
118	Xinyang	84.97
119	Dezhou	84.84
120	Zaozhuang	84.6
121	Luohe	84.56
122	Wuhu	83.8
123	Jiujiang	83.59
124	Weinan	83.39
125	Zhuzhou	83.17
126	Tongling	82.92
127	Ma'anshan	82.5
128	Dongying	81.78
129	Shangqiu	81.52
130	Zhenjiang	81.44
131	Zibo	81.39
132	Sanmenxia	81.28
133	Suqian	81.2
134	Binzhou	80.9
135	Xiaogan	80.89
136	Xingtai	80.78
137	Chizhou	80.71
138	Suzhou	79.87
139	Zhumadian	79.78
140	Huludao	79.43
141	Xiangtan	78.97
142	Tai'an	78.25
143	Jiaozuo	78.14
144	Luoyang	78.04
145	Pingdingshan	77.28

Rank	City	Total Score
146	Jingmen	76.41
147	Yiyang	75.89
148	Jining	75.18
149	Heze	74.36
150	Hebi	74.02
151	Handan	73.97
152	Xiangyang	72.99
153	Linyi	72.79
154	Taiyuan	72.73
155	Zhoukou	72.33
156	Fuyang	72.28
157	Xuzhou	71.77
158	Puyang	71.19
159	Nanyang	70.7
160	Xuchang	67.06
161	Huaibei	66.73
162	Kaifeng	66.72
163	Anyang	66.44
164	Huainan	65.48
165	Jincheng	64.26
166	Bozhou	64.17
167	Yuncheng	62.24
168	Linfen	61.51

The distribution of scores for all cities is shown in Table 7.

Table 7 Distribution of air quality management scores for 168 cities

Range of Score	Performance	Number of Cities
>100	Excellent	14
(85, 100]	Good	103
(70, 85]	Ordinary	42
(60, 70]	Poor	9
≤60	Underperforming	0

All comprehensive scores for air quality management were above the pass line and no city was ranked as “underperforming”. These results are similar to the scores for air quality improvement.

Cities ranked as “excellent”: Beijing and Chengdu were on the list for double excellence, and Yinchuan achieved the top ranking with its comprehensive score

A total of 14 cities scored higher than the full marks of 100. Ranked from highest to lowest scores, these cities are Yinchuan, Lhasa, Luzhou, Beijing, Meishan, Lanzhou, Chengdu, Shanghai, Taizhou, Chongqing, Hangzhou, Guangzhou, Neijiang and Qingdao.

Among these cities, scores for air quality improvement were either “excellent” or “good”. Six of the cities (i.e., Lhasa, Taizhou, Guangzhou, Yinchuan, Shanghai and Neijiang) met the national standard for $PM_{2.5}$ in 2019, while cities such as Meishan, Lanzhou, Chongqing, Hangzhou, and Qingdao came close to meeting the standard. Most (12 cities) of the cities ranked as “excellent” received outstanding scores for policies and measures as well. For example, Beijing and Chengdu were on the lists of “excellent” cities in both air quality improvement and policies and measures. They represent typical examples of cities which have made significant progress in air quality improvement through concerted efforts. Shanghai and Hangzhou also scored close to double excellence.

Cities like Yinchuan, Lhasa, Meishan and Luzhou made significant gains due to large improvement ranges for their three-year moving average in $PM_{2.5}$ and attainment days. Yinchuan topped the list in terms of its comprehensive score. Its annual mean concentration of $PM_{2.5}$ dropped from 56 ug/m^3 in 2016 to 31 ug/m^3 in 2019, meeting the national standard for the first time. Meanwhile, its number of attainment days increased by 72.

Cities ranked as “good”: capacity for air quality management showed steady improvements while the number of cities in this category continued to grow

103 cities were on the list of “good” cities with scores ranging from 85 to 100. This cohort includes the largest number of cities, registering an increase of 4 cities compared to last year. Over 70% of the cities have either “good” or “excellent” effort and effect scores, and most cities performed well in both aspects. These good results can be attributed the strong policies and measures for air pollution prevention and control that have been steadily implemented by central and local governments at all levels across China, leading to continuous improvements in overall air quality.

14 cities were put on this list because of excellent improvements in air quality. Zhangjiakou, Chengde, Zhoushan, Lishui, Jinhua, and Haikou made ongoing improvements after meeting the $PM_{2.5}$ standard. Huzhou, Suining, and Ziyang met the $PM_{2.5}$ standard for the first time in 2019, while cities like Mianyang, Zigong, and Yichun saw noticeable improvements in air quality. These 14 cities achieved “good” scores for their policies and measures.

In addition, five cities were ranked as “excellent” in their scores for policies and measures. These cities are Tianjin, Shenzhen, Wuhan, Zhengzhou, and Jinan. Among them, only Shenzhen received a “good” score for air quality improvement, while others either saw a limited improvement range or experienced rebounds. Only by ensuring the implementation of policies can these cities further improve air quality to achieve double excellence.

Cities ranked as “ordinary”: some cities in key regions showed no significant improvements, pulling down the overall score

A total of 42 cities recorded scores ranging from 70 to 85. More than 80% of these cities were in the BTH region and surrounding areas and the YRD. They gained low scores for air quality improvement and have all been ranked as either “ordinary” or “poor” (mainly from Shandong and Henan Provinces). In terms of policies and measures, half of these cities demonstrated good performance. However, their comprehensive scores were lower due to limited improvements in air quality. Many cities saw only marginal increases, or even decreases, in the number of attainment days. Taking Jining as an example, its score of policies and measures was as high as 48.54, but its three-year moving average of attainment days decreased by 8.58%. As a result, Jining's final score for air quality improvement was only 26.64.

Cities ranked as "poor": this list included three cities in the provinces of Shanxi, Henan and Anhui while Linfen continued to lag behind the other cities

9 cities achieved comprehensive scores ranging from 60 to 70. They are in Shanxi Province (Linfen, Jincheng and Yuncheng), Henan Province (Anyang, Kaifeng and Xuchang) and Anhui Province (Bozhou, Huainan and Huaibei). Scores for air quality improvement across these cities were also poor, while 7 of them ranked "ordinary" in terms of scores for policies and measures. In all these cities, three-year averages of $PM_{2.5}$ were above 56 $\mu g/m^3$, with the highest average at 76.67 $\mu g/m^3$ (Anyang). Their three-year moving averages of attainment days all showed declines, ranging from 3.97% to 13.75%. For the 3 cities in Henan Province, numbers of attainment days have been dropping for three consecutive years. Meanwhile, Linfen continued to lag behind other cities due its high $PM_{2.5}$ concentration and substantially deteriorating air quality.

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