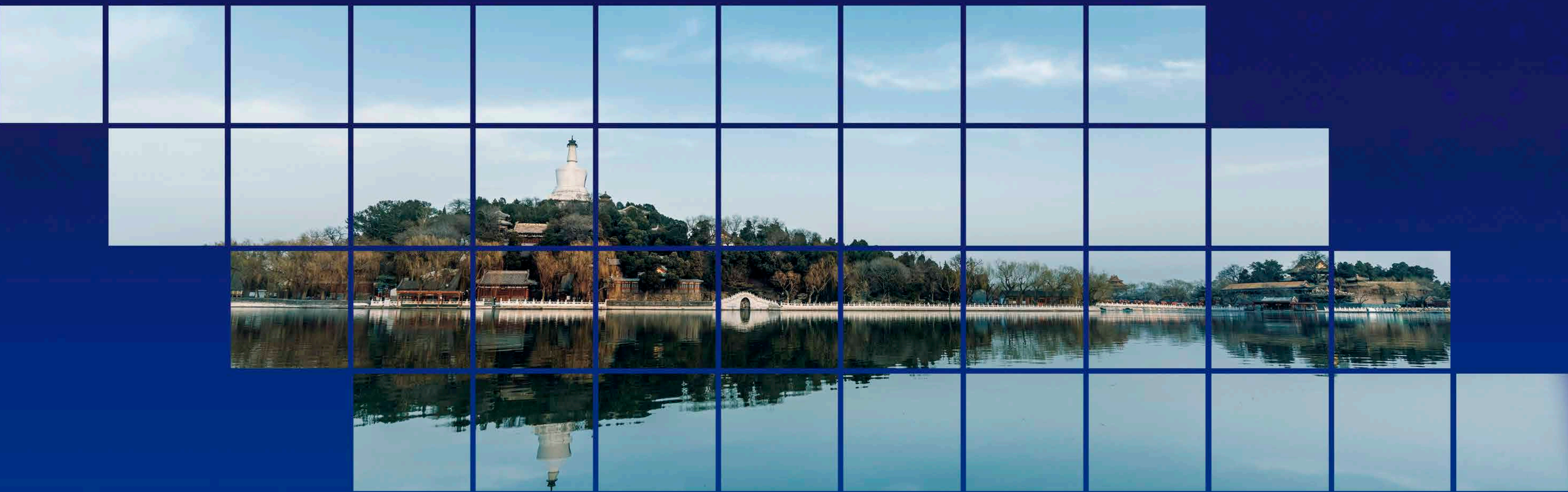

China Air 2022

Air Pollution Prevention and Control Progress in Chinese Cities

CLEAN AIR ASIA
亚洲清洁空气中心

Clean Air Asia

About Clean Air Asia

Clean Air Asia (CAA) is an international nonprofit organization seeking to improve air quality and build livable cities in Asia. Launched in 2001, CAA is also a recognized partner of the UN.

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

CAA has been working in China since 2002, where it continues to focus on air quality management, green transportation, and energy transition. On March 12, 2018, CAA was issued its "Representative Office of an Overseas Non-Governmental Organization Registration Certificate" by the Beijing Municipal Public Security Bureau and set up the CAA (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, and public education initiatives in the field of air pollution prevention and control across China.

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Figures and Tables

Abstract

CAA has released the series of report China Air: Air Pollution Prevention and Control Progress in Chinese Cities since 2015, aiming to objectively record and analyze the air quality, policies and measures of air pollution prevention and control at country, region and city level. With the emerging synergy between air pollution control and climate change mitigation and deepening of structural adjustment for energy, industry, and transport, China Air report further includes relevant policies and measures, and analyzes the implementation progress.

Starting in the report China Air 2019, CAA has conducted a comprehensive assessment and ranking of air quality management for 168 key cities in the series of report. Unlike the traditional city ranking for air quality, this assessment approach enables a more extensive evaluation of cities' efforts and achievements in air pollution control. The ranking can motivate cities to strive for continuous air quality improvement.

Content and scope

As the eighth edition of the China Air: Air Pollution Prevention and Control Progress in Chinese Cities series, this report records and analyzes air quality data from 339 cities at and above the prefecture level in 2021. It also provides a recap of China's policies, measures, and implementation progress in air pollution prevention and control over the same year, as well as a comprehensive assessment and ranking of 168 key cities in the management of air quality.

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 and systematically collected to ensure accuracy and comprehensiveness. Specific sources include (i) air quality data from environmental quality reports and official news released by the Ministry of Ecology and Environment (MEE) and its provincial and municipal bureaus and (ii) 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 the key cities: improvements in air quality and the relevant policy measures in place. This approach emphasizes that both the efforts made and the outcomes achieved are equally important for air pollution control. Improvements in air quality are assessed using the range of improvement in the three-year moving average of $PM_{2.5}$ concentrations (i.e., the range of improvement in average concentrations in 2019–2021 compared to 2018–2020) and the range of improvement in the three-year moving average of the number of attainment days. Policy measures assessed include control and reduction measures for emissions from stationary, mobile, and area sources, as well as capacity building and safeguarding measures. The assessment result for air quality improvement is the effect score, while the assessment result for policy measures is the effort score. The sum of the two scores makes the total score.

Conclusions

Air Quality

In 2021, the first year of the 14th Five-Year Plan, the overall air quality of 339 Chinese cities at the prefecture level and above continued to improve. The overall annual mean concentrations of the six criteria pollutants decreased, and the average percentage of attainment days increased. In 168 key cities, for the first time, the annual mean concentrations of all six criteria pollutants were lower than the standard limits in the "China National Ambient Air Quality Standards."

Overall air quality in China continued to improve, achieving the target percentage of attainment days by 2025.

In 2021, the overall national annual mean concentrations of the six criteria pollutants further improved compared to 2020 (see Figure 1). The number of cities meeting air quality standards increased to 218, accounting for 64.3% of all cities. The overall national annual mean concentrations of the major pollutants $PM_{2.5}$ and O_3, as well as the average percentages of non-attainment days and non-attainment cities,

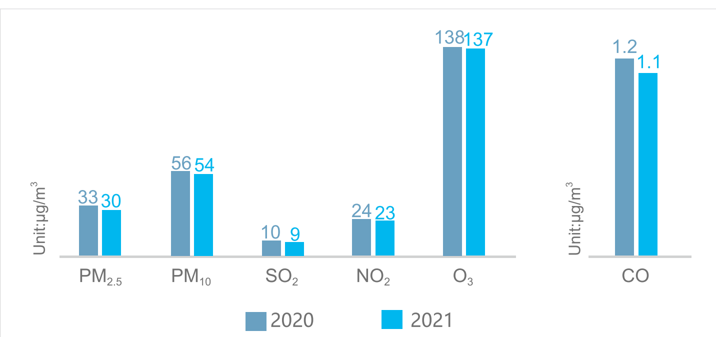


Figure 1: National Overall Annual Mean Concentrations of the Six Criteria Pollutants in 2020 and 2021

decreased for two consecutive years. The average percentage of attainment days in 339 prefecture-level cities and above rose to 87.5%, achieving the target "percentage of attainment days reaches 87.5% by 2025" proposed in the "Opinions on Further Fighting the Tough Battle of Pollution Prevention and Control" ahead of schedule.

In terms of the proportion of attainment cities for each pollutant, all cities met the standards for SO_2 and CO for the third consecutive year. Up to 99.7% of all Chinese cities met the standard for NO_2, with Lanzhou being the only exception. 85.3%, 82.0%, and 70.2% of all cities in China met the standards for O_3, PM_{10}, and $PM_{2.5}$, respectively—a year-on-year increase of 6–25 cities, as shown in Figure 2.

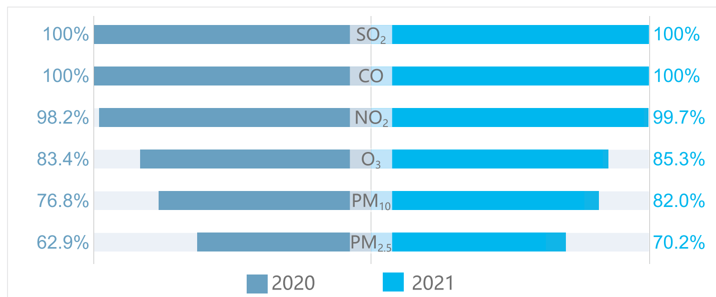


Figure 2: Percentages of Attainment Cities for the Six Criteria Pollutants in 2020 and 2021

Overall O_3 concentration continued to improve nationwide, except for a slight deterioration in the Fenwei Plain.

Since China included O_3 in its regular monitoring in 2013, the overall national annual mean concentration of O_3 has followed a worsening trend, especially in the key regions. In 2020, however, O_3 concentration decreased for the first time, mitigating the situation. In 2021, the overall national concentration further decreased by 1 μg/m^3 from the 2020 level. Among the three key regions, the annual mean concentration of O_3 in the Beijing-Tianjin-Hebei (BTH) region and its surrounding regions decreased year-on-year by 5.0%, and in the Yangtze River Delta (YRD) region by 0.7%. In contrast, the annual mean concentration of O_3 in the Fenwei Plain rebounded with an increase of 3.1%, as shown in Figure 3.

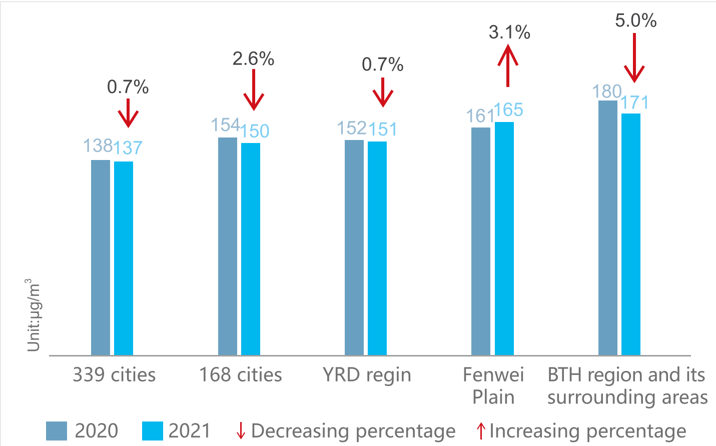


Figure 3: Annual Mean Concentration of O_3 across the Country and in the Key Regions in 2020 and 2021

Policies and Measures

As it enters the 14th Five-Year Plan period, China continues to fight the battle against pollution by striving to reduce air pollution and CO_2 emissions. Aiming to achieve its "Dual Carbon" goals of carbon peaking and carbon neutrality, China has intensified its control of pollution sources; reduced air pollutants and greenhouse gas (GHG) emissions in the energy, industry, and transportation sectors; strengthened policies on structural adjustment and optimization; and achieved initial results in coordinated control on air pollution and climate change.

The intensive monitoring of multi-pollutants and monitoring of pollution sources made overall progress.

In 2021, the number of state-controlled ambient air quality monitoring stations in 339 cities at the prefecture level and above expanded from 1,436 to 1,734. The number of network sites and cities for the monitoring of ambient particulate matter (PM) components also significantly increased. At the same time, involved cities continued to strengthen their volatile organic compounds (VOCs) component monitoring and photochemical monitoring capacities. All 339 cities have implemented the automatic monitoring of non-methane hydrocarbon in ambient air, and some cities have started monitoring Photochemical Assessment Monitoring Station (PAMS) substances, 13 kinds of aldehydes and ketones, and 47 kinds of TO-15 substances.

To strengthen the monitoring capacity of the coordinated control of $PM_{2.5}$ and O_3 during the 14th Five-Year Plan period, China has comprehensively carried out the monitoring of pollution sources, focusing on transportation, industrial parks, and enterprises discharging air pollution. The first strategy involves building traffic-related pollution monitoring stations at highways, ports, airports, and railroad yards in the key areas specified in the plan for air pollution prevention and control and in cities with high emissions of VOCs and NOx. The second involves conducting monitoring in petrochemical, chemical, industrial painting, packaging and printing, and other industrial clusters and parks involving VOCs emissions and those with high NOx emissions. The third requires enterprises discharging air pollution to regularly monitor pollution sources according to the requirements of the technical guidelines for self-monitoring. The goal is to encourage key enterprises to speed up the installation of automatic monitoring facilities for flue gas emissions.

The energy consumption structure continued to be optimized, with the proportion of installed non-fossil energy capacity exceeding that of coal-fired power for the first time.

In 2021, China's energy consumption used up 5.24 billion tons of standard coal, an increase of 5.2% from the previous year. Energy consumption continued to follow the clean and low-carbon transformation trend. Compared to 2020, coal consumption accounted for 56.0% of total energy consumption, down by 0.9%, while clean energy consumption rose by 1.2% to 25.5% of the total. From 2014-2021, the proportion of clean energy consumption rose 8.6% accumulatively, and the increase in clean energy consumption accounted for more than 60% of the total increase in energy consumption.

By the end of 2021, the national overall installed power generation capacity was 2.38 billion kW, of which coal-fired power was 1.11 billion kW, accounting for 46.7% of the total and decreasing by 2.3% year-on-year. Non-fossil energy was 1.12 billion kW, up by 13.4% year-on-year and accounting for 47.0% of the total, exceeding the proportion of coal-fired power for the first time in history.

Notably, coal-fired power plants remained the primary power supplier in China. Under the "Dual Carbon" goals, coal-fired power needs to gradually transform from being the leading power supplier to becoming the primary security power supplier. In this process, energy security cannot be lax, posing challenges to the transformation of China's energy system.

Key industries made progress in reducing pollution and carbon emissions, and crude steel output dropped for the first time in seven years.

In 2021, China's crude steel production decreased to 1.03 billion tons, the first decrease in the sector since 2015. As the second-largest carbon-emitting industry after the power sector, the iron and steel industry still faces problems of overcapacity and underdeveloped low-carbon green technologies. As part of the "Dual Carbon" goals, the iron and steel industry has upgraded the implementation method of capacity replacement and started developing the industry's carbon peaking action plan. At the same time, the iron and steel industry's ultra-low emission transformation has been steadily advancing, with a total of 34 steel enterprises having completed the transformation so far.

The cement industry is another key industry in China's air pollution emission control, as its total carbon emission is next only to the power and steel industries. As a major emitter in the non-electric industry, the cement industry's ultra-low emission transformation has been added to the agenda. China released several 14th Five-Year schemes in 2021, which all pointed to the steady implementation of the cement industry's ultra-low emission transformation. In 2021, some provinces either released their specific implementation plans for ultra-low emissions in the cement industry, specified ultra-low emission limits and the timelines of phased implementations, or revised local standards for the cement industry. The key indicators of the local standards are stricter than the national ones, which tightens the overall pollution control of the cement industry.

The clean heating rate in northern China reached 73.6%, while rural areas remained crucial in household pollution control.

In 2021, the closing year of the implementation of the "Clean Winter Heating Plan for Northern China (2017-2021)," northern China successfully completed the planned target of "achieving a 70% clean heating rate and replacing 150 million tons of loose coal," with the clean heating rate reaching 73.6%, the total replacement of loose coal exceeding 150 million tons, and the clean heating area surpassing 15.6 billion square meters.

While the central government has been expanding the pilot cities for clean winter heating, clean heating transformation in northern China has gradually deepened after years of continuous progress. Compared with 2020, the number of households using loose coal decreased significantly in key provinces in 2021, and the range of households that could be transformed shrunk. The remaining unchanged households are mainly in rural areas, where the insulation condition of houses and infrastructure are usually poor and rural inhabitants' established energy-consuming habits are difficult to change. These factors still restrict the promotion of clean heating in these areas and must be addressed.

Multiple policies were released and implemented to optimize the transportation structure.

China's freight transportation restructuring has achieved phased results. From 2017-2021, the national railway and waterway freight volumes grew by 29.4% and 23.4%, respectively, much higher than the overall growth rate of the freight transportation volume (10.3%). However, road transportation remains the major transportation mode, and bulk commodities like coal, ore, mining and construction materials, and cement are still transported by road. The proportion of container rail-water transportation is still far below the advanced global level. Transportation restructuring needs to be strengthened during the 14th Five-Year Plan period.

In 2021, China updated its goals of transportation restructuring in the 14th Five-Year Plan period as follows: "In 2025, the national railway and waterway freight volume would increase by about 10% and 12%, respectively, compared with 2020, and the turnover of railway freight would reach 17%." Multiple policies have been released targeting the two major challenges in the restructuring of transportation—the "last mile" issue in railway transportation and the poor linkage among different transportation modes—to accelerate the construction of dedicated railway lines and enhance the level of multi-modal transport development in the 14th Five-Year Plan period. The ultimate goal is to achieve an annual average growth of over 15% in container rail-water transportation by 2025.

Progress toward transportation energy utilization accelerated, contributing to the green transformation of the transport sector.

The zero-emission transformation of all means of transportation is key to increasing the effectiveness of air pollution and GHG emission reduction in the transportation sector. In 2021, multiple policies were successively released to promote the application of new energy and clean energy in the transportation sector, with quantitative targets set. These targets include that by 2025, electric vehicles will account for around 20% of new vehicle sales, and by 2030, the proportion of vehicles (automobiles, ships, etc.) using clean energy and new energy will account for about 40% of newly added vehicles.

In 2021, the promotion of new energy and clean energy vehicles became more diverse and detailed. In terms of low-carbon energy alternatives for automobiles, urban buses, taxis, port and airport services, urban logistics, postal delivery, cold-chain logistics, port trucks, and others became key areas for the promotion of electric vehicles. In terms of low-carbon energy alternatives for ships, new energy vessels, mainly electric vessels, have been piloted in different setups, such as inland passenger transport, inland freight transport, and port operations.

Assessment of City Air Quality Management

Cities' overall air quality improved, with Beijing topping the list.

The report provides a comprehensive assessment of the efforts and results of air quality management in 168 key cities. The assessment is based on the improvement of the three-year moving average of the $PM_{2.5}$ annual average concentration and number of attainment days, as well as the implementation of relevant policies and measures. The results show that the overall air quality of key cities is improving, with most cities scoring “excellent” or “good” in terms of air quality improvement, including some cities in Henan Province that used to be at the bottom of the list in previous assessments. Only 20% of cities received “ordinary” results in this assessment. At the same time, the policy framework of air pollution prevention and control in key cities has gradually improved. The policies for structural adjustment have been fortified as part of the “Dual Carbon” goals, and the scientific governance capacity of first-tier cities has continued to increase.

Beijing has been making consistent efforts toward air pollution prevention and control. As a result, air quality in the city has continued to improve and finally met all the national standards. Due to the sustained decline of $PM_{2.5}$ concentration in the city, the significant increase in its number of attainment days, and top-tier emission reduction measures and management capability in all areas, Beijing obtained the highest score in overall air quality management in this assessment.

Recommendations

Revise the ambient air quality standards promptly to consolidate and strengthen the achievements of air pollution prevention and control.

Over the past decade, China has become the fastest country in improving air quality worldwide. Since 2020, the coordinated control of $PM_{2.5}$ and O_3 has achieved initial success, but challenges in sustainably improving air quality and further protecting public health remain. There is still a big gap between the national annual average $PM_{2.5}$ concentration and the World Health Organization (WHO) air quality guideline. Improvements in reducing O_3 pollution are also generally small, with O_3 concentration rebounding in 2021 in the Fenwei Plain and O_3 concentration in the BTH region still exceeding the standards by a significant margin.

WHO updated and released the “Global Air Quality Guidelines” in 2021. Compared to the new guidelines and the current standard limits in developed countries and regions such as the European Union, Japan, and the United States, China's ambient air quality standards are still more lenient. This is especially true for the country's $PM_{2.5}$ concentration limit, which still matches earlier stages of the WHO guidelines. With the number of cities meeting the $PM_{2.5}$ standards increasing yearly and more than 70% cities meeting the standards in 2021, it is recommended for China to start revising its ambient air quality standards in due course and tighten the $PM_{2.5}$ concentration limit in the new standards to strengthen $PM_{2.5}$ pollution prevention and control efforts in various regions, further protecting public health.

In addition, it is recommended that based on the transportation paths and range of effects of O_3 pollution, regional collaborative O_3 pollution prevention and control strategies should be strengthened, a collaboration mechanism across administrative regions should be established, regional emission reduction plans should be formulated, and emission reduction targets of O_3 precursors and tasks for each region should be clarified following scientific research and the evaluation of the effectiveness of emission reduction measures.

Promote "three retrofitting" for coal-fired power units in a scientific way, focusing on low-carbon transformation and maintaining a stable supply.

In 2021, the low-carbon transformation of China's energy structure continued to advance. However, coal consumption still dominates energy consumption, and coal-fired power is still the primary source of energy used in the power system. The power shortage in some local areas in 2021 also suggests that under the "Dual Carbon" goals, achieving low-carbon transformation and maintaining a stable supply are the two major challenges that China's energy system is facing.

Based on the clear roles of coal-fired power which are to guarantee the supply and adjust power system stated in relevant policies, the following recommendations are proposed for existing and newly installed coal-fired power generation units. For existing coal-fired power generation units, the "three retrofitting" (i.e., retrofitting for energy conservation, retrofitting for heat provision, and retrofitting for the improvement of adjustment capability) should be promoted to improve the efficiency and flexibility of coal-fired power generation units. It is important to avoid blind retrofitting and balance the retrofitting's environmental, social, and economic benefits. Meanwhile, outdated units should be phased out promptly and converted into spare units. It is important to note that this conversion should strictly follow the criteria for which outdated units could be turned into spare emergency units. Only units that meet the requirements for energy efficiency, environmental protection, and safety—without having to be rebuilt at the original site or reconstructed in rural areas—can be used as backup power supply and phased out without demolition. For newly installed units, in terms of quality, it is recommended that various regions still strictly control the access threshold to ensure that newly installed units meet environmental and efficiency standards. In terms of quantity, new coal-fired power projects should be reasonably controlled to prevent the disorganized growth of related projects.

Strictly control new production capacities in key industrial sectors and accelerate the shift toward clean energy.

The ultra-low emission transformation of the iron and steel and cement sectors is progressing, effectively reducing pollution in key industrial sectors and significantly improving ambient air quality. However, in the 14th Five-Year plan period, China's economic growth will continue to demand a high iron and steel and cement production capacity. As a result, both pollution and carbon reduction goals face tough challenges.

Under the "Dual Carbon" goals, China has introduced a series of new policies in the industrial sector to reduce pollution and carbon emissions. The capacity replacement schemes of some sectors have been refined and upgraded to impose higher requirements on key industrial sectors. At the local level, the government is advised to strictly implement capacity swaps, strictly control new capacities, and resolutely curb illegal construction and production projects. At the sector level, energy efficiency and clean energy should be further promoted. For example, advanced energy-saving and carbon-reducing technologies should be introduced in production projects with high energy consumption and emissions, such as by recycling waste heat from riser pipes in the steel sector and reducing heat dissipation in rotary kilns in the cement sector with high-efficiency sealing technology. Another example is the construction and promotion of solar photovoltaic power generation within local consumption systems in the iron and steel industry and the development of coordinated disposal and utilization systems for biomass fuel to replace coal in cement kilns.

Deepen the optimization of the transportation structure and improve relevant policies.

In recent years, the optimization of China's transportation structure has achieved initial results. However, the zero emission of medium-duty and heavy-duty trucks and vessels still face tough challenges. China needs to improve the technical and cost advantages of new energy and clean energy compared to traditional fuel for transportation. Moreover, the country needs to improve the construction and distribution of infrastructure. It is recommended for the government to further enhance related policies and promote the large-scale application of new energy and clean energy on medium-duty and heavy-duty trucks and vessels in the following three aspects.

First, the policy framework for promoting electric vehicles and vessels should be strengthened to enhance their technical and cost advantages. For example, carbon emission regulations and standards for automobiles, as well as the credit policy system for commercial vehicles, should be improved as soon as possible to entice manufacturers into investing in new energy and clean energy medium-sized and heavy-duty trucks. China should also improve the preferential fiscal and tax policies for electric vehicles and vessels. The country should introduce subsidy policies for transport enterprises and infrastructure operators to reduce the cost of using new energy and clean energy vehicles and vessels during their initial rollout. In addition, local governments should promote the right of way of new energy and clean energy vehicles and vessels.

Second, the distribution of infrastructure should be accelerated to facilitate the use of new energy and clean energy vehicles and vessels. To meet the operational needs of medium-sized and heavy-duty trucks, related infrastructure, such as charging and switching stations and hydrogen-refueling stations, will have high requirements for construction, including land area, power grid capacity, and number of stations. Therefore, it is necessary to comprehensively plan the distribution and scale of relevant infrastructure, taking into account the abovementioned factors, the development characteristics of the regional road transportation sector, the development plan of new energy transportation equipment, the industrial environment, and other basic conditions. For new energy and clean energy vessels in their initial rollout, it is necessary for ports and shipping enterprises to promote energy transformation strategies and study the layout of supporting supply facilities, such as hydrogen, methanol, and battery exchange stations, according to local conditions.

Thirdly, green freight and shipping corridors should be established as demonstration projects. The demonstration impacts are helpful in promoting the large-scale utilization of new energy and clean energy vehicles and vessels. Some regions can choose road freight corridors or routes with large freight volume as “green corridors” to vigorously carry out demonstration actions and commercial operations. These regions should encourage cargo owners and shipping enterprises to adopt the use of new energy and clean energy vehicles and vessels, which will not only facilitate the commercial application of zero-emission technologies but also form a demonstration and promotion model.

Chapter I.

Current Air Quality Status

In 2021, the first year of the 14th Five-Year Plan, the overall annual mean concentrations of the six criteria pollutants in China further decreased. The average percentage of attainment days also increased to 87.5%, reaching in advance the target that "the percentage of air quality attainment days should reach 87.5% by 2025" set out in the "Opinions on Further Fighting the Tough Battle of Pollution Prevention and Control." Specifically, the percentage of attainment days of 266 cities exceeded 80%—a year-on-year increase of six cities. A total of 218 cities, a year-on-year increase of 16 cities, fulfilled the attainment requirement for all six criteria pollutants.

The overall annual mean concentrations of the six criteria pollutants decreased throughout the country on a year-on-year basis. In the 168 key cities, the overall annual mean concentration of $PM_{2.5}$ dropped to 35 μg/m^3, meaning the average concentrations of 168 cities attained the standard for all six criteria pollutants for the first time. Among the key regions, the BTH region and its surrounding areas, the YRD region, and the Fenwei Plain saw encouraging improvement in the annual mean concentration of $PM_{2.5}$, with the rate in the three regions faring better than the national average. However, the concentration of O_3 in the Fenwei Plain rebounded.

$PM_{2.5}$

- In 2021, the overall annual mean concentration of $PM_{2.5}$ across the country continued to decline by 9.1% to 30 μg/m^3, a year-on-year decrease of 3 μg/m^3.

- The proportion of attainment cities increased from 62.9% to 70.2%, up by 25 cities compared to 2020.

- The mean concentration of $PM_{2.5}$ noticeably fell in the three key regions, with a year-on-year decrease of 10% or above. The annual mean concentration of $PM_{2.5}$ in the BTH region and its surrounding areas dropped by 18.9% to 43 μg/m^3. The annual mean concentration of $PM_{2.5}$ in the YRD region decreased by 11.4% to 31 μg/m^3. In the Fenwei Plain, the annual mean concentration of $PM_{2.5}$ declined by 16.0% to 42 μg/m^3.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Zhangjiakou	34	32	31	29	25	23	23	23
	Chengde	43	40	35	32	29	27	27	30
	Qinhuangdao	45	46	44	38	41	34	34	34
	Langfang	85	66	60	52	46	42	42	37
	Tianjin	70	69	62	52	51	48	48	39
	Cangzhou	70	69	66	59	49.7	47	47	40
	Beijing	80.6	73	58	51	42	38	38	33
	Tangshan	85	74	66	60	53.9	49	49	43
	Handan	91	82	86	69	66	57	57	46
	Hengshui	99	87	77	62	56	52	52	42
	Xingtai	101	87	80	69	65	53	53	43
	Baoding	107	93	84	67		50	50	43
	Shijiazhuang	89	99	86	72	66	58	58	46
Fen-wei Plains	Lvliang			55	52	39	33	33	27
	Jinzhong		62	59	55	45	42	42	37
	Linfen	59	74	83	70	62	52	52	53
	Yuncheng			73	60	61	57	57	48
	Sanmenxia	75	66	57	57	55	48	48	44
	Luoyang		79	73	59	62	51	51	43
	Xi'an	57	71	73	63	57	51	51	43
	Xianyang	64	82		71	66	54	54	48
	Baoji	57	59		54	51	47	47	40
	Tongchuan	58	59	54	49	47	43	43	36
	Weinan	60	76	71	71	57	53	53	44

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Zhoushan	30	30	25	25	22	20	17	15
	Lishui	39	38	33	33	28	25	21	21
	Taizhou	43	39	36	33	29	25	25	23
	Wenzhou	46	44	38	38	30	28	25	25
	Ningbo	46	45	39	37	33	29	23	21
	Quzhou	57	45	43	42	33	33	26	24
	Yancheng	57.5	49	43	43	43	39	33	27.7
	Jiaxing	57	53	44	42	37	35	28	26
	Shanghai	52	53	45	39	36	35	32	27
	Shaoxing	63	56	45	41	37	38	28	27
	Jinhua	64	54	46	42	34	31	26	27
	Suzhou	66	58	46	43	42	36	31	28
	Nantong	62	58	46	39	41	37	34	30
	Lianyungang	61.2	55	46	45	44	43	37	32
	Huzhou		57	47	42	36	32	26	25
	Nanjing	73.8	57	47.9	40	43	40	31	29
	Changzhou	67	59	49	47	50	44	40	35
	Hangzhou	64.6	57	49	45	40	38	30	28
	Zhenjiang	68	59	50	56	54	45	38	36
	Yangzhou	65.2	55	51	54	49	43	36	33
	Taizhou	68	60	51	48	47	44.1	35	32
	Wuxi	68	61	53	45	43	39	33	29
	Huai'an	68	58	53	50	45.2	42	42	36
	Suqian	67.5	61	56	55	53	47	45	38
	Xuzhou	67.3	65	60	66	62	57	50	42

Unit:μg/m³

Figure 4: Annual Mean Concentrations of $PM_{2.5}$ in 339 Cities in 2014-2021

North China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Erdos		27	24	25	27	23	24	22
	Chifeng		41	37	34	31	23	25	22
	Hohhot		43	41	44	36	38	40	28
	Wuhai			46	44	39	32	32	26
	Baotou			47	46	42	40	44	30
	Ulanqab				29	28	24	22	21
	Xilingol				15	16	10	9	9
	Hulun Buir				20	17	17	18	17
	Tongliao				35	33	33	34	29
	Bayannur				36	35	33	33	25
	Hinggan League				20	21	25	25	24
	Alxa League				35	38	27	23	20
Henan	Xinyang			58	54	53	48	40	38
	Nanyang			63	58	60	60	51	47
	Sanmenxia		75	66	57	57	55	48	44
	Xuchang			68	59		60	53	44
	Zhoukou			68	56	58	56	50	44
	Zhumadian			68	59	62	52	45	42
	Puyang			69	64	63	63	58	51
	Kaifeng			72	62		62	55	47
	Hebi			73	65	55	61	57	50
	Pingdingshan			75	63	65	60	51	46
	Luohe			77	64	61	59	55	49
	Shangqiu			77	75	62	55	52	44
	Zhengzhou	88	96	78	66	63	58	51	42
	Luoyang			79	73	59	62	51	43
	Xinxiang			84	66	61	56	51	47
	Jiaozuo		87	85	77	67	63	56	45
	Anyang			86	85	74	71	62	49

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Xinzhou			56	58	53	41	44	40
	Jincheng			62	62	60	54	46	35
	Jinzhong			62	59	55	45	42	37
	Taiyuan	72	62	66	66	59	56	54	44
	Linfen		59	74	83	70	62	52	53
	Datong				36	36	32	31	28
	Changzhi				60	54	47	44	38
	Yangquan				61	59	47	46	43
	Shuozhou				48	46	45	37	31
	Yuncheng				73	60	61	57	48
	Lvliang				55	52	39	33	27

East China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Weihai		38	35	32	25	29	24	24
	Yantai		45	39	35	29	35	30	27
	Qingdao	59	51	45	37	34	37	31	28
	Rizhao		57	55	48	42	45	35	31
	Tai'an		69	63	56	51	53	46	42
	Binzhou		77	70	64	54	53	49	40
	Ji'nan	90	87	73	63	52	53	47	40
	Zaozhuang		92	81	66	56	59	54	45
	Dezhou		101	81	68	58.7	53	49	45
	Heze		94	82	70	58	57	53	48
	Liaocheng		101	86	71	61	60	53	46
	Ji'ning		82		61	52	54	51	47
	Dongying		79		57	49	48	45	36

	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Zibo				63	55	56	52	47
	Weifang				58	51.2	54	47	38
	Linyi				60	54	57	49	41
Fujian	Longyan			24	24	26		18	
	Nanping			25	24	24		19	18
	Sanming			26	27	26		22	
	Fuzhou		29	27	27	25	24	21	21
	Ningde			27	24	25	19	22	16
	Xiamen	37	29	28	27	25	24	18	20
	Quanzhou			28	28	27		21	21
	Putian			29	28	27	25	22	22
	Zhangzhou			33	35	33		20	24
Anhui	Huangshan			28	26	24	24	20	20
	Lu'an			46	47	45	41	37	32
	Maanshan		61	49	50	45	42.8	36	35
	Tongling			50.9	58.2	49	47	35	34
	Xuancheng			51	50	44	41	33	30
	Wuhu		58	53	49	49	39	35	34
	Anqing			54	56	46	45	36	33
	Huai'nan			56	62	56.3	53.4	48	42
	Hefei	83	66	57	56	48	44	36	32
	Bozhou			58	63	58.6	52.9	47	38
	Chuzhou			59	56	50	48	39	34
	Bengbu				60	54.7	50.9	43	37
	Huaibei				64	57	54	48	41
	Fuyang				68	55	51	50	44
	Suzhou				70	58.3	50.2	46	41
	Chizhou			44	60	44	42	34	31

	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Yingtan			41	41	36	40	32	
	Fuzhou			41	47	36.6		27	
	Shangrao			41	44	36		29	
	Nanchang	52	43	44	41	30	35	33	30.7
	Ganzhou			45	47	39	32		
	Jiujiang			50	48	43	46	38	33
	Jingdezhen				40	31.25		25	25
	Pingxiang				51	43	40	33	
	Xinyu			43	48	39.2	35	30	31
	Ji'an				53	40.2			
	Yichun				51	40	36	31	31

South China

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Xiaogan		72	45	49	42	43	35	33
	Xianning		55	48	47	37	36	30	29
	Enshi		54	48	36	38	32	27	24
	Huanggang		59	51	49	42	40	36	31
	Shiyan		56	51	41	43	39	33	31
	Suizhou		66	56	51	45	42	37	36
	Wuhan	82	70	57	53	49	45	37	37
	Huangshi		68	57	55	43	40	35	33
	Jingmen	88	71	58	50	57	56	45	44
	Jingzhou		70	60	56	49	46	37	35
	Ezhou		68	60	56	46	42	38	36
	Yichang	93	70	62	58	53	52	41	39
	Xiangyang		76	64	66	61	60	52	49

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Chenzhou			41	38	31	30		
	Huaihua			42	39	31	29		27
	Yiyang			44	41	35	54	43	36
	Xiangxi Prefecture			44	40	35	30	25	24
	Yongzhou			45	45	48	39	28	28
	Loudi			46	41	34	40	33	37
	Zhangjiajie		53	48	42	32	31		
	Yueyang			49	49	45	43	37	36
	Zhuzhou		55	51	52	45	47	38	40
	Xiangtan		56	51	51	49	48	39	42.6
	Hengyang			52	49	43	37	32	35
	Changsha	74	61	53	52	48	47	42	43
	Shaoyang			54	55	47	43		
	Changd		52	56	54	44	48	41	41
Guangxi	Fangchenggang			29	30	30	29	22	23
	Hechi			34	35	31	30	25	26
	Nanning	49	41	36	35	34	33	26	26
	Qinzhou			37	35	32			28
	Guigang			38	42	40			
	Liuzhou		50	44	45	41	38	29	30
	Guilin		51	47	44	38	37		29
	Beihai				28	27		23	24
	Wuzhou				41	37			26
	Yulin				40	39			
	Baise				42	37			
	Hezhou				42	37.95	33		27
	Laibin				48	40			33
	Chongzuo				32	31	32		30

	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shanwei		28	24	27		21	18	18
	Zhanjiang		28	26	29	27		21	23
	Meizhou		35	28	30	30	26	22	20
	Shantou		33	30	29	27		19	20
	Heyuan		34	32	29			22	21
	Chaozhou		38	33.4	30			24	
	Qingyuan		33	36	32	31	32	28	
	Jieyang		39	39	34		31	28	
	Shaoguan		34	33	38		29	24	24
	Maoming		32	30	32			21	21
	Yangjiang		32	31	33			21	21
	Yunfu		34	34	37	33	29	22	24
	Zhuhai		31	26	30	27	25	19	20
	Shenzhen	34	30	27	28	26	24	19	18
	Huizhou		27	27	29	28	25	20	19
	Zhongshan	38	33	30	33	30	27	20	20
	Jiangmen	44	34	34	37	31	27	21	23
	Dongguan	45	36	35	37	36	32	24	22
	Guangzhou	49	39	36	35	35	30	23	24
	Zhaoqing	52	39	37	37	33	32	23	22
	Foshan	45	39	38	40	35	30	22	23
Hainan	Sanya		17	14	15		14	11	12
	Haikou		22	21	20	18	17	14	14

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Guangyuan			27.9	23.1	27.1	27.6	25	24
	Panzhihua		32	32	34	36	35	29	31
	Ya'an			42	49	40.8	41.7	27	28
	Suining			44	38	36	31.2	29	30
	Guang'an			46	37	40.3	33.8	32	34
	Mianyang		47	49	47.8	45	37.6	34	35
	Ziyang			49	36	35.7	34.7	30	28
	Neijiang			54	48	38	35	34	35
	Deyang		53	55	54	49	40.2	37	37
	Dazhou			56	50	47.1	45.8	39	38
	Chengdu	77	64	63	56	51	43	41	40
	Leshan			63.3	55.3	47	39.1	35	37
	Luzhou		61	64	52.6	39	41	38	40.6
	Zigong		73	73	66	54.1	44.9	43	44
	Yibin		58		56	51.9	47	40	44
	Nanchong				46	47.9	42.3	37	37
	Meishan				49.2	35.4	36.4	32	34
	Bazhong				32.7	30.3	35	28	28
	Aba Prefecture				17	15	13	16	17
	Ganzi Prefecture				19	19.8	11.3	9	8
	Liangshan Prefecture				22	23.7	20.4	22	21
Tibet	Lhasa		26	28	20	17	12		10
	Changdu Prefecture							12	
	Shannan Prefecture								
	Shigatse Prefecture								
	Naqu Prefecture							11	
	Ali Prefecture								
	Linzhi Prefecture								

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	65	57	54	45	40	38	33	35
Yunnan	Chuxiong Prefecture			22	22	24		24	20
	Kunming		30	28	29	28	26		24
	Lincang			28	24			20	28
	Qujing				28	30			23
	Yuxi				23				21
	Zhaotong				31				24
	Lijiang				14				12
	Honghe Prefecture				34				27
	Diqing Prefecture				10			19	15
	Baoshan				25	21	20		23
	Puer				28				21
	Wenshan Prefecture				23			29	23
	Xishuangbanna				26	26	20		22
	Dali Prefecture				23	17	14		17
	Dehong Prefecture				30				27
	Nujiang Prefecture				20				24
Guizhou	Tongren			25	24	26	31	25	23
	Anshun			27	30	32	23	23	25
	Qiandongnan Prefecture			28	32		26	24	23
	Bijie			30	30	31	26	24	25
	Guiyang	48	39	37	32	32	27	23	23
	Liupanshui			39	40	35	24	22	25
	Zunyi		42	44	33	28	21	18	23
	Qianxi'nan Prefecture						20	19	22
	Qiannan Prefecture						19	17	18

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Jinchang			32	29	22	20		18
Gansu	Jiayuguan			33	23	23	22	22	19
Gansu	Dingxi			36	36	40	26		22
Gansu	Zhangye			38	29	32	28		25
Gansu	Gannan			38		32	22		14
Gansu	Baiyin			39	33	34	27		23
Gansu	Wuwei			39	38	36	29		28
Gansu	Pingliang			41	30	37	24		17
Gansu	Tianshui			42		40	30		25
Gansu	Lanzhou		52	54	49	47	36	34	32
Gansu	Jiuquan				28	32	25		23
Gansu	Qingyang						30		23
Gansu	Longnan				31	34	19		18
Gansu	Linxia Prefecture					46	29		26
Qinghai	Yushu Prefecture			17	19	18	10	8	9
Qinghai	Haixi Prefecture			27	24	20	14	12	13
Qinghai	Hainan Prefecture			31	27	20	20	19	19
Qinghai	Haibei Prefecture			32	28	25	18	19	21
Qinghai	Guoluo Prefecture			37	27	24	15	16	18
Qinghai	Huangnan Prefecture			45	33	30	22	21	21
Qinghai	Haidong Prefecture			46	47	45	36	38	33
Qinghai	Xi'ning	63	49	49	39	45	34	35	32
Ningxia	Shizuishan			47		39	34	40	33
Ningxia	Wuzhong			48		31	28	34	27
Ningxia	Yinchuan		51	56	49	38	31	36	33
Ningxia	Guyuan					34	24	24	
Ningxia	Zhongwei				34	33	29	33	27

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Karamay		31	30		28		26	24
Xinjiang	Urumqi	61	66	74	70		50	47	40
Xinjiang	Korla					50			41
Xinjiang	Turpan								49
Xinjiang	Changli Prefecture				48				52
Xinjiang	Ili Prefecture				51				36
Xinjiang	Hami Prefecture				31				29
Xinjiang	Bortala Prefecture								22
Xinjiang	Aksu Prefecture								51
Xinjiang	Kizilsu Prefecture								45
Xinjiang	Kashi Prefecture								84
Xinjiang	Hetian Prefecture								94
Xinjiang	Tacheng Prefecture							12	12
Xinjiang	Altay Prefecture								10
Xinjiang	Wujiaqu								60
Xinjiang	Shihezi					60			56
Shaanxi	Shangluo			39	36		32	30	
Shaanxi	Tongchuan		58	59	54	49	47	43	36
Shaanxi	Baoji		57	59		54	51	47	40
Shaanxi	Xi'an	76	57	71	73	63	57	51	43
Shaanxi	Weinan		60	76	71	71	57	53	44
Shaanxi	Xianyang		64	82		71	66	54	48
Shaanxi	Yan'an						31	32	27
Shaanxi	Hanzhong				53	49	46	40	38
Shaanxi	Yulin				34	35	35	33	
Shaanxi	Ankang						39	26	29

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Jixi		29	28	43	34	31	28	30
	Shuangyashan		43	34	40	28	29	26	26
	Qiqihar		38	36	38	28	28	31	20
	Mudanjiang	59	48	37	36	30	33	31	29
	Harbin	72	70	52	58	39	42	47	37
	Daqing		45	38	35	28	29	28	26
	Hegang		48	38	35	27	24	24	23
	Yichun		30	19	23	21	22	21	23
	Jiamusi		31	33	38	29	28	28	29
	Qitaihe		56	47	47	32	34	33	29
	Heihe		29	23	23	19	16	17	15
	Suihua		36	33	36	35	36	41	33
	Great Khingan		24	22	19	19	20	14	16
Jilin	Yanbian			31	31	27	26	21	21
	Songyuan			35	35	27	29	27	23
	Jilin		59	42	52	37	38	41	32
	Tonghua			42	35	28	29	27	23
	Changchun	68	66	46	46	33	38	42	31
	Siping			46	46	38	36	33	28
	Liaoyuan			46	44	34	36	39	32
	Baicheng			48	31	28	26	25	23
	Baishan			50	44	32	29	28	25

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Dalian	53	48	39	34	30	35	30	28
	Zhaoyang			39	42	39	37	35	31
	Panjin			40	39	36	39	35	
	Dandong		46	42	35	29	32	29	28
	Fushun		53	44	47	43	45	43	
	Yingkou		49	44	43	40	43	41	37
	Benxi		56	45	40	34	37	35	30
	Huludao		54	47	47	42.8	47	43	38
	Liaoyang			47	47	39	41	41	37
	Tieling			48	50	40	41	39	
	Shenyang	74	72	54	51	41	43	42	38
	Jinzhou		60	55	48	46	47	47	42
	Anshan		72		48	41	43	44	39
	Fuxin				41	37	37	36	34

PM_{10}

- In 2021, the overall annual mean concentration of PM_{10} across the country decreased to 54 μg/m^3, down by 3.6% year-on-year.

- The proportion of attainment cities increased from 76.8% to 82.0%, up by 18 cities compared to 2020.

- In the key regions, the annual mean concentration of PM_{10} in the BTH region and its surrounding areas decreased to 78 μg/m^3, with a year-on-year decrease of 11.4%. In the YRD region, the annual mean concentration remained the same as that in 2020 at 56 μg/m^3. In the Fenwei Plain, the annual mean concentration dropped to 76 μg/m^3, a year-on-year decrease of 8.4%.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Chengde	111	92	81	82	78	63	55	55
	Qinhuangdao	114	99	87		77	80	62	63
	Beijing	115.8	101.5	92	84	78	68	56	55
	Tianjin	133	116	103	94	82	76	68	69
	Langfang	159	137	112	102	97	85	76	73
	Tangshan	163	141	127	119	110	101	88	79
	Hengshui	192	174	143	137	101	94	83	70
	Baoding	224	174	147	135	114		86	79
	Shijiazhuang	216	147	164	154	131	122	101	84
	Handan	187	166		155	133	124	102	78
	Cangzhou	138	121		105	102	89		69
	Xingtai	235	172	144	148	131	115	92	75
	Zhangjiakou	78	78		70	69	56		48
Fen-wei Plains	Lvliang				112	95	87	86	83
	Jinzhong			109	112	110	86	75	67
	Linfen		89			117	103	86	72
	Yuncheng				125	108	100	90	84
	Sanmenxia		134	127	98	99	90	76	89
	Luoyang			130	123	104	107	91	77
	Xi'an	147	125	137	130	122	96	91	96
	Xianyang			149		134	101	91	85
	Baoji		108	111		105	82	74	
	Tongchuan		104	104	97	89	80	71	66
	Weinan		110	139	135	134	101	91	84

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Shanghai	71	69	59	55	51	45	41	43
	Ningbo	73	69	62	60		48	39	
	Shaoxing		79	68	63	59		47	47
	Nantong	96	88	70	65	63	55	46	45
	Suzhou	86	80	72	66	65	62	50	48
	Zhenjiang	107	82	80	90	76	72	58	58
	Changzhou	104		81	73	73	69		60
	Wuxi	105	94	82	79	75	69	56	54
	Nanjing	123	96	85.2	76	75	69	56	56
	Yangzhou		101	87	95	90	71	63	62
	Taizhou	107	101	87	79	74			
	Lianyungang	111	94	87	75		66	55	57
	Huai'an	105	96	92	89	69.5	73	61	67
	Xuzhou	119	122	118	119	104	96	83	75
	Taizhou	71	66		59		44	45	
	Huzhou		76		64			53	
	Yancheng	92	85		79	81	68	54	50
	Hangzhou	98	85		72	68	66	55	55
	Jiaxing	81			67			46	
	Lishui	62			50	46		40	
	Wenzhou	75			65	58	53	51	52
	Suqian	113			78	76	78	67	66
	Jinhua				58	55	52	44	47
	Zhoushan				45			31	
	Quzhou				64	54	51	42	51

Unit:μg/m^3

Figure 5: Annual Mean Concentrations of PM_{10} in 339 Cities in 2014-2021

North China

	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Erdos		69	63	72	90	65	58	57
	Chifeng		88	76	73	76	60	54	46
	Baotou			105	99	103	82	78	65
	Wuhai			111	113	99	92	81	81
	Hohhot		103		99	86	77	71	60
	Ulanqab				53	63	42	39	47
	Xilingol				46	68	36	26	26
	Hulun Buir				42	31	33	28	28
	Tongliao				69	65	71	54	52
	Bayannur				96	99	78	69	68
	Hinggan League				45	39	43	38	35
	Alxa League				76	94	56	44	42
Henan	Xinyang			96	90	86	76	63	62
	Zhoukou			113	98	103	94	75	71
	Nanyang			119	109	96	92	80	88
	Zhumadian			120	106	111	86	71	66
	Kaifeng			122	103			86	80
	Xuchang			122	96		88	75	69
	Pingdingshan			125	106	101	93	82	80
	Sanmenxia		134	127	98	99	90	76	89
	Shangqiu			127	131	103	90	78	71
	Hebi			128	120	108	99	92	88
	Luoyang			130	123	104	107	91	77
	Luohe			130	116	103	94	82	80
	Puyang			137	107	102	102	87	78
	Jiaozuo		150	142	134	116	114	97	84
	Zhengzhou	158		143	118	106	98	84	76
	Xinxiang			144	116	105	101	89	93
	Anyang			155	132	123	115	104	89

	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Xinzhou			103	112	96	79	71	73
	Jinzhong			109	112	110	86	75	67
	Jincheng			111	117	118	111	96	76
	Taiyuan	138	114	125	131	135	107	95	83
	Linfen		89			117	103	86	72
	Datong				73	82	73	70	60
	Changzhi				103	98	84	77	65
	Yangquan				116	108	84	78	73
	Shuozhou				99	112	86	87	78
	Yuncheng				125	108	100	90	84
	Lvliang				112	95	87	86	83

East China

	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Weihai		65	63	62	50	56	44	43
	Yantai		77	76	69	66	70	58	53
	Qingdao	107	94	85	76	72	74	61	56
	Rizhao		102	101	87	79	85	62	59
	Tai'an		126	112	103	102	97	82	76
	Binzhou		126	123	110	98	91	81	74
	Ji'nan	172	157	141	130	112	103	86	78
	Zaozhuang		159	141	126	115	113	96	83
	Dezhou			141	122	113.6	103	91	96
	Heze		155	143	131	119	112	99	93
	Liaocheng		164	151	136	123	116	94	85
	Ji'ning		140		103	99			
	Dongying		136		110	94		80	

	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Zibo				119	106	104	77	77
	Weifang				103	94	104	71	71
	Linyi				114	106	106	79	79
Fujian	Nanping			37	37	35		29	33
	Putian			43	44	44	43	40	40
	Longyan			44	42	46		33	
	Sanming			46	44	42		38	
	Ningde			46	44	42	35	37	31
	Xiamen	59	48	47	48	46	40	33	36
	Quanzhou			48	53	53		38	40
	Fuzhou			50	51	48	42	38	39
	Zhangzhou			65	59	60		46	46
Anhui	Huangshan			45	51	42	39	34	33
	Chizhou			66	89	67	61	51	52
	Xuancheng			68	76	64	56	43	45
	Anqing			71	80	65	62	48	
	Lu'an			73	80	78	72	62	63
	Wuhu		81	75	82	67	62	50	57
	Maanshan		87	75	83	75	68	57.7	61
	Chuzhou			77	83	80	72	61	63
	Tongling			77.8	88.4	75	75	64	65
	Hefei	113	91.9	83	80	73	68	58	63
	Bozhou			83	103	98.3		79	72
	Huai'nan			85	107	88.9	91.3	78	71
	Huaibei			87	100	90	84		73
	Bengbu				98	87.3			
	Fuyang				108	90	84	78	79
	Suzhou				97	90.1			

	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Yingtan			59	59	52	52	40	
	Fuzhou			63	64	59		46	
	Ganzhou			68	72	63	56		
	Shangrao			70	75	63			
	Jiujiang			74	70	68			51
	Nanchang	85	75	78	76	64			
	Jingdezhen				67	56		45	
	Pingxiang				84	71			
	Xinyu			76	82	70.5	64		
	Ji'an				75	66.7			
	Yichun				76	65.8		52	56

South China

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Enshi Prefecture	79	76	69	54	60	58	45	48
	Huanggang	102	85	75	84	74	73	61	61
	Xianning	94	90	77	62	56	56	49	48
	Xiaogan	103	110	78	80	72	73	56	58
	Shiyan	98	90	81	64	71	68	54	52
	Suizhou	108	103	88	75	73	69	59	59
	Huangshi	103	102	89	86	70	71	63	64
	Wuhan	113	104	92	88	73	71	59	59
	Xiangyang	113	108	93	90	89	84	68	64
	Yichang	136	107	97	88	77	73	57	58
	Jingmen	110	114	99	84	79	75	57	56
	Jingzhou	150	109	100	92	86	83	64	64
	Ezhou	110	104	100	85	73	74	65	67

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Chenzhou			70	70	61	52		
	Yongzhou			70	67	69	56	43	42
	Loudi			71	66	66	66	55	55
	Yueyang			72	71	72	68	56	54
	Zhangjiajie		78	72	67	58	50		
	Changsha	84	76	73	70	61	57		52
	Hengyang			76	70	66	59	50	54
	Shaoyang			77	78	65	59	52	
	Xiangxi Prefecture			78	75	59	49	41	38
	Huaihua			79	83	50	46		41
	Changde		82	80	77	62	60	50	51
	Yiyang			82	78	69	72	58	52
	Zhuzhou		86	83	82	71	66	51	53
	Xiangtan			85	81	68	63		
Guangxi	Fangchenggang			45	46	47	51	42	45
	Guigang			55	66	63			
	Hechi			55	60	59	53	43	48
	Nanning	84	72	62	56	57	58	46	46
	Guilin		70	64	60	55	54		45
	Liuzhou		70	66	66	62	57	43	47
	Beihai		48		45	46		40	41
	Wuzhou				60	61			
	Qinzhou				55	53			44
	Yulin				59				
	Baise				63	60			
	Hezhou				66	57	53		46
	Laibin				70	65			
	Chongzuo				47	52	58		49

	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shanwei		41	38	43		37	29	32
	Zhanjiang		45	39	42	39		35	37
	Yangjiang		48	44	48			34	37
	Meizhou		51	46	50	49	42	33	33
	Heyuan		49	46	48			37	39
	Maoming		48	47	50			39	41
	Shantou		52	48	49	44		34	35
	Shaoguan		50	51	52		43	37	39
	Yunfu		54	51	57	53	50	37	44
	Chaozhou		58	51.2	50			41	
	Qingyuan		51	52	47	46	52	46	
	Jieyang		56	60	55		52	44	
	Zhuhai		51	41	43	43	41	34	37
	Shenzhen	53	49	42	45	44	42	35	37
	Zhongshan	57	49	44	49	45	43	36	39
	Huizhou		50	45	51	47		38	40
	Dongguan	60	51	49	51	50	38	38	42
	Foshan	66	58	55	63	60	56	43	46
	Jiangmen	64	50	55	60	56	49	41	45
	Zhaoqing	74	56	55	56	51	48	37	37
	Guangzhou	67	59	56	56	54	53	43	46
Hainan	Sanya		32	28	28		27	23	24
	Haikou		40	39	37	35	32	29	28

	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Panzhihua		64	65	66	64	70	48	47
	Suining			68	63	61	49	47	49
	Ya'an			68	67	55.8	30.5	38	40
	Guangyuan			69.6	59.2	56.5	49.1	44	41
	Neijiang			76	70	58	51	48	52
	Mianyang		72	78	71.4	72	58.6	54	57
	Guang'an			78	74	70.3	55.5	51	51
	Dazhou			86	77	74.6	73.2	61	60
	Luzhou		89	86.8	80	59	54	48	52
	Deyang		75	91	87	78	66.6	61	63
	Leshan			92.9	83.7	70.1	61.7	53	54
	Ziyang			95	82	69.5	54	50	51
	Zigong		103	99	89	77.8	67.1	62	66
	Chengdu	123	108	105	88	81	68	64	61
	Yibin		82		80	75	62	60	60
	Nanchong				72	72.9	63.4	56	55
	Meishan				80.1	60.6	60.5	54	54
	Bazhong				53.6	51.4	59	44.8	44
	Aba Prefecture				34	26.6	25	23	26
	Ganzi Prefecture				31	31.5	18.6	16	17
	Liangshan Prefecture				45	37.6	34.3	37	36
Tibet	Lhasa		59	80	54				
	Changdu Prefecture								
	Shannan Prefecture								
	Shigatse Prefecture							28	
	Naqu Prefecture								
	Ali Prefecture								
	Linzhi Prefecture								

	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	98	87	77	72	64	60	53	54
Yunnan	Chuxiong Prefecture			35	40	40			31
	Lincang			43.5	40			42	38
	Kunming		56	55	58	51	45	35	41
	Qujing				54	53			37
	Yuxi								36
	Zhaotong				56				37
	Lijiang				27				24
	Honghe Prefecture				51				35
	Diqing Prefecture				36			24	17
	Baoshan				39	40	30		29
	Puer				44				34
	Wenshan Prefecture				39.7				33
	Xishuangbanna				48		54		40
	Dali Prefecture				33	38	28		26
	Dehong Prefecture				46				47
	Nujiang Prefecture				43				39
Guizhou	Anshun			38	44	47	30	29	31
	Bijie			44	47	52	38	35	35
	Qiandongnan Prefecture			45	46		36	33	32
	Tongren			50	66	57	52	41	39
	Guiyang	73	61	63	53	57	47	41	42
	Liupanshui			68	66	57	39	34	37
	Zunyi		71	69	54	47	38	30	39
	Qianxi'nan Prefecture						31	29	32
	Qiannan Prefecture						31	27	27

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Gannan			70		63	44		34
	Dingxi			75	69	81	57		52
	Tianshui			80		79	56		52
	Pingliang			80	73	75	56		48
	Zhangye			90	81	66	55		52
	Baiyin			95	85	82	62		59
	Wuwei			97	81	80	61		65
	Jiayuguan		98	98	97	79	61	58	54
	Jinchang			104	101	76	58		58
	Lanzhou	126	120	132	111	103	79	76	72
	Jiuquan				89	90.7	65		64
	Qingyang						58		49
	Longnan				62	58	38		44
	Linxia Prefecture					81	59		55
Qinghai	Yushu Prefecture			40	46	49	26	25	24
	Haixi Prefecture			65	62	45	39	39	31
	Hainan Prefecture			69	57	51	39	36	33
	Guoluo Prefecture			72	56	47	32	27	32
	Haibei Prefecture			76	55	49	34	39	31
	Huangnan Prefecture			86	56	60	44	47	40
	Xi'ning	120	106	113	99	89	59	61	58
	Haidong Prefecture			114	104	85	60	63	59
Ningxia	Wuzhong			98		75	64	67	62
	Shizuishan			114		89	76	75	74
	Yinchuan		112	111	117	87	68	72	102
	Guyuan					82	59	46	
	Zhongwei				81	75	61	65	65

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Karamay		64	55		60		54	56
	Urumqi	146	133	115	106		86	83	74
	Korla					177			158
	Turpan								151
	Changli Prefecture				77				92
	Ili Prefecture				83				66
	Hami Prefecture				78				90
	Bortala Prefecture								64
	Aksu Prefecture								160
	Kizilsu Prefecture								181
	Kashi Prefecture								237
	Hetian Prefecture								327
	Tacheng Prefecture								43
	Altay Prefecture								16
	Wujiaqu								110
	Shihezi								94
Shaanxi	Shangluo			72	65		54		
	Tongchuan		104	104	97	89	80	71	66
	Baoji		108	111		105	82	74	
	Xi'an	147	125	137	130	122	96	91	96
	Weinan		110	139	135	134	101	91	84
	Xianyang			149		134	101	91	85
	Yan'an						67		56
	Hanzhong				86	81	71		60
	Yulin					78	66		
	Ankang						64	44	47

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Jixi		61	53	75	57	54	49	53
	Shuangyashan		69	55	61	49	50	44	43
	Qiqihar		63	61	65	53	52	54	44
	Mudanjiang	91	78	68	65	58	61	51	51
	Harbin	111	103	74	87	65	67	64	57
	Daqing		62	59	59	46	48	45	41
	Hegang		78	67	65	61	46	46	44
	Yichun		51	33	36	38	35	30	33
	Jiamusi		53	48	57	47	44	43	45
	Qitaihe		85	74	84	80	63	57	51
	Heihe		50	37	41	40	34	31	26
	Suihua		60	58	65	53	56	57	49
	Great Khingan		55	43	33	34	30	25	22
Jilin	Yanbian			49	46	45	44	35	35
	Liaoyuan			63	59	48	51	54	47
	Jilin		98	69	79	63	63	60	51
	Songyuan			69	71	61	58	50	43
	Baicheng			75	55	50	49	38	38
	Tonghua			76	62	54	51	50	44
	Siping			77	80	68	69	59	55
	Changchun	118	107	78	78	61	64	59	54
	Baishan			81	71	59	56	60	57

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Dalian	74	81	67	59	56	60	50	
	Panjin			67	66	59	56		
	Zhaoyang			69	76	76	68	66	58
	Dandong		76	71	61	50	55	48	48
	Yingkou		77	73	69	69	69		64
	Benxi		89	74	71	65	66		57
	Fushun		93	78	81	73	78	71	
	Jinzhou		92	81	78	78	77		
	Fuxin			83	81	69	67		63
	Liaoyang			83	82	69	74	69	62
	Tieling			83	85	74	76		
	Huludao		99	87	80	74.25	77	67	66
	Shenyang	124	115	94	88	75	77	74	65
	Anshan		115		95	77	81	74	69

SO_2

- In 2021, the overall annual mean concentration of SO_2 across the country continued to drop to 9 μg/m^3, down by 10.0% year-on-year and steadily meeting the national level-1 standard.

- As in 2020, the proportion of attainment cities remained at 100%, indicating that all cities consistently met the standard.

- In the three key regions, the annual mean concentration of SO_2 in the BTH region and its surrounding areas declined to 11 μg/m^3, a year-on-year decrease of 15.4%. In the YRD region, the annual mean concentration remained the same as that in 2020 at 7 μg/m^3. In the Fenwei Plain, the annual mean concentration dropped to 10 μg/m^3, a year-on-year decrease of 16.7%.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Beijing	21.8	13.5	10	8	6	4	4	3
	Tianjin	49	29	21	16	12	11	8	8
	Shijiazhuang	64	47	41		23	18	12	9
	Tangshan	73	49	46	40	34	22	18	10
	Qinhuangdao	54	38	28		21	19	15	11
	Handan	57	45			22	15	14	12
	Baoding	67	55	39	29	21		11	8
	Chengde	40	22	17	17	13	14	12	11
	Cangzhou	40	40			24	18		8
	Hengshui	42	36			15	13	12	12
	Xingtai	75	60	52		26	19	14	10
	Zhangjiakou	53	31			14	11		9
	Langfang	36	24	18	14	11	8	8	7
Fen-wei Plains	Lvliang					40	29	18	13
	Jinzhong			88	84	37	26	20	18
	Linfen					46	28	18	12
	Yuncheng				51	30	15	13	10
	Sanmenxia			33					8
	Luoyang			39	25	17	10	8	6
	Xi'an	32	24	20	19	15	9	8	8
	Xianyang		24	20		16	9		10
	Baoji		15	13		10	8	8	
	Tongchuan		25	22	20	21	12	12	10
	Weinan		23	22	18	13	10	11	36

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Shanghai	18	17	15	12	10	7	6	6
	Jiaxing	26							
	Shaoxing		21	12	9	7		5	6
	Zhoushan								
	Wenzhou	17			12	9	8	6	9
	Jinhua					8	7	6	6
	Quzhou					8	7	6	6
	Taizhou	12	9				4	4	
	Lishui	13				7			
	Nanjing	25	19	18.2	16	10	10	7	6
	Suzhou	24	21	17	14	8	9	8	6
	Wuxi	29	26	18	13	12	8	7	7
	Changzhou	36		19	17	14	10		9
	Yangzhou		24	23	18	13	10	8	9
	Zhenjiang	24	25	24	15	10	9	8	7
	Nantong	26	30	25	21	17	10	9	6
	Taizhou								
	Xuzhou	38	38	35	22	17	11	10	9
	Lianyungang	30		25	18		13	10	10
	Huai'an	32	21	18		9.25	10	7	6
	Yancheng	20	19			9	4	5	5
	Suqian						8	6	6
	Hangzhou	21	16		11	10	7	6	6
	Ningbo	17	15	13					
	Huzhou		17					6	

Unit:μg/m^3

Figure 6: Annual Mean Concentrations of SO_2 in 339 Cities in 2014-2021

North China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Hohhot		34		29	20	15	13	11
	Chifeng		49		23	20	19	15	14
	Baotou			31	28	24	22	20	15
	Erdos		20	15	14	13	13	13	11
	Ulanqab				27	23	20	20	17
	Xilingol				18	19	15	13	10
	Wuhai			56	51	35	32	26	22
	Hulun Buir				4	3	3	3	4
	Tongliao				14	14	11	11	9
	Bayannur				24	14	14	16	10
	Hinggan League				8	8	7	5	5
	Alxa League				11	10	9	8	6
Henan	Zhengzhou			29		15	9	9	8
	Pingdingshan			30				12	
	Sanmenxia			33					8
	Luoyang			39	25	17	10	8	6
	Anyang			52					9
	Kaifeng			28					
	Jiaozuo		49	40	25	18	13		10
	Xuchang			28				11	10
	Nanyang			24			7	8	9
	Xinyang			14			7		
	Zhoukou			21					
	Hebi			43		19	13	11	11
	Xinxiang			40	28	19	16		
	Puyang			29		16		10	
	Luohe			28	15	12	10	9	8
	Shangqiu			23					
	Zhumadian			31	16				

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Taiyuan	73		69		29	22	17	14
	Datong					31	30	29	21
	Changzhi				43	22	16	17	14
	Linfen					46	28	18	12
	Yangquan					32	16	20	19
	Jincheng			70	47	25	16	13	10
	Shuozhou					40	26	25	15
	Jinzhong			88	84	37	26	20	18
	Yuncheng				51	30	15	13	10
	Xinzhou			49		34	29	20	16
	Lvliang					40	29	18	13

East China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Ji'nan	72	50	38	25	17	15	12	11
	Qingdao	37	28	20	14	10	8	7	8
	Zibo		83		38	24	20	17	14
	Zaozhuang		63	38	29	19	17	16	14
	Yantai		21	21	15	10	8	8	9
	Weifang				26	19.9	13	11	8
	Ji'ning		56		24	18			
	Tai'an		39	35.2	25	18	15	14	12
	Rizhao		27	23	16	12	9	8	8
	Dongying		54			18		15	
	Liaocheng			31	18	14	14	12	14
	Binzhou		58	39	32	22	19	16	16
	Heze		42	35		14	14	11	10
	Weihai		17	15	10	7	6	5	5

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Linyi				23	18	15	12	12
	Dezhou			34		25.5	15	12	10
Fujian	Fuzhou			6		7	5	5	4
	Xiamen	16	10	11		9	6	6	5
	Quanzhou			11		10		5	5
	Putian			7		9	6	6	5
	Sanming			15		13		8	
	Zhangzhou			15		8		7	6
	Nanping			11		9		6	7
	Longyan			10		10		8	
	Ningde			6	9	8	8	6	6
Anhui	Hefei		16	15	12	7	6	7	7
	Wuhu		20	21	15	11.5	11	9	9
	Maanshan		24	20		15.3	12	10	9
	Bengbu					16.1			
	Huai'nan			19	18	15.4	14	10	8
	Huaibei				21	17	11		7
	Tongling			43	27	18	15	13	11
	Anqing			19	15	11	9	8	
	Huangshan			15		10	9	6	6
	Chuzhou			18	13	11	10	7	8
	Fuyang				13	9	6	7	7
	Suzhou					16.2			
	Lu'an			13	11	7	6	6	6
	Bozhou			27		12.7		7	6
	Chizhou			20	15	12		8	7
	Xuancheng			21	21	11	8	7	7

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Nanchang		19	17	15	11			
	Jiujiang			21	20	13			7
	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		13	11
	Fuzhou					13.8			
	Shangrao					22.6			

South China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Wuhan	21	18	11	10	9	9	8	8
	Yichang		20	14	12	11	7	7	7
	Jingzhou		26	23	18	15	9	7	8
	Huangshi			19	18	14	14	15	14
	Ezhou			23	15	11	12	11	9
	Xiaogan			11	11	9	7	6	7
	Huanggang			9	11	9	10	10	12
	Xianning			8	7	5	7	9	7
	Shiyan			17	14	15	9	6	6
	Xiangyang			15	16	14	11	11	10
	Jingmen			21	18	15	9	6	5
	Suizhou			10	9	7	7	6	8
	Enshi Prefecture			10	9	7	4	7	7

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Changsha	24	18	16	13	10	7		7
Hunan	Yueyang			21	14	10	9	10	9
Hunan	Changde		25	19	12	11	8	7	8
Hunan	Zhangjiajie		10	7	8	7	4		
Hunan	Zhuzhou		25	25	19	18	11	8	7
Hunan	Xiangtan			25	20	16	10		
Hunan	Yueyang			16	16	16	14		8
Hunan	Shaoyang			31	29	18	15	12	
Hunan	Yiyang			27	13	9	7		
Hunan	Chenzhou			16	15	15	11		
Hunan	Yongzhou			19	12	11	9		
Hunan	Huaihua			19	11	10	8		8
Hunan	Loudi			22	17	11	10		
Hunan	Xiangxi Prefecture			10	4	4	6		
Guangxi	Nanning	15	13	12	11	11	10	8	8
Guangxi	Guilin		21	17	15	12	13		11
Guangxi	Beihai							8	8
Guangxi	Liuzhou		24	21	19	15	14	10	11
Guangxi	Wuzhou				12				
Guangxi	Fangchenggang			9		11			9
Guangxi	Qinzhou								14
Guangxi	Guigang								
Guangxi	Yulin								
Guangxi	Baise								
Guangxi	Hezhou						11		9
Guangxi	Hechi			12	9				8
Guangxi	Laibin								
Guangxi	Chongzuo						7		9

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shaoguan		19				10		9
Guangdong	Shantou		13	14	12	12			9
Guangdong	Zhanjiang		10	10		9			9
Guangdong	Maoming		14						11
Guangdong	Meizhou		9	7	8	7	8	7	7
Guangdong	Shanwei		10				8	8	8
Guangdong	Heyuan		10	7					7
Guangdong	Yangjiang							7	7
Guangdong	Qingyuan			14	11	10	9		
Guangdong	Chaozhou								
Guangdong	Jieyang		17	15	15		11		
Guangdong	Yunfu					15	15		11
Guangdong	Guangzhou	17	13	12	12	10	7	7	8
Guangdong	Shenzhen	9	8	8	8	7	5	6	6
Guangdong	Zhuhai		9	9		7	5	5	6
Guangdong	Foshan	25	17	14	13	11	9	7	8
Guangdong	Jiangmen	24	16	12	12	9	7	7	7
Guangdong	Dongguan	19		11	12	10	10	8	9
Guangdong	Zhongshan	16		11	10	9	6	5	5
Guangdong	Huizhou								
Guangdong	Zhaoqing	25	20	16	13	11		9	8
Hainan	Haikou		6	6	6	5	5	4	4
Hainan	Sanya		3		2		4	4	4

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Chengdu	19	14	14	11	9	6	6	
	Mianyang		13	11	9	6.4	9	5	8
	Yibin		24		18	16	10	7	
	Panzhihua		34	38	35	40	31	25	22
	Luzhou		22	18	17	15	11	10	12
	Zigong		17	15	15	13.3		6	8
	Deyang		22	15	14	12		6	
	Nanchong					9.4			5
	Suining			13		10	9.3	8.5	8
	Neijiang			18		10	7	8	9
	Leshan			19.4	16.2	7.7	12.9		9
	Meishan					9.8			
	Guang'an			18	13	9			6
	Dazhou			12	11	10.2			
	Ziyang			17	10	8.1		7	7
	Guangyuan			18.9	21.1	19.7	11		7
	Ya'an			15	11	14.5		7.3	7
	Bazhong				42	4.2	4.3		
	Aba Prefecture				11	7.8	9		7
	Ganzi Prefecture					10.4			
	Liangshan Prefecture				12	16.4			
Tibet	Lhasa		10	8					
	Changdu Prefecture								
	Shannan Prefecture								
	Shigatse Prefecture							4	
	Naqu Prefecture								
	Ali Prefecture								
	Linzhi Prefecture								

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	24	16	13	12	9	7	8	9
Yunnan	Kunming		17	17	15	13	12	9	9
	Qujing					14		11	8
	Yuxi								9
	Zhaotong								9
	Lijiang								6
	Chuxiong Prefecture			22	19	15			10
	Honghe Prefecture								12
	Diqing Prefecture						5		8
	Baoshan					7		5	5
	Puer								6
	Lincang			11.5	12				8
	Wenshan Prefecture				9.7		6		6
	Xishuangbanna						10		8
	Dali Prefecture					5			6
	Dehong Prefecture								7
	Nujiang Prefecture								8
Guizhou	Guiyang	24	17	13	13	11	10	10	10
	Zunyi		16	11	12	12	12	11	12
	Liupanshui			17	18	17	12	9	6
	Bijie			17	13	11	9	8	8
	Anshun			22	20	17	14	13	13
	Tongren			12	10	4	4	4	4
	Qianxi'nan Prefecture						5	6	8
	Qiandongnan Prefecture			13	8		18	18	8
	Qiannan Prefecture						10	7	6

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Lanzhou	29		19	20	21	18	15	15
	Jiayuguan		25	21	17	14	11	13	14
	Jinchang			37	27	21	17		16
	Baiyin			42		46	42		31
	Tianshui			27		17	12		11
	Wuwei			23	14	8	8		7
	Zhangye			25	13	10	12		9
	Pingliang			19		11	9		7
	Jiuquan				14	9.4	10		7
	Qingyang						11		9
	Dingxi			25	22	17	11		12
	Longnan				20	17	16		16
	Linxia Prefecture					23	13		8
	Gannan			19		14	11		12
Qinghai	Xi'ning	41	31	31	24	20	17	15	18
	Haidong Prefecture			22	20	18	14	14	15
	Haibei Prefecture			19	14	16	14	11	14
	Huangnan Prefecture			17	15	17	15	11	9
	Hainan Prefecture			13	18	9	10	10	11
	Guoluo Prefecture			25	27	23	19	21	15
	Yushu Prefecture			13	20	15	9	14	14
	Haixi Prefecture			21	20	17	9	11	15
Ningxia	Yinchuan		64		48	27	15		14
	Shizuishan					17	30		
	Wuzhong			41		17	16		
	Guyuan					27	10		
	Zhongwei				24	41	14		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Urumqi	25	15	14	13				7
	Karamay								6
	Korla					7			4
	Turpan								8
	Changli Prefecture				15				11
	Ili Prefecture				23				12
	Hami Prefecture								10
	Bortala Prefecture								9
	Aksu Prefecture								6
	Kizilsu Prefecture								4
	Kashi Prefecture								7
	Hetian Prefecture				35				12
	Tacheng Prefecture								5
	Altay Prefecture								3
	Wujiaqu								9
	Shihezi								9
Shaanxi	Xi'an	32	24	20	19	15	9	8	8
	Xianyang		24	20		16	9		10
	Tongchuan		25	22	20	21	12	12	10
	Yan'an						10		5
	Baoji		15	13		10	8	8	
	Weinan		23	22	18	13	10	11	36
	Hanzhong				15	11	13		9
	Yulin						15		
	Ankang						12		
	Shangluo			20			13		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Harbin	57	40	28		20	17		
	Qiqihar		26	23	22	15			14
	Daqing		18		13	13	9		
	Mudanjiang	25	20	18	10			9	
	Jixi			20			8		
	Hegang								
	Shuangyashan			18	13	9	8	10	
	Yichun								
	Jiamusi								
	Qitaihe								
	Heihe				16				
	Suihua								
	Great Khingan						19		
Jilin	Changchun	41	36	28	26	16	11	10	9
	Jilin		30	23	18	15	12	14	12
	Siping			22	26	14	11	11	9
	Liaoyuan			25	18	13	15	14	12
	Tonghua			29	26	16	11	15	17
	Baishan			35	29	21	14	14	15
	Songyuan			15	14	7	6	6	6
	Baicheng			12	11	10	8	9	9
	Yanbian			14	15	11	9	11	10

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Shenyang	82	66	47	37	26	21	18	15
	Dalian	29		26	17	12		10	
	Anshan		49			22		16	13
	Fushun		31	27				17	
	Benxi		43	36	27	21			16
	Jinzhou		59	52	45	39			
	Dandong								
	Yingkou		29	23		12			11
	Panjin								
	Huludao		47			38.3		23	21
	Fuxin			39					19
	Liaoyang			27				16	
	Tieling			30	20				
	Zhaoyang			34				15	12

NO_2

- In 2021, the overall annual mean concentration of NO_2 across the country continued to decrease to 23 μg/m^3, a year-on-year decrease of 4.2%.

- The proportion of attainment cities rose from 98.2% to 99.7%, with only Lanzhou failing to attain the standard among 339 cities throughout the country.

- Among the key regions, the annual mean concentration of NO_2 in the BTH region and its surrounding areas dropped to 31 μg/m^3, a year-on-year decrease of 11.4%. The annual mean concentration in the YRD region decreased by 3.4% to 28 μg/m^3. In the Fenwei Plain, the annual mean concentration declined to 33 μg/m^3, a year-on-year decrease of 2.9%.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Beijing	56.7	50	48	46	42	37	29	26
	Tianjin	54	42	48	50	47	42	39	37
	Shijiazhuang	54	51	58		50	40	41	32
	Tangshan	60	61	58	59	56	51	46	39
	Qinhuangdao	49	45	48		45	42	41	32
	Handan	52	47			43	38	35	28
	Baoding	55	54	58	50	47		37	36
	Chengde	39	35	35	35	34	32	31	30
	Cangzhou	33	41			43	38		31
	Hengshui	43	44			34	33	31	30
	Xingtai	62	60	61		50	45	37	31
	Zhangjiakou	29	26			23	22		18
	Langfang	49	47	52	48	47	39	36	36
Fen-wei Plains	Lvliang					45	45	39	40
	Jinzhong			36	44	45	41	36	31
	Linfen					40	39	38	34
	Yuncheng				35	31	28	26	25
	Sanmenxia			39					29
	Luoyang			47	42	40	40	34	29
	Xi'an	47	44	53	59	55	48	41	40
	Xianyang		39	50		50	43		40
	Baoji		36	39		41	34	30	
	Tongchuan		36	35	35	37	36	31	28
	Weinan		29	47	56	51	42	38	

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Shanghai	45	46	43	44	42	42	37	35
	Jiaxing	44							
	Shaoxing		37	31	31	29		27	28
	Zhoushan								
	Wenzhou	50			41	37	34	30	33
	Jinhua					29	27	24	25
	Quzhou					32	31	29	28
	Taizhou	25	23				19	20	
	Lishui	23				23			
	Nanjing	54	50	44.3	47	44	42	36	33
	Suzhou	53	54	51	48	48	37	34	33
	Wuxi	45	41	47	46	43	40	35	34
	Changzhou	40		37	41	44	37		35
	Yangzhou		30	30.5	40	38	35	32	31
	Zhenjiang	46	42	38	43	38	33	30	30
	Nantong	40	38	36	38	36	32	27	26
	Taizhou								
	Xuzhou	37	39	42	44	42	37	35	32
	Lianyungang	35		30	33		30	28	27
	Huai'an	27	22	25		31	26	25	25
	Yancheng	27	23			27	24	22	21
	Suqian						29	25	25
	Hangzhou	50	49		45	43	41	38	34
	Ningbo	41	43	39					
	Huzhou		40					35	

Unit:μg/m^3

Figure 7: Annual Mean Concentrations of NO_2 in 339 Cities in 2014-2021

North China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Hohhot		39		45	41	39	33	28
	Chifeng		25		20	27	26	24	23
	Baotou			39	42	39	39	38	32
	Erdos		24	23	27	26	26	25	22
	Ulanqab				28	25	25	25	21
	Xilingol				19	12	11	10	10
	Wuhai			28	31	30	29	28	25
	Hulun Buir				18	14	12	12	12
	Tongliao				22	20	20	18	20
	Bayannur				27	22	21	20	15
	Hinggan League				16	13	15	14	14
	Alxa League				11	11	10	9	8
Henan	Zhengzhou			56		50	45	39	32
	Pingdingshan			43				31	
	Sanmenxia			39					29
	Luoyang			47	42	40	40	34	29
	Anyang			51					31
	Kaifeng			40					
	Jiaozuo		50	48	44	41	37		26
	Xuchang			47				30	26
	Nanyang			29			29	24	23
	Xinyang			28			24		
	Zhoukou			29					
	Hebi			52		44	38	36	36
	Xinxiang			49	50	49	44		
	Puyang			42		36		30	
	Luohe			39	36	35	29	26	22
	Shangqiu			32					
	Zhumadian			38	36				

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Taiyuan	36		46		52	50	45	39
	Datong					29	34	32	24
	Changzhi				41	31	34	31	26
	Linfen					40	39	38	34
	Yangquan					45	34	41	36
	Jincheng			40	45	40	38	31	28
	Shuozhou					31	41	32	28
	Jinzhong			36	44	45	41	36	31
	Yuncheng				35	31	28	26	25
	Xinzhou			39		44	43	35	28
	Lvliang					45	45	39	40

East China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Ji'nan	53	48	45	46	45	41	35	33
	Qingdao	43	33	32	33	31	32	31	30
	Zibo		61		47	43	42	38	35
	Zaozhuang		36	31	31	35	34	30	29
	Yantai		33	33	30	27	27	25	27
	Weifang				36	34.6	37	32	31
	Ji'ning		43		38	34			
	Tai'an		42		39	36	34	29	29
	Rizhao		34	35	36	35	35	31	29
	Dongying		41			36		31	
	Liaocheng			41	40	38	39	33	32
	Binzhou		41	39	40	39	39	37	31
	Heze		42	36		39	33	30	27
	Weihai		23	20	23	17	20	15	18

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Linyi				45	42	38	34	30
	Dezhou			40		36.8	34	28	27
Fujian	Fuzhou			30		26	22	19	18
	Xiamen	37	31	31		31	23	19	19
	Quanzhou			27		25		19	18
	Putian			18		20	18	16	15
	Sanming			27		26		21	
	Zhangzhou			31		30		24	24
	Nanping			18		17		14	11
	Longyan			25		24		21	
	Ningde			26	22	20	13	16	11
Anhui	Hefei		33	45	52	41	42	39	36
	Wuhu		36	45	49	41.8	26	37	32
	Maanshan		35	34		37.25	36	34	33
	Bengbu					37.9			
	Huai'nan			35	31	28.75	28	28	23
	Huaibei				35	33	29		21
	Tongling			43	50	41	37	37	35
	Anqing			39	36	31	30	27	
	Huangshan			21		16	18	16	12
	Chuzhou			39	40	40	35	31	20
	Fuyang				36	28	31	26	24
	Suzhou					42.5			
	Lu'an			35	38	34	31	26	25
	Bozhou			36		28.75		23	18
	Chizhou			33	35	35		26	25
	Xuancheng			38	32	34	29	29	26

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Nanchang		31	33	37	36			
	Jiujiang			30	29	29			20
	Jingdezhen					16			
	Pingxiang					26			
	Xinyu					28.7	26		
	Yingtan			24	26	24	24		
	Ganzhou			24		25	24		
	Ji'an					19.8			
	Yichun					24.2		20	22
	Fuzhou					17.9			
	Shangrao					22.5			

South China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Wuhan	55	52	46	50	47	44	36	40
	Yichang		35	35	35	34	29	24	25
	Jingzhou		36	34	36	34	32	26	25
	Huangshi			31	37	36	33	30	30
	Ezhou			34	36	34	34	29	31
	Xiaogan			25	26	20	21	18	20
	Huanggang			25	27	24	25	22	22
	Xianning			19	18	23	21	17	17
	Shiyan			28	22	29	26	21	21
	Xiangyang			32	35	34	32	27	26
	Jingmen			35	38	34	27	23	24
	Suizhou			25	24	24	24	19	20
	Enshi Prefecture			19	23	24	22	18	14

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Changsha	42	38	38	40	34	33		29
	Yueyang			25	25	23	27	25	25
	Changde		24	23	22	25	23	19	20
	Zhangjiajie		18	21	22	22	20		
	Zhuzhou		35	35	36	33	34	29	29
	Xiangtan			37	37	35	33		
	Hengyang			30	28	30	27		14
	Shaoyang			22	24	23	23	20	
	Yiyang			29	29	25	23		
	Chenzhou			27	26	26	24		
	Yongzhou			24	22	25	27		
	Huaihua			17	18	13	12		11
	Loudi			23	22	22	22		
	Xiangxi Prefecture			19	19	19	16		
Guangxi	Nanning	37	33	32	35	35	32	24	24
	Guilin		26	27	25	23	25		20
	Beihai							12	14
	Liuzhou		24	24	26	24	25	20	21
	Wuzhou				26				
	Fangchenggang			17		19			14
	Qinzhou								14
	Guigang								
	Yulin								
	Baise								
	Hezhou						21		19
	Hechi			27	25				20
	Laibin								
	Chongzuo						19		16

	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shaoguan		25				24		19
	Shantou		20	21	21	19			16
	Zhanjiang		15	14		14			14
	Maoming		15						14
	Meizhou		23	25	28	28	25	22	21
	Shanwei		13				11	10	11
	Heyuan		23	19					19
	Yangjiang							14	17
	Qingyuan			37	23	22	33		
	Chaozhou								
	Jieyang		21	25	25		22		
	Yunfu					31	29		24
	Guangzhou	48	47	46	52	50	45	36	34
	Shenzhen	35	33	33	30	29	25	23	24
	Zhuhai		29	32		30	27	24	22
	Foshan	48	41	41	44	41	41	31	32
	Jiangmen	32	31	34	38	35	32	26	30
	Dongguan	42		34	41	39	37	27	29
	Zhongshan	32		34	36	32	32	25	25
	Huizhou								
	Zhaoqing	37	31	33	27	25	33	26	19
Hainan	Haikou		14	16	12	5	13	11	10
	Sanya		13		12		9	9	8

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Chengdu	59	53	54	53	48	42	37	35
Sichuan	Mianyang		34	36	32	31.5	53	28	26
Sichuan	Yibin		29		34	35	30	28	29
Sichuan	Panzhihua		32	34	36	38	40	32	30
Sichuan	Luzhou		33	29	35	35	30	27	27
Sichuan	Zigong		31	33	37	30.9		27	24
Sichuan	Deyang		29	25	28	29		29	31
Sichuan	Nanchong					32.8			21
Sichuan	Suining			24		29	23.1	18	20
Sichuan	Neijiang			28		26	25	22	24
Sichuan	Leshan			24.8	24.6	32.8	24		23
Sichuan	Meishan					34.9			31
Sichuan	Guang'an			24	27	27			19
Sichuan	Dazhou			41	39	40.2			31
Sichuan	Ziyang			20	27	27.2		24	23
Sichuan	Guangyuan			35.5	38.2	34.5	31		27
Sichuan	Ya'an			27	28	20.8		19.6	20
Sichuan	Bazhong				26.5	23.8	24.5		
Sichuan	Aba Prefecture				11	9.5	11		9
Sichuan	Ganzi Prefecture					15.9			20
Sichuan	Liangshan Prefecture				14	20.5			15
Tibet	Lhasa		21	24					
Tibet	Changdu Prefecture								
Tibet	Shannan Prefecture								
Tibet	Shigatse Prefecture							10	
Tibet	Naqu Prefecture								
Tibet	Ali Prefecture								
Tibet	Linzhi Prefecture								

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	39	45	46	46	44	40	39	32
Yunnan	Kunming		30	28	32	33	31	26	23
Yunnan	Qujing					19		16	16
Yunnan	Yuxi								19
Yunnan	Zhaotong								14
Yunnan	Lijiang								9
Yunnan	Chuxiong Prefecture			21	21	20			16
Yunnan	Honghe Prefecture								9
Yunnan	Diqing Prefecture								8
Yunnan	Baoshan					12	12	11	10
Yunnan	Puer								16
Yunnan	Lincang			12	20				14
Yunnan	Wenshan Prefecture				14.6				11
Yunnan	Xishuangbanna						20		18
Yunnan	Dali Prefecture					16	11		12
Yunnan	Dehong Prefecture								21
Yunnan	Nujiang Prefecture								15
Guizhou	Guiyang	31	28	29	27	25	21	18	20
Guizhou	Zunyi		29	32	29	27	26	19	18
Guizhou	Liupanshui			25	23	23	26	15	13
Guizhou	Bijie			23	22	20	17	16	14
Guizhou	Anshun			16	15	15	12	11	10
Guizhou	Tongren			16	22	19	21	16	16
Guizhou	Qianxi'nan Prefecture						14	14	16
Guizhou	Qiandongnan Prefecture			11	21		23	19	18
Guizhou	Qiannan Prefecture						14	9	9

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Lanzhou	48		57	57	55	50	47	46
	Jiayuguan		27	26	25	26	22	20	19
	Jinchang			17		16	15		15
	Baiyin			27		26	27		24
	Tianshui			36		34	31		27
	Wuwei			27	28	26	25		23
	Zhangye			22	21	18	20		23
	Pingliang			39		35	35		33
	Jiuquan				27	12.3	22		22
	Qingyang						18		15
	Dingxi			31	30	27	25		24
	Longnan				26	25	23		21
	Linxia Prefecture					21	21		27
	Gannan			22		23	21		19
Qinghai	Xi'ning	38	38	42	40	39	37	36	36
	Haidong Prefecture			41	36	39	40	33	32
	Haibei Prefecture			13	14	16	15	13	12
	Huangnan Prefecture			11	16	13	12	12	10
	Hainan Prefecture			16	15	20	16	17	16
	Guoluo Prefecture			17	16	16	13	15	15
	Yushu Prefecture			13	15	15	13	14	11
	Haixi Prefecture			13	15	13	14	13	16
Ningxia	Yinchuan		39		42	37	37		30
	Shizuishan					25	29		
	Wuzhong			28		24	28		
	Guyuan					37	28		
	Zhongwei				26	32	26		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Urumqi	56	52	53	49				38
	Karamay								22
	Korla					21			25
	Turpan								31
	Changli Prefecture				23				35
	Ili Prefecture				38				30
	Hami Prefecture								26
	Bortala Prefecture								19
	Aksu Prefecture								29
	Kizilsu Prefecture								13
	Kashi Prefecture								35
	Hetian Prefecture				26				25
	Tacheng Prefecture								11
	Altay Prefecture								14
	Wujiaqu								30
	Shihezi								37
Shaanxi	Xi'an	47	44	53	59	55	48	41	40
	Xianyang		39	50		50	43		40
	Tongchuan		36	35	35	37	36	31	28
	Yan'an						41		34
	Baoji		36	39		41	34	30	
	Weinan		29	47	56	51	42	38	
	Hanzhong				32	29	26		23
	Yulin						42		
	Ankang						25		
	Shangluo			26			23		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Harbin	52	51	44		37	33		
	Qiqihar		24	23	22	18			16
	Daqing		25		26	23	20		
	Mudanjiang	32	25	26	26			23	
	Jixi			20			20		
	Hegang								
	Shuangyashan			22	21	19	15	14	
	Yichun								
	Jiamusi								
	Qitaihe								
	Heihe				15				
	Suihua								
	Great Khingan						14		
Jilin	Changchun	47	45	40	40	35	34	32	31
	Jilin		37	30	29	27	24	25	24
	Siping			32	33	28	27	24	25
	Liaoyuan			28	30	27	23	21	20
	Tonghua			31	32	26	26	24	20
	Baishan			27	26	22	19	19	21
	Songyuan			23	20	16	17	19	18
	Baicheng			20	22	16	15	14	14
	Yanbian			23	22	21	18	16	15

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Shenyang	52	48	40	40	39	36	35	33
	Dalian	27		30	28	27		25	
	Anshan		38			34		30	27
	Fushun		34	33				27	
	Benxi		41	33	31	31			29
	Jinzhou		38		38	35			
	Dandong								
	Yingkou		31	28		29			29
	Panjin								
	Huludao		37			33			
	Fuxin			26					22
	Liaoyang			29				27	
	Tieling			23	32				
	Zhaoyang			22				21	20

CO

- In 2021, the overall annual mean concentration of CO across the country continued to decline to 1.1 mg/m^3, down by 8.3% year-on-year.

- As in 2020, the proportion of attainment cities remained at 100%. As with SO_2, all cities met the standard for the annual mean concentration of CO.

- Among the key regions, the annual mean concentration of CO in the BTH region and its surrounding areas decreased to 1.4 mg/m^3, a year-on-year reduction of 22.2%. It fell to 1.0 mg/m^3 in the YRD region and to 1.3 mg/m^3 in the Fenwei Plain, with a year-on-year decrease of 9.1% and 13.3%, respectively.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Beijing	3.2	3.6	3.2	2.1	1.7	1.4	1.3	1.2
	Tianjin	2.9	3.1	2.7	2.8	1.9	1.8	1.7	1.4
	Shijiazhuang	4.3	4.3	3.9		2.6		2.1	1.4
	Tangshan	2.4	4.2	2.3	2	3.3	2.9	2.5	1.9
	Qinhuangdao	3.5	3.6	2.9		2.5	2.6	1.8	1.8
	Handan	3.9	3.8			2.8	2.6	2.1	1.6
	Baoding	5.4	5.8	4.4	3.6	2.4		1.8	1.3
	Chengde	2.3	2.3	2.4	2.1	1.9	1.8	1.8	1.6
	Cangzhou	2.9	3.2			1.8	1.8		1.2
	Hengshui	3	3.7			1.8	1.8	1.6	1
	Xingtai	3.8	5.1	1.8		2.8	2.4	2.1	1.6
	Zhangjiakou	2.2	1.6			1.4	1.1		1
	Langfang	3.6	3.4	3.5	2.9	2	1.7	1.6	1.3
Fen-wei Plains	Lvliang					2.4	1.6	1.1	1
	Jinzhong			4.1	2.8	2.1	1.6	1.6	1.2
	Linfen					3.6	3.1	2.5	2
	Yuncheng					3.3	2.7	2.2	1.9
	Sanmenxia			3					1.2
	Luoyang			3.38	2.4	2	1.5	1.3	1.1
	Xi'an	4.3	4.3	3.1	2.8	2.2	1.7	1.5	2.1
	Xianyang					2.1	1.6		1.5
	Baoji		2.7	2.2		1.5	1.6	1.2	
	Tongchuan		2.5	2.16	2.2	2	1.7	1.3	1.1
	Weinan					1.9	1.9	1.7	

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Shanghai	0.77	0.86	0.79	0.76	0.67	0.66	1.1	0.9
	Jiaxing	0.9							
	Shaoxing		0.9	0.8	0.8	1.2			0.9
	Zhoushan								
	Wenzhou	1.7			1	1	1	0.8	0.8
	Jinhua					1.1	0.7	0.9	1
	Quzhou						1.1	1	1
	Taizhou	1	0.8				0.9	0.7	
	Lishui	1.2				1			
	Nanjing	0.95	1	1	1.5	1.4	1.3	1.1	1
	Suzhou	0.92	0.92	1.5	1.4	1.2	1.2	1.2	1
	Wuxi		1.0	1.1	1.5	1.6	1.4	1.2	1.1
	Changzhou				1.5	1.6	1.2		1.6
	Yangzhou		1.4			0.84	0.6	1	0.9
	Zhenjiang			0.9	0.9	0.7	0.7	0.9	1
	Nantong						1.1	1.1	
	Taizhou								
	Xuzhou				1	0.9	0.8	1.4	1.2
	Lianyungang	2		1.6	1.5		1.5	1.3	1.1
	Huai'an	1.3	1.1	1		0.9	1.2	1	1
	Yancheng					1.26		0.8	0.9
	Suqian						1.2	1.2	0.9
	Hangzhou		1.5					1.1	0.9
	Ningbo	0.9	1.4	1.2					
	Huzhou		0.9					1	

Unit: mg/m^3

Figure 8: Annual Mean Concentrations of CO in 339 Cities in 2014-2021

North China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Hohhot					2.2	2.2	2.4	1.4
	Chifeng		1.0			0.8	1.3	1.5	1
	Baotou					2.3	2.6	3.2	1.9
	Erdos		0.7	0.7		1.1	1.1	1.1	0.9
	Ulanqab					1	1	1	0.9
	Xilingol					0.8	0.4	0.5	0.5
	Wuhai			2		1.8	1.6	1.8	1.5
	Hulun Buir					0.6	0.6	0.6	0.6
	Tongliao					1	0.9	0.7	0.7
	Bayannur					1.2	1.4	1.6	0.9
	Hinggan League					1	1	0.9	0.8
	Alxa League					0.9	0.8	0.7	0.6
Henan	Zhengzhou			2.8		1.8	1.6	1.4	1.2
	Pingdingshan			2.1				1.3	
	Sanmenxia			3					1.2
	Luoyang			3.38	2.4	2	1.5	1.3	1.1
	Anyang			4.7					1.8
	Kaifeng			2.7					
	Jiaozuo		3.9	1.9					1.4
	Xuchang			2.9				1.5	1.3
	Nanyang			2.1			1.6		1.3
	Xinyang			1.6					
	Zhoukou			2.7					
	Hebi			4.1		2.5	2	1.9	1.7
	Xinxiang			1.5	3	2.3	2.08		
	Puyang			2.9		1.1		0.8	
	Luohe			2.1	1	0.84	0.71	0.7	0.7
	Shangqiu			1.7					
	Zhumadian			1.8	1				

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Taiyuan	3.2		3.3		1.9	1.9	1.8	1.5
	Datong					3.1	3	2.8	1.4
	Changzhi				3.1	2.4	2.1	2	1.6
	Linfen					3.6	3.1	2.5	2
	Yangquan					2.2	2.1	1.8	1.5
	Jincheng			4.1	4.3	2.9	2.6	2.1	1.8
	Shuozhou					1.9	1.6	1.3	1.1
	Jinzhong			4.1	2.8	2.1	1.6	1.6	1.2
	Yuncheng					3.3	2.7	2.2	1.9
	Xinzhou			3.5		2	1.9	1.7	1.2
	Lvliang					2.4	1.6	1.1	1

East China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Ji'nan					1.7	1.6	1.5	1.3
	Qingdao				1.3	1.4	1.5	1.2	1.1
	Zibo				2.6	2.1	1.9	1.8	1.6
	Zaozhuang								
	Yantai		0.8	0.8	0.7	1.3		1.1	1.1
	Weifang						1.7	1.6	1.3
	Ji'ning								
	Tai'an								
	Rizhao								
	Dongying					1.5			
	Liaocheng					1.9	1		
	Binzhou							1.6	1.4
	Heze								
	Weihai			1.1			1.1	0.9	0.8

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Linyi				2	1.9	1.6	1.5	3
	Dezhou						1.6		1.2
Fujian	Fuzhou			1.1		0.9	0.9	0.9	0.8
	Xiamen	1	0.9	0.9		0.9	0.8	0.7	0.7
	Quanzhou			1		0.8		0.8	0.7
	Putian			0.9		0.8	1	0.8	0.8
	Sanming			2.1		1.7		1.2	
	Zhangzhou			1.2		1		0.8	0.7
	Nanping			1.4		1		0.7	0.8
	Longyan			1.2		1		0.8	
	Ningde			1.6	1.1	1.2	1.2	1	1
Anhui	Hefei		1.06	1	1.4	1.5	1.2	1.1	1
	Wuhu						1.2	1.2	1.1
	Maanshan		1.5	2.1		1.7	1.4	1.2	1.2
	Bengbu					1.2			
	Huai'nan			1	0.8	1.2	1.1	1.1	0.9
	Huaibei				1.5	1.4	1.3		
	Tongling			1.31	1.1	1	0.9	0.8	1.2
	Anqing			1.3	1.1	1.1	1.1	1	
	Huangshan			0.5		1.1	1	0.9	0.8
	Chuzhou			0.9	0.8	0.7	0.8	1.2	1
	Fuyang				0.9	0.75	0.7	0.6	0.6
	Suzhou					1.3			
	Lu'an			1.3	1.2	1.1	1.1	1.1	1
	Bozhou			1.12		1.3		1.1	1.9
	Chizhou			1.6	1.6	1.4			1.1
	Xuancheng			1.2	1.3	1.2	1.1	1	0.9

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Nanchang			1.6	1.6	1.5			
	Jiujiang					1.6			1
	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		1.4	1.3
	Fuzhou					1.05			
	Shangrao					1.2			

South China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Wuhan	1.1	1.1	1.7	1.1	1	1.5	1.2	1.3
	Yichang		1.7	1.7	1.7	1.6	1.4	1.2	1.1
	Jingzhou		1.8	1.8	1.7	1.8	1.5	1.3	1.3
	Huangshi			2.5	1.7	1.7	1.5	1.5	1.8
	Ezhou			1.8	1.6	1.7	1.6	1.3	1.2
	Xiaogan			2.8	3	1.6	1.6	1.5	1.4
	Huanggang			1.7	1.5	1.4	1.2	1.2	1
	Xianning			1.4	1.6	1.5	1.2	1.3	0.9
	Shiyan			1.9	1.7	1.4	1.4	1.3	1
	Xiangyang			2	1.8	1.6	1.4	1.3	1.1
	Jingmen			1.6	1.4	1.5	1.2	1.1	1
	Suizhou			2	2.6	1.5	1.4	1.2	1.2
	Enshi Prefecture			1.5	1.6	1.5	1.3	0.8	1.2

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Changsha			1.4	1.3	1.3	1.3		1.1
	Yueyang			1.4	1.4	1.4	1.4	1.2	1.1
	Changde		1.4	1.8	1.8	1.4	1.5	1.1	1.1
	Zhangjiajie		1.6	2.2	1.9	1.4	1.3		
	Zhuzhou		0.9	1.4	1.4	1.4	1.2	1	1.1
	Xiangtan			1.4	1.3	1.3	1.3		
	Hengyang			1.8	1.7	1.6	1.6		1.1
	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		1
	Loudi			2.5	2.6	2.3	1.6		
	Xiangxi Prefecture			1	1.8	1.2	1.2		
Guangxi	Nanning	1.6		1.3		1.3	1.4	1	1
	Guilin		1.8	1.7	1.3	1.3	1.4		1.2
	Beihai							1	1
	Liuzhou			1.6	1.5	1.4	1.6	1.2	1.2
	Wuzhou				1.5				
	Fangchenggang					1.3			1.1
	Qinzhou								1.5
	Guigang								
	Yulin								
	Baise								
	Hezhou						0.8		1.1
	Hechi			1.6	1.3				0.9
	Laibin								
	Chongzuo						1.2		1

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shaoguan		1				1.3		1
	Shantou		1.2	1.2	1.1	1			0.8
	Zhanjiang		1.4	1.2		0.9			0.8
	Maoming		0.9						0.9
	Meizhou		1.3	1.3	1.3	1.2	1.1	1	0.8
	Shanwei		0.8				0.9	0.8	0.8
	Heyuan		1.3	1.2					1.1
	Yangjiang							1	0.9
	Qingyuan			1.6	1.5	1.3	1.4		
	Chaozhou								
	Jieyang		1.5	1.5	1.3		1.2		
	Yunfu					1.2	1.2		1
	Guangzhou		1	1.3	1.2	1.2	1.2	1	1
	Shenzhen	1.1	0.9	0.8	0.8	0.6	0.6	0.6	0.6
	Zhuhai		1.6	1.1		1	1.2	0.9	0.8
	Foshan	1.6	1.4	1.3	1.2	1.2	1.3	1	1
	Jiangmen		1.5	1.3	1.3	1.2	1.3	1.1	1
	Dongguan	1.4		1.3	1.2		1.1	0.9	0.9
	Zhongshan	1.7		1.4	1.3	1.1	1.2	1	0.9
	Huizhou								
	Zhaoqing	1.8	1.5	1.4	1.3	1.2	1.3	0.9	0.8
Hainan	Haikou		0.9	0.9	0.8	0.8	0.9	0.8	0.7
	Sanya		0.8		0.8		0.7	0.6	0.6

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Chengdu	2	2	1.8	1.7	1.4	1.1	1	
	Mianyang		1.4	1.6	1.4	1.1	1	1	1
	Yibin		0.9		1.2	0.9	0.8	1.1	
	Panzhihua		2.7	2.2	2.2	2.5	2.3	2.5	2.3
	Luzhou		0.9	0.9	1	1	1	1	1
	Zigong		1.5	1.5	1.6	1.4		1	0.9
	Deyang		1.4	1.4	1.5	1.3		1	
	Nanchong					1.2			1.1
	Suining			1.4		1.1	0.9	1	0.9
	Neijiang			1.4		1.2	1.2	1.1	1.1
	Leshan			1.1	1.4	1.2	1.4		1
	Meishan					1.1			
	Guang'an			1.4	1.5	1.3			1.1
	Dazhou			1.9	1.9	1.9			
	Ziyang			1.2	1.2	1		1	1.1
	Guangyuan			0.8	1.5	1.3	1.4		1.2
	Ya'an			1.6	1.2	1.1		0.9	0.8
	Bazhong				1.5	1.1	1.1		
	Aba Prefecture				1.3	0.8	1.2		0.9
	Ganzi Prefecture					0.7			
	Liangshan Prefecture				1	1.2			
Tibet	Lhasa		1.1	1					
	Changdu Prefecture								
	Shannan Prefecture								
	Shigatse Prefecture							0.9	
	Naqu Prefecture								
	Ali Prefecture								
	Linzhi Prefecture								

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	1.8	1.5	1.4	1.4	1.3	1	1.1	1
Yunnan	Kunming		1.0	1.0	0.9	1.2		1.2	0.9
	Qujing					1.4			1
	Yuxi								1.5
	Zhaotong								0.9
	Lijiang								0.8
	Chuxiong Prefecture			0.8	0.9	0.7			1
	Honghe Prefecture								0.9
	Diqing Prefecture						0.5	0.6	0.8
	Baoshan					0.6			0.8
	Puer								0.8
	Lincang			1.0	0.9				1
	Wenshan Prefecture				0.7		0.7		0.8
	Xishuangbanna								1
	Dali Prefecture					0.7			0.8
	Dehong Prefecture								1
	Nujiang Prefecture								1.2
Guizhou	Guiyang	1.3	1.1	1.1	1.1	1	0.9	0.9	0.9
	Zunyi		1.2	1.2	1.1	1.1	0.9	0.8	0.9
	Liupanshui			1.3	1.1	1.2	1.1	1.1	1
	Bijie			1.6	1.7	1.3	1	0.8	0.8
	Anshun			1.1	0.9	1	0.9	1	0.9
	Tongren			1.2	1.3	1.4	1.4	1	1
	Qianxi'nan Prefecture						0.8	0.8	0.8
	Qiandongnan Prefecture			1.3	1.2		1	1	1.1
	Qiannan Prefecture						0.7	0.9	1.1

	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Lanzhou			2.9	2.8	2.7	2.5	2	2
	Jiayuguan			1	1	1	0.9	0.8	0.8
	Jinchang			1.9		0.9	0.9		1
	Baiyin			1.4		1.6	1.4		1.2
	Tianshui			2		1.6	1.6		1.4
	Wuwei			2.7	1.8	1.6	1.2		1
	Zhangye					1	0.9		0.8
	Pingliang						1		0.9
	Jiuquan				1	1.6	1		0.8
	Qingyang						1.2		1
	Dingxi				1.6	1.4	1.2		1.2
	Longnan				2	0.8	1.5		1.7
	Linxia						1.8		1.6
	Gannan			2.2		1.5	1.2		0.8
Qinghai	Xi'ning	1.3		3.2	2.8	2.8	2.3	2.3	2
	Haidong Prefecture			2.3	2.5	1.6	1.3	1.4	1.3
	Haibei Prefecture			1	0.9	1.1	0.9	0.9	0.8
	Huangnan Prefecture			1.6	1.4	1.5	1.4	0.9	1.1
	Hainan Prefecture			0.8	1.4	1.3	0.9	0.9	0.9
	Guoluo Prefecture			1.2	1.3	1.2	1.3	1.1	0.6
	Yushu Prefecture			1.2	1.1	1.1	0.9	1.1	0.9
	Haixi Prefecture			1.3	1	1.1	0.9	0.7	0.6
Ningxia	Yinchuan		2.5		2.5	2.1	2		1.5
	Shizuishan					1.2	1.6		
	Wuzhong			1.6		1.2	1		
	Guyuan					2.1	1.4		
	Zhongwei				1.4	1.7	1		

	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Urumqi	1.4		1.5					0.8
	Karamay								0.5
	Korla								0.5
	Turpan							0.9	1.1
	Changli Prefecture				1.1				1.1
	Ili Prefecture				1.8				1.3
	Hami Prefecture								0.5
	Bortala Prefecture								0.4
	Aksu Prefecture								0.7
	Kizilsu Prefecture								0.6
	Kashi Prefecture								1.2
	Hetian Prefecture				1.3				1
	Tacheng Prefecture								0.4
	Altay Prefecture								0.4
	Wujiaqu								0.9
	Shihezi								0.9
Shaanxi	Xi'an	4.3	4.3	3.1	2.8	2.2	1.7	1.5	2.1
	Xianyang					2.1	1.6		1.5
	Tongchuan		2.5	2.16	2.2	2	1.7	1.3	1.1
	Yan'an						1.9		1.5
	Baoji		2.7	2.2		1.5	1.6	1.2	
	Weinan					1.9	1.9	1.7	
	Hanzhong				2.4	2.1	2		1.7
	Yulin						1.8		
	Ankang						1.4		
	Shangluo			1.2			1.2		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Harbin			2					
	Qiqihar		1.5	1.5	1.5	1.1			0.9
	Daqing		0.6		1.3	1	0.9		
	Mudanjiang								
	Jixi								
	Hegang								
	Shuangyashan			0.81	0.75	0.7	1.4	1	
	Yichun								
	Jiamusi								
	Qitaihe								
	Heihe				1				
	Suihua								
	Great Khingan						0.6		
Jilin	Changchun	1.5	1.8	1.6	1.9	1.3	1.3	1.3	1
	Jilin		1.9	1.5	1.8	1.5	1.3	1.4	1.1
	Siping			1.5	1.8	1.5	1.2	1.3	1
	Liaoyuan			1.9	1.8	1.6	1.4	1.6	1.2
	Tonghua			2.3	2	1.8	1.6	1.6	1.4
	Baishan			1.9	1.6	1.6	1.8	2	1.6
	Songyuan			1.4	1.6	1.2	1	1.2	1
	Baicheng			1.1	1.1	1.2	0.9	1	0.7
	Yanbian			1.4	1.4	1.2	1	0.9	0.9

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Shenyang		1	1.7	1.7	1.8	1.9	1.7	1.5
	Dalian				1.4	1.3		1.1	
	Anshan		2.7			2.2		2	1.9
	Fushun		2.5	2.1				1.5	
	Benxi		2.9	2.1	2.3	2.2			1.9
	Jinzhou		2.3		2	1.8			
	Dandong								
	Yingkou		1			1.7			1.7
	Panjin								
	Huludao		1.5			1.7			
	Fuxin			1.2					1.2
	Liaoyang								
	Tieling			1.4	1.2				
	Zhaoyang							1.8	1.4

O_3

- Since decreasing for the first time in 2020, the overall annual mean concentration of O_3 across the country has maintained a downward trend, dropping year-on-year by 0.7% to 137 μg/m^3 in 2021.

- The proportion of attainment cities continued to climb from 83.4% in 2020 to 85.3% in 2021, with a year-on-year increase of six cities.

- In the key regions, the annual mean concentration of O_3 in the BTH region and its surrounding areas dropped to 171 μg/m^3, a year-on-year decrease of 5.0%. The concentration decreased to 151 μg/m^3 in the YRD region, down by 0.7% year-on-year. In the Fenwei Plain, the annual mean concentration rebounded to 165 μg/m^3, up 3.1% year-on-year.

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Beijing-Tianjin-Hebei	Beijing	197.2	202.6	199	193	192	191	174	149
	Tianjin	157		157	192	201	200	190	160
	Shijiazhuang	159	148	164		211		180	173
	Tangshan		182			197	190	182	161
	Qinhuangdao	114	107	149		164	181	166	152
	Handan	147	141			201	201	182	174
	Baoding	177.6	183	174	218	210		178	175
	Chengde	167	178	177	162	174	163	154	131
	Cangzhou	172	169			200	185		164
	Hengshui	188	183			191	192	180	165
	Xingtai	157	140			203	209	186	172
	Zhangjiakou	133	159			181	162		144
	Langfang	165	171	182	207	192	196	185	171
Fen-wei Plains	Lvliang					163	163	152	161
	Jinzhong			142	190	179	192	176	169
	Linfen					217	204	184	197
	Yuncheng					189	181	164	173
	Sanmenxia			162					158
	Luoyang			189	204	175	188	166	172
	Xi'an	131	145	162	185	180	166	159	154
	Xianyang					198	162	160	161
	Baoji		132	158		150	138	136	
	Tongchuan		132	170	165	168	158	153	153
	Weinan					170	169	159	163

Region	City	2014	2015	2016	2017	2018	2019	2020	2021
Yangtze River Delta	Shanghai	149	161	164	181	160	151	152	145
	Jiaxing	109						160	156
	Shaoxing					156		148	138
	Zhoushan							136	
	Wenzhou	134			145	141	136	140	126
	Jinhua					152	86	132	134
	Quzhou						140	140	142
	Taizhou						125	139	
	Lishui	111				135		124	
	Nanjing								
	Suzhou			167	173	173	166	163	162
	Wuxi			186	184	179	180	171	175
	Changzhou				170	191			174
	Yangzhou		175			109	108	176	176
	Zhenjiang			96	108	109	107	164	175
	Nantong						157	148	156
	Taizhou								
	Xuzhou				114	111	107	161	156
	Lianyungang	145		158	153		167	163	150
	Huai'an	106	105	101		104.9	165	154	153
	Yancheng					166		159	150
	Suqian						180	170	157
	Hangzhou		167					151	162
	Ningbo							146	
	Huzhou		106					160	

Unit:μg/m³

Figure 9: Annual Mean Concentrations of O_3 in 339 Cities in 2014-2021

North China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	Hohhot					150	146	141	144
	Chifeng		61			86	127	130	119
	Baotou					156	143	134	142
	Erdos		101	105		163	155	145	151
	Ulanqab					155	152	136	140
	Xilingol					141	122	112	113
	Wuhai			140		165	153	146	151
	Hulun Buir					112	108	104	100
	Tongliao					148	132	132	120
	Bayannur					152	143	134	142
	Hinggan League					118	113	112	106
	Alxa League					163	146	136	150
Henan	Zhengzhou			177		194	194	182	177
	Pingdingshan			165				160	
	Sanmenxia			162					158
	Luoyang			189	204	175	188	166	172
	Anyang			154					176
	Kaifeng			152					
	Jiaozuo		150	166					183
	Xuchang			158				158	154
	Nanyang			171			181		149
	Xinyang			148					
	Zhoukou			158					
	Hebi			154		199	198	177	176
	Xinxiang			175	209	202	178		
	Puyang			176		117		104	
	Luohe			161		111	110	101	102
	Shangqiu			158					
	Zhumadian			159	108				

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shanxi	Taiyuan	125		140		191	186	186	192
	Datong					153	147	150	140
	Changzhi				188	189	187	170	159
	Linfen					217	204	184	197
	Yangquan					184	187	176	171
	Jincheng				218	214	201	176	180
	Shuozhou					152	192	150	143
	Jinzhong			142	190	179	192	176	169
	Yuncheng					189	181	164	173
	Xinzhou			138		166	171	170	161
	Lvliang					163	163	152	161

East China

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Ji'nan					202	203	184	181
	Qingdao			147	172	154	147	145	144
	Zibo				193	201	204	188	183
	Zaozhuang					115			
	Yantai		148	142	164	157		152	150
	Weifang					179.1	180	168	156
	Ji'ning								
	Tai'an								
	Rizhao								153
	Dongying					198		177	
	Liaocheng					212	114		
	Binzhou							192	180
	Heze								
	Weihai			137			160	142	145

	City	2014	2015	2016	2017	2018	2019	2020	2021
Shandong	Linyi				184	185	187		162
	Dezhou						201	179	171
Fujian	Fuzhou			114		151	138	128	113
	Xiamen	128	95	103		127	136	126	128
	Quanzhou			109		150		136	138
	Putian			129		156	138	140	133
	Sanming			106		124		114	
	Zhangzhou			114		155		138	138
	Nanping			112		128		118	92
	Longyan			125		129		114	
	Ningde			120	124	148	123	137	101
Anhui	Hefei				170	168	167	144	143
	Wuhu						196	140	152
	Maanshan			158		183	178	148	159
	Bengbu					167.7			
	Huai'nan				109	167	173	160	162
	Huaibei				184	183	185		
	Tongling			81		89	92	84	138
	Anqing			130	136	163	106	145	
	Huangshan			72		95	140	130	120
	Chuzhou				115	113	106	153	159
	Fuyang					104	110	99	97
	Suzhou					171.6			
	Lu'an			146	156	166	145	154	145
	Bozhou					170.3		166	154
	Chizhou			130	138	158			152
	Xuancheng				142	137	134	137	142

	City	2014	2015	2016	2017	2018	2019	2020	2021
Jiangxi	Nanchang			138	146	144			
	Jiujiang					153			135
	Jingdezhen					118.8			
	Pingxiang					140			
	Xinyu					124	144		
	Yingtan			139	151	154	172		
	Ganzhou			128		153	170		
	Ji'an					136			
	Yichun					122.4	154	135	127
	Fuzhou					127.9			
	Shangrao					120.7			

South China

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hubei	Wuhan			160	151		183	150	155
	Yichang		122	126	137	143	162	135	137
	Jingzhou			156	140	157	158	137	134
	Huangshi			158	145	164	167	150	156
	Ezhou			156	139	165	162	150	154
	Xiaogan			160	158	158	171	142	150
	Huanggang			176	159	175	167	149	161
	Xianning			158	156	163	170	142	140
	Shiyan			122	130	145	140	135	123
	Xiangyang			152	152	155	162	142	143
	Jingmen			130	145	154	161	141	140
	Suizhou			152	148	156	160	142	140
	Enshi Prefecture			94	121	96	126	110	98

	City	2014	2015	2016	2017	2018	2019	2020	2021
Hunan	Changsha			150	153	161	171		144
	Yueyang			158	142	155	164	134	140
	Changde			136	147	151	160	132	132
	Zhangjiajie			124	129	130	122		
	Zhuzhou			142	142	148	162	142	140
	Xiangtan			142	142	153	168		
	Hengyang			132	141	130	145		130
	Shaoyang			137	138	134	147		
	Yiyang			150	143	140	151		
	Chenzhou			126	140	137	140		
	Yongzhou			124	129	138	143		118
	Huaihua			122	122	121	119		102
	Loudi			139	134	143	150		
	Xiangxi Prefecture			120	110	104	115		
Guangxi	Nanning	126		114		128	138	118	118
	Guilin		138	135	139	136	149		121
	Beihai							120	133
	Liuzhou			123	127	127	145	115	122
	Wuzhou				119				
	Fangchenggang					126			109
	Qinzhou								117
	Guigang								
	Yulin								
	Baise								
	Hezhou						82		129
	Hechi			119	110				114
	Laibin								
	Chongzuo						131		124

	City	2014	2015	2016	2017	2018	2019	2020	2021
Guangdong	Shaoguan						145		140
	Shantou		141	132	140	152			138
	Zhanjiang		137	138		150			131
	Maoming								125
	Meizhou		118	111	120	123	131	118	122
	Shanwei						143	136	138
	Heyuan		134	124					133
	Yangjiang							130	140
	Qingyuan			144	128	127	152		
	Chaozhou		163.2						
	Jieyang		136	130	146		147		
	Yunfu					134	138		124
	Guangzhou			155	162	174	178	160	160
	Shenzhen			135		137	156	126	130
	Zhuhai		142	144		162	167	142	144
	Foshan	167	140	160	174	172	185	154	169
	Jiangmen		146	162	193	184	198	173	163
	Dongguan	187	172	166	170	171	191	155	165
	Zhongshan	152		153	181	165	197	154	154
	Huizhou								
	Zhaoqing		147	150	143	145	163	128	131
Hainan	Haikou		103	107	127	116	144	120	124
	Sanya		113		110		188	99	106

	City	2014	2015	2016	2017	2018	2019	2020	2021
Sichuan	Chengdu	148	183	168	171	167	160	169	151
Sichuan	Mianyang		137	136	134	151.6	137	150	139
Sichuan	Yibin		72			92	83	151	142
Sichuan	Panzhihua		118	112	119	140	140	128	133
Sichuan	Luzhou		121	154	147	149	147	142	131
Sichuan	Zigong		119	116	150	171.6		152	142
Sichuan	Deyang		156	140	130	158		158	146
Sichuan	Nanchong					151			112
Sichuan	Suining			150		147	135.2	132	126
Sichuan	Neijiang			157		152	140	142	127
Sichuan	Leshan			143	129.4	128.6	121.4		128
Sichuan	Meishan					155			149
Sichuan	Guang'an			147	142	144			126
Sichuan	Dazhou			114	123	143			96
Sichuan	Ziyang			157	150	157.6		148	122
Sichuan	Guangyuan			134	120.6	126	101		112
Sichuan	Ya'an			119	132	124		132	118
Sichuan	Bazhong				115	106.6	160		
Sichuan	Aba Prefecture				125	118.8	106		99
Sichuan	Ganzi Prefecture					126			96
Sichuan	Liangshan Prefecture				108	137			129
Tibet	Lhasa		142	151					
Tibet	Changdu Prefecture								
Tibet	Shannan Prefecture								
Tibet	Shigatse Prefecture							136	
Tibet	Naqu Prefecture								
Tibet	Ali Prefecture								
Tibet	Linzhi Prefecture								

	City	2014	2015	2016	2017	2018	2019	2020	2021
	Chongqing	146	127	141	163	166	157	150	127
Yunnan	Kunming		79	82		130	134		134
Yunnan	Qujing					128		128	142
Yunnan	Yuxi								135
Yunnan	Zhaotong								122
Yunnan	Lijiang								119
Yunnan	Chuxiong Prefecture			76		81			128
Yunnan	Honghe Prefecture								122
Yunnan	Diqing Prefecture								120
Yunnan	Baoshan					91	88	81	134
Yunnan	Puer								131
Yunnan	Lincang			72					125
Yunnan	Wenshan Prefecture				118				116
Yunnan	Xishuangbanna						82		123
Yunnan	Dali Prefecture					92			122
Yunnan	Dehong Prefecture								127
Yunnan	Nujiang Prefecture								116
Guizhou	Guiyang	103	120	130	121	118	125	113	114
Guizhou	Zunyi		108	114	109	124	125	118	112
Guizhou	Liupanshui			96	114	109	110	102	105
Guizhou	Bijie			114	120	124	124	124	123
Guizhou	Anshun			116	122	125	118	120	123
Guizhou	Tongren			71		108	121	94	101
Guizhou	Qianxi'nan Prefecture						116	114	116
Guizhou	Qiandongnan Prefecture			104	83		106	102	106
Guizhou	Qiannan Prefecture						115	102	106

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Gansu	Lanzhou			144	161	168	151	150	145
	Jiayuguan			138	148	140	138	122	129
	Jinchang			128		146	134		122
	Baiyin			112		133	119		118
	Tianshui			134		134	127		130
	Wuwei			140	138	143	134		129
	Zhangye					143	138		127
	Pingliang						130		130
	Jiuquan				144	148.4	134		130
	Qingyang						132		129
	Dingxi				144	134	129		132
	Longnan				119	86	120		114
	Linxia Prefecture						126		133
	Gannan			146		136	121		122
Qinghai	Xi'ning			128	136	138	129	130	142
	Haidong Prefecture			130	142	153	138	136	137
	Haibei Prefecture			154	136	144	131	130	139
	Huangnan Prefecture			132	124	118	107	119	120
	Hainan Prefecture			149	130	120	144	130	125
	Guoluo Prefecture			132	140	142	139	121	139
	Yushu Prefecture			87	131	118	115	98	100
	Haixi Prefecture			110	128	126	153	130	131
Ningxia	Yinchuan		125		169	166	147		152
	Shizuishan					144	150		
	Wuzhong			130		147	145		
	Guyuan					166	128		
	Zhongwei				157	157	140		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Xinjiang	Urumqi								87
	Karamay								84
	Korla								93
	Turpan								96
	Changli Prefecture								92
	Ili Prefecture								86
	Hami Prefecture								91
	Bortala Prefecture								83
	Aksu Prefecture								92
	Kizilsu Prefecture								103
	Kashi Prefecture								96
	Hetian Prefecture								99
	Tacheng Prefecture								75
	Altay Prefecture								78
	Wujiaqu								87
	Shihezi								86
Shaanxi	Xi'an	131	145	162	185	180	166	159	154
	Xianyang					198	162	160	161
	Tongchuan		132	170	165	168	158	153	153
	Yan'an						143		139
	Baoji		132	158		150	138	136	
	Weinan					170	169	159	163
	Hanzhong				145	137	121		125
	Yulin						159		
	Ankang						122		
	Shangluo			98			139		

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Heilongjiang	Harbin	198		106					
	Qiqihar		108	98	111	121			113
	Daqing				126	127	118		
	Mudanjiang								
	Jixi								
	Hegang								
	Shuangyashan			54		79	102	103	
	Yichun								
	Jiamusi					161			
	Qitaihe								
	Heihe				100				
	Suihua								
	Great Khingan						98		
Jilin	Changchun	132	151	141	142	133	134	126	116
	Jilin		154	151	147	149	135	132	120
	Siping			130	142	159	150	141	126
	Liaoyuan			157	141	154	152	141	127
	Tonghua			129	120	140	104	114	115
	Baishan			136	126	134	128	118	110
	Songyuan			154	144	136	121	117	123
	Baicheng			119	123	135	120	112	107
	Yanbian			115	126	130	115	107	102

Province	City	2014	2015	2016	2017	2018	2019	2020	2021
Liaoning	Shenyang		155	162	166	163	155	154	142
	Dalian			155	163	157		144	
	Anshan								
	Fushun		149	162				148	
	Benxi		136	137	116	137			119
	Jinzhou		165	180	172	151			
	Dandong								
	Yingkou		111			186			144
	Panjin								
	Huludao					137.2			
	Fuxin								
	Liaoyang								
	Tieling			160	159				
	Zhaoyang							153	126

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Inner Mongolia				35	32	31	27	23
	Shanxi		64	56	60	59	55	48	39
	Tianjin	96	83	70	69	62	52	51	39
	Hebei	108	95	77	70	65	56	50.2	38.8
	Henan				73	62	61	59	45
	Beijing	89.5	85.9	80.6	73	58	51	42	33
East China	Fujian				26	27	22	21	18
	Zhejiang	61	53	43	37	35	33	31	24
	Shanghai	62	52	53	45	39	36	35	27
	Jiangxi			45	45	46	38	35	29
	Jiangsu	73	66	58	51	49	48	43	33
	Anhui			55	53	56	49	46	35
	Shandong	98	82	76	66	57	49	50	39
South China	Hainan			20	18	18	17	16	13
	Guangdong		41	34	32	33	31	27	22
	Guangxi			41	37	38	35	34	28
	Hunan				48	46	41	41	35
	Hubei			65	54	49	44	42	34

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang				34	36	28	28	26
	Jilin			55	43	40	32	32	26
	Liaoning		58	55	46	44	38	40	35
Northwest China	Qinghai				35	30	29	22	21
	Gansu				39	37	34	26	23
	Ningxia		49	47	46	42	35	29	27
	Xinjiang			53	62	55	41	47	31
	Shaanxi		67	59	62	57	51	48	36
Southwest China	Yunnan			28	26	24	25	22	22
	Guizhou			32	32	29	28	24	23
	Sichuan			47	47	42	38.6	34.4	32
	Chongqing	70	65	57	54	45	40	38	35
	Tibet								

Unit: $\mu g/m^3$

Figure 10: Annual Mean Concentrations of $PM_{2.5}$ in Provinces, Autonomous Regions, and Municipalities in 2014-2021

PM_{10}

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Inner Mongolia				77	74	80	61	51
	Beijing	108.1	115.8	101.5	92	84	78	68	55
	Tianjin	150	133	116	103	94	82	76	69
	Shanxi		114	98	109	109	107	93	74
	Hebei	190	165	136	123	117	104	93	70
	Henan				128	106	103	96	77
East China	Fujian				46	47	42	39	34
	Shanghai	82	71	69	59	55	51	45	43
	Zhejiang	91	78	68	60	57	56	53	47
	Jiangxi	77	75.8	68	72	73	64	59	51
	Anhui		95	80	77	88	76	72	61
	Jiangsu	115	106	96	86	81	76	70	57
	Shandong	170	142	131	120	106	97	94	72
South China	Hainan		38	35	31	29	30	28	25
	Guangdong	60	60	51	48	51	49	46	40
	Guangxi	62	69	61	56	58	57	56	48
	Hunan				76	74	66	61	50
	Hubei		103	99	85	77	72	70	58

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang				56	61	52	49	42
	Jilin	78	80	88	71	67	57	56	47
	Liaoning	86	99	93	79	77	69	70	60
Northwest China	Qinghai		106		79	67	59	42	38
	Gansu			95	90	93	77	58	55
	Ningxia		105	106	103	106	82	66	62
	Shaanxi		128	109	112	103	104	81	66
	Xinjiang	137	144	129	141	121	99	126	74
Southwest China	Yunnan		48	45	43	44	46	38	34
	Guizhou			55	53	50	49	38	35
	Sichuan	85	80	76	75	67.7	62.6	52.9	49
	Chongqing	106	98	87	77	72	64	60	54
	Tibet								

Unit:μg/m^3

Figure 11: Annual Mean Concentrations of PM_{10} in Provinces, Autonomous Regions, and Municipalities in 2014-2021

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Beijing	26.5	21.8	13.5	10	8	6	4	3
	Tianjin	59	49	29	21	16	12	11	8
	Henan				33		16	11	9
	Hebei	74	55	41	34	27	20	15	10
	Shanxi		65	61	60	56	33	24	15
	Inner Mongolia				23	21	17	15	11
East China	Zhejiang	26	21	14	11	9	9	7	6
	Fujian				12	10	9	8	6
	Shanghai	24	18	17	15	12	10	7	6
	Jiangsu	35	29	25	21	16	12	9	7
	Anhui		26	22	21	17	13	10	8
	Jiangxi	34	31	27	24	23	17	13	12
	Shandong	71	59	45	35	24	16	14	11
South China	Hainan		5	5	5	5	5	5	5
	Guangdong	19	18	13	12	11	10	9	8
	Hubei			18	14	13	11	9	8
	Guangxi	25	21	18	15	14	13	12	10
	Hunan				20	14	12	9	8

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang				18	15	12	11	9
	Jilin	32	31	27	23	20	14	11	11
	Liaoning	42	46	40	34	28	23	19	14
Northwest China	Xinjiang	18	16	16	14	13	11	9	7
	Qinghai		29		20	20	17	13	14
	Shaanxi		32	28	23	20	16	12	10
	Gansu			31	26	21	18	14	13
	Ningxia		47	42		33	22	17	13
Southwest China	Chongqing	32	24	16	13	12	9	7	9
	Yunnan		25	15	14	12	11	9	8
	Guizhou			19	15	13	12	10	8
	Sichuan	34	25	18	17	13.9	12.2	9.4	8
	Tibet								

Unit: $\mu g/m^3$

Figure 12: Annual Mean Concentrations of SO_2 in Provinces, Autonomous Regions, and Municipalities in 2014-2021

NO_2

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Henan			42		39			27
	Beijing	56.7	50	48	46	42	37	29	26
	Tianjin	54	42	48	50	47	42	39	37
	Hebei	48	46	49	47	43	39	34	31
	Shanxi	35	34	37	42	40	39	35	31
	Inner Mongolia			25	26	23	23	21	19
East China	Fujian			19	26	17	15	13	13
	Jiangxi	27	25	25	26	25	24	22	22
	Zhejiang	39	28	26	27	32	31	29	29
	Jiangsu	39	37	37	39	38	34	30	29
	Shandong	46	41	38	37	36	35	32	29
	Anhui	30	31	38	38	35	31	29	26
	Shanghai	45	46	43	44	42	42	37	35
South China	Hainan	10	9	9	9	8	8	7	7
	Guangxi	24	21	21	23	22	22	18	19
	Hubei		28	26	28	28	26	22	4.8
	Hunan			26	26	26	25	21	21
	Guangdong	30	27	27	29	28	26	21	22

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang			23	23	21	19	18	19
	Jilin	30	31	28	28	24	23	22	21
	Liaoning	36	33	31	31	30	28	27	26
Northwest China	Qinghai	24		21	22	21	20	19	18
	Xinjiang	36	28	29	31	27	27	24	25
	Gansu		31	30	29	27	25	24	24
	Shaanxi	39	36	38	42	40	36	31	30
	Ningxia	29	27		32	29	30		25
Southwest China	Yunnan	15	17	17	19	18	16	15	16
	Guizhou		21	22	21	20	18	15	15
	Sichuan	32	30	30	31.5	30.1	27.8	25	24
	Chongqing	39	45	46	46	44	40	39	32
	Tibet								

Unit:μg/m^3

Figure 13: Annual Mean Concentrations of NO_2 in Provinces, Autonomous Regions, and Municipalities in 2014-2021

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Tianjin	2.9	3.1	2.7	2.8	1.9	1.8		1.4
	Beijing	3.2	3.6	3.2	2.1	1.7	1.4		1.2
	Hebei	3.6	3.7	3.3	2.9	2.3		1.8	1.4
	Shanxi		3.5		3	2.5	2.2	1.9	1.5
	Henan					2.1			1.3
	Inner Mongolia				1.6			1.3	1
East China	Shanghai	0.77	0.86	0.79	0.76	0.67	0.66		0.9
	Fujian			1.1	1.1	1	1	0.9	0.8
	Zhejiang	1.4	1.4	1.2	1.1	1.2	1	0.9	0.9
	Anhui		1.8	1.6	1.4	1.4	1.2	1.1	1
	Jiangxi		1.5	1.6	1.4	1.4	1.4	1.2	1.1
	Jiangsu	1.7	1.7	1.7	1.5	1.4	1.2	1.1	1
	Shandong						1.5	1.4	1.2
South China	Hainan		1.1	1.1	1	0.9	0.8	0.8	0.7
	Guangdong	1.7	1.4	1.3	1.2	1.1	1.2	1	0.9
	Guangxi		1.8	1.4	1.4	1.4	1.4	1.1	1.1
	Hunan			1.6	1.6	1.5	1.4	1.2	1.1
	Hubei		1.9	1.8	1.7	1.6	1.4	1.3	1.2

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang			1.5	1.4	1.2	1.1	1.1	1
	Jilin		1.9	1.6	1.7	1.4	1.3	1.4	1.1
	Liaoning			2	1.8	1.7	1.7	1.6	1.5
Northwest China	Qinghai			1.76	1.6	1.5	1.2	1.2	1
	Gansu			1.9	1.6	1.5	1.3	1.1	1.1
	Shaanxi		3	2.7	2.3	2	1.8	1.5	1.3
	Ningxia	2	1.8		1.8	1.5	1.4		1.2
	Xinjiang				2.4	1.1	0.9	0.8	0.8
Southwest China	Guizhou		1.3	1.2	1.2	1.1	1	0.9	0.9
	Chongqing	1.8	1.5	1.4	1.4	1.3	1.2		1
	Sichuan		1.5	1.5	1.4	1.3	1.1	1.1	1.1
	Tibet								
	Yunnan						1	1	1

Unit:mg/m^3

Figure 14: Annual Mean Concentrations of CO in Provinces, Autonomous Regions, and Municipalities in 2014-2021

O_3

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
North China	Tianjin	157	142	157	193	201	200	190	160
	Beijing	197.2	202.6	160	192	192	191	174	149
	Hebei	159	160	171	193	193		174	162
	Shanxi		134		186	182	180	169	169
	Inner Mongolia				143	146		130	132
	Henan								163
East China	Fujian			109	137	125	117	109	107
	Zhejiang	153	135	132	135	159	154	145	142
	Jiangxi		119	132	141	145	151	138	126
	Anhui		106	140	160	166	165	148	148
	Shanghai	149	161	164	181	160	151	152	145
	Jiangsu	154	167	165	177	177	173	164	163
	Shandong						186	172	166
South China	Hainan		118	105	107	107	118	105	111
	Guangxi		122	120	128	128	140	117	122
	Hunan			136	137	140	148	126	127
	Guangdong	148	138	138	153	154	158	138	144
	Hubei		146	139	139	154	158	139	138

Region	Province	2014	2015	2016	2017	2018	2019	2020	2021
Northeast China	Heilongjiang			98	106	120	103	107	111
	Jilin		136	137	135	141	129	123	116
	Liaoning			155	157	157	151	146	131
Northwest China	Qinghai			128	133	132	135	124	129
	Gansu		129	133	140	139	131	126	129
	Shaanxi		143	158	166	164	151	145	146
	Ningxia	139	135		154	151	142		145
	Xinjiang				124	89	87	87	90
Southwest China	Guizhou		106	108	108	116	118	110	111
	Sichuan		131	132	140.5	144.4	134.1	135	127
	Chongqing	146	127	141	163	166	157	150	127
	Tibet						127	120	126
	Yunnan								

Unit:μg/m^3

Figure 15: Annual Mean Concentrations of O_3 in Provinces, Autonomous Regions, and Municipalities in 2014-2021

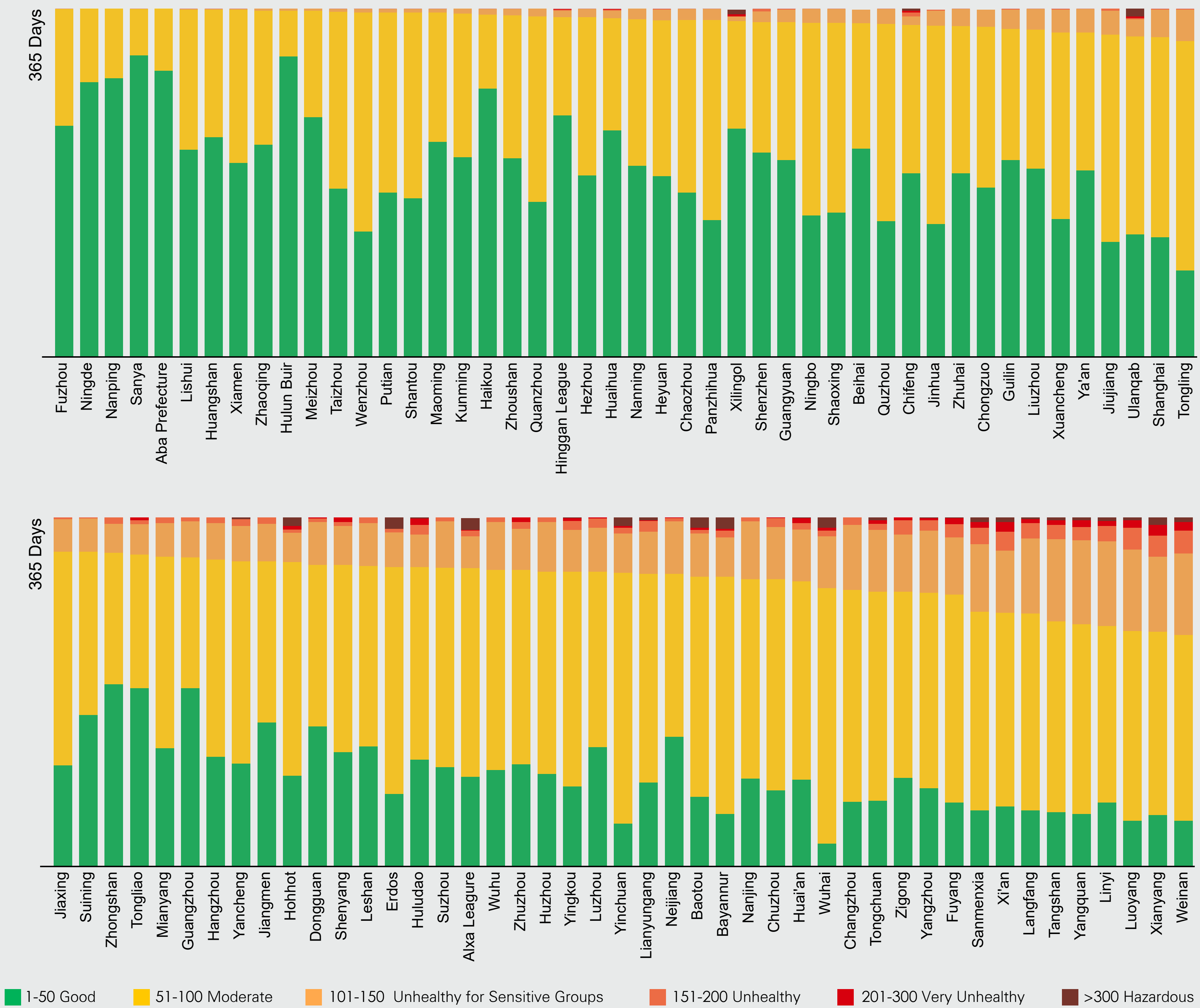


Figure 16: Distribution of AQI for some cities in 2021

Overall, air quality in Chinese cities in 2021 showed the following characteristics.

Overall air quality continued to improve, and the target of attainment days for 2025 was achieved.

In 2021, in 339 cities at the prefecture level or above in China, the overall annual mean concentrations of the six criteria pollutants continued to decrease after meeting the standard in 2020 (see Figure 17). In the 168 key cities, the overall annual mean concentrations of the six criteria pollutants all met the standards for the first time (see Figure 18). The number of air quality attainment cities increased to 218, accounting for 64.3% of all cities. Regarding major pollutants $PM_{2.5}$ and O_3, the overall annual mean concentrations, average proportions

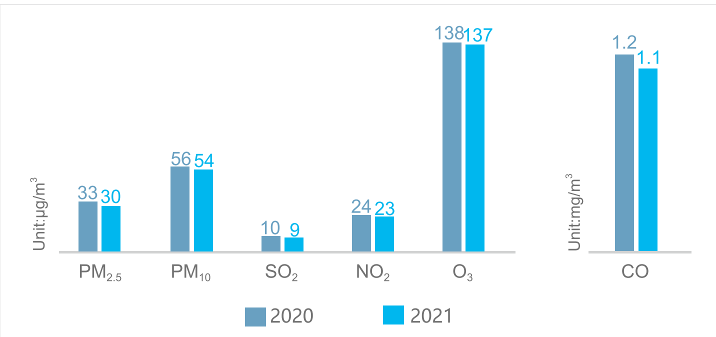


Figure 17: Overall Annual Mean Concentrations of the Six Criteria Pollutants in China in 2020 and 2021

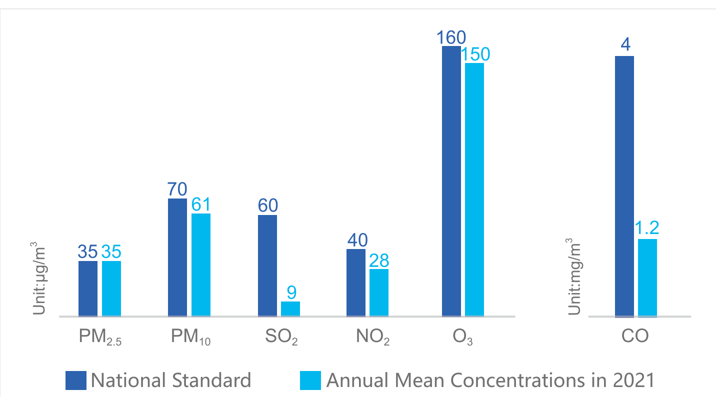


Figure 18: Overall Annual Mean Concentrations of the Six Criteria Pollutants in the 168 Key Cities in 2021

of non-attainment days, and proportions of non-attainment cities all decreased for two consecutive years. In the 339 cities at the prefecture level or above, the average percentage of attainment days rose to 87.5%, achieving ahead of schedule the target that "the percentage of air quality attainment days should reach 87.5% by 2025" set out in the "Opinions on Further Fighting the Tough Battle of Pollution Prevention and Control."

With respect to the percentage of attainment cities for each pollutant, all cities steadily reached the standards for SO_2 and CO for the third consecutive year. The proportion of attainment cities for NO_2 increased to 99.7%, with only Lanzhou failing to attain the standard. The attainment cities for O_3, PM_{10}, and $PM_{2.5}$ increased to 85.3%, 82.0%, and 70.2%, respectively, with a year-on-year increase of 6–25 cities, as shown in Figure 19.

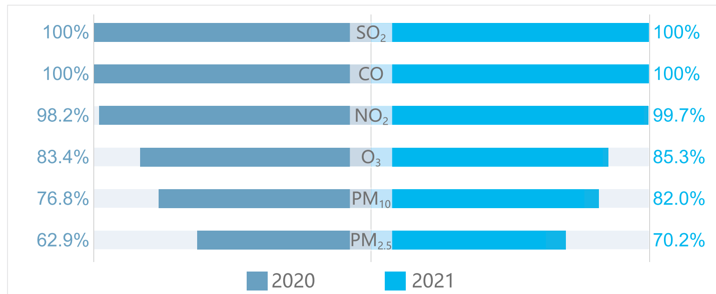


Figure 19: Percentages of Attainment Cities for the Six Criteria Pollutants in China in 2020 and 2021

Overall O_3 pollution concentration in China continued to decrease except in the Fenwei Plain, where O_3 pollution slightly deteriorated.

Since O_3 was included as part of normalized monitoring in China in 2013, the overall annual mean concentration of the pollutant across the country had worsened, and pollution in the key regions had become more serious. This trend was reversed in 2020. In 2021, the overall concentration of O_3 in the country further declined by 1 μg/m³ from the 2020 concentration. Among the three key regions, the annual mean concentration of O_3 in the BTH region and its surrounding areas and in the YRD region decreased year-on-year by 5.0% and 0.7%, respectively. However, the concentration rebounded with an increase of 3.1% in the Fenwei Plain, as shown in Figure 20.

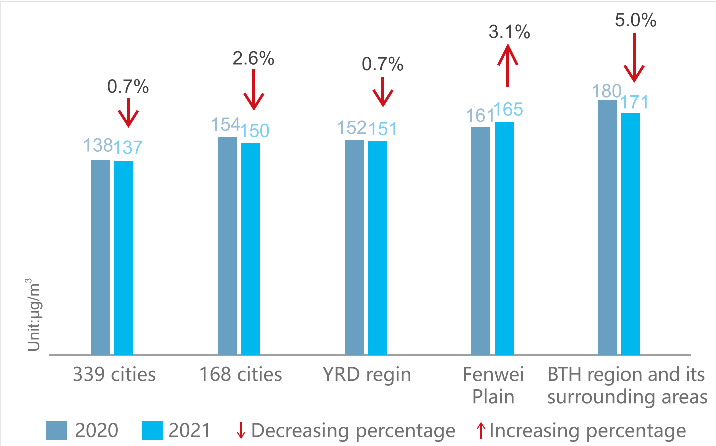


Figure 20: Annual Mean Concentration of O_3 across the Country and in the Key Regions in 2020 and 2021

The overall proportion of attainment days rose in the key cities, but the number of cities with declining attainment days increased significantly.

In 2021, the overall annual mean concentration of $PM_{2.5}$ in the 168 key cities complied with the standard for the first time, and the proportion of attainment days rose on a year-on-year basis. However, the number of cities with a deteriorating $PM_{2.5}$ concentration or declining attainment days increased significantly. Specifically, the number of cities with increasing $PM_{2.5}$ concentration rose to 24, more than three times the amount in 2020. The number of cities with declining attainment days increased to 64, more than six times than in 2020, mainly in the YRD region, the Chengdu-Chongqing region, and the city clusters in the middle and lower reaches of the Yangtze River. Given this context, the reduction of $PM_{2.5}$ concentration and increase in the average proportion of attainment days in the 168 key cities resulted mainly from the contribution of improving cities, as shown in Figure 21-22.

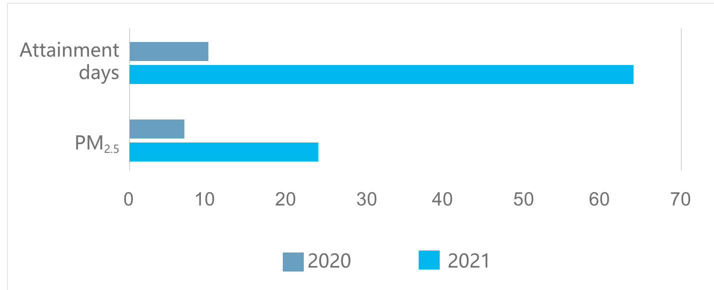


Figure 21: Number of Cities with Deteriorating $PM_{2.5}$ and Attainment Days among the 168 Key Cities in 2020 and 2021

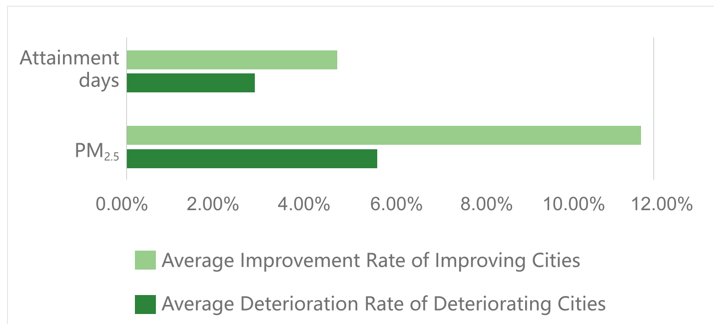


Figure 22: Changes in $PM_{2.5}$ Concentration and Attainment Days in the 168 Key Cities in 2021

Chapter II.

Policy Progress

As it enters the 14th Five-Year Plan period, China continues to fight the tough battle against air pollution and promote the control of pollution sources under the guidance of the "Dual Carbon" goals to reduce the emission of both air pollutants and GHGs in the energy, industrial, and transportation sectors.

The energy consumption structure continued its transition toward clean energy, and the proportion of coal consumption continued to decrease. The national installed capacity structure was also optimized further, with the proportion of non-fossil energy exceeding that of coal power for the first time. In the industrial sector, the iron and steel industry made remarkable progress in terms of ultra-low emission retrofitting, and the cement industry also started work in this aspect. In the transportation sector, in terms of continuing pollution control and emission reduction measures for diesel trucks, China strengthened the "adjustment of the transportation structure" and the implementation of "alternatives for transportation energy" to boost the optimization of the transportation structure and the low-carbon transformation of transportation equipment.

China also made efforts in the coordinated monitoring of multiple pollutants and the special monitoring of pollution sources. All cities at the prefecture level or above carried out the automatic monitoring of non-methane hydrocarbons (NMHC) and special monitoring of pollution sources, focusing on transportation, industrial parks, and pollutant discharging units. Thirteen cities were selected as pilot cities to carry out atmospheric GHG monitoring and build a carbon monitoring system to strengthen the weak links in the air monitoring system. The domestic carbon market also officially launched online transactions, with a cumulative transaction of 179 million tons of carbon emission allowances and a cumulative transaction value of RMB7.661 billion.

Major Milestones for Air Pollution Prevention and Control in 2021

1 Jan.

◆ January 11: The MEE issued the "Guiding Opinions on Coordinating and Strengthening Work Related to Addressing Climate Change and Protecting the Ecological Environment," which defines the main fields and key tasks for coordinating and strengthening the work related to addressing climate change and protecting the ecological environment. The aim is to steadily improve the ecological and environmental governance system and capacity of the country.

2 Feb.

◆ February 1: The "Management Measures for Carbon Emissions Trading (Trial)" came into force, arranging for various preparations for and ensuring the smooth implementation of trading activities in the national carbon market.

3 Mar.

◆ March 1: The "Regulations on the Administration of Pollutant Discharge Permits" came into force, regulating the administration of pollutant discharge permits by defining the administration scope and categories of such permits, standardizing the procedures for the application for and approval of these permits, enhancing pollutant discharge management, tightening the supervision and inspection of pollutant discharges, and strengthening related legal liabilities.

4 Apr.

◆ April 26: The MEE issued the "Notice on Carrying Out City-tailored Research on the 'City-Specific Strategies' for the Coordinated Prevention and Control of $PM_{2.5}$ and O_3 Pollution." Working groups were set up in various cities to do city-tailored research, and specialized units comprising teams of experts were organized to delve deep into relevant research work in urban frontlines.

5 May

◆ May 10: The MEE issued the "Capacity Building Program for the National Monitoring Network of the Coordinated Control of $PM_{2.5}$ and O_3 during the 14th Five-Year Plan Period," requiring the automatic monitoring of NMHC in all cities at the prefecture level or above and the Xiong'an New Area, the coordinated monitoring of $PM_{2.5}$ and VOCs in the key cities for air pollution prevention and control, and the special monitoring of pollution sources focusing on transportation, industrial parks, and pollutant discharging units.

◆ May 31: The MEE issued the "Guiding Opinions on Strengthening the Prevention and Control of Ecological and Environmental Pollution Sources of High Energy Consumption and High Emission Construction Projects." These guidelines aim for the low-carbon green transformation and development of "dual high" projects and boost the attainment of the carbon peaking goal and the improvement of the regional environment.

6 Jun.

◆ June 9: The Ministry of Finance (MOF) issued the "Management Measures for Air Pollution Prevention and Control Funds," specifying that the scope of key financial support covered clean heating in Northern China in winter, the capacity building of atmospheric environment governance and management, the coordinated control of $PM_{2.5}$ and O_3, and other important matters.

Figure 23: Major Milestones for Air Pollution Prevention and Control in 2021

7
Jul.

◆ July 15: The national carbon emissions trading market officially launched online transactions. The first implementation period included 2,162 key emission units in the power generation industry, covering about 4.5 billion tons of CO_2 emissions annually.

8
Aug.

◆ August 4: The MEE issued the "Notice on Accelerating the Resolution of Current Prominent Problems in the Control of Volatile Organic Compounds," requiring a review of how key tasks are fulfilled and problems are rectified, as well as the identification and rectification of existing prominent problems.

9
Sep.

◆ September 12: The MEE issued the "Plan for the Pilot Work in Carbon Monitoring and Assessment," requiring the implementation of pilot work in CO_2 monitoring and assessment at the three levels (key industries, cities, and regions). It explores the establishment of a technology and methodology system for CO_2 monitoring and assessment and forms a business operation mode to provide data support for assessing the effectiveness of the response to climate change.

◆ September 22: The Central Committee of the Communist Party of China (CPC) and the State Council of the People's Republic of China issued the "Opinions on Completely, Accurately, and Comprehensively Implementing the New Development Philosophy and Doing a Good Job in Carbon Peaking and Carbon Neutrality," laying out systematic plans and the overall arrangement for carbon peaking and neutrality.

10
Oct.

◆ October 24: The State Council issued the "Action Plan for Carbon Peaking by 2030," laying out the overall plan for attaining carbon peaking across the country.

◆ October 27: The State Council issued the white paper titled "Responding to Climate Change: China's Policies and Actions," which introduces China's progress, practice, and experience in coping with climate change.

◆ October 28: Ten ministries and commissions and seven municipalities and provinces issued the "2021-2022 Action Plan for Integrated Air Pollution Prevention and Control in Autumn and Winter," maintaining the primary goals of reducing heavy pollution days and $PM_{2.5}$ concentration as in previous years and adjusting the scope of the geographical area.

◆ October 29: The National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) issued the "Notice on Carrying Out the Nationwide Retrofitting and Upgrading of Coal-Fired Power Units," aiming to further reduce the energy consumption of coal-fired power units and improve their flexibility and cleanliness and efficiency levels through retrofitting and upgrading. It also defines the retrofitting target during the 14^{th} Five-Year Plan period.

11
Nov.

◆ November 2: The CPC Central Committee and the State Council issued the "Opinions on Further Fighting the Tough Battle of Pollution Prevention and Control," setting out the main goals, major tasks, and key initiatives for ecological civilization development and ecological and environmental protection during the 14^{th} Five-Year Plan period and up to 2035.

12
Dec.

◆ December 25: The State Council issued the "Work Plan for Promoting the Development of Multi-Modal Transportation and Optimizing and Adjusting the Transportation Structure (2021–2025)," aiming to promote the deep integration of various transportation modes, further optimize and adjust the transportation structure, improve the efficiency of comprehensive transportation, and cut down the cost of social logistics.

◆ December 28: The State Council issued the "Comprehensive Work Plan for Energy Conservation and Emission Reduction during the 14^{th} Five-Year Plan Period," proposing that by 2025, China's energy consumption per unit of GDP should be 13.5% lower than that of 2020 and the chemical oxygen demand and the total emissions of ammonia nitrogen, NOx, and VOCs decrease by 8%, 8%, over 10%, and over 10%, respectively, from their 2020 values.

◆ December 28: The MEE issued the "14^{th} Five-Year Plan for Ecological Environment Monitoring," proposing to speed up the implementation of CO_2 monitoring and assessment, focus on coordinated control, deepen the atmospheric environment monitoring, etc.

Scientific Capacity Building

The urban ambient air quality monitoring system in China continued to improve. In 2021, the number of state-controlled monitoring sites maintained a substantial increase, the PM component monitoring network was further expanded, all cities at the prefecture level or above nationwide carried out the automatic monitoring of NMHC, and the component monitoring of VOCs was carried out in the key cities for air pollution prevention and control. The special monitoring of pollution sources focusing on transportation, industrial parks, and pollutant discharging units was also carried out. Thirteen cities were selected as pilot cities to implement the monitoring of atmospheric GHGs and start building a CO_2 monitoring system to strengthen the weak links in the air monitoring system. The MEE organized the implementation of city-tailored research on the "City-Specific Strategies" for the coordinated prevention and control of $PM_{2.5}$ and O_3 pollution, and dispatched expert teams to do city-tailored research and provide technical assistance and guidance in cities.

The monitoring network continued to improve, and the number and functions of sites were further expanded.

In 2021, the number of state-controlled monitoring sites for ambient air quality in 339 cities at the prefecture level or above increased from 1,436 to 1,734. 313 sites were added and 15 abolished according to site optimization and adjustment principles and technical requirements. The numbers of both cities and sites covered by the manual and automatic monitoring of the atmospheric PM component network increased significantly (see Figure 24). Specifically, the pilot monitoring of ammonia was launched at the automatic monitoring sites in the PM component network of seven cities (area)—Beijing, Jinan, Shijiazhuang, Taiyuan, Tianjin, Xiong'an New Area, and Zhengzhou—in the BTH region and its surrounding areas.

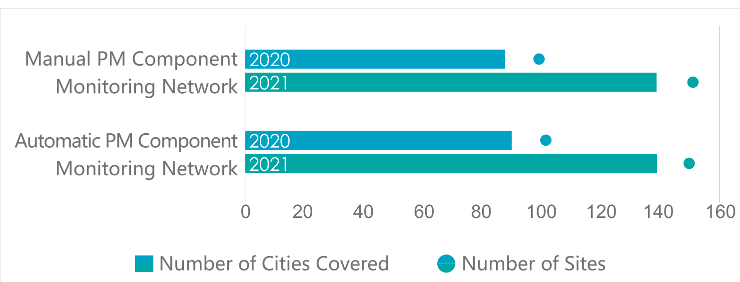


Figure 24: Expansion of the PM Component Monitoring Network in 2021

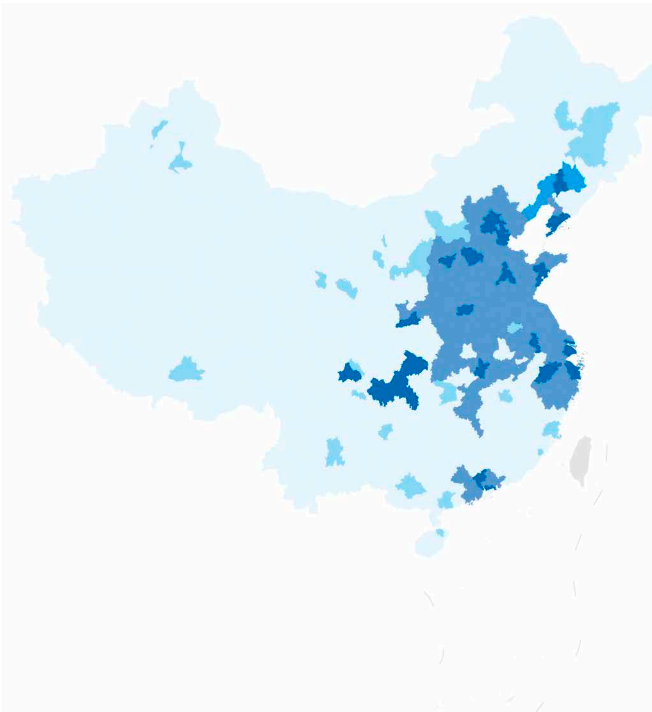
At the city level, the VOCs component and photochemical monitoring abilities continued to be enhanced. The automatic monitoring of NMHC in ambient air was carried out in all 339 cities, and the automatic monitoring of PAMS substances was conducted in 149 key cities, among which 122 cities, together with Fushun, Fuxin, Huludao, Jinzhou, and Tieling, were required to simultaneously conduct the manual monitoring of PAMS substances and 13 kinds of aldehydes and ketones. In addition, four municipalities directly under the central government, four cities with independent planning status, and 11 provincial capitals were also required to manually monitor 47 kinds of TO-15 substances, as shown in Figure 25.

To enhance the country's coordinated $PM_{2.5}$ and O_3 control and monitoring ability during the 14th Five-Year Plan period, the special monitoring of pollution sources focusing on transportation, industrial parks, and pollutant discharge units was carried out throughout China in 2021.

- Traffic-related pollution monitoring stations were established at highways, ports, airports, and railway freight yards in the key regions for air pollution prevention and control during the 14th Five-Year Plan period in the cities with high VOCs emissions. Monitored elements include PM, NOx, NMHC, PAMS substances, black carbon, meteorological parameters, and traffic flow.

- With a focus on the key regions for air pollution prevention and control during the 14th Five-Year Plan period, coordinated monitoring was carried out in industrial clusters and parks involving VOCs, such as the petrochemical, chemical engineering, industrial coating, and packaging and printing industries, as well as industrial clusters and parks with relatively high NOx emissions. Monitored items include the six conventional criteria pollutants and at least 57 kinds of PAMS substances for parks involving VOCs emissions.

- Stationary pollution source monitoring was conducted in line with the requirements of the technical guidelines for the self-monitoring of pollutant discharging enterprises; key enterprises were spurred to accelerate the installation of automatic monitoring facilities for flue gas emissions; and trifluoromethane (HFC-23) monitoring was carried out around enterprises producing chlorodifluoromethane (HCFC-22).



- Cities that conducted automatic monitoring of NMHC and PAMS substances and manual monitoring of PAMS substances, aldehydes and ketones, and TO-15 substances
- Cities that conducted automatic monitoring of NMHC and PAMS substances and manual monitoring of PAMS substances, aldehydes, and ketones
- Cities that conducted automatic monitoring of NMHC and manual monitoring of PAMS substances, aldehydes, and ketones
- Cities that conducted automatic monitoring of NMHC and PAMS substances
- All other cities that conducted automatic monitoring of NMHC
- No data

Figure 25: Monitoring of VOCs and PAMS Substances in 339 Cities in 2021

Pilot work for CO_2 monitoring and assessment was launched, with a focus on key industries, cities, and regions.

To assess the effectiveness of the response to climate change and provide support for the realization of the "Dual Carbon" goals, in 2021, China launched the pilot projects of CO_2 monitoring and assessment, with a focus on the three levels (key industries, cities, and regions).

The first batch of key industries to launch the pilot monitoring of GHGs included thermal power, iron and steel, oil and gas extraction, coal mining, and waste treatment. Monitored elements were as follows: The thermal power and iron and steel industries mainly monitored CO_2, the oil and gas extraction and coal mining industries primarily monitored CH_4, and the waste treatment industry monitored CO_2, CH_4, and N_2O.

There were 13 cities in the first batch to launch the pilot monitoring of atmospheric GHGs. Specifically, Lishui, Ordos, Taiyuan, Tangshan, and Tongchuan were the pilot cities to carry out the high-precision monitoring and assessment of CO_2 and CH_4. Chengdu, Chongqing, Hangzhou, Jinan, Ningbo, Shanghai, Shenzhen, and Zhengzhou were the pilot cities to carry out the high-precision monitoring and assessment of CO_2, CH_4, and other GHGs. In addition, four cities, namely Nantong, Panjin, Shenzhen, and Zhenjiang, were selected as pilot cities for marine carbon sink monitoring.

At the regional monitoring level, Wuyishan in Fujian, Hulun Buir in Inner Mongolia, Shennongjia in Hubei, Lijiang in Yunnan, Hailuogou in Sichuan, Menyuan in Qinghai, Changdao in Shandong, Pangquangou in Shanxi, and Nanling in Guangdong were selected as the locations of nine national background monitoring stations to carry out regional GHGs monitoring and assessment. Other monitoring contents include satellite remote-sensing monitoring, ground-based remote-sensing monitoring in key regions, and ecological pilot monitoring.

City-tailored research was carried out to strengthen scientific support for the coordinated prevention and control of $PM_{2.5}$ and O_3.

In 2021, to promote the application of the research results and strengthen scientific support on the causes and control of heavy air pollution, the MEE carried out city-tailored research on the "City-Specific Strategies" for the coordinated prevention and control of $PM_{2.5}$ and O_3 pollution. The ministry dispatched a total of 52 expert teams to 54 cities in the BTH region and its surrounding areas, the Fenwei Plain, and the Jiangsu-Anhui-Shandong-Henan border area to conduct this research and provide technical assistance and guidance. The main tasks of the working groups in these cities included:

- strengthening the analysis on the sources and causes of O_3 pollution, helping local governments in accurately identifying the main problems in the prevention and control of O_3 pollution, and putting forward "city-specific," "industry-specific," and "enterprise-specific" comprehensive solutions;

- establishing a consultation mechanism, conducting analysis on the O_3 pollution situation and organizing expert consultation on the pollution process before the occurrence of regional O_3 pollution, dissecting pollution causes and developing prevention and control countermeasures, and intensifying the efforts of regional collaboration on prevention and control;

- summarizing and reviewing in a timely manner; regularly organizing seminars, training sessions, and workshops to summarize the progress, results, and existing problems of pollution prevention and control in various cities; and helping the stationed working groups to constantly improve their technical assistance ability; and

- innovating working methods and improving the effectiveness of city-tailored research through "mutual-help" technical support between cities and cooperation between provincial and municipal expert teams.

The city-tailored research on the "City-Specific Strategies" is based on integrated research, production, application, feedback, and improvement. It facilitates the organic combination of scientific research and administrative management and aims to provide support for the scientific decision-making and precise policy implementation of the coordinated prevention and control of $PM_{2.5}$ and O_3 pollution.

Control of Major Pollution Sources

Stationary Sources

Energy Structure Adjustment and Clean Utilization

In 2021, China's economy continued to recover steadily while the demand for energy production and consumption remained strong. The energy consumption structure generally continued its clean transformation. Both the proportion of coal consumption and the energy consumption per unit of GDP decreased. However, some provinces caused concerns due to their ineffective "dual control" of energy consumption intensity and total energy consumption in the first half of the year. Meanwhile, the national installed capacity structure was further optimized. With policy support, the installed capacity of renewable energy, represented by wind power and solar power, achieved remarkable growth. The proportion of the installed capacity of non-fossil energy also exceeded that of coal power for the first time. The policy orientation of transitioning from the "dual control" of energy consumption to the "dual control" of carbon emission intensity and total carbon emission also left more room for the growth of renewable energy. At the same time, the overall demand for electricity in society rapidly grew while the power supply remained tight. Taking into account electric power security and low-carbon development, coal power gradually shifted to the role of supporting and regulating the power supply, and "three retrofitting" became a crucial measure for coal power transformation.

Energy consumption continued to follow the trend toward low-carbon transformation, but some provinces failed to achieve the targets of the "dual control" of energy consumption in the first half of the year.

In 2021, China's annual energy consumption included a total of 5.24 billion tons of standard coal equivalent (tce), up by 5.2% from the previous year. Coal consumption increased by 4.6%, crude oil by 4.1%, natural gas by 12.5%, and electricity by 10.3%. Energy consumption continued to follow the trend toward clean low-carbon transformation, and coal consumption accounted for 56.0% of the total energy consumption, down by 0.9 percentage points from the previous year. Clean energy consumption rose by 1.2 percentage points on a year-on-year basis to 25.5% of the total. From 2014–2021, the proportion of clean energy consumption, including natural gas, hydropower, nuclear power, wind power, and solar power, cumulatively increased by 8.6%, accounting for more than 60% of the increase in energy consumption.

In 2021, China continued to make solid progress in energy conservation and consumption reduction. The national energy consumption per RMB10,000 of GDP dropped by 2.7% from the previous year. Since 2014, China had cut energy consumption per unit of GDP by 20% accumulatively, supporting the 6.2% national economic growth with an average annual energy consumption growth of around 2.9%. However, in the first half of 2021, some provinces raised concerns for failing to achieve the targets of the “dual control” of energy consumption. Instead of decreasing, the energy consumption intensity of nine provinces (autonomous regions), namely, Fujian, Guangdong, Guangxi, Jiangsu, Ningxia, Qinghai, Shaanxi, Xinjiang, and Yunnan, saw a year-on-year increase. Ten provinces, namely Anhui, Gansu, Guizhou, Heilongjiang, Henan, Jiangxi, Liaoning, Shanxi, Sichuan, and Zhejiang, also did not meet the required progress for the reduction rate of energy consumption intensity, meaning that more than half of the provinces failed to achieve the “dual control” targets in the first half of the year. In September 2021, the NDRC issued the “Plan for Improving the Dual Control System for Energy Consumption Intensity and Total Energy Consumption,” requiring all local governments to properly control their total energy consumption and appropriately enhance their management flexibility. In the “dual control” assessment, for projects that met specific requirements, their energy consumption can be deducted to some extent. For provinces with high energy consumption, solving the contradiction between energy conservation and consumption reduction on one side and economic transformation and development on the other under the “Dual Carbon” goals has become a new challenge.

The proportion of the installed capacity of non-fossil energy exceeded that of coal-fired power for the first time, and the “dual control” of carbon emissions and carbon intensity left room for the growth of renewable energy.

By the end of 2021, China’s full-scale power generation installed capacity was 2.38 billion kW, with a year-on-year growth of 7.9%. The installed capacity of coal-fired power was 1.11 billion kW, up by 2.8% year-on-year, accounting for 46.7% of the total installed capacity. The installed capacity of non-fossil energy power was 1.12 billion kW, up by 13.4% year-on-year, accounting for 47.0% of the total and exceeding that of coal-fired power for the first time in history, as shown in Figure 26.

In 2021, China’s newly installed power generation capacity reached 176.29 million kW, 138.09 million kW of which was from non-fossil energy, accounting for 78.3% of newly added installed capacity, up by 5.2% year-on-year. Boosted by a series of policies, the newly installed capacities of wind power and solar power reached a new high of 101 million kW, with 47.57 million kW of wind power and 52.97 million kW of solar power,

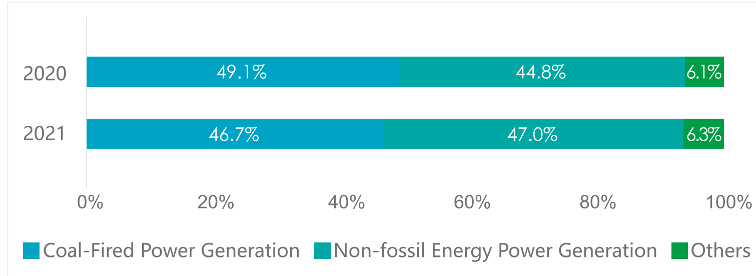


Figure 26: China's Structure of Installed Power Generation Capacity in 2020 and 2021

thereby achieving the goal of “ensuring basic-need grid-connected capacity of no less than 90 million kW in 2021” set by the NEA in the first half of the year.

In September 2021, the NEA issued a notice that a total of 676 counties (cities and districts) were included in the list of pilot areas for rooftop-distributed photovoltaic (PV) energy development. Throughout the year, the cumulative registered capacity of pilot counties promoting countywide rooftop-distributed PV power generation reached 46.23 million kW, and the cumulative grid-connected capacity was 17.78 million kW. In December, the NEA and the NDRC released a list of large-scale wind power and solar base construction projects involving 18 provinces, including Inner Mongolia Autonomous Region, Gansu, and Qinghai and the Xinjiang Production and Construction Corps, with a total installed capacity of 97.05 GW. By the end of 2021, the construction of about 75 GW capacity had commenced.

Meanwhile, the policy for shifting from the “dual control” of total energy consumption and energy intensity to the “dual control” of carbon emissions and carbon intensity also left room for the growth of renewable energy. In December 2021, the Central Economic Working Conference proposed for the conditions for shifting from the “dual control” of energy consumption to the “dual control” of carbon. Newly added renewable energy consumption is not included in the control of total energy consumption. Carbon emissions from the energy sector accounted for more than 80% of total emissions across the country. Although the “dual control” of total energy consumption and energy intensity in the past made a certain contribution to carbon emission control, it did not reflect the differences in the emission intensity per unit of energy consumption of different energy sources, which may suppress the growth momentum of renewable energy. The shifting from the “dual control” of energy consumption to the “dual control” of carbon, on the one hand, highlights more clearly the policy orientation of controlling fossil energy consumption and will contribute to driving the further development of renewable energy and speeding up the transformation of the energy structure. On the other hand, the increasing use of non-fossil energy satisfies the reasonable growth demand of energy consumption, which will in turn support the coordination between economic development and carbon emission reduction.

Taking both energy security and the reduction of pollution and carbon emissions into account, “three retrofitting” became a crucial measure for coal-fired power transformation.

In 2021, the power supply and demand in China was generally tense, and power supply was tight in some areas. From September–October, because of the influence of multiple factors—such as the tight supply of thermal coal and other fuels, the year-on-year reduction of hydroelectric power generation, the fast growth of electricity consumption demand, and the strengthening of the “dual control” of total energy consumption and energy intensity in some regions—more than 20 provincial grids adopted measures for the orderly use of electricity, and individual regions implemented power rationing at some time. Coal-fired power will continue to play an important role in ensuring electric power security for a long time in China as coal continues to dominate the country’s resource endowment. In 2021, coal-fired power accounted for less than 50% of the country’s installed capacity but produced 60% of its electricity and undertook 70% of the peak power tasks. However, achieving the “Dual Carbon” goals requires the structural transformation of energy and electric power. In the process of building a new carbon-neutral power system, clean and low-carbon development, power supply security, and the cost of system transformation need to be taken into consideration.

Considering China’s coal resource endowment and economic development stage, the clean and efficient utilization of coal-fired power has been the main direction of the sector’s development in recent years. By the end of 2021, China had completed the ultra-low emission retrofitting of more than 1 billion kW of coal-fired power units. The standard coal consumption for power supply by thermal power plants with a capacity of 6,000 kW or above was 301.5 g/kWh, down by 2.01 g/kWh year-on-year, with supercritical and ultra-supercritical power units accounting for more than 50% of total coal consumption. Coal-fired power units reaching ultra-low emission limits also took up 93.0% of the national total installed capacity of coal-fired power. National emissions of soot, SO_2, and NOx by electric power were about 123,000 tons, 547,000 tons, and 862,000 tons, respectively, down by 20.7%, 26.4%, and 1.4% year-on-year.

However, given the current limited increase of the installed capacity of coal-fired power, the space for ultra-low emission retrofitting and for decreasing the average coal consumption of thermal power supply is constantly narrowing. Meanwhile, as coal-fired power units start to play an increasingly prominent role in in-depth peak regulation, supporting new energy consumption, and guaranteeing the security of electric power, their operating load rate will decline, and the increase in low-load operating time will become an inevitable trend, which may have an adverse impact on the operating efficiency of coal-fired units and the coal consumption for power supply.

On this ground, the “Notice on the Nationwide Retrofitting and Upgrading of Coal-Fired Power Units” arranged two aspects: the optimization of existing units and the stricter access threshold of new units. For one, it laid out the utilization of “three retrofitting” for existing units (i.e., retrofitting for energy conservation, retrofitting for heat provision, and retrofitting for the improvement of adjustment capability) in supporting and adjusting new energy power generation and guaranteeing electric power security. China proposed that during the 14^{th} Five-Year Plan period, the scale of retrofitting for energy conservation should be no less than 350 million kW, the scale of the retrofitting for providing heat should reach 50 million kW, and retrofitting for improving adjustment capability should amount to 200 million kW. In 2021, the country completed the retrofitting a scale of 240 million kW coal-fired power units, laying a good foundation for the 600 million kW goal during the plan period. If China achieves this goal as scheduled for this period, it is expected to save more than 50 million tons in coal consumption and increase new energy consumption capacity by more than 50 million kW. For another, small low-parameter thermal power units were shut down, and efforts were intensified to eliminate outdated coal-fired power capacity. However, eliminated coal-fired power units were required to be “shut down but not dismantled” so that they could serve as backup peak regulation power sources to guarantee energy security.

For new units, the requirements were to improve their parameters, execute strict standards for the coal consumption of their power supply, and implement end-of-pipe control and ultra-low emission limits. Based on the current energy plans for the 14^{th} Five-Year Plan period published by various local governments, a number of clean and efficient coal-fired power units will be added in China in the future, but the new units will inevitably bring a certain increment of carbon emissions. In the context of the “Dual Carbon” goals, the trend toward coal-fired power transition is irreversible, but how to control the progress of transition and strike a balance between energy security and carbon reduction is still an urgent issue to address.

Emission Reduction and Comprehensive Control of Key Industrial Sectors

During the 13th Five-Year Plan period, remarkable results were achieved in the green development of China's industrial sector. Clean production levels were effectively increased. The ultra-low emission retrofitting of all coal-fired power units was completed, and ultra-low emission retrofitting was also launched for 620 million tons of crude steel capacity. The emission intensity of major pollutants in key sectors was reduced by more than 20%. A long-term exit mechanism for outdated capacity was established. The iron and steel industry achieved the target of cutting excess capacity by 150 million tons ahead of schedule, and the electrolytic aluminum and cement sectors basically closed down outdated capacity.

As China entered the 14th Five-Year Plan period, the "Dual Carbon" goals guided key industrial sectors in cooperatively pushing forward with the reduction of both air pollutant and GHG emissions. The iron and steel industry achieved a drop in crude steel output for the first time and continued to deepen ultra-low emission retrofitting, completing the process for a total of about 145 million tons of iron and steel capacity. Meanwhile, the whole industry and a number of iron and steel enterprises put forward their own "Dual Carbon" goals. For the cement industry, Ningxia and Shanxi launched ultra-low emission retrofitting, while Hainan, Jiangsu, and Sichuan revised their local standards. Difficulties in VOC control continued to be addressed, and petrochemical, chemical engineering, and other key industries conducted a review of the fulfillment of key tasks and rectification of problems.

To meet the "Dual Carbon" goals, key industrial sectors focused on restructuring and source prevention and control.

Key industrial sectors are the primary areas of energy consumption and GHG emission in China, with energy consumption accounting for around 70% of the total consumption of the industrial sector. In 2020, the carbon emissions of key industrial sectors (including iron and steel, cement, and petrochemicals) accounted for more than two-thirds of the total CO_2 emissions of industries above the designated size and more than half of the total CO_2 emissions in China. In recent years, although China has been strictly controlling the expansion of energy-intensive industries and eliminating outdated capacities, the energy structure of the industrial sectors—in which energy-intensive heavy industry took up a high proportion and fossil fuels played a dominant role—remained unchanged, and deep decarbonization remained under great pressure. Based on the above situation, to further implement the "Action Plan for Carbon Peaking by 2030" in China, the industrial sectors committed to accelerate the adjustment of the industrial structure, actively phase out outdated capacities, develop strategic emerging industries and hi-tech industries, continuously optimize the industrial layout in key regions and river basins, and comprehensively boost the green and low-carbon transition of the sector.

In addition, in 2021, "dual high" projects (those with high energy consumption and high emissions) followed a rising trend in Guizhou, Jilin, Liaoning, Ningxia, and Shanxi, challenging the "Dual Carbon" goals and the improvement of regional environmental quality. As a result, the national level constantly sent notices to resolutely curb the blind development of "dual high" projects. With this context, many local governments successively issued relevant documents in compliance with the notices, explicitly raising the access threshold for such "dual high" projects in the iron and steel, cement, plate glass, and electrolytic aluminum industries, with some projects even banned. Some provinces, including Henan, Inner Mongolia, and Yunnan, also canceled the preferential electricity price policies for such projects, strictly controlled their credit scale, and cut off funding sources for the construction and operation of illegal "dual high" projects.

China's crude steel output fell for the first time in seven years as the iron and steel industry focused on simultaneously carrying out capacity replacement and pollution and CO_2 reduction.

In 2021, China's iron and steel industry continued to eliminate outdated capacities and phase out excess capacity. As a result, for the first time since 2015, the nationwide crude steel output fell, from 1.065 billion tons in 2020 to 1.035 billion tons in 2021, down by 2.8% year-on-year. Regardless, the iron and steel industry remained the second-largest CO_2 emitter, next only to the power sector, accounting for 15% of national total CO_2 emissions in 2020. Problems such as overcapacity pressure and the low level of green and low-carbon development continued. Given this context, the iron and steel industry revised its capacity replacement measures, began to vigorously promote the reduction of air pollutant and CO_2 emissions, and explored the path to achieving the "Dual Carbon" goals while making further efforts to deepen ultra-low emission retrofitting.

Since its release and implementation at the end of 2017, the "Implementing Measures of Capacity Replacement for the Iron and Steel Industry" had effectively curbed the expansion of steel capacity and played a positive role in dissolving excess capacity, adjusting industrial distribution, saving energy, and reducing emissions. However, some problems were also found in the implementation process, including a low proportion of capacity replacement, inconsistent standards for capacity identification, and the risk of the revival of “zombie enterprises.” To address these problems, the Ministry of Industry and Information Technology issued the new edition of the “Implementing Measures of Capacity Replacement for the Steel Industry” in 2021, demonstrating greater determination to carry out structural adjustment in the iron and steel industry and reflecting China’s efforts in controlling overcapacity, air pollution, and carbon emissions. Encouraged by the latest capacity replacement measures, the electric furnace construction capacity in the capacity replacement circulars of various provinces was significantly increased, and non-blast furnace iron-making projects emerged one after another. However, it is worth noting that from 2017–2021, the overall structure of China’s iron and steel industry remained unchanged and was still dominated by the blast furnace-converter long-process steel-making technology with a high carbon emission intensity, and the capacity of electric furnace steel-making was less than 10%. Therefore, to meet the “Dual Carbon” goals, the structural transformation of the iron and steel industry remains imperative and extremely urgent.

In addition, ultra-low emission retrofitting for the iron and steel industry was also advanced systematically. By the end of 2021, 34 iron and steel enterprises had completed the public disclosure of ultra-low emission retrofitting. Among them, 23 iron and steel enterprises completed whole-process ultra-low emission retrofitting and passed the public disclosure of assessment and monitoring, with an iron and steel capacity of about 145 million tons, accounting for about 27% of the ultra-low emission retrofitting target set in the 14th Five-Year Plan. Another 11 steel enterprises completed ultra-low emission retrofitting and made progress with the public disclosure of assessment and monitoring in some processes, with an iron and steel capacity of about 84 million tons. More than 200 enterprises with a crude steel production capacity of about 400 million tons carried out ultra-low emission retrofitting. According to the data published by the China Iron and Steel Association, in 2021, SO_2, PM, and NOx emissions in the exhaust gases from key iron and steel enterprises decreased year-on-year by 21.15%, 15.16%, and 13.89%, respectively.

In 2021, with China proposing that “the industrial sector should accelerate its green and low-carbon transformation and high-quality development and strive to take the lead in achieving the carbon peaking goal,” the first draft of the “Action Plan for Carbon Peaking and Reduction in the Iron and Steel Industry” was finished. It put forward the preliminary goals for the plan, including that the iron and steel industry should realize the carbon emission peaking goal by 2025 and reduce its carbon emissions by 30% from the peak value by 2030. In addition, China Baowu Steel Group, an industry leader in China, took the lead in putting forward the schedule of achieving the “Dual Carbon” goals. It was followed by a number of key enterprises, including HBIS, Ansteel, and Baogang, as shown in Table 1.

Table 1: “Dual Carbon” Goals of Some Enterprises in the Iron and Steel Industry

	Planned Year of Achieving the Carbon Peaking Goal	Planned Year of Achieving the Carbon Neutrality Goal	Issuance Date
Baowu Steel Group	2023	2050	Jan. 2021
HBIS Group	2022	2050	Mar. 2021
Baogang Group	2023	2050	May 2021
Ansteel Group	Before 2025	To be the first batch of iron and steel enterprises in China to achieve carbon neutrality	May 2021
China South Steel Group	2023	2050	Dec. 2021

Pollution control was comprehensively deepened in the cement industry, and some provinces launched ultra-low emission retrofitting.

As one of the major air pollutant emitters in China, the cement industry accounted for 20.9% and 17.3% of China’s total industrial emissions of PM and NOx, respectively, in 2020. Therefore, pollution control needed to be further deepened in the cement industry, so its ultra-low emission retrofitting was put on the agenda in 2021. Multiple plans for the 14th Five-Year Plan period published in China pointed out that ultra-low emission retrofitting should be steadily implemented in the cement industry. In this context, the cement industry would become the third key industry to fully implement ultra-low emission retrofitting, following the power industry and the iron and steel industry.

In 2021, Jilin Province, Ningxia Hui Autonomous Region, and Shanxi Province issued their implementing plans for the ultra-low emission retrofitting of the cement industry, specifying ultra-low emission limits and the milestones for phased implementation. Among them, Ningxia and Shanxi achieved their ultra-low emission retrofitting targets for cement enterprises. In addition, Hainan, Jiangsu, and Sichuan Provinces revised

Table 2: National and Some Provincial Emission Limits for Major Pollutants in the Cement Industry (Waste Heat Utilization System of Cement Kiln and Kiln Tail)

Unit:mg/m^3	PM	SO_2	NOx	Issuance Date	Source
National	30	200	400	2013	National Standard (GB4915–2013)
Hainan Province	10	100	200	Jan. 2021	Local Standard (DB46/524–2021)
Sichuan Province	10	35	100	Dec. 2021	Local Standard (DB51/2846–2021)
Jiangsu Province	10	35	100	Dec. 2021	Local Standard (DB32/4149–2021)
Ningxia Hui Autonomous Region	10	50	100	Jan. 2021	Implementing Plan for Flue Gas Ultra–Low Emission Retrofitting in the Cement Industry
Shanxi Province	10	35	50	Apr. 2021	Implementing Plan for Ultra–Low Emission Retrofitting in the Cement Industry
Jilin Province	10	35	100	Nov.2021	Implementing Plan for Ultra–Low Emission Retrofitting in the Cement Industry (Exposure Draft)

their local standards for the cement industry, all of which became more stringent than the current national standard, with some indicators reaching ultra-low emission levels. Table 2 shows the national and some provincial emission limits for major pollutants in the cement industry.

In 2021, in the "Notice on the Action Plan for Deepening the Reform of the Price Mechanism During the 14th Five-Year Plan Period," the NDRC raised the requirements for "dual high" industries to improve green electricity price policies, such as differential electricity pricing and tiered electricity pricing, and strengthen the coordination with industrial and environmental protection policies. Some provinces, including Fujian, Hebei, Henan, and Qinghai, issued notices on the differential electricity pricing policy for the ultra-low emission of cement enterprises.

The control of VOCs was deepened, and the reinspection and rectification were carried out

During the 13th Five-Year Plan period, O_3 pollution in many Chinese cities was prominent, becoming a key and difficult problem in the field of air pollution prevention and control. At the present stage, the pollution prevention and control of VOCs, the precursors of O_3, would be an effective way to control O_3 pollution. In line with this, China successively issued numerous policies, standards, and other documents to promote the control of VOCs.

In 2021, the MEE issued the "Notice on Accelerating the Resolution of Current Prominent Problems in the Control of Volatile Organic Compounds," requiring the reinspection of the fulfillment of key control tasks and measures and the rectification of control problems required in the policies during the 13th Five-Year Plan period. At the same time, focusing on industries such as chemical engineering and packaging and printing, the notice also required enterprises to be organized in carrying out the investigation and rectification of key links of VOCs emissions by referring to the Law on Air Pollution Prevention and Control, pollutant discharge permits, relevant emission standards, and the standard VOCs content limits of products.

To implement the above requirements, local authorities at all levels made a series of arrangements for the control of prominent VOCs problems. Major measures included on-site inspection, comprehensive investigation, special law enforcement, and other actions, such as "city-specific" and "enterprise-specific" strategies.

Mobile Sources

To promote synergy in reducing pollution and carbon in the transportation sector, in 2021, the start year of the 14th Five-Year Plan period, China added the "replacement of transportation energy" and "adjustment of transportation structure" to continue the emission reduction measures for the prevention and control of pollution from diesel trucks. A number of policies were also introduced to boost the adjustment and optimization of the transportation structure and the low-carbon transformation of transportation equipment.

Entering the 14th Five-Year Plan period, transportation remained one of the main sources of air pollutant emissions in China, accounting for about 10% of national total carbon emissions. The challenges of pollution and carbon reduction cannot be ignored, and there is still a long way to go in solving these problems. Road transportation dominated by traditional fuel vehicles remained the main source of transportation emissions. It accounted for 61.3% of the total passenger transport volume and 73.9% of the total freight volume.

The adjustment of the transportation structure is an arduous long-term task, and multi-modal transport is an effective approach.

The adjustment of the transportation structure is an important way to reduce pollution and carbon in the transportation sector. At present, the "road-to-railway" and "road-to-waterway" freight flow diversion in China has made preliminary progress, but the dominance of road transportation has not been effectively reversed. Changes in the freight structure from 2017–2021 showed that the proportions of railway freight and waterway freight increased from 7.7% to 9.0% and 13.9% to 15.6%, respectively, while that of road freight decreased from 76.7% to 73.9%. One of the difficulties in further optimizing the transportation structure is still "road-to-railway" freight flow diversion. The growth target of "increasing railway freight volume by 1.1 billion tons in 2020 compared with 2017" in the "Three-Year Action Plan for the Structural Adjustment of Transportation" was narrowly met in 2021, while the growth target for waterway freight volume was overfulfilled ahead of schedule in 2019.

During the 14th Five-Year Plan period, the adjustment of the transportation structure faced new development direction and targets. China clearly proposed that by 2025, national railway and waterway freight volumes should increase by about 10% and 12%, respectively, compared with 2020, and the proportion of railway freight turnover should reach 17%. See Figures 27 and 28 for the current situation of railway and waterway freight volumes in China and the goals to be achieved during the 14th Five-Year Plan period.

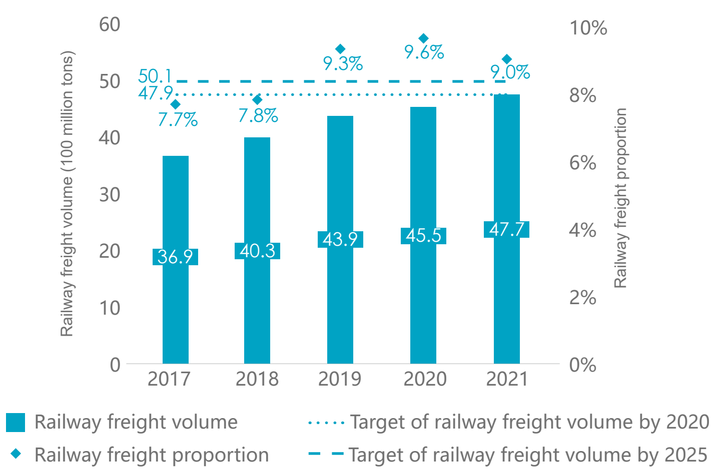


Figure 27: China's Railway Freight Volumes from 2017–2021 and Targets for the 14th Five-Year Plan Period

Railway construction is a key link in further promoting the "road-to-railway" freight flow diversion in bulk cargo and medium- and long-distance cargo transportation.

In 2021, China successively issued multiple policies clarifying that during the 14th Five-Year Plan period, it will speed up the construction of freight railways, special railway lines, and railways for collection and distribution ports. It will also carry out a special campaign for the construction of transportation structure adjustment demonstration zones to speed up the "road-to-railway" diversion process. On the one hand, the construction of special railway lines for major ports in the BTH region and its surrounding areas and the YRD region will be deepened, and the proportion of the green transportation of coal, ore, and coke will be improved in large industrial and mining enterprises. On the other hand, a demonstration zone for transportation structure adjustment in the major coal-producing regions of Inner Mongolia, Shaanxi, and Shanxi will be built, and the construction of freight railways and special railway lines will be accelerated in coal-producing areas and logistics parks, to raise the proportion of coal and coke railway transportation to around 80%, with a transportation distance of over 500 km transported out of provinces (regions) by 2025.

Based on incomplete statistics, Heilongjiang, Jiangxi, Qinghai, and Yunnan Provinces included the expansion and improvement of enterprise parks and the construction of special railway lines for collection and distribution ports into their own 14th Five-Year Plans. Gansu Province and Inner Mongolia Autonomous Region will focus on coal transportation,

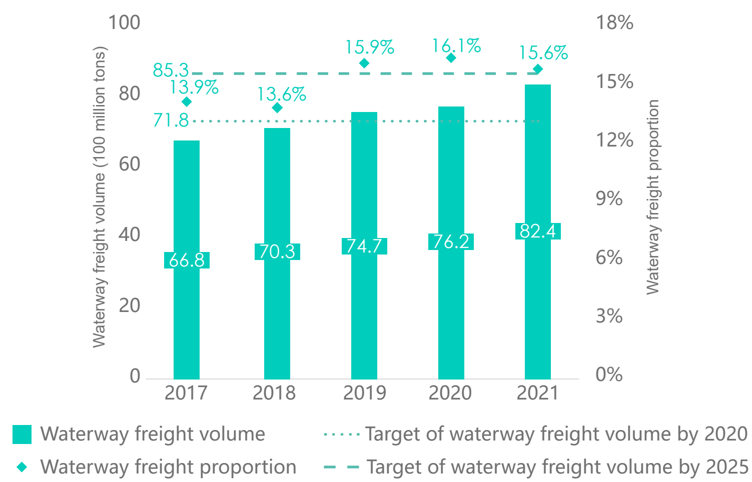


Figure 28: China's Waterway Freight Volumes from 2017–2021 and Targets of the 14th Five-Year Plan Period

promote railway electrification, and improve the through transport and transfer capabilities of north-to-south coal transportation and domestic coal transportation from Inner Mongolia. Public documents reveal that up to 166 key projects of special railway lines will be constructed from 2022–2023, covering 20 provinces (municipalities) across China.

Multi-Modal transport is an effective approach for transportation structure adjustment during the 14th Five-Year Plan period.

In 2021, the container volume of rail-water combined transport to and from ports reached 754 Twenty Feet Equivalent Unit (TEUs) in China. During the 14th Five-Year Plan period, China set the development targets for the level of multi-modal transport to significantly improve by 2025 and for the container volume of rail-water combined transport to increase by more than 15% annually. To this end, during this plan period, China will deal with the problem through various levels, such as the improvement of the carrying capacity and connection level of multi-modal transport, the innovation of the organization model, the accelerated adjustment of the transportation structure in key regions, and the accelerated upgrading of technical equipment, to advance the rapid and stable development of multi-modal transport (as shown in Table 3).

Table 3: Specific Measures in the "Work Plan for Advancing the Development of Multi-Modal Transport and Optimizing the Transport Structure (2021–2025)"

Development Aspect of Multi-Modal Transportation	Specific Measures
Improving the carrying capacity and connection level	Improving the backbone railways of multi-modal transport; speeding up the layout and construction of freight hubs; improving the collection, distribution, and transport systems of port areas and industrial parks
Innovating the organization model	Enriching service products; carrying out the construction of multi-modal transport demonstration projects and cultivating market entities; focusing on the connection between rail and sea transportation; promoting the integration of transportation service rules and further advancing the "one-order system" of multi-modal transport; strengthening the sharing of information resources among railway, port, shipping, and civil aviation enterprises
Accelerating the adjustment of the transportation structure in key regions	Boosting the "road-to-railway" and "road-to-waterway" diversion of bulk cargo in the key regions of transportation structure adjustment; pushing ahead with the green and low-carbon transition of transportation in the BTH region and its surrounding areas and the major coal-producing regions of Inner Mongolia, Shaanxi, and Shanxi; speeding up the development of rail-water and river-ocean combined transport in the YRD region and the Guangdong-Hong Kong-Macao Greater Bay Area
Accelerating the upgrading of technology and equipment	Promoting and applying standardized carrying units; enhancing the research, development, and application of technology and equipment; raising the environment-friendly level of technology and equipment

Electric vehicles are gaining momentum, further reducing pollution and carbon in the automotive sector.

In the past few years, China's electric vehicle (battery electric vehicle, hybrid electric vehicle, plug-in hybrid electric vehicle, and fuel cell vehicle) industry has been developing rapidly, boosting the reduction of pollution and carbon in the automotive sector. Since 2020, quantitative indicators have been put forward in multiple policies to promote electric vehicles, including that by 2025, the sales of new electric vehicles should take up about 20% of the total sales of new vehicles. By 2030, in the key regions for air pollution prevention and control, the sales of new electric vehicles should account for around 50% of the total, and vehicles using clean energy and new energy should account for about 40% of new vehicles (automobiles, ships, etc.).

In 2021, the electric vehicle market of China further expanded. According to data from the Ministry of Public Security, by the end of 2021, the electric

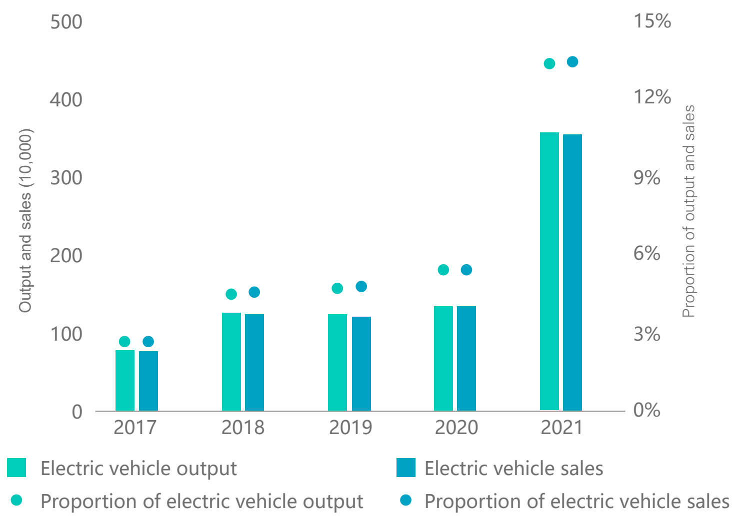


Figure 29: Changes in the National Output and Sales of Electric Vehicles and Their Proportions (2017–2021)

vehicle ownership nationwide reached 7.84 million, up by 59.4% year-on-year, accounting for 2.6% of total vehicle ownership (up by 0.85% year-on-year). According to public data from the China Association of Automobile Manufacturers, the output and sales of electric vehicles have changed dramatically in the last five years. In 2021, both the output and sales of electric vehicles increased by more than 1.5 times year-on-year, reaching 3.545 million and 3.521 million, respectively, with the market penetration rate exceeding 10%, up about 8% year-on-year, as shown in Figure 29.

In terms of 14th Five-Year Plans nationwide, 11 provinces (municipalities), including Beijing, Guangdong, Shanghai, Tianjin, and Zhejiang, specified their output, sales, and ownership targets for electric vehicles by 2025, as shown in Table 4. To speed up the promotion, application, and development of electric vehicles in China, a number of policies and measures were released at the national and local levels in 2021, targeting the expansion of application fields, the shifting of subsidy direction, infrastructure construction, and the promotion of hydrogen fuel cell vehicles (HFCVs).

Table 4: Targets for Electric Vehicle Promotion and Application in Some Provinces (Municipalities) by 2025

Planned Targets	Provinces/ Municipalities	Specific Targets
Electric vehicle output	Shanghai	1.2 million
	Guangdong	0.6 million
	Zhejiang	0.6 million
	Shaanxi	50%
	Hubei	20%
Electric vehicle sales	Tianjin	25%
	Fujian	20%
	Chongqing	20%
	Qinghai	20%
	Ningxia	15%
Electric vehicle ownership	Beijing	2 million

The application fields for electric vehicles expanded, and application scenarios, such as public transport and passenger and cargo transportation, were included in the key scopes for promotion.

In terms of electric vehicle promotion, policies at the national and local levels mainly focused on the application in the fields of urban buses, taxis, port and airport services, public institution vehicles, urban logistics distribution, postal express, and cold-chain transportation.

In 2021, China successively issued the “Guiding Opinions of the State Council on Accelerating the Establishment and Improvement of a Green and Low-Carbon Circular Development Economic System” and the “14th Five-Year Plan for Green Transportation,” explicitly putting forward speeding up the promotion of electric vehicles in the fields of urban buses, taxis, port and airport services, urban logistics distribution, and postal express and setting specific expected targets. One target is that by 2025, the proportion of electric vehicles nationwide in the fields of urban buses, taxis (including online car-hailing services), and urban logistics distribution should reach 72%, 35%, and 20%, respectively, and the proportion of new energy and clean energy container trucks at international container hub ports should reach 60% (see Figure 30). With respect to the field of cold-chain transportation, China also issued plans to encourage the adoption of electric models for new or upgraded refrigerated vehicles. Moreover, for the promotion of electric vehicles in public institutions, “in principle, the proportion of electric vehicles among new and upgraded vehicles should not be less than 30%, and electric vehicles should be equipped when they are used for confidential communications or law and duty enforcement and commute with relatively fixed routes.”

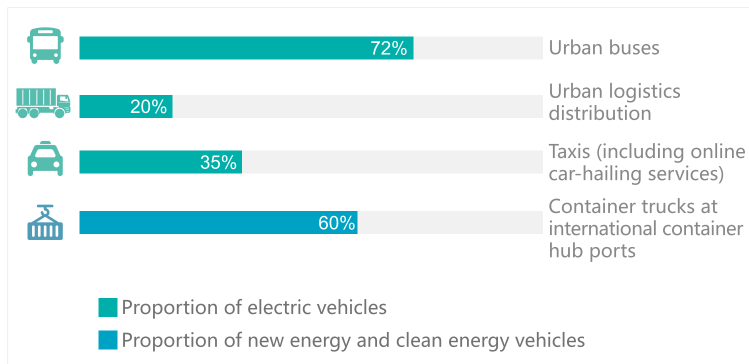


Figure 30: 2025 Targets for the Promotion of Electric Vehicles in Different Application Fields

At the local level, so far, at least 18 provinces (municipalities) have clearly defined their electric vehicle promotion targets in the fields of urban buses, taxis, logistics distribution, and municipal administration during the 14th Five-Year Plan period. In particular, in the field of public transport, Henan, Liaoning, and Shandong clearly required a complete transition to electric vehicles, as seen in Table 5.

Table 5: Targets for Electric Vehicle Promotion in Different Application Fields at the Local Level during the 14th Five-Year Plan Period

Application Fields	Regions	Proportion Target for Replacement with Electric Vehicles
Urban Buses	Henan, Liaoning, and Shandong	100%
	Hebei	90%
	Anhui, Inner Mongolia, and Jiangsu	80%
	Heilongjiang, Jiangxi, and Yunnan	72%
	Ningxia	45%
Taxis	Liaoning and Henan	100%
	Hebei and Shandong	80%
	Yunnan	35%
Light Logistics Distribution Vehicles	Liaoning	100%
Municipal Vehicles	Ningxia	100%

Subsidies were transferred from purchase links to operation, charging, and other links to improve the application environment for electric vehicles.

In 2021, subsidies for the purchase of electric vehicles continued to decline systematically. While the technical indicators and thresholds of purchase subsidies remained unchanged, the subsidy amount declined by 20% in 2021 compared with 2020. For the key promotion fields of electric vehicles, the subsidies decreased by 10%. In December 2021, China released the financial subsidy policy for the promotion and application of electric vehicles in 2022, cutting down the subsidy by 30% compared to the 2021 standard. For the key promotion fields of electric vehicles, there will be a slight 20% decline in subsidies. There is also clear policy that purchase subsidies for electric vehicles will be terminated by the end of 2022.

Given this context, China provided continuous incentives for the promotion of electric vehicles and increased subsidies and tax incentives for the use. Specifically, for one, relevant subsidy policies were shifted from the purchase link to the use link of vehicles, such as by providing charging fee subsidies for electric vehicles, operation subsidies for buses and logistics distribution, preferential parking fees at commercial parking lots, hydrogen price subsidies, and construction and operation rewards and subsidies for hydrogen-fueling or charging facilities, and guiding operating enterprises to appropriately reduce charging service fees. The goals are to alleviate the overall impact of the decrease in purchase subsidy by reducing the use cost of electric vehicles and promote the further expansion of the electric vehicle market. For another, China will also support the consumption of electric vehicles by putting an exemption on purchase tax and providing corporate incentives. Seventeen departments, including the Ministry of Commerce, issued the “Measures to Invigorate Automobile Circulation and Boost Auto Consumption,” showing that they will study the extension of the purchase tax exemption policy for electric vehicles after it expires and guide enterprises in scaling up promotion activities to stimulate the consumption and use of electric vehicles in rural areas.

The construction of battery charging and swapping infrastructures was strengthened, and the network layout was improved to support the promotion of battery electric vehicles in the use link.

At present, more battery charging and swapping infrastructures in China need to be constructed, and existing ones need to be improved to ensure that their development keeps up with the promotion of electric vehicles. According to the data published by the China Electric Vehicle Charging Infrastructure Promotion Alliance, by the end of 2021, there were 2.617 million charging facilities in China, including 1.147 million public charging piles, with a vehicle-to-pile ratio of 3:1. In terms of the construction of battery swapping stations, there are only 1,298 battery swapping stations at present, with a ratio of the ownership of swapping vehicles to the number of battery swapping stations of 193:1.

Since 2021, multiple policies and plans have been released specifying the construction targets for charging and swapping infrastructures during the 14th Five-Year Plan period. Several departments, including the NDRC, proposed that by the end of the plan period, charging infrastructures should meet the charging demand of more than 20 million electric vehicles. The "14th Five-Year Plan for National Urban Infrastructure Construction" also clearly puts forward that in the next five years, more than 600 battery charging and swapping stations and a total of 1.5 million public charging facilities for electric vehicles will be built across China.

To smoothly achieve its construction targets, China started with the network layout of charging and swapping facilities to accelerate relevant infrastructure construction. Relevant policy documents were put forward proposing to actively support the construction of charging facilities in residential communities, parking lots, gas stations, expressway service areas, and passenger and cargo transportation hubs. For battery-swapping vehicles, swapping stations had been laid out according to local conditions, with support for the development of innovative swapping models. Meanwhile, the establishment of unified battery-swapping standards was promoted in the main application fields to enhance the safety, reliability, and economic efficiency of swapping models. In addition, the "Work Plan on Energy and Resource Conservation among Public Institutions during the 14th Five-Year Plan Period" explicitly requires public institutions to lead demonstration efforts, increase the number of special parking stalls and charging infrastructures for electric vehicles, and encourage public access to internal charging infrastructures.

The promotion and application of HFCVs are strengthened to complement the development strategy for battery electric vehicles.

The promotion of HFCVs is still in its infancy. The "Development Plan for the New Energy Vehicle Industry (2021–2035)" puts forward the promotion targets for HFCVs, stating that by 2025, the commercial application of HFCVs should be realized, the ownership of HFCVs should reach 50,000, and the establishment of the hydrogen fuel supply system should be steadily promoted. As revealed by data from the China Association of Automobile Manufacturers, in 2021, both the output and sales of fuel cell vehicles in China reached 2,000, up by 48.7% and 35.0%, respectively.

Currently, HFCVs are mainly demonstrated and promoted in key regions and fields. In September and December 2021, China approved two application batches for the "Fuel Cell Vehicle Demonstration Zone" after issuing the "Notice on Launching Fuel Cell Vehicle Demonstration Projects," forming five demonstration city clusters in the BTH region, Guangdong, Hebei, Henan, and Shanghai. By the end of 2021, the three demonstration city clusters in Beijing, Shanghai, and Guangdong had been launched one after another. In the four-year demonstration period, more than 20,000 fuel cell vehicles are planned to be promoted, and more than 306 hydrogen-fueling stations established, covering more than 18 application scenarios, including ore and steel transportation and vehicle logistics. The "Medium- and Long-term Plan for the Development of the Hydrogen Energy Industry (2021–2035)" also specifies that during the 14th Five-Year Plan period, China will carry out the innovative application and demonstration of the hydrogen energy industry in the transportation sector and explore the demonstration and application of hydrogen fuel cell trucking in fields with high operating intensity and fixed routes, such as mining areas, ports, and industrial parks.

Relevant supporting policies should be provided for demonstration zones to facilitate the promotion and demonstration application of HFCVs. For example, Beijing has established a policy support system for the links of key technology research and development, industry chain construction, and full-scenario demonstration application. Shanghai has provided policy support in six aspects, including vehicle purchase incentives, key component incentives, vehicle operation incentives, bus operation support, construction subsidies for hydrogen-fueling stations, and hydrogen retail price subsidies.

All-around supervision was further intensified to boost "the reduction of pollution and carbon" in in-use vehicles.

By the end of 2021, the ownership of vehicles in China reached 302 million, of which electric vehicles only accounted for 2.6%, and oil was still the main fuel for in-use vehicles. Therefore, it is essential to continuously advance the reduction of pollution and emissions from in-use vehicles. In 2021, China continued to strengthen the "vehicle-fuel-road" integrated regulatory system; supervise the emissions from in-use vehicles by means of the inspection and maintenance (I/M) system, On-Board Diagnostics (OBD) remote emission management, and environmental supervision and sampling test; promote the elimination or traffic restriction of high-emission vehicles; and enhance whole-chain fuel quality supervision.

The I/M system was continuously improved, and the regulation on I/M institutions was upgraded.

Strengthening regulation on the Inspection Station and Maintenance Station is the fundamental guarantee for the vehicle emission I/M system to effectively play its role. To regulate the Inspection Station, the "Specification for the Periodic Emissions Inspection of Motor Vehicles (HJ 1237-2021)" (hereinafter referred to as the Specification) was issued in December 2021, further improving the strictness, standardization, and authenticity of the test for the Inspection Station. The Specification mainly puts forward the requirements on the whole-process video monitoring of the inspection and archiving of vehicles tested. The whole-process video monitoring of inspection can prevent inspection institutions from fraud, illegal operations, and so on, while the archiving of vehicles tested aims to promote the inspection of vehicles according to their operating mode and ensure that the same test method is adopted for the same vehicle or vehicles of the same model.

Some provinces and municipalities adopted video monitoring for the Maintenance Station and ensured that regulatory departments could have access to the real-time video remotely for them to review the video records within a year and reduce or eliminate fraud in exhaust control, the illegal issuance of "exhaust control certificates," and other misconducts.

The coverage of OBD remote emission management was further expanded, and the real-time monitoring of in-use vehicle emissions was strengthened.

In 2021, many provinces and cities continued to install OBD vehicle-mounted terminals in diesel trucks with networking functions. The current CHINA VI Emission Standards (GB17691-2018) clearly prescribe that diesel-fueled heavy-duty vehicles (CHINA VI) must be installed with OBD vehicle-mounted terminals at the VI a stage. At the VI b stage, it is mandatory for all heavy-duty vehicles to remain connected online during their entire life span to send data to the departments of ecology and environment and to production enterprises. Public information shows that various cities in Henan Province, Beijing, Chengdu, Taiyuan, and other cities have persistently promoted the installation and networking of OBD in vehicles (CHINA V), and Beijing even advanced its implementation through fines and the disapproval of inspection passes.

The remote monitoring of heavy-duty vehicle emissions can monitor the vehicle emission status in real time and urges vehicles exceeding emission standards to undergo timely maintenance. It is an important means of in-use vehicle supervision. In 2021, some provinces, such as Guizhou and Zhejiang, proposed a convenient measure for heavy-duty vehicles with vehicle-mounted terminal networking to become "exempt from emission inspection." Ningbo will no longer conduct exhaust emission inspections on diesel-fueled heavy-duty vehicles that meet the necessary conditions, including proper network connectivity and participation in regular local inspections.

Restrictions on vehicles with emissions exceeding the CHINA V Emission Standards were tightened, and China has entered a new ear of CHINA VI.

The optimization of the vehicle fleet structure is one of the key measures in reducing the pollution and emissions of diesel trucks. So far, all diesel-fueled vehicles in China have met the China VI Emission Standards, and certain policies, such as vehicle phaseout and traffic restrictions, will be gradually implemented for vehicles with emissions exceeding the CHINA V Emission Standards.

Vehicles with emissions exceeding the CHINA III Emission Standards will be phased out during the 14^{th} Five-Year Plan period. During the period of the Blue Sky Defense Battle (2018–2020), more than 900,000 diesel-fueled heavy-duty trucks with emissions exceeding the CHINA III Emission Standards were eliminated in the BTH region and its surrounding areas and in the Fenwei Plain. Many policies in 2021 expressly proposed that "vehicles with emissions exceeding the CHINA III Emission Standards should be phased out across the country during the 14^{th} Five-Year Plan period." At present, the elimination policies for outdated vehicles at the local level mainly focus on two aspects: subsidies and traffic restrictions. Regarding subsidies, many provinces and municipalities such as Beijing, Jiangsu, and Shandong, provide elimination subsidies for outdated diesel trucks amounting up to RMB39,600. In terms of traffic restrictions, Yancheng City of Jiangsu requires vehicles failing to pass the safety or environmental inspection to not be issued road transport certificates or to go through the annual examination procedures to receive these certificates. Tianjin requires that eliminated vehicles should not pass the examination for environmental permits or be transferred into the city.

CHINA IV vehicles have been included in the phaseout scope, and many local governments have expanded the traffic restriction areas. Shandong, as a major freight carrier in China and a key region in the Blue Sky Defense Battle, proposed to systematically advance the phaseout of operating heavy-duty trucks meeting the CHINA IV Emission Standards. However, the current means of control over CHINA IV diesel trucks in most regions still focuses on expanding traffic restriction areas. For instance, Beijing prohibits the entry of China IV diesel-fueled trucks from other provinces by not issuing them Beijing Entry Permits. Taiyuan of Shanxi, Bozhou of Anhui, Jinzhou of Liaoning, and Jining of Shandong have demarcated traffic restriction areas in their respective jurisdictions to prohibit CHINA IV diesel trucks from running during restricted periods and in forbidden areas.

CHINA V vehicles are "blacklisted" by some plant areas and regions. Many iron and steel enterprises in Tianjin City and Hebei, Henan, Fujian, Shaanxi, and Shandong Provinces have issued notices banning transport vehicles with emissions exceeding the CHINA V Emission Standards from entering their plant areas starting January 1, 2022. Taking Tianjin as an example, before the end of December 2021, the proportion of the transportation of raw materials and products in the iron and steel (including coking) industry using trucks exceeding the CHINA V Emission Standards was set to be less than 10% throughout the city. Apart from the prohibition of CHINA V vehicles in plant areas, some regions have also demarcated restricted zones within their urban areas. In November 2021, Shijiazhuang of Hebei issued a notice banning heavy-duty trucks exceeding the CHINA V Emission Standards from running in its main urban areas and setting a detour for those passing through from other cities.

With the full implementation of the CHINA VI Vehicle Emission Standards, Beijing remained "ahead of the game" in upgrading vehicle and fuel standards. According to GB17691-2018, since July 1, 2021, all heavy-duty vehicles with the greatest emission reduction burden have met the CHINA VI Emission Standards and will start to enter VI b stage in 2023. However, Beijing has required all diesel-fueled heavy-duty vehicles sold and registered to meet the requirements of Ⅵ b stage since as early as 2020. In the second year after the implementation of Ⅵ b requirements, Beijing issued the "Beijing 6b" standards for vehicle gasoline and diesel, which came into effect in December of the same year. According to the actual vehicle test data of the China Automotive Technology and Research Center, compared with vehicles using fuel meeting the "Beijing 6" standards, those using "Beijing 6b" diesel is expected to reduce PM and NOx emissions by 20% and 10%, respectively, which will play an important role in the coordinated emission reduction of $PM_{2.5}$ and O_3.

"Clean Fuel Action" was carried out continuously, and whole-chain fuel quality supervision was enhanced.

In 2021, fuel quality supervision continued to be carried out across China, covering the whole chain from production to sales and then to use. In July 2021, Shandong Department of Ecology and Environment and other four departments of Shandong Province jointly issued the "Notice on Establishing the Fuel Quality Traceability Mechanism for In-Use Vehicles" to severely crack down on the illegal production, operation, transportation, and storage of substandard fuel oil and other illegal activities. In November of the same year, Henan launched the "special regulation campaign on the refined oil market." To achieve the objectives of the dynamic elimination of unlicensed gas stations and keep the qualified rate of fuel steadily over 95% according to CHINA VI standards, Henan severely cracked down on various tax evasion activities in refined oil circulation, unlicensed gas stations (sites), mobile unlicensed refueling trucks, and the sales of fuel not meeting the national quality standards for automotive fuel. In addition, according to public information, in Zhengzhou and Qingyuan, the personnel involved in unlicensed gas stations (sites) are subject to criminal detention.

Multiple measures were simultaneously taken to continuously strengthen the control over non-road mobile sources.

Non-road mobile sources cannot be ignored in the reduction of emissions from mobile sources in China. In 2020, NOx and PM emissions from non-road mobile sources accounted for 43.3% and 77.7% of total mobile source emissions in China, respectively. In view of the wide variety and high mobility of non-road mobile sources, the standards for newly produced machinery and ships and the supervision of in-use machinery and ships were continuously tightened at the local level in 2021. In addition, a number of policy documents were issued in 2021 to promote synergy in the reduction of pollution and carbon from non-road mobile sources. The first deals with "energy transition," which clearly proposes the development and exploration of ships using new or clean energy, such as electric power, hydrogen fuel, and methanol, and prioritizes the use of new and clean energy for new and replaced port operating machinery to spur the low-carbon transformation of transportation equipment.

The next stage for emission standards was implemented, and control over newly produced non-road mobile machinery and ships was tightened.

For non-road mobile machinery, the Stage-IV emission standards (hereinafter referred to as the CHINA IV Standards), namely the "Amended Scheme for Limits and Measurement Methods for Exhaust Pollutants from the Diesel Engines of Non-Road Mobile Machinery (CHINA III, IV)" (GB 20891-2014), are scheduled to be implemented beginning December 1, 2022. The CHINA IV Standards are applicable to non-road mobile machinery with 560 kW capacity and below produced, imported, and sold in China. Multiple new requirements have been added, such as a whole engine test using the Portable Emissions Measurement System method, particle number (PN) limits, remote monitoring and positioning, etc., which are helpful in controlling the emission of whole engines and effectively regulating the normal operations of emission control systems. Several cities, including Beijing and Shenzhen, have implemented or plan to implement the CHINA IV Standards for non-road mobile machinery in advance.

For ships, the Stage-II standards, namely the “Limits and Measurement Methods for Exhaust Pollutants from Marine Engines (CHINA I, II)” (GB 15097-2016), have been officially put into effect on July 1, 2021. Compared with Stage I, Stage II standards require a further decrease of PM and NOx emissions by 40% and 20%, respectively, which will contribute to the improvement of air quality in cities along rivers and coasts and at ports. These standards apply to Class-1 and Class-2 marine engines with a rated net power greater than 37 kW installed on ships sailing or operating in China. Engines with a rated net power of less than 37 kW should comply with the emission limit standards for non-road mobile machinery.

The low-emission zone policy was advanced, and the regulation of non-road mobile sources was facilitated by science and technology.

In addition to the tightening of emission standards for newly produced machinery and ships to reduce emissions at the source, the supervision of in-use non-road mobile machinery and ships was also persistently strengthened, mainly including control over low-emission zones; the elimination, upgrading, and retrofitting of in-use machinery; and all-round regulation.

The designation of low-emission zones was the primary measure for restricting the use of high-emission machinery. In 2021, various local governments implemented stricter emission control over low-emission zones by newly demarcating or expanding the scope of each zone, increasing the types of machinery covered, and raising standards and requirements, as listed in Table 6.

Promoting the elimination and upgrading of high-emission in-use machinery is also a key link in pollution and carbon reduction. According to the “2021–2022 Autumn and Winter Action Plan for Air Pollution Management,” ports, mines, and large industrial enterprises are priority sectors. The introduction of policies on the elimination and upgrading of non-road mobile machinery with emissions exceeding the CHINA I Emission Standards (or with over 15 service years) is encouraged. Some provinces and municipalities have begun to explore the retrofitting scheme for in-use outdated machinery. For example, Handan of Hebei and Jiaozhou of Shandong have promoted the retrofitting of machinery falling below the CHINA III Emission Standards and those meeting CHINA I Emission Standards and lower to be upgraded to meet the CHINA III Emission Standards.

Science and technology have played an important role in regulating non-road mobile sources. In 2021, local governments stepped up efforts to

Table 6: Progress in the Control of Low-Emission Zones in Some Cities in 2021

City	Policy Documents	Implementation Date	Control Measures	Control Basis
Chengdu	"Circular from the Chengdu Municipal People's Government on the Demarcation of Areas Prohibiting High–Emission Non–Road Mobile Machinery"	Jun. 24, 2021	Raising limit standards	Not meeting Stage–III standards in GB20891–2014
Beijing	"Circular from the Beijing Municipal People's Government on the Demarcation of Areas Prohibiting High–Emission Non–Road Mobile Machinery" (JZF [2021] No. 16)	Dec. 1, 2021	Expanding the areas Increasing the types of machinery	Not meeting the Class–III limit standards for exhaust smoke in GB36886–2018
Wuhan	"Circular from the Wuhan Municipal People's Government on the Demarcation of Areas Prohibiting High–Emission Non–Road Mobile Machinery" (WZG [2021] No. 15)	Dec. 1, 2021	Demarcating new emission control areas	Core prohibited areas: not meeting the Class–III limit standards for exhaust smoke in GB36886–2018
Hangzhou	"Circular from the Hangzhou Municipal People's Government on Adjusting Areas Prohibiting High–Emission Non–Road Mobile Machinery" (HZH [2021] No. 74)	Jan. 1, 2022	Expanding the areas	Not meeting the Class–III limit standards for exhaust smoke in GB36886–2018
Shenyang	"Circular on Adjusting the Low–Emission Areas for Motor Vehicles and Non–Road Mobile Machinery"	Jan. 1, 2022	Expanding the areas	Not meeting the Class–III limit standards for exhaust smoke in GB36886–2018
Tianjin	"Work Plan for Adjusting the Areas Prohibiting High–Emission Non–Road Mobile Machinery (Exposure Draft)"	Scheduled for the second half of 2022	Expanding the areas Increasing the types of machinery	Class–I prohibited areas: not meeting the Stage–III standards in GB20891–2014 and the Class–III limit standards for exhaust smoke in GB36886–2018

improve relevant policies and fully implemented the code registration system for non-road mobile machinery. To enhance the accurate supervision of in-use machinery, many local governments combined multiple scientific and technological means, such as electronic tagging, electronic fences, remote emission management platforms, etc.

In terms of controlling the sulfur content of ships fuel, the quick monitoring equipment for sulfur content of fuel has become the standard equipment of the maritime sector. Maritime departments in Shanghai, Shenzhen, and Tianjin have adopted telemetry technologies, such as unmanned aerial vehicles detection, small air stations, shipborne detection stations, and shore-based detection, to monitor ship exhaust emissions in real time and establish an integrated “at sea, on land, and in air” regulatory system, thus supporting the implementation of emission control areas.

The energy transition of docked ships was accelerated, while the use of shore power still needs to be strengthened.

In 2021, both national and local policies encouraged the use of new energy and clean energy for non-road mobile machinery and ships and promoted the regular use of shore power for ships. Ports not only serve as key places for the use of non-road mobile machinery but also provide “charging stations” to boost the emission reduction of docked ships. It is a key field for the emission reduction of non-road mobile sources.

Regarding energy replacement for port machinery, some ports have achieved certain results in the past few years. For instance, new energy and clean energy machinery adopted by Xiamen Port and Zhanjiang Port have accounted for more than 50% of total machinery of two ports. During the 14^{th} Five-Year Plan period, policies will continue to “give priority to new and clean energy in the addition and replacement of port operating machinery.” Shenzhen has specified completing the clean energy replacement of non-road mobile machinery at ports by 2025.

Regarding the use of shore power for ships, policies on its construction, use, and supervision in the Yangtze River Economic Belt are relatively complete. In 2021, the “Regulations of Shore Power for Ports and Vessels” were revised, prescribing penalties for ships berthing at ports in the Yangtze River Basin that failed to use shore power according to regulations. In addition, relevant policies set clear annual targets and implementing plans for the retrofitting of ship power-receiving facilities, the shore power utilization rate of docked ships, and the construction of shore power facilities at ports along the inland rivers in the Yangtze River Economic Belt. By the end of 2021, in the Yangtze River Economic Belt, 5,391 ships had completed the retrofitting of shore power-receiving facilities, 11 provinces and municipalities had added shore power facilities that covered 1,601 berths, and ships had used shore power for more than 499,000 times, 5.535 million hours, and 65.7 million kWh, reducing CO_2 emissions by about 50,000 tons (Figure 31). Incentive measures and the supervision of shore power in the Yangtze River Basin were further strengthened, such as through lockage priority and penalties on those failing to use shore power as required.

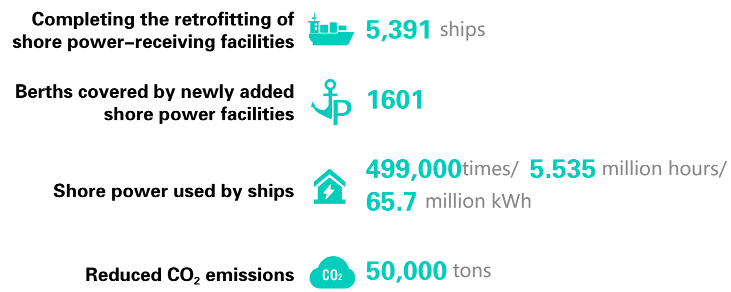


Figure 31: Shore Power Progress in the Yangtze River Economic Belt in 2021

Promoting the use of shore power for ocean-going vessels is more challenging. In 2020, the utilization rate of shore power at Shenzhen Port and Lianyungang Port was relatively low at 3.8% and 11.0%, respectively. These outcomes were related to the low configuration rate of power-receiving facilities on vessels and incomplete supporting supervision and incentive policies for the use of shore power. Shenzhen took the lead in putting forward the target for the “shore power utilization rate of ocean-going vessels.” It planned to strive to achieve an over 10% shore power utilization rate for docked ocean-going vessels by 2025 and provided incentive measures, such as preferential electricity prices and lower facility testing and maintenance fees.

In terms of energy replacement for ships, China made a breakthrough in multi-scenario green marine application in 2021. Yachts and cruise ships powered by hydrogen fuel cells, electric container ships for inland rivers, and electric tugboats successively achieved trial voyages or official launch operations in 2021.

Area Sources

In 2021, the clean heating rate in Northern China continued to increase, the number of pilot cities for clean heating grew constantly, and loose coal control and clean heating in rural areas remained key tough issues. Given the context of energy structure adjustment and the "Dual Carbon" goals, renewable energy is expected to enter more rural areas and help rural heating in an optimized combination. Strict control over straw burning was adopted in key regions, and more provinces implemented full-area straw burning prohibition and continued to advance the comprehensive utilization of straw. The refined management of urban fugitive dust was further enhanced.

There is huge room for heating with renewable energy in rural areas, and more attention was paid to the control of agricultural coal use.

In 2021, the last year of the implementation of the "Plan for Clean Heating in Winter in Northern China (2017–2021)," the "70% clean heating rate and replacement of loose coal by 150 million tons" goals were achieved as planned. The clean heating rate reached 73.6%, and the region accumulatively replaced more than 150 million tons of loose coal and covered 15.6 billion m2 of clean heating area.

The number of pilot cities for clean heating in winter funded by the central government continued to increase, and 20 cities in 14 provinces (autonomous regions) were included in the fourth batch of pilot cities for clean heating. In contrast to the previous pilot cities, which are from the key regions for air pollution prevention and control, more than 10 cities from the recent batch are from non-key regions in the northwest and northeast of China. Together with the 43 cities included in the pilot program from 2017–2019, the total number of pilot cities funded by the central government reached 63.

After years of continuously being promoted, clean heating in the north has gradually entered the tough phase. Before the heating season in 2020, a total of 7.09 million households in Hebei, Henan, Shaanxi, Shanxi, and Shandong finished the replacement of loose coal, but before the heating season in 2021, the number of such households decreased to 3.48 million. In 2021, the number of households finishing loose coal replacement in provinces in the key regions decreased significantly compared with 2020 (Figure 32), indicating that as the replacement of loose coal advanced, the number of residents who met retrofitting conditions shrunk. The remaining residents who had yet to apply retrofitting were mainly from rural areas. Several factors restrict the expansion and promotion of clean heating, such as the poor insulation performance of houses, weak infrastructure, and difficulty in changing the traditional energy use habits of villagers. Clean heating work in rural areas still needs to overcome these practical obstacles.

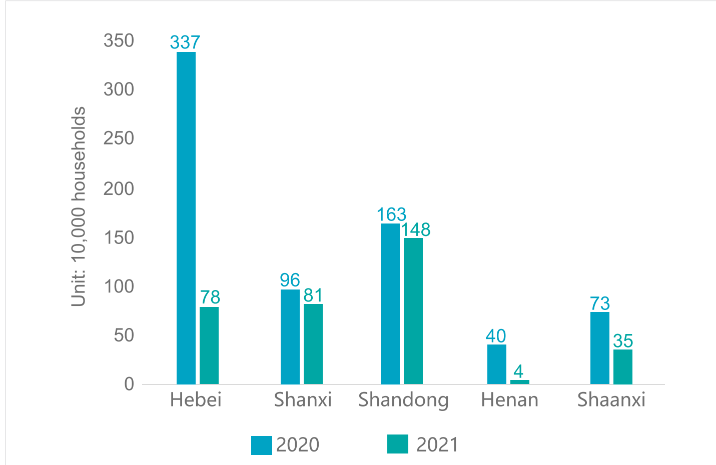


Figure 32: The Number of Households Finishing Loose Coal Replacement before Heating Seasons in 2020 and 2021

To meet the "Dual Carbon" goals, clean heating in rural areas should not only consider attaining "cleanliness" but also pay attention to achieving "low carbon" levels. In December 2021, three ministries and commissions, including the NEA, specified that further efforts should be made in carrying out clean energy replacement in rural heating and vigorously promoted heating with solar and wind energy. In rural areas of the key regions for air pollution prevention and control, centralized heating, such as "wind/PV + regenerative electric boiler," was implemented throughout counties. More renewable energy has entered rural areas and made rural heating energy cleaner, with less carbon emissions, which is of great significance in improving the rural environment and expanding the space for clean energy consumption.

In addition, based on the "Action Plans for Integrated Air Pollution Prevention and Control in Autumn and Winter (2021–2022)" published by local authorities at all levels, much more attention has been paid to the control of agricultural coal use. A total of 28 cities in Shanxi, Shandong, Henan, and Shaanxi included the control of agricultural coal use in the list of control measures for the first time and replaced with clean energy or even banned the hot blast stoves in agricultural greenhouses and the coal-fired drying kilns for grains, tobacco, and edible fungi.

The comprehensive utilization rate of straw steadily increased, and straw burning prohibition in key regions achieved remarkable results.

In 2021, the comprehensive utilization rate of crop straw in China steadily increased to 88.1%, up by 3.4% from 2018. The amount of straw being returned to the field reached 400 million tons. The efficiency of off-field straw utilization was continuously improved, and the amount of straw utilization as feed, fuel, substrate, and raw material exceeded 200 million tons. In the "14th Five-Year Plan on the Comprehensive Work for Energy Conservation and Emission Reduction," the State Council put forward the goal of stabilizing the comprehensive utilization rate of straw to over 86% by 2025 and planned to continuously consolidate the comprehensive utilization of straw in the next few years.

The "Action Plan for Integrated Air Pollution Prevention and Control in Autumn and Winter (2021–2022)" issued by the MEE specifies the tasks and targets for intensifying the control over straw burning prohibition. It highlights the efforts to boost the comprehensive utilization of straw, aims to improve the regulatory system through scientific and technological means, and strives to strengthen the control and guidance over straw burning prohibition in Northeast China.

According to statistical data from previous years, the straw burning spots in China are mainly distributed in Northeast China and the North China Plain with large grain planting areas, making them the key control regions. In 2021, many local governments in the key control regions took such measures as prohibiting full-area straw burning and strengthening the regulatory system, achieving notable results in controlling fire spots. Among them, Heilongjiang Province was able to implement the prohibition of full-area straw burning for three consecutive years. During the prohibition period of 2020–2021, only two open straw burning spots were found, down by 97.6% from 85 spots during the same period in 2018–2019. Jilin Province implemented full-area straw burning prohibition for the first time in the autumn of 2021 and established a straw disposal ledger covering the whole province. Meanwhile, local authorities at all levels across the province established and improved the disposal system and the quick response mechanism for open straw burning spots, improved the multi-level grid regulatory system, and carried out stationed assistance during key periods. In 2021, the number of straw burning spots in Jilin decreased by 74% year-on-year, and the number of heavy pollution days during the peak period of straw burning was reduced by 87.5%. Liaoning Province included straw burning control in the key tasks of the "100-Day Campaign," established a list of responsibilities for straw burning for local authorities at all levels, monitored spots by adopting satellite remote sensing technology, organized law enforcement and supervision forces from other regions to carry out inspections, and enhanced the work scheduling of straw burning prevention and control and the regular reporting of assessment work.

The refined management of urban fugitive dust was further enhanced.

The "Action Plan for Integrated Air Pollution Prevention and Control in Autumn and Winter (2021–2022)" issued by the MEE and the "Opinions on Further Fighting the Tough Battle of Pollution Prevention and Control" issued by the CPC Central Committee and the State Council both clearly propose to strengthen the comprehensive control of fugitive dust, including such tasks as refining the control requirements for dustfall amount; strengthening refined control over construction dust; enhancing road dust control; and carrying out the identification, filing, and control of bare construction land. Some typical municipalities, such as Beijing and Chongqing, also improved the level of fugitive dust management by integrating scientific and technological methods with administrative measures.

In 2021, Beijing further advanced the refined treatment of fugitive dust, built a centralized visual and smart video monitoring platform for fugitive dust, and dynamically achieved 100% connectivity of video monitoring devices. Data sharing and interconnection among departments were achieved by connecting the site video monitoring signals of urban management, water affairs, landscaping, transportation, and other departments to the platform. A total of 123 "Green Card" construction sites of fugitive dust control were evaluated, more than 2,400 construction sites (stations) were installed with video monitoring devices for fugitive dust, and mechanical cleaning was provided for 2,058 backstreets and alleys. The dustfall amount citywide was reduced to 4.1 tons/km2 · month (excluding the impact of dust storms), down by nearly 20% year-on-year. Meanwhile, Beijing also utilized high-resolution satellites to dynamically identify the situation of uncontrolled bare land across the city to assist in the refined management of fugitive dust in bare land. In addition, local authorities persistently carried out the monitoring and assessment of dust load on the roads in plain areas and those on both sides of the exits of construction sites (stations) and strengthened cleaning for various roads in a targeted way to improve urban cleanliness.

Chongqing has been implementing the "Control Standard for Fugitive Dust from Construction sites" since October 2021. The city established and consolidated 430 demonstration sites and 430 demonstration roads for fugitive dust control. A special law enforcement campaign for fugitive dust pollution prevention and control were organized at construction sites and on roads nearby. More than 8,700 (times) construction sites were inspected, and more than 20,000 construction waste trucks were investigated and fined. More urban road flushing and cleaning were conducted, with the mechanical sweeping rate of main roads remaining over 90%.

Supporting Measures

In 2021, the MEE focused on building a top-level design to lay the foundation for relevant ecological and environmental protection planning and reform during the 14th Five-Year Plan period. It continued to offer assistance in supervising air control improvement in key regions, optimize law enforcement methods for the ecological environment, and promote differentiated law enforcement and regulation. In terms of economic means, the use and management of funds at the state level for air pollution prevention and control were strengthened. Green finance was vigorously developed, and its evaluation was carried out.

Administrative Measures

The implementation scope of the action plan in the key regions in autumn and winter was adjusted, and supervision and assistance on air quality improvement were continuously advanced.

In 2021, China continued to carry out the integrated control of air pollution in the key regions in autumn and winter. The “2021–2022 Action Plan for Integrated Air Pollution Prevention and Control in Autumn and Winter” jointly issued by 10 ministries and commissions, including the MEE, and seven cities and provinces continued the primary goals of reducing heavy pollution episodes and $PM_{2.5}$ concentration set in previous years. Additionally, the geographical scope of the action plan implementation was adjusted. Firstly, after the elimination of heavy pollution weather in the YRD region, only seven cities in the region need to continue to comply with the action plan. Second, in view of the impact of atmospheric conditions and regional transmission in autumn and winter, besides the BTH region and its surrounding areas and the Fenwei Plain, some cities in northern Hebei, northern Shanxi, eastern and southern Shandong, and southern Henan were added . See Figure 33 for the changes in the scope of regions.

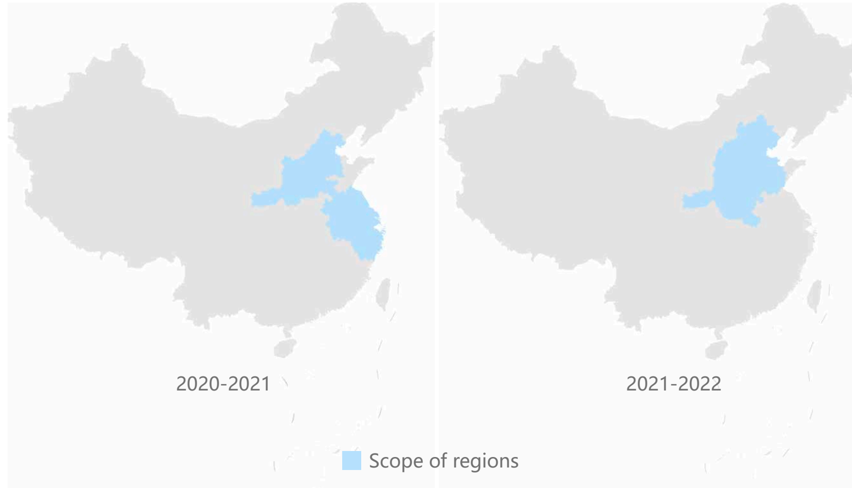


Figure 33: Changes in the Scope of Regions in the Action Plan for Integrated Air Pollution Prevention and Control in Autumn and Winter

In May, the MEE launched the supervision and assistance work on air quality improvement in the key regions, optimized supervision and assistance methods, and implemented a new mechanism combining specialized supervision and regular assistance. Specialized supervision focused on key industries, parks, clusters, and enterprises, while regular assistance was for key cities facing high pressure in terms of air quality improvement. Regular assistance involved helping key cities check common problems and conduct the regular identification of prominent air quality management problems and providing assistance in the rectification of problems found through specialized supervision. Under the new mechanism, the number of personnel dispatched for supervision and assistance was cut by 60% and working hours by 50%, but the number of prominent problems found quadrupled compared with 2020. By the end of the year, more than 9,000 enterprises had been inspected on site, with more than 14,000 problems related to air pollutant emissions identified.

The regulation of differentiated law enforcement was promoted, and unnecessary on-site law enforcement inspections were reduced.

In 2021, the MEE further optimized law enforcement methods, deepened the implementation of the positive list system for supervision and law enforcement, and included some qualified law-abiding model enterprises in the positive list. In principle, on-site surveys and guidance are not proactively carried out on enterprises in the positive list. If these companies are included in the scope of various specialized environmental protection campaigns or inspections organized by local departments of ecology and environment, the law enforcement inspections are mainly carried out off-site. Throughout the year, more than 31,000 enterprises were included in the positive list of supervision and law enforcement, and more than 71,000 off-site inspections were conducted across the country.

This system is a form of differentiated management measure of the departments of ecology and environment in enforcing law on enterprises, and it promotes the replacement of on-site law enforcement inspection with the off-site method. Implementing this system can increase the proportion of off-site law enforcement inspections on enterprises and the proportion of illegal environmental problems found through that method, cut the number of unnecessary on-site law enforcement inspections, and reduce interference with the normal production and business activities of enterprises. It explores and innovates law enforcement ideas and methods.

A holistic approach was taken to further advance the reform of "power delegation, administration streamlining, and service improvement" for environmental impact assessment (EIA).

In the second half of 2021, China's economic development was under pressure from many aspects. To coordinate epidemic prevention and control, economic and social development, people's livelihood guarantee, and ecological and environmental protection, the MEE further advanced the reform of "power delegation, administration streamlining, and service improvement" for EIA, demoting the EIA categories of 51 secondary industries and canceling the requirement to fill in registration forms for 40 secondary industries. From January–November 2021, with the growth of national fixed-asset investments, the number of EIA project reports (forms) that needed to be approved across the country decreased by 43.4% year-on-year, and the number of project registration forms filed decreased by 57.4%. The country continued to rely on the "three-ledger" (EIA approval and service lists of major national, local, and foreign-funded projects) EIA approval and service mechanism to promote the implementation of major projects and energy supply guarantee projects, as well as spur the rapid development of "two-new and one-major" industries (new types of infrastructure, new types of urbanization, major projects in transportation, water conservancy, etc.). However, equal emphasis was put on delegation and regulation, and the blind development of "dual high" projects was resolutely curbed. The number of EIA approvals for "dual high"-related industries fell by more than 30% throughout the year.

Economic Means

Funds for air pollution prevention and control from the central government increased, and clean heating received major support.

In 2021, the MOF allotted RMB27.5 billion of the budget for air pollution prevention and control, an increase of 10% from 2020. The key support scope of the funds covered clean heating in Northern China in winter, the capacity building of atmospheric environment governance and management, the coordinated control of $PM_{2.5}$ and O_3, and other important matters concerned. The funds were managed by the MOF in conjunction with the MEE. The clean heating projects in Northern China in winter supported by the funds were determined publicly by the MOF and the MEE through competitive review. The remaining funds were allocated according to the weights of "regional $PM_{2.5}$ concentration improvement," the "achievement of the attainment days target," the "achievement of VOCs emission reduction target," and the "achievement of the NOx emission reduction target."

Great efforts were made on green finance, and the scope of green bond projects was expanded.

In February 2021, the State Council explicitly proposed once again to vigorously develop green finance. In April, the People's Bank of China, the NDRC, and the China Securities Regulatory Commission jointly issued the "Catalog of Projects Supported by Green Bonds (2021 Edition)," which expanded the scope of green bond projects, unified domestic standards, and integration with international standards. By the third quarter of 2021, China had issued more than RMB400 billion green bonds. In the next stage, ensuring the common improvement of both the "quality" and "quantity" of green bonds will be the focus of market building. China Central Depository & Clearing Co., Ltd. published the "China Bond - Green Bond Environmental Benefit Information Disclosure Indicator System" in April 2021 and launched the country's first green bond environmental benefit information database in September, aiming to establish comprehensive, objective, and quantifiable standards for environmental benefit information disclosure, improve the quality of information disclosure, and provide motivation and guarantee for the high-quality development of the green bond market.

China's domestic carbon market officially started online trading.

In 2021, the MEE successively issued multiple documents to arrange for various preparations for trading in the domestic carbon market; regulated the registration, trading, and settlement activities of carbon emissions rights nationwide; and required local ecology and environment departments to properly supervise and manage the data quality of the national carbon market to prevent management and market risks caused by data quality problems.

On July 16, China's domestic carbon market officially started online trading. In the first compliance period, 2,162 key emission units in the power generation industry were brought in, covering about 4.5 billion tons of CO_2 emissions annually and making it the world's largest carbon market in terms of emissions covered. By the end of 2021, the cumulative transaction of carbon emission allowances in the national carbon market was 179 million tons, and the cumulative transaction volume was RMB7.661 billion. The carbon market closed at RMB54.22/ton on the last trading day of 2021, up by 13% from the opening price on July 16.

Chapter III.

Assessment of Cities' Air Quality Management

In 2018, CAA developed a tool to assess air quality management based on the air quality management framework. Building on the idea of the "Clean Air Scorecard," this method was used to comprehensively evaluate air quality improvement and the implementation of policy measures in cities and then rank these cities based on their total scores. Unlike the traditional city rankings only focusing on air quality, this report adopts a comprehensive assessment approach, enabling a more extensive evaluation of cities' efforts and achievements in air pollution prevention and control.

In 2010, the Clean Air Scorecard was developed by CAA with the support of the ADB, aiming to provide a comprehensive assessment tool for air quality management in Asian cities. It has been applied in several cities in China, Southeast Asia, and South Asia and has been continuously revised and optimized through the years. The China Air report learned from the evaluation of the Clean Air Scorecard and redesigned the scoring method to make it more in line with the characteristics of the implementation and assessment system of the air pollution prevention and control policy in China.

In 2021, the report team made some adjustments to assessment indicators and the scoring method based on experts' feedback. With the policy of strengthening air pollution control, carbon reduction, and coordinated governance, the adjusted scoring method put more emphasis on the effectiveness of the adjustment of the energy and transportation structures. The team also adjusted the scoring rules reflecting the latest policy requirements and the development trends in monitoring, attainment planning, and information disclosure.

Assessment Method

The assessment tool grades cities through two indicators: air quality improvement and policy measures. The full score is 100 points, with 50 points for each indicator, emphasizing that the efforts and the outcome of air pollution control in the cities are equally important. Apart from receiving the full score of 100 points, cities that perform exceptionally well in air quality improvement and that have leading practices in their policy measures, such as putting forward stricter and more advanced measures and standards in addition to national policies and requirements, are given bonus points. At the same time, points are deducted for cities that fail to publish environmental status bulletins and disclose air quality data as per the national policy requirements. Points are also deducted for cities whose air quality exceeds the standard and yet have not formulated and issued air quality attainment plans according to the law, or with whom the MEE have had a regulatory talk due to their ineffective work in air pollution prevention and control.

Figure 34 shows the structure of the assessment tool. Air quality improvement is assessed based on two sub-indexes: the improvement range of the three-year moving average of $PM_{2.5}$ (that is, the improvement range of the average concentrations in 2019-2021 compared to 2018-2020) and the improvement range of the three-year moving average of the number of attainment days. The change in the number of attainment days can comprehensively reflect the change in the overall urban air quality level, especially the change in major excessive pollutants. Using the three-year moving average for comparison can reduce the influence of meteorological fluctuations and other factors on air quality in a specific year and better

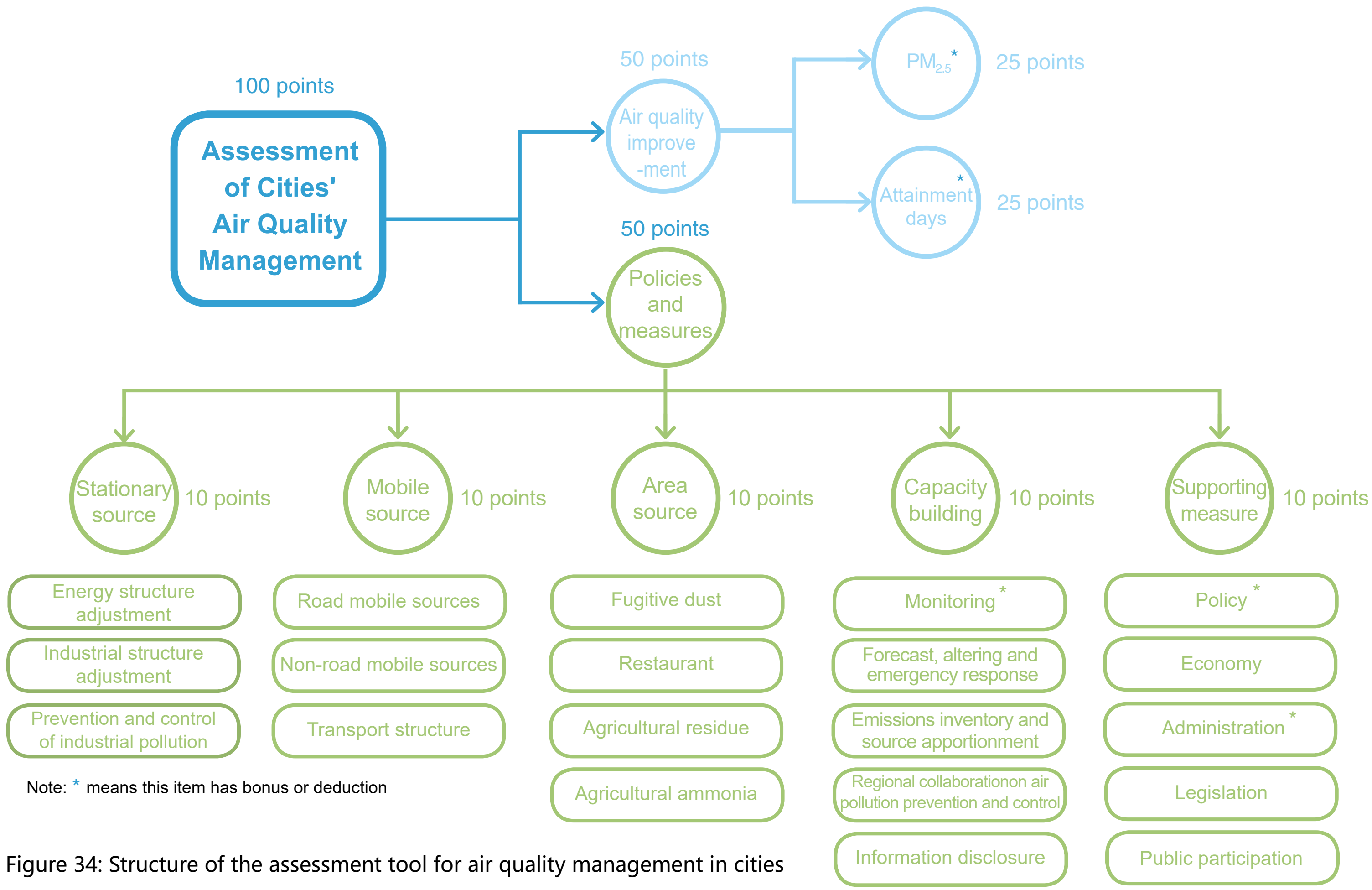


Figure 34: Structure of the assessment tool for air quality management in cities

reflect the overall improvement of air quality in cities in recent years. This part of the score was the “effect score” of city air quality management.

The indicator of policies and measures included five sub-indexes: the stationary source, mobile source, area source, capacity building, and safeguarding measures. Each sub-index included several sub-items, the aggregate score of which produced the total score for the indicator of policies and measures. This part of the score was the “effort score” obtained for city air quality management.

A sample graph of the final score is in Figure 35.

Figure 35: Sample Graph of the Assessment Result of a City's Air Quality Management

Score Analysis and City Rankings

Based on the assessment framework above, this section of the report ranked and analyzed 168 cities based on their scores on air quality improvement and their policy measures. It examined the cities' progress and achievements in these fields. Finally, this report ranked the cities based on their total scores across both indicators. The list highlighted cities with good effect and effort scores to encourage other cities to continuously improve their air quality. At the same time, it motivates cities that performed poorly in both areas to act proactively in raising their position in the rankings.

Air Quality Improvement

The scoring criteria for air quality were designed to encourage cities to make constant improvements in air quality. Cities gained different base scores subject to their current air quality status; they either acquired or lost scores based on the degree of improvement or deterioration. It meant cities that had already met air quality standards obtained higher scores if they kept improving, while those with poor air quality had to make more significant improvements to raise their scores; on the contrary, cities with a good air quality history that worsened got point deductions, and cities with already poor air quality that continued to deteriorate were included in the category of poorest performers. Table 7 shows the scores for air quality improvement across 168 cities.

Table 7: Rankings of Air Quality Improvement Scores for 168 Cities

Rank	City	Air Quality Improvement Score
1	Lhasa	61.97
2	Lvliang	56.61
3	Zhaoqing	56.53
4	Ningbo	55.55
5	Lanzhou	54.89
6	Foshan	54.24
7	Xiamen	54.00
	Huangshan	54.00
	Lishui	54.00
10	Jincheng	53.93
11	Xinyang	53.85
12	Xingtai	53.80
13	Zhangjiakou	53.40
14	Baoding	53.39
15	Zhongshan	53.07
16	Changzhi	52.87
17	Taizhou	52.41
18	Beijing	52.32
19	Huizhou	52.22
20	Guiyang	51.87

Rank	City	Air Quality Improvement Score
21	Zhoushan	51.76
22	Dongguan	51.66
23	Dongying	51.59
24	Jinzhong	51.54
25	Pingdingshan	51.53
26	Shenzhen	51.49
27	Jiangmen	51.16
	Suqian	51.16
29	Fuzhou	51.11
30	Wenzhou	51.00
31	Nanjing	50.83
32	Zhuhai	50.71
33	Yangzhou	50.64
	Hefei	50.64
35	Hangzhou	50.62
36	Wuhu	50.54
37	Huzhou	50.48
	Zhenjiang	50.48
39	Xuzhou	50.47
40	Chengde	50.40

Rank	City	Air Quality Improvement Score
41	Zhengzhou	50.26
42	Cangzhou	50.07
	Haikou	50.00
	Kunming	50.00
	Guangzhou	50.00
	Quzhou	50.00
	Jinhua	50.00
	Nanning	50.00
	Ya'an	50.00
	Jiaxing	50.00
	Suining	50.00
	Datong	50.00
	Ziyang	50.00
	Dalian	50.00
	Shaoxing	50.00
	Shanghai	50.00
	Suzhou	50.00
43	Xianning	50.00
	Xinyu	50.00
	Yichun	50.00
	Yancheng	50.00
	Guang'an	50.00
	Yinchuan	50.00
	Nantong	50.00
	Wuxi	50.00
	Xining	50.00
	Meishan	50.00
	Chaoyang	50.00
	Xuancheng	50.00
	Neijiang	50.00
	Huanggang	50.00
	Lu'an	50.00
	Xiaogan	50.00

Rank	City	Air Quality Improvement Score
	Shuozhou	50.00
	Anqing	50.00
	Changzhou	50.00
	Jingzhou	50.00
	Wuhan	50.00
43	Chuzhou	50.00
	Langfang	50.00
	Xinzhou	50.00
	Tongchuan	50.00
	Bengbu	50.00
	Suzhou	50.00
	Weinan	50.00
86	Chengdu	49.93
87	Qingdao	49.90
88	Jiaozuo	49.88
89	Ma'anshan	49.86
90	Hengshui	49.82
91	Xi'an	49.75
92	Shijiazhuang	49.73
93	Nanchong	49.70
94	Jiujiang	49.66
95	Ezhou	49.62
96	Taizhou	49.53
97	Bozhou	49.49
98	Nanchang	49.30
99	Huangshi	49.28
100	Baotou	49.20
101	Yichang	49.08
102	Tongling	49.01
103	Yueyang	48.98
104	Lianyungang	48.95
105	Zigong	48.90
106	Mianyang	48.85

Rank	City	Air Quality Improvement Score
106	Xuchang	48.85
108	Hohhot	48.80
109	Kaifeng	48.44
110	Yangquan	48.39
111	Chizhou	48.26
112	Rizhao	48.12
113	Huaibei	48.12
114	Zhumadian	47.88
115	Shangqiu	47.85
116	Tangshan	47.81
117	Suizhou	47.55
118	Luoyang	47.36
119	Anyang	47.16
120	Xianyang	47.12
121	Handan	47.06
122	Binzhou	47.03
123	Taiyuan	46.93
124	Dazhou	46.84
125	Weifang	46.73
126	Liaocheng	46.68
127	Tianjin	46.60
128	Zhoukou	46.59
129	Yibin	46.57
130	Pingxiang	46.12
131	Leshan	45.96
132	Xinxiang	45.73
133	Nanyang	45.66
134	Huai'an	45.55
135	Xiangtan	45.44
136	Linyi	45.41
137	Sanmenxia	44.99
138	Luohe	44.91

Rank	City	Air Quality Improvement Score
139	Zaozhuang	44.56
140	Dezhou	44.34
141	Huludao	44.14
142	Jingmen	43.98
143	Deyang	43.83
144	Changsha	43.57
145	Urumqi	43.54
146	Zhuzhou	43.24
147	Linfen	43.22
148	Xiangyang	43.21
149	Shenyang	42.79
150	Huainan	42.76
151	Chongqing	42.45
152	Heze	41.73
153	Jinan	41.48
154	Qinhuangdao	41.03
155	Changde	40.97
156	Fuyang	40.67
157	Baoji	40.02
158	Zibo	39.63
159	Changchun	39.53
160	Tai'an	38.63
161	Harbin	38.47
162	Yuncheng	38.37
163	Puyang	37.80
164	Luzhou	35.87
165	Jining	35.84
166	Jinzhou	35.60
167	Yiyang	35.14
168	Hebi	31.72

Based on the cities' scores for air quality improvement, the report divided them into five categories: "excellent," "good," "ordinary," "poor," and "underperforming." Table 8 and Figure 36 show the air quality improvement and distribution of scores of all cities.

Table 8: Cities' Air Quality Improvement and Distribution of Scores

Range of Scores	Improvement	Number of Cities	Average concentration of $PM_{2.5}$ in 2019–2021	Average improvement rate compared with 2018–2020	Average number of attainment days in 2019–2021	Average improvement rate compared with 2018–2020
>50	**Excellent**	42	32.37	11.50%	302	5.70%
(45, 50]	Good	94	39.79	9.10%	288	5.60%
(30, 45]	Ordinary	32	46.84	5.00%	262	4.50%
(15, 30]	Poor	0	–	–	–	–
⩽ 15	Underperforming	0	–	–	–	–

Figure 36: Improvement Range of Three-year Averages of $PM_{2.5}$ concentration and attainment days in 2019-2021 compared with 2018-2020

As overall air quality improved during the assessment period from 2018-2021, all cities' performance in air quality improvement was rated "ordinary" or above, and no city was ranked as "poor" or "underperforming," meaning the country achieved no bad performances for the first time. There were no cities with a serious deterioration of the three-year moving average of $PM_{2.5}$ concentration or number of attainment days. Among the 168 key cities, in 2018-2020, only Luzhou, Nanchang, and Yiyang saw their three-year moving average of $PM_{2.5}$ rebound by less than 1 μg/m^3, and Qingdao and Yiyang saw a slight decrease by one day and three days, respectively, in their three-year moving average of the number of attainment days. The remaining cities all had improved three-year moving averages of $PM_{2.5}$ and number of attainment days.

Cities Ranked as "Excellent": The three-year moving average of $PM_{2.5}$ improved significantly, with nearly half of all cities reaching the standard for four consecutive years.

Cities Ranked as “Excellent” (score > 50): These are cities that met the standard and made continuous notable improvements in air quality or made significant improvements despite their air quality failing to reach the standard. In this assessment period, 42 cities got bonus points, attaining higher than the full score of 50 points and being ranked as “excellent.” These cities made considerable improvements in both $PM_{2.5}$ concentration and the number of attainment days, and the average value of improvement of the three-year moving averages in both metrics of “excellent” cities were 11.5% and 5.7%, respectively.

In 2021, a total of 30 “excellent” cities met the standard for the annual average concentration of $PM_{2.5}$, with the three-year average ranging between 11.33 μg/m^3-45.00 μg/m^3 in 2019-2021 and that of attainment days ranging between 227-365 days. Among them, four cities, namely Beijing, Hefei, Jincheng, and Yangzhou, reached the standard for the first time in 2021. Twenty-six cities met the standard in the last two years, 21 met the standard in the last three years, and 18 met the standard in all four years of the current assessment period.

Among the cities reaching the standard for four consecutive years, six cities (Lishui, Huangshan, Ningbo, Taizhou, Wenzhou, and Zhoushan) were in the YRD region, six (Foshan, Huizhou, Jiangmen, Shenzhen, Zhongshan, and Zhuhai) were in the Pearl River Delta region, and the remaining six were Chengde, Fuzhou, Guiyang, Lhasa, Xiamen, and Zhangjiakou. The three-year average range of $PM_{2.5}$ of these cities in 2019-2021 was only 11.33 μg/m^3-28.67 μg/m^3, and their three-year average range of attainment days was 303-365 days. Lhasa, which ranked first, achieved 100% of the attainment days for two consecutive years.

Although the other 12 cities still failed to meet the standard for the $PM_{2.5}$ annual average concentration, their air quality improved significantly, with the three-year average range of both $PM_{2.5}$ and the number of attainment days in 2019-2021 improving by more than 10% compared with 2018-2020. These cities were mainly from Hebei, Henan, Jiangsu, and Shanxi. It’s worth mentioning that three cities that ranked at around 150th as “ordinary” in the previous assessment period had entered the “excellent” category this time, and they were Pingdingshan, Xuzhou, and Zhengzhou. In 2018–2021, the three cities showed no deterioration in $PM_{2.5}$ and no deduction in the number of attainment days, and the improvement range of their three-year moving averages was as high as 10.8%–14.4%, so they all gained bonus points for the substantial improvement in the number of attainment days.

Cities Ranked as "Good": This category covered the largest number of cities, and a number of cities in Henan Province had a big jump in ranking.

Cities Ranked as “Good” (score (45–50]): These are cities that improved in air quality or where air quality was naturally good and then still witnessed some slight improvement. A total of 94 cities, the largest number in the current assessment period, entered this category, indicating that most of the key cities had good air quality improvement between 2018–2021. The average value of improvement of the three-year moving averages for both $PM_{2.5}$ and the number of attainment days of “good” cities were 9.1% and 5.6%, respectively. Forty-five percent of the cities scored a full mark of 50 points. They got no bonus points because they had slightly less improvement in air quality than “excellent” cities.

Two of the top 20 “excellent” cities in the previous assessment period (Tongling and Chizhou in Anhui Province) respectively fell to 102nd and 111th in the current assessment period. Compared to their significant improvement in both $PM_{2.5}$ and attainment days in the previous assessment period, their improvement ranges of the three-year moving averages of both metrics notably decreased in 2018–2021, with the number of attainment days even decreasing, lowering their scores and dragging them down to the category of “good” cities.

At the same time, eight “ordinary” cities that ranked in the bottom 20 in the previous assessment period remarkably moved up to the “good” category because of good air quality improvement in 2018–2021: The improvement ranges of their three-year moving averages of $PM_{2.5}$ and the number of attainment days were 7.6%–12.1% and 7.9%–12.2%, respectively. These eight cities were all from Henan Province.

Cities Ranked as "Ordinary": This category covered the least number of cities, and there were no cities in the lower categories.

Cities Ranked as “Ordinary” (score (30–45]): A total of 32 cities, the least number in the current assessment period, were ranked as “ordinary,” showing that there was only a minority of cities with little improvement or deterioration in air quality during the current period. The $PM_{2.5}$ concentrations of these cities all exceeded the standard, with the three-year average ranging between 35.33 μg/m^3–57.33 μg/m^3 and that of attainment days ranging between 198–325 days in 2019–2021. Among them, Luzhou, Nanchang, and Yiyang showed a slight deterioration in $PM_{2.5}$ concentration.

Compared with the previous assessment period, Linfen was the city with the biggest drop in ranking, from a “good” city ranking 30th in the last assessment to an “ordinary” city ranking 147th this year. This was because its $PM_{2.5}$ concentration in 2021 rebounded slightly compared with 2020, making it the one with the highest $PM_{2.5}$ concentration among the 168 cities in 2021, thus narrowing the improvement range of the three-year moving average of $PM_{2.5}$ and bringing down its score.

As in the previous assessment period, the city ranking last this year was still Hebi, because its mean $PM_{2.5}$ concentration in 2019–2021 was as high as 56 μg/m^3, the sixth highest among the 168 cities, but its improvement range compared to 2018–2020 was a mere 2.9%, whereas the average improvement range of the other five cities with a higher $PM_{2.5}$ concentration than Hebi was 11.2%. At the same time, Hebi’s improvement range of the three-year moving average of attainment days was 5.5%, significantly lower than the 13.4% of the other five cities.

Policies and Measures

The scores in the assessment on policies and measures were based on the measures for controlling emissions from stationary, mobile, and area sources, the measures for capacity building that supported the scientific implementation of policies, and the safeguarding measures for promoting the effective implementation of relevant policies. Table 9 shows the scores for policies and measures across 168 cities.

Table 9: Rankings of the Scores for Policies and Measures of 168 Cities

Rank	City	Score for Policies and Measures
1	Beijing	52.96
2	Hangzhou	51.95
3	Shenzhen	51.53
4	Qingdao	51.5
	Guangzhou	51.5
6	Shanghai	51.47
7	Zhengzhou	51.38
8	Jinan	51.07
9	Chengdu	50.89
10	Chongqing	50.26
11	Hefei	50.03
12	Tianjin	50.01
13	Wuhan	50
14	Changsha	49.89
15	Nanjing	49.5
16	Shijiazhuang	48.88
17	Zhongshan	48.59
18	Yangzhou	48.57
19	Xiamen	48.53
20	Nantong	48.5
21	Suzhou	48.46
22	Lanzhou	48.44
23	Changchun	48.25
24	Lianyungang	48.07
25	Shaoxing	48.03
26	Anqing	48.02
27	Handan	48.01
28	Wuxi	48
29	Xingtai	47.94
	Changzhi	47.94
31	Yangquan	47.9
32	Zhuhai	47.76
33	Wenzhou	47.7
34	Xi'an	47.69

Rank	City	Score for Policies and Measures
35	Dongguan	47.57
	Zhaoqing	47.57
	Baoji	47.57
38	Jinhua	47.55
39	Hengshui	47.51
40	Tongling	47.44
41	Yancheng	47.2
42	Jincheng	47.16
	Dalian	47.16
44	Jiangmen	47.15
45	Ma'anshan	47.13
46	Shenyang	47.1
47	Lishui	47.08
	Quzhou	47.08
49	Hohhot	47.07
50	Huainan	47.04
51	Yichang	46.99
52	Jining	46.98
53	Huangshan	46.82
54	Wuhu	46.79
55	Huzhou	46.76
56	Changzhou	46.6
	Li'an	46.6
	Chizhou	46.6
	Xuancheng	46.6
	Xining	46.6
61	Zhangjiakou	46.57
	Zhenjiang	46.57
63	Binzhou	46.51
	Sanmenxia	46.51
	Chuzhou	46.51

Rank	City	Score for Policies and Measures
66	Taiyuan	46.44
	Liaocheng	46.44
	Changde	46.44
69	Fuyang	46.37
70	Linfen	46.36
71	Ezhou	46.23
72	Haikou	46.22
73	Taizhou	46.2
	Ningbo	46.2
75	Jingzhou	46.17
76	Mianyang	46.14
	Zigong	46.14
	Nanchang	46.14
	Yueyang	46.14
80	Huai'an	46.13
81	Suqian	46.12
82	Xuzhou	46.1
83	Anyang	46.07
84	Yinchuan	46.03
85	Luoyang	46.01
86	Huaibei	45.97
87	Xianning	45.96
88	Zibo	45.94
89	Xiaogan	45.92
90	Huangshi	45.86
91	Ya'an	45.84
92	Ziyang	45.78
93	Kunming	45.77
94	Luzhou	45.73
	Huanggang	45.73
96	Chengde	45.7

Rank	City	Score for Policies and Measures
97	Qinhuangdao	45.7
98	Deyang	45.68
99	Nanning	45.64
100	Guiyang	45.6
101	Linyi	45.57
102	Cangzhou	45.55
103	Langfang	45.51
	Jinzhou	45.51
105	Xianyang	45.41
	Tongchuan	45.41
107	Bengbu	45.35
108	Harbin	45.31
109	Puyang	45.26
110	Weinan	45.24
111	Jiaxing	45.23
112	Zaozhuang	45.17
113	Hebi	45.16
114	Foshan	45.11
115	Zhuzhou	45.1
116	Taizhou	45.07
117	Jingmen	44.95
118	Yuncheng	44.88
119	Fuzhou	44.86
120	Xinxiang	44.82
121	Suining	44.74
122	Tangshan	44.64
123	Dezhou	44.63
124	Nanyang	44.6
125	Baoding	44.57
126	Bozhou	44.56
127	Huizhou	44.55

Rank	City	Score for Policies and Measures
128	Neijiang	44.54
129	Xiangyang	44.44
130	Nanchong	44.27
131	Leshan	44.22
132	Shuozhou	44.2
133	Yibin	44.19
134	Zhumadian	44.08
135	Jiaozuo	43.95
136	Suzhou	43.93
137	Suizhou	43.89
138	Datong	43.77
139	Rizhao	43.71
140	Urumqi	43.7
141	Xuchang	43.49
142	Xinzhou	43.29
143	Pingdingshan	43.27
144	Xinyang	43.21
145	Huludao	43.2
146	Luohe	43.17
147	Zhoushan	42.95
148	Xinyu	42.79
149	Dazhou	42.71
150	Lvliang	42.45
	Heze	42.45
152	Meishan	42.42
153	Jiujiang	42.3
154	Yichun	42.25
155	Guang'an	42.24
156	Jinzhong	41.99
157	Weifang	41.89
158	Yiyang	41.75

Rank	City	Score for Policies and Measures
159	Kaifeng	41.57
160	Baotou	41.52
161	Xiangtan	41.42
162	Shangqiu	41.3
163	Chaoyang	41.21
164	Tai'an	40.68
165	Pingxiang	40.32
166	Dongying	40.15
167	Zhoukou	40.01
	Lhasa	40.01

Table 10 shows the distribution of the scores for policies and measures of all cities.

Table 10: Distribution of Scores for Policies and Measures of Cities

Range of Score	Performance	Number of Cities
>50	Excellent	12
(45, 50]	Good	104
(40, 45]	Ordinary	52

Regarding the assessment of the policies and measures of cities, the evaluation based on publicly available information and data was found to reflect the level of completion of a city's air quality management framework and the comprehensiveness of its measures. However, the assessment of the actual implementation remained limited because the comprehensiveness and timeliness of each dataset released at the city level were quite different. Similar to the previous year's assessment results, there was a high degree of homogeneity in the policies associated with air pollution prevention and control at the city level, meaning the final scores of policies and measures in the assessment were relatively close to each other, all at above 40. These results meant that the 168 key cities had implemented comprehensive air pollution prevention and control measures. Overall, the air pollution prevention and control policy system had not changed significantly, nor were there any significant intercity gaps.

Cities Ranked as "Excellent": First-tier cities demonstrated outstanding comprehensive strength and continued to lead in this regard in China.

A total of 12 cities scored higher than the full mark of 50 points and performed well in implementing policy measures for air pollution prevention and control, and they were Beijing, Chengdu, Chongqing, Guangzhou, Hangzhou, Hefei, Jinan, Qingdao, Shanghai, Shenzhen, Tianjin, and Zhengzhou. Ten of these cities were rated “excellent” in terms of policies and measures for three consecutive years. Chongqing was added to the “excellent” cities, while Wuhan dropped out of the “excellent” category due to a significant increase in the proportion of road transportation in the freight structure affecting its score. The total score of Beijing topped the rankings because the city had complete measures for controlling all kinds of pollution sources and performed noticeably well in capacity building and safeguarding measures, including building the air quality monitoring super-station, regularly updating and releasing the results of source apportionment, and regularly formulating and publishing action plans related to air pollution prevention and control. It also conducted a cost-benefits assessment on relevant policies and realized air quality attainment in 2021.

All 12 “excellent” cities are traditional or new first-tier cities, including four municipalities directly under the central government, six provincial capitals, and two cities with independent planning status. All “excellent” cities ranked in the top 20 of the GDP rankings of Chinese cities in 2021. They have solid financial abilities, scientific research competencies, and planning capabilities. Compared with other cities, they continuously invested more resources in improving air quality and have robust hardware and software. The leading cities scored high because of better practices. For one, they have comprehensive emission reduction measures for all kinds of pollution sources, including setting targets for coal consumption control, popularizing urban public transport, and adjusting freight structure. For another, they have advanced scientific decision-making foundations, control plans, and regulations, including the systematic construction of air quality monitoring stations, the regular updating of emissions inventory and source apportionment, and the regular release and effectiveness evaluation of action plans. These practices have ensured sustainability in the air quality improvement of “excellent” cities.

Cities Ranked as "Good": The number of cities in this ranking increased significantly, and the scientific and technological capacity was strengthened.

A total of 104 cities scored between 45 and 50 (included), 70% of which were in the three key regions, namely the BTH region and its surrounding areas, the YRD region, and the Fenwei Plain. There were also nearly 20 small and medium-sized cities from Hubei, Hunan, and Sichuan, with the rest scattered in other provinces. Despite some slight gaps with the “excellent” cities in terms of financial, scientific research, and assessment abilities, these cities were those that put much effort into air pollution prevention and control. Specifically, 80% of these cities were included in the categories of “excellent” and “good” in the air quality improvement assessment. Sixty percent of these cities updated their air pollutant emission inventories from 2020, strengthening the scientific foundation for air pollution prevention and control.

In the current assessment, the number of “good” cities increased by more than 30 compared to the previous year, mainly due to these cities’ improvement of capacity building and safeguarding measures, such as the dynamic updating of emissions inventory, the enhancement of air quality information disclosure, the formulation and release of annual action plans for air pollution prevention and control, and the formulation of an air quality attainment plan.

Cities Ranked as "Ordinary": Most of these cities did not meet the standard for $PM_{2.5}$.

A total of 52 cities scored between 40 and 45 (included), among which 35 cities failed to meet the standard for the annual mean concentration of $PM_{2.5}$ in 2021. Among the 20 cities with the highest concentrations, half were from Henan Province, with the rest scattered in Hebei, Hubei, and Shandong. Their ranking suggests that these cities may have a poor air quality level due to inadequate policy actions.

Under the category of “ordinary,” there were more than 10 air quality attainment cities in 2021, including Fuzhou, Huizhou, Lhasa, and Zhoushan. Due to their location in coastal areas or their low industrialization level, these cities had limited pollution sources, good diffusion conditions, and naturally good air quality, so they didn’t take very strict pollution control measures, resulting in the relatively low “effort score.” However, these cities maintained excellent air quality, so they gained high base scores in the air quality improvement assessment due to their natural advantage.

“Ordinary” cities often lacked the disclosure of important information on their progress for implementing measures in air pollution prevention and control, such as information about the adjustment of the energy and transportation structures. Most of these cities also did not perform well in disclosing environmental information. For example, they did not release environmental status bulletins or provide any data on pollutant concentrations in the bulletins.

Analysis of the Comprehensive Scoring of the Air Quality Management of Cities

The comprehensive scoring for air quality management in cities is the sum of two scores: the air quality improvement score and the policy measures score, both of which reflect the efforts and achievements of the cities in a holistic manner. Specifically, the “effort score” represents the efforts made in association with policy measures, evaluating the implementation of measures in the most recent year. The effort score sufficiently reflects the degree of comprehensiveness of the pollution prevention and control policies of the cities at the given period. Meanwhile, the “effect score” deals with air quality improvement. Because the assessment focuses on changes in the three-year moving average, the scores are influenced by current policies but are also determined by the accumulated effects of the measures over the past few years. In general, only cities that have made sufficient efforts can ensure sustainable improvement in air quality. In contrast, cities that have demonstrated insufficient efforts (excluding non-industrial cities with inherently good air quality) are bound to receive a poor “effect score,” putting them at the lowest of the overall rankings.

Table 11 shows the total scores for air quality management in the 168 cities based on their scores for air quality improvement and policy measures.

Table 11: Ranking of Total Air Quality Management Scores for 168 Cities

Rank	City	Total Score
1	Beijing	105.28
2	Zhaoqing	104.10
3	Lanzhou	103.33
4	Shenzhen	103.02
5	Hangzhou	102.57
6	Xiamen	102.53
7	Lhasa	101.98
8	Ningbo	101.75
9	Xingtai	101.74
10	Zhongshan	101.66
11	Zhengzhou	101.64
12	Guangzhou	101.50
13	Shanghai	101.47
14	Qingdao	101.40
15	Jincheng	101.09
16	Lishui	101.08
17	Chengdu	100.82
	Huangshan	100.82
19	Changzhi	100.81
20	Hefei	100.67
21	Nanjing	100.33
22	Wuhan	100.00
23	Zhangjiakou	99.97
24	Foshan	99.35
25	Dongguan	99.23
26	Yangzhou	99.21
27	Lvliang	99.06
28	Wenzhou	98.70
29	Taizhou	98.61
	Shijiazhuang	98.61
31	Nantong	98.50
32	Zhuhai	98.47
33	Suzhou	98.46
34	Jiangmen	98.31

Rank	City	Total Score
35	Shaoxing	98.03
36	Anqing	98.02
37	Wuxi	98.00
38	Baoding	97.96
39	Jinhua	97.55
40	Guiyang	97.47
41	Xi'an	97.44
42	Wuhu	97.33
	Hengshui	97.33
44	Suqian	97.28
45	Huzhou	97.24
46	Yancheng	97.20
47	Dalian	97.16
48	Quzhou	97.08
49	Xinyang	97.06
50	Zhenjiang	97.05
51	Lianyungang	97.02
52	Ma'anshan	96.99
53	Huizhou	96.77
54	Tianjin	96.61
55	Changzhou	96.60
	Li'an	96.60
	Xuancheng	96.60
	Xining	96.60
59	Xuzhou	96.57
60	Chuzhou	96.51
61	Tongling	96.45
62	Yangquan	96.29
63	Haikou	96.22
64	Jingzhou	96.17
65	Chengde	96.10
66	Yichang	96.07
67	Yinchuan	96.03
68	Fuzhou	95.97
69	Xianning	95.96
70	Xiaogan	95.92
71	Hohhot	95.87
72	Ezhou	95.85
73	Ya'an	95.84
74	Ziyang	95.78
75	Kunming	95.77
76	Huanggang	95.73
77	Nanning	95.64
78	Cangzhou	95.62
79	Langfang	95.51
80	Nanchang	95.44
81	Tongchuan	95.41
82	Bengbu	95.35
83	Weinan	95.24
84	Jiaxing	95.23
85	Huangshi	95.14
86	Yueyang	95.12
87	Handan	95.07
88	Zigong	95.04
89	Mianyang	94.99
90	Chizhou	94.86
91	Pingdingshan	94.80
92	Suining	94.74
93	Zhoushan	94.71
94	Taizhou	94.60

Rank	City	Total Score
95	Neijiang	94.54
96	Shuozhou	94.20
97	Huaibei	94.09
98	Bozhou	94.05
99	Nanchong	93.97
100	Suzhou	93.93
101	Jiaozuo	93.83
102	Datong	93.77
103	Binzhou	93.54
104	Jinzhong	93.53
105	Changsha	93.46
106	Taiyuan	93.37
	Luoyang	93.37
108	Xinzhou	93.29
109	Anyang	93.23
110	Liaocheng	93.12
111	Xinyu	92.79
112	Chongqing	92.71
113	Jinan	92.55
114	Xianyang	92.53
115	Tangshan	92.45
116	Meishan	92.42
117	Xuchang	92.34
118	Yichun	92.25
119	Guang'an	92.24
120	Jiujiang	91.96
	Zhumadian	91.96
122	Rizhao	91.83
123	Dongying	91.74
124	Huai'an	91.68

Rank	City	Total Score
125	Sanmenxia	91.50
126	Suizhou	91.44
127	Chaoyang	91.21
128	Linyi	90.98
129	Yibin	90.76
130	Baotou	90.72
131	Xinxiang	90.55
132	Nanyang	90.26
133	Leshan	90.18
134	Kaifeng	90.01
135	Shenyang	89.89
136	Huainan	89.80
137	Zaozhuang	89.73
138	Linfen	89.58
139	Dazhou	89.55
140	Deyang	89.51
141	Shangqiu	89.15
142	Dezhou	88.97
143	Jingmen	88.93
144	Weifang	88.62
145	Zhuzhou	88.34
146	Luohe	88.08
147	Changchun	87.78
148	Xiangyang	87.65
149	Baoji	87.59
150	Changde	87.41
151	Huludao	87.34
152	Urumqi	87.24
153	Fuyang	87.04
154	Xiangtan	86.86

Rank	City	Total Score
155	Qinhuangdao	86.73
156	Zhoukou	86.60
157	Pingxiang	86.44
158	Zibo	85.57
159	Heze	84.18
160	Harbin	83.78
161	Yuncheng	83.25
162	Puyang	83.06
163	Jining	82.82
164	Luzhou	81.60
165	Jinzhou	81.11
166	Tai'an	79.31
167	Yiyang	76.89
168	Hebi	76.88

Table 12 shows the distribution of the total scores of all cities.

Table 12: Distribution of Total Air Quality Management Scores for 168 Cities

Range of Score	Performance	Number of Cities
>100	Excellent	21
(85, 100]	Good	137
(70, 85]	Ordinary	10
(60, 70]	Poor	0
⩽ 60	Underperforming	0

Similar to last year, in the current assessment period, the total scores of the 168 key cities were all above 70 points, and no cities ranked as "poor" or "underperforming."

Cities Ranked as "Excellent": Five cities achieved "double excellent" in two lists, and Beijing ranked first in terms of comprehensive scoring.

A total of 21 cities scored higher than the full mark of 100 points, among which 17 cities ranked as "excellent" in the assessment of air quality improvement and nine were "excellent" cities in the assessment of policy measures. Additionally, five cities ranked as "excellent" in the assessment of both indicators, exemplifying constant air quality improvement through efforts. These cities were Beijing, Hangzhou, Hefei, Shenzhen, and Zhengzhou. Beijing ranked first in terms of comprehensive scoring.

Among the 21 cities, only Lhasa ranked as "ordinary" in the assessment of policy measures, and the other 20 cities were "excellent" or "good" in the assessments of both indicators. Lhasa ranked as "excellent" in the comprehensive assessment because of its extraordinarily excellent performance in air quality improvement: Its annual mean $PM_{2.5}$ concentration met the standard and did not rebound for four consecutive years in the current assessment period (dropping to 10 $\mu g/m^3$ in 2021), and it kept the ratio of its attainment days at 100% for two consecutive years.

Cities Ranked as "Good": The air quality management abilities of these cities generally improved, and the number of "good" cities continued to increase.

A total of 137 cities scored 85 to 100 (included) points and ranked as "good," the category with the largest number of cities, with an increase of 27 cities compared to last year. This number had also increased for the third consecutive assessment period. Among the cities, more than 80% ranked as "good" or "excellent" in the assessment of air quality improvement, while nearly 70% ranked as "good" or "excellent" in the assessment of policy measures, indicating that most of the cities performed well in terms of both effort and effect. The reason for such results is that over recent years, effective policy measures for air pollution prevention and control have been vigorously carried out from the central government to local governments in China, resulting in the continuous improvement in air quality on the whole.

Cities Ranked as "Ordinary": Poor improvement in air quality pulled down the total score.

Merely 10 cities scored between 70 and 85 (included) points in the comprehensive scoring, all of which were pulled down by their poor improvement in air quality. Nine of them were also the last nine cities with the lowest scores in the assessment of air quality improvement. In the assessment of policy measures, there were six "good" and four "ordinary" cities. As in the previous assessment period, Hebi ranked last in the comprehensive scoring, but its score increased by more than six points compared to the last assessment period due to its progress in air quality improvement.

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