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(NEASPEC)

Best Available Techniques (BAT) or Similar Concepts for Air Pollution Control and Management Policies in North-East Asia

(China, Japan, Mongolia, the Republic of Korea, and the Russian Federation)

Review Paper

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Depending on the implementation scopes and desired goals, the best available techniques (BAT) have been defined in various ways. Generally, BATs are the technology-based approaches of advanced processes, facilities or methods of operations applied in a particular process or industrial installation for control and prevention of pollution. BAT has evolved as a key element for setting the emission limit values (ELVs) for industrial operations and other processes that generate pollution.

In 1993, the countries of Northeast Asia established the North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) – an inter-governmental cooperation mechanism for addressing environmental challenges in North-East Asia. The United Nations ESCAP East and North-East Asia Office (ESCAP-ENEA) is serving as the Secretariat of the NEASPEC. In October 2018, the NEASPEC launched the North-East Asia Clean Air Partnership (NEACAP) to support the Member States in addressing air pollution issues in North-East Asia.

The United Nations ESCAP East and North-East Asia Office, under its NEACAP, is conducting a review study to understand the current processes and approaches of BAT applications (or similar concepts) to policies in the Member States. This paper provides a comprehensive review of the national regulation, policies, and measures that China, Japan, Mongolia, the Republic of Korea, and the Russian Federation are implementing for air pollution control and management. The paper includes an overview of national regulations, policies, and similar measures relating to BAT; national processes and approaches for specifying and establishing BAT (or similar concepts); approaches for evaluating the effectiveness of policies and practices; examples of BAT (or similar concepts) implementation; key BAT technologies deployed in transport, industry, and residential sectors, and suggestions on subregional cooperation on BAT applications (or similar concepts).

China enacted several laws, regulations, and policies to protect the environment including air pollution control and management, e.g., the Environmental Protection Law in 1979 (amended in 2015), the Air Quality Standards in 1982 (amended in 2012), the Atmospheric Pollution Prevention and Control Law in 1987 (latest amendment in 2016), the Environmental Impact Assessment Law in 2002 (amended in 2016), the Environmental Protection Tax Law in 2018. For evaluation of the effectiveness of policies and regulations, air quality monitoring data are used. China's national air quality monitoring network includes more than 2,100 air quality stations across the country. The air monitoring quality data from 2014 to 2020 showed that air quality in China is improving. In 2014, only 10% of cities in China were meeting the national air quality standards which increased to 60% in 2020. This shows that air pollution control and prevention policies and regulations are effective in China. Some key policies China implements for air pollution control and management are the Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs), Emission Limit Values (ELVs), Air Pollution Tax, Five-Year Target Plan, Pollutant Emission Trading, Air Quality Standards, Air Pollution Action Plan, Increase Green Coverage, and Integrated, Intelligent and International Platform for Environmental Technologies (3iPET). Policies that are implemented in the transport sector are

stringent emission standards for on-road vehicles, improving fuel quality, installing urea-based selective catalytic reduction converters, installing real drive emission tests (RDE), scraping yellow label vehicles, and promoting eco-friendly vehicles; in the industrial sector, stringent industrial emission standards, use of ultralow standards for power plants, revamping permitting systems, phasing out high-emitting factories and outdated facilities, installing NMVOC emission control facility, and investment in green energy; and in the residential sector, replacing residential coal with electricity and strengthening regulations and standards for indoor air pollution.

Japan enacted the Air Pollution Control Act (APCA) in 1968 which has been amended several times by adding relevant legislation, such as introducing national uniform emission control and penalty in 1970, strengthening automobile exhaust gas in 1973, control of asbestos emission from facilities in 1989, measures for hazardous air pollutants in 1996, VOCs emission control in 2006, and BAT control of mercury emission in 2018. The APCA contains 6 Chapters and 37 Articles. The purpose of the APAC is to protect air quality through multiple measures, targeting both stationary and mobile emission sources. The process of specifying and establishing legislation is conducted under the Ministry of Environment. Air quality monitoring data are used for the evaluation of air pollution policies and regulations. Additionally, the government surveyed the enforcement status of the air pollution control regulation. Examples of BAT (or similar concepts) implementation are enforcement of environmental quality standards, emission control of VOCs, use of BAT for the development of emission standards for mercury, improvement in forecasting/prediction of $PM_{2.5,}$ and issuance of alerts. Examples of BAT (or similar concepts) in transport include the implementation of a zero-emission strategy in Tokyo, promoting the Global Facility for Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth, manufacturing hydrogen-powered buses, implementation of new fuel efficiency standards, entry bans on diesel vehicles in some prefectures, promoting clean fuels, and while cool biz and warm biz initiatives for the residential sector.

Mongolia approved the Law on Air Pollution Fee in 2010 (latest amendment in 2019) to regulate the imposition of compensatory fees on entities for polluting the air. Later in 2012, Mongolia approved a comprehensive legislation “the Law on Air” (latest amendment in 2019). The Law on Air (2012) has 5 Chapters and 28 Articles that provide an overall institutional framework and functions for air pollution control and prevention in Mongolia. The National Committee on Reduction of Air Pollution under the Ministry of Environment and Tourism is responsible for the preparation of legislation for air quality management including the implementation of short-term and medium-term activities outlined in the National Programme on Air Protection. Mongolia established a network of 40 ambient air quality monitoring stations across the country including 18 monitoring sites in Ulaanbaatar metropolitan city. The air quality monitoring data are used for the evaluation of the effectiveness of air pollution control policies and regulations. The professional units have the responsibility of air quality monitoring and drawing conclusions on the status of air quality and the effectiveness of air pollution control policies and regulations. Some examples of air pollution control and prevention policies and regulations of Mongolia are the National Programme for Air and Environmental Pollution

Reduction (NPRAEP – with over 60 control measures including 50 measures focused on air pollution reduction), Air Pollution Tax, Polluters to Pay Penalty, Ulaanbaatar Air Quality Improvement Programme, National Ambient Air Quality Standards, and ban on the use of raw coal. The policies implemented in the transport sector are promoting the use of gas-diesel combined fuel in public transport; in the industry sector, increasing the share of renewable energy; and in the residential sector, a master plan for decreasing air pollution in Ulaanbaatar city, providing discount bank loans on the electric appliances, upgrading briquette coal production, promoting low power consumption products, and providing tax exception on indoor filters and electric-saving heaters.

The Republic of Korea enacted the Clean Air Conservation Act in 1990 (latest amendment in 2022) which aims to prevent and control air pollution by implementing multiple control measures. The Republic of Korea passed the Environmental Impact Assessment Law in 1993 to strengthen the implementation of the Clean Air Conservation Act and listed 18 activity sectors that need to conduct environmental impact assessment (EIA). The sectors are mostly infrastructure developments including urban development projects, energy sources, harbor development, road, railroad, airport constructions, etc. The Republic of Korea also passed the Act on Integrated Control of Pollutant-Discharging Facilities (or the IPPC Act) in 2015 (enforced in 2017) which aims to promote the development of environmental technologies by integrating the control of pollutant-discharging facilities to reduce emissions of pollutants and establishing a system under which BAT can be applied for pollution control including meeting the environmental standards of business entities. The Republic of Korea has developed BAT Reference Documents (BREFs) for several industrial sources. The Ministry of Environment is overall responsible for the development, specification, and establishment of the environmental legislations and their implementation. The Republic of Korea is operating the national air quality monitoring network with 610 monitoring stations across the country. Air quality data is used for evaluating the effectiveness of air pollution control policies and regulations. Air quality monitoring data of key air pollutants showed a decreasing trend from 2010 to 2019 which shows that air pollution control regulations and policies are effective in reducing emissions of air pollutants in the country. Some examples of air pollution control and prevention policies that the Republic of Korea established include a cap-and-trade system in Seoul Metropolitan Area (SMA), implementing the comprehensive plan on fine dust management and air quality control master plan, air pollution tax, emission limit values (ELVs) associated with BATs, and air quality standards. The key policies implemented in the transport sector are stringent emission standards for on-road vehicles, installing selective catalyst reduction (SCR) for diesel vehicles, promoting eco-friendly vehicles, and introducing real-driving emissions (RDE) standards; in the industrial sector, strengthening regulations for power plants and management of fugitive volatile organic compounds (VOCs), retrofitting power plants with selective catalyst reduction (SCR) and flue gas desulfurization (FGD), closing of 30-year-old coal-fired plants, replacing turbines to boost power efficiency, replacing outdoor coal storage facilities, and increasing share of green energy; and in the residential sector, replacing old boilers in households and installing air purifiers in homes, and establishing a monitoring system for diseases caused by fine dust.

The Russian Federation has adopted more than 4,000 environmental laws and regulations to protect the environment. These legislations are closely interrelated to each other. The Russian Federation enacted the Federal Law (No. 96-FZ) on the Protection of the Atmospheric Air (Air Quality Law) in 1999 which established the legal basis for the protection of atmospheric air and addressed air quality issues including air emission limitations, permitting procedures for facilities that emit air pollutants and control procedures. The Russian Federation also enacted the Federal Law on Environmental Protection in 2002 (latest amended in March 2022) which sets the fundamental principles of environmental regulation and provides an overall framework for environmental management including imposing general environmental protection requirements related to the construction and operation of various facilities that may be harmful to the environment. With the amendment in 2014, the Federal Law on Environmental Protection introduced the use of BAT to achieve standards for environmental protection based on the latest science considering social, environmental, and economic factors. As of November 2021, 37 BAT applications have been developed for industrial operations and other processes. The Russian Federation has formed a BAT Bureau to standardize the execution of BAT policies in the county. The Bureau has 4 goals to implement the BAT with a timeline of 25 years (2015 -2040). Evaluation of the effectiveness of BAT is done by the Technical Working Group (TWGs) through interactions, questionnaires, and meetings. TWGs have prescribed five main criteria for the determination of BAT, namely, lowest possible negative environmental impacts, economic efficiency, resource and energy saving, a timeline of implementation, and a successful introduction of BAT in at least two plants that emit pollution. While evaluating BATs, technical, environmental, and economic factors are also considered. Apart from the development and implementation of BATs in industrial processes and air protection, the Government has set temporary quotas for pollutant emissions for 12 major urban industrial areas (for the experiment) intending to reduce emissions of air pollutants by at least 20%. To reduce emissions of air pollutants from the transport sector, the government is placing restrictions on traffic movement within the city (e.g., Moscow) and developing infrastructures of road and railway.

Air pollution follows no political boundary. It can transport from the source region to distant places and cause harmful impacts on humans and the environment. Considering the transboundary impacts of air pollution, it needs cooperation among the neighboring countries of Northeast Asia for making joint efforts in the mitigation of air pollution in the region. In this context, the subregional cooperation on advanced air pollution mitigation technologies or BATs could be the way forward. The subregional cooperation may be established in several areas, such as (1) establishing information sharing platform, (2) establishing an experience-sharing and learning forum, (3) developing regional guidelines on BATs, (4) sharing or transferring air pollution mitigation technologies, (5) capacity building, (6) establishing financial assistance mechanism for supporting countries, and (7) establishing a crisis management mechanism.

1. BACKGROUND

Depending on the implementation scopes and desired goals, the best available techniques (BAT) have been defined in various ways. For example, in the EU Industrial Emission Directive (2010/75/EU), BAT has been defined as "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values (ELVs) and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole".

Considering technological-based approaches, BATs are defined as "the emerging state-of-the-art technology-based approaches of advanced processes, facilities or methods of operation applies in a particular process or industrial installations for pollution control and prevention". Whereas, in the Multilateral Environmental Agreements (MEAs), such as in the Minamata Convention, BAT is defined more specifically as "those techniques that are the most effective to prevent and, where that is not practicable, to reduce emissions and releases of mercury to air, water, and land and the impact of such emissions and releases on the environment as a whole, taking into account economic and technical considerations for a given Party or a given facility within the territory of that Party".

At the country level, for instance, in the Republic of Korea, BAT is defined as "technically and economically applicable control techniques that can most effectively reduce discharge of pollutants as environmental control techniques for the designing, installation, operation, and management of discharging facilities and prevention facilities" (Article 14 of the Act on the Integrated Control of Pollutant-Discharging Facilities, 2015). In the Russian Federation, "technology" has been used in place of "technique," and two terms, namely, the "best available technology" and the "best existing technology" have been used in the Russian Federation Federal Law on Environmental Protection (2002, amended in 2015). The best available technology is defined as "technology of production of products (goods), performance of work, provision of services, determined on the basis of modern achievements of science and technology and the best combination of criteria for achieving the goals of environmental protection, subject to the availability of the technical possibility of its application." Whereas, a best existing technology is a "technology based on the latest science and technology achievements aimed at reducing negative effects on the environment which has an established practical application term with due regard to economic and social factors".

In general, BATs have been formulated considering the technology-based approaches. However, in some countries, it is combined with an approach based on environmental quality. BAT concept is evolved as an important key element for setting the Emission Limit Values (ELVs) or Emission Standards for industrial operations and other processes which generate pollution. BAT-based approaches are helping in achieving desired pollution control and prevention. While specifying the BATs, several criteria are considered. For example, the techniques must be practically relevant to the business entities, pollutant reducing capabilities

in volume, comparable pricing, ability to reduce or recycle the wastes, energy efficiency, and ability to control the pollution from sources themselves.

The BAT concept was used for the first time in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) in 1992 for the protection of the marine environment of the North-East Atlantic from all types of industrial installations, such as chemical plants. The concept of BAT is used in the Multilateral Environmental Agreements (MEAs) related to industrial pollution control (e.g., Minamata Convention on Mercury and Stockholm Convention on Persistent Organic Pollutants). Similar concepts are being used worldwide, namely, Best Available Control Technology (BACT), Best Available Techniques/Technology Not Entailing Excessive Cost (BATNEEC), Best Conventional Pollutant Control Technology (BCT), Best Environmental Management Practice (BEMP), Best Environmental Practice (BEP), Best Practicable Environmental Option (BPEO), Best Practicable Means (BPM), Best Practicable Control Technology Currently Available (BPT), and Reasonably Available Control Technology (RACT) (OECD, 2017).

The North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) is an inter-governmental cooperation mechanism for addressing environmental challenges in North-East Asia. The United Nations ESCAP East and North-East Asia Office (ESCAP-ENEA) serves as the secretariat of the NEASPEC. The NEASPEC's 22nd Senior Officials Meeting, held in October 2018 in Beijing, launched the North-East Asia Clean Air Partnership (NEACAP) to act as the key voluntary framework in addressing air pollution issues in North-East Asia. The NEACAP Work Plan 2021-2025 identified "policy and technology cooperation (PTC)" as the priority area to facilitate the NEACAP member States to share information on policies, technologies, and best practices, and undertake technological cooperation. A key activity of the PTC is to support voluntary collaboration among the Member States on BATs. The 3rd NEACAP's Science and Policy Committee Meeting (SPC-3) in April 2021 agreed to conduct a review paper as a reference for understanding current processes and approaches of BAT applications to policy in the Member States.

This paper provides a comprehensive review of the development, use, and application of BAT (or similar concepts) in policies and measures of air pollution control and management in China, Japan, Mongolia, the Republic of Korea, and the Russian Federation.

The paper consists of, for each country:

(a) An overview of national regulations, policies, and similar measures relating to BAT (or similar concepts) for preventing, controlling, and managing air pollution;

(b) National processes and approaches of specifying advanced techniques and establishing BAT (or similar concepts);

(c) Approaches for evaluating the effectiveness of policies and practices that embody BAT (or similar concepts);

(d) Practical examples of BAT implementation in air pollution control and management;

(e) Key BAT technologies and deployment in sectors such as transport, industry, and residential that are key to air pollution abatement; and

(f) Suggestions on subregional cooperation on BAT with a focus on the use and application of BAT to policy.

2. CHINA

2.1. Overview of national regulations, policies, and similar measures relating to BAT

Over the past three decades, China has put constant efforts into combating air pollution arising from rapid economic growth, industrialization, and urban development. In 1979, China introduced its first regulation of the environmental protection framework – "the Environmental Protection Law". It was later accompanied by the issuance of Air Quality Standards in 1982 (GB3095-82) and the Atmospheric Pollution Prevention and Control Law in 1987. Since then, air pollution monitoring systems have been gradually established at both local and national levels. Table 1 lists China's national laws, regulations, and policies since 1979.

Table 1. List of national regulations and policies of China

No.	Name of Law or Policies	Year of Enactment	Purpose
1.	Environmental Protection Law	1979	To establish a legal framework for environmental protection for the first time
2.	Air Quality Standards (GB3095-82)	1982	To regulate ambient air concentration levels of TSP, CO, SO_2, NO_2, O_X, and Pb.
3.	Atmospheric Pollution Prevention and Control Law	1987	To regulate soot and ash emissions from industrial factories
4.	Atmospheric Pollution Prevention and Control Law (1st amendment)	2000	To focus on SO_2 and PM_{10} from the coal-burning industries
5.	Environmental Impact Assessment Law	2002	To prevent the adverse impact of planning and construction projects on the environment and address air pollution directly from the source
6.	New Ambient Air Quality Standards (GB 3095-2012)	2012	To adjust the items and limits for pollutants, increased the limits for the average concentration of $PM_{2.5}$ and the 8-hour average concentration of ozone, and stringent the limits for the concentration of pollutants such as PM_{10} and NO_2.
7.	Action Plan for Atmospheric Pollution Prevention and Control	2013-18	To set a "national 10 measures" road map for air pollution control, including the Jing-Jin-Ji area and the Yangtze and Pearl River Deltas
8.	Environmental Protection Law (amendment)	2015	To strengthen penalties for non-compliance as well as strengthen the importance of the Environmental Impact Law, public interest environmental litigation is clearly stated for the first time

9.	Atmospheric Pollution Prevention and Control Law (2nd amendment)	2016	To introduce cross-regional cooperation during extremely polluted weather, enhance local government accountability
10.	Environmental Impact Assessment Law (amendment)	2016	To enhance the credibility and effectiveness of EIA, emphasis the importance of obtaining EIA before starting a project
11.	Environmental Protection Tax Law	2018	To replace the decade-old pollution fee system
12.	Action Plan for Winning the Blue-Sky War	2018-20	To cover more cities than the previous plan targeted the VOC and NO_x for reducing ground-level ozone

China passed the Environmental Protection Law in 1979 (amended in 2015) and the Atmospheric Pollution Prevention and Control Law in 1987 (amended in 2000 and 2016). Both the 13th and 14th Five-Year Plans have a positive effect on China's air quality (2016-2020 and 2021-2025 respectively) as well as the long-term objectives till 2035. For example, the air quality in Beijing-Tianjin-Hebei city clusters has improved significantly, and the average annual concentration of $PM_{2.5}$ dropped by 36% in 2019 as compared to that in 2015 (Sohu, 2020). Further country-wide improvement in air quality has been predicted by several air quality modeling studies during the 14th Five-Year Plan as several air pollution reduction measures have been proposed and are being implemented.

Environmental Protection Law (2015)

China passed the Environmental Protection Law in 2014, which came into effect in 2015. It was the first major reform of China's environmental protection policy in two and a half decades. The Environmental Protection Law (2015) is considered a milestone to a stronger legal system for environmental protection. It has 70 Articles including the "Information Disclosures and Public Participation".

Key points of the law involving air pollution control and prevention are as follows:

- The law is well placed to address many aspects of air protection issues, including a weak environmental assessment regulatory system, lack of government accountability and public disclosures, and vague public interest litigation as well as relatively light penalties for non-compliance.
- The law greatly increases the importance of the Environmental Impact Assessments (EIA), as it clarifies the need for EIA (Article 19). The projects and planning that do not meet the assessment criteria are not allowed to begin, and, if sub-standard projects are approved by the local governments or governors who are directly in charge of, they may receive administrative sanctions for allowing and covering up illegal acts (Article 68). The law also instructs the construction entities to explain the project to people who may be affected, and seek for their permission (Article 56).

- The law instructs local government officials to list emitting entities that emit illegally and violate the Environmental Protection Law (Article 54).
- The law provides provisions on information disclosures and public participation to increase transparency during the disposal process and public participation. It involves the disclosure of certain pollutant discharge information to the public (Article 55).
- The law provides provisions for social organizations to file lawsuits to the court against the emitters that may cause severe ecological damages and human health impacts (Article 58).
- The law provides a strict penalty if the emitting entities refuse to correct and would rather pay the fines (Article 59).

Atmospheric Pollution Prevention and Control Law (2016)

China enacted the Atmospheric Pollution Prevention and Control Law in 2016 to improve air quality through multiple measures. It has 8 chapters and 129 Articles (https://www.mee.gov.cn).

The key points of the law are as follows:

- The law covers comprehensive emission sectors to monitor emissions. The list of enforceable emission sectors includes coal combustion, industrial sectors (e.g., iron and steel, building materials, non-ferrous metals, and chemical industries), vehicles, marine vessels, and agricultural machinery.
- The law instructs provincial and municipal governments to take responsibility for the local air quality control plans with accountabilities, such as air quality attainments and air pollution prevention targets which become a key performance indicator for the local government evaluation (Article 4); if a provincial or municipal government fails to meet the targets, it will have to make concrete correction plans (Article 14); and the correction planning process should be open to the public for its input (Article 15).
- The law strengthens the national pollutant discharge permitting system, such as the emitting industries (e.g., iron and steel, building materials, non-ferrous metals, petroleum, and chemical industries). Industries that satisfy the emission standards can receive permissions from the local government to discharge air pollutants (Article 19); if a province or municipality no longer meets the air quality targets within a period, new projects involving air pollutants discharge will be suspended from the approval (Article 22); emitting industries are required to install an air pollutant monitoring system that is automatically connected to the Ecological and Environmental authorities; and the industries are responsible for assuring authenticity and accuracy of the data (Article 24).
- The law calls for a change in the energy consumption structure in China including reducing the consumption of coal and promoting clean energy (Article 32). New coal plants need to install coal washing and processing equipment to wash off the sulfur and ash contents and install the equipment within a limited time (Article 33).

- The law provides the rights to the city and municipal governments to delineate high-polluted areas and temporarily ban the use of highly polluting fuels to recover the local air quality (Article 38).
- The law instructs river-sea direct link ships to use standard diesel oil and ocean vessels to use fuel oils that meet the air pollutant control requirements (Article 63).
- The law includes provisions on heavily polluted weather and air pollution prevention and control in the heavily polluted regions. The relevant provinces and municipalities can carry out cross-regional law enforcement (Article 92) and conduct an environmental assessment in the industrial zones that may cause heavy pollution at both local and regional levels and report the information on time (Article 89). The law also includes provisions to stop or limit the production of the industries and restrict the number of automobiles in the area and other measures (Article 96).

2.2. National processes of and approaches to specifying and establishing BAT (or similar concepts)

There is no reference to BAT documents in the policies and practices in China. The processes of specifying and establishing environmental policies in China are conducted under the Ministry of Ecology and Environment (MEE), formerly known as the Ministry of Environmental Protection (MEP). In the Division of Regulations and Standards of MEE, experts review previous literature and collect relevant environmental data to analyze the effectiveness of the current laws and policies. The discussion is made among the experts during which the initial draft of the environmental legislation or policy is prepared and later submitted to the Standing Committee for consideration. Once the Standing Committee approves the draft, it is released to the public via the National Congress's website for public opinion. Anyone can submit their opinions and suggestions to the legislation and policies, and their opinions are considered in the next Standing Committee executive meeting. The amended draft is discussed during the meeting and is released again to the public for soliciting opinions. The process will continue one more time until the second draft is amended after considering opinions from the public and experts. Then, the draft will be finalized and approved by the government.

Flowchart 1 illustrates the process of specifying and establishing environmental laws and policies in China.

Flowchart 1. The process of specifying and establishing environmental laws and policies in China

2.3. Approaches to evaluating the effectiveness of policies and practices of BAT (or similar concepts)

China's national air quality monitoring network includes more than 2,100 air quality stations national wide, including 1,436 stations in 338 cities at or above prefecture level and 96 regional monitoring stations in the countryside. As per the provision in the Atmospheric Pollution Prevention and Control Law (2016), the China National Environmental Monitoring Center (CNEMC) has the responsibility to operate more than 1,436 air quality monitoring stations. The local air quality data, such as PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3, meteorological parameters, and visibility, are synchronized to the CNEMC for enhancing the credibility of the information obtained.

Table 2 provides the national annual average of key air pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3) from 2014 to 2020 while Figure 1 shows the time series of the national average concentration levels of key air pollutants (upper panel) and the number of cities meeting the national air quality standards (lower panel). The air quality monitoring data show that air quality in China is improving since the ambient concentration levels of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO (except O_3) have shown decreasing trends from 2014 to 2020. Similarly, the number of cities meeting the national air quality standards is increasing gradually. In 2014, only 10% of the

cities in China met the national air quality standards which increased to 60% in 2020 (Government of China, 2014). This suggests that the air pollution control laws and policies in China are effective in controlling and preventing air pollution in the country.

Table 2. The mean annual concentration of the major pollutants national wide

Pollutants*	Unit	2014**	2015***	2016	2017	2018	2019****	2020
$PM_{2.5}$	$\mu g/m^3$	62	50	47	43	39	36	33
PM_{10}	$\mu g/m^3$	105	87	82	75	71	63	56
O_3	$\mu g/m^3$	140	134	138	149	151	148	138
SO_2	$\mu g/m^3$	35	25	22	18	14	11	10
NO_2	$\mu g/m^3$	38	30	30	31	29	27	24
CO	mg/m^3	2.2	2.1	1.9	1.7	1.5	1.4	1.3

Notes: *$PM_{2.5}$, PM_{10}, SO_2, and NO_2 are measured in annual average concentration, while CO and O_3 are measured in the 90th-percentile value of the mean daily value of the maximum 8-hour readings.

**2014's mean annual concentration is based on 161 APL (at or above the prefecture-level) cities including 74 cities at Stage I and 87 at Stage II that enforced the new ambient air quality standards

***2015-18's mean annual concentrations are based on all 338 APL cities that enforced the new ambient air quality standards

****2019-20's mean annual concentrations are based on all 337 APL cities that enforced the new ambient air quality standards. Since Laiwu City merged with Jinan City in 2019, the number of APL cities changed from 338 to 337.

Data source: Ministry of Ecology and Environment of China, Available at: https://www.mee.gov.cn/hjzl/dqhj/cskqzlzkyb/

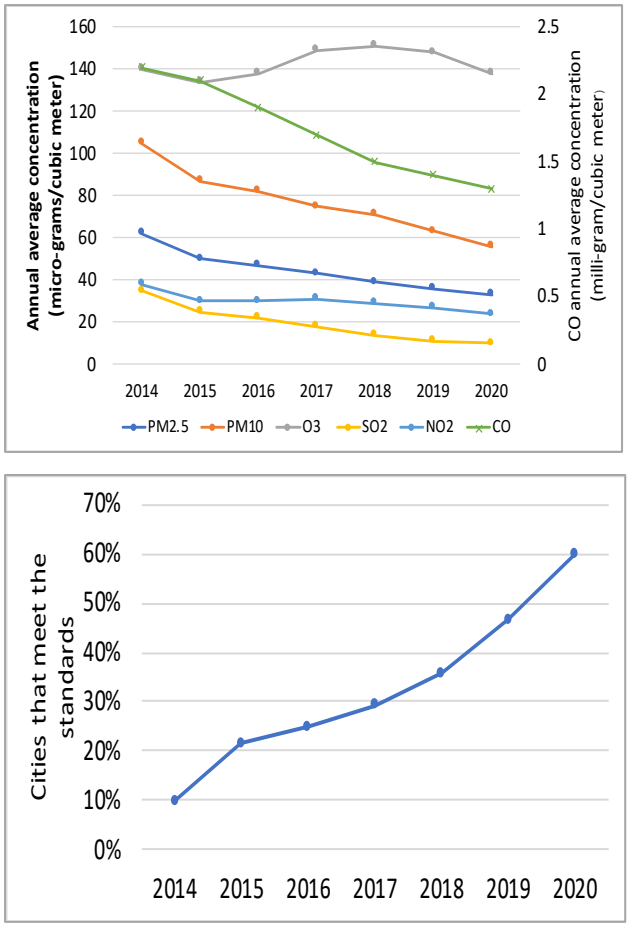

Figure 1. Annual average concentration trends of the key pollutants in the APL cities from 2014-20 (left panel) and increasing trends in the number of cities that meet the national air quality standards (right panel)

Data source: Peking University News, Available at: https://news.pku.edu.cn/jxky/247def43de89468e9064ceef5ff6ef74.htm, and Leung F. (2021), Available at: https://earth.org/how-china-is-winning-its-battle-against-air-pollution/

For the evaluation of the effectiveness of air pollution control and prevention technologies, 15 indicators are developed allotting some points to each indicator, with a total of 100 points for all indicators. The OECD (2018) report provides a list of indicators with corresponding points for each indicator and marking criteria, shown in Table 3.

Table 3. Evaluation Criteria for Air Pollution Prevention and Control Technologies

Indicator	Maximum Points	Marking Criteria
Rationality of technological process	5	The process shall be short and complete, with high optimization of component integration, and the process design shall be reasonable. Unreasonable processes will receive 0 points.
Applicability and effectiveness of	5	The technology shall be suitable for the treatment of industry-specific pollution and can effectively remove characteristic

technology		pollutants. Inapplicable technologies will receive 0 points.
Innovation and progressiveness of technology	15	The technology shall be technologically innovative partly or as a whole, with its innovations reaching an internationally advanced level. Out-dated or obsolete technologies will receive 0 points.
Effect on reducing pollutant emission	8	The technology shall have fair effects on removing characteristic pollutants and can meet the related standards steadily. Its total removal amount shall be higher than that of similar technologies. A technology without obvious effects will receive 0 points.
Effect on controlling secondary pollution	5	In the process of pollution treatment, there shall be no transfer or diffusion of potential pollutants caused by the phase change or addition of substances. A technology that causes secondary pollution will receive 0 points.
Effect on solving industry-specific pollution	6	It can completely solve critical issues of industry-specific pollution as a whole and play a key role in industry-specific pollution treatment. A technology with poor effect will receive 0 points.
Maturity and practicality of technology	10	The technology has a good industrialization level of its technological achievements with extensive engineering applications, and its practicability has been proved through engineering practices. A technology without practical engineering applications will receive 0 points.
Economic feasibility	8	On a comparable basis, its overall unit construction cost and operating cost (expenses) shall be relatively low, and its application shall be economically feasible. A technology that severely deviates from the average market cost will receive 0 points.
Energy and resource conservation	5	Less construction space shall be occupied for the technology application, and fewer resources and energy shall be consumed during the facility's operation. During the process of pollution treatment, the recycling or reuse of resources and energy can be realized. A technology that is incapable of energy and resource conservation will receive 0 points.
Stability of facility operation	5	The facility shall be in stable working operation and shall be able to realize given parameters with minimal instability and failures. A technology that fails to operate stably will receive 0 points.
Usability of facility operation	5	The level of facility automation shall be high; the operations shall be simple, convenient, and easy to control. A technology that has extremely complex operations and is difficult to be controlled will receive 0 points.
Market demand and prospect	7	The market demand of the technology shall be high, and it shall have a good market prospect for its application. It is a technology much needed currently by the market. A technology that has no market prospect for its application will

		receive 0 points.
Promotion of technology	9	The technology has been promoted and widely used, and its owner has an effective promotion strategy and decent promotion capabilities. A technology that cannot be promoted effectively will receive 0 points.
Comprehensive strength of the supporting institution	7	Supporting (owner) institution shall be a medium to large company, a listed company, or with well-rounded strengths in R&D, marketing, manufacturing, engineering, and internal management. The institution that has no such basic strengths will receive 0 points.
Total points	100	Each expert will rate a given technology by adding up points from all indicators. A technology's final score will be an average of the total scores from all experts. A ranking of all technologies will then be done based on the final averaged scores.

Source: *Adapted from the OECD report (2018), Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution (Activity 2: Approaches to Establishing BAT Around the World)*

2.4. Examples of BAT (or similar concepts) implementation in air pollution control and management

- **Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs)**: The GATPPCs are non-binding guidelines for providing technical guidance for facilitating the enforcement of Emission Limit Values (ELVs). Table 4 provides a list of GATPPCs developed by China from March 2010 to May 2021. The structure of the GATPPCs varies according to the emission sector. In general, GATPPCs present the Emission Limit Values (ELVs) of the concerned sector, as well as a list of available technologies for pollution prevention and control. Normally, the GATPPCs include a list of evaluation criteria or indicators (as shown in Table 3) for the evaluation of air pollution control technologies. The exact criteria for the selection of techniques to develop a GATPPC depends on a case-by-case basis. However, the development of a GATPPC generally involves an integrated assessment of the variety of raw materials, production processes, pollution prevention and control techniques, environmental management measures in the industry, as well as the overall development of the industry, its resource consumption level and pollution emission level, types of pollutants generated, and enterprises' performance in terms of meeting emission standards, etc.

***Table 4**. List of Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs) in China*

No.	Industrial sector	Month and year of publication	GATPPC No.
1	Mining and Mineral Processing of the Iron and Steel Industry	03/2010	HJ BAT - 3 (on Trial)

2	Treatment and Disposal of Sludge from Municipal Wastewater Treatment Plant	03/2010	HJ BAT - 2 (on Trial)
3	Rolling Process of the Iron and Steel Industry	12/2010	HJ BAT- 6 (on Trial)
4	Steel-making Process of the Iron and Steel Industry	12/2010	HJ BAT - 5 (on Trial)
5	Coking Process of the Iron and Steel Industry	12/2010	HJ BAT - 4 (on Trial)
6	Lead Smelting	01/2012	HJ BAT - 7 (on Trial)
7	Medical Waste Treatment and Disposal	01/2012	HJ BAT - 8 (on Trial)
8	Tanning of Hides and Fur Industry	01/2014	Huangfa [2006] No.38
9	Electrolytic Manganese Industry	12/2014	on Trial
10	Sintering and Pelletizing Process of the Iron and Steel Industry	12/2014	on Trial
11	Cement Industry	12/2014	on Trial
12	Cobalt Smelting Industry	04/2015	on Trial
13	Nickel Smelting Industry	04/2015	on Trial
14	Copper Smelting Industry	05/2015	on Trial
15	Thermal Power Plant	06/2017	HJ 2301 - 2017
16	Pulp and Paper Industry*	03/2018	HJ 2302 - 2018
17	Coking Chemical Industry	03/2019	HJ 2306 - 2018
18	Glass Manufacturing Industry	03/2019	HJ 2305 - 2018
19	Ceramics Manufacturing Industry	03/2019	HJ 2304 - 2018
20	Sugar Industry	03/2019	HJ 2303 - 2018
21	Printing Industry	01/2020	HJ 1089 - 2020
22	Automotive Industry	05/2021	HJ 1181 - 2021
23	Furniture Manufacturing Industry	05/2021	HJ 1180 - 2021
24	Paint and Ink Industry	05/2021	HJ 1179 - 2021
25	Industrial Boiler Industry	05/2021	HJ 1178 - 2021
26	Textile Industry	05/2021	HJ 1177 - 2021

Source: Adapted from the OECD report (2018), Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution (Activity 2: Approaches to Establishing BAT Around the World)

*** Note:** As per the announcement of the MEP in March 2018, the issuance of three guidelines including guidelines for the available techniques of pollution prevention and control of the wood pulping process in the paper industry (No. 81, 2013) shall be abolished.

- **Emission Limit Values (ELVs):** The ELVs are associated with the implementation of the GATPPCs. The emitter entities have to comply with the ELVs. It constitutes a more

overarching document than the Development Guideline for GATPPCs. The development of ELVs involves several stages, such as the proposal stage, the first draft stage, the second draft stage, the administrative examination stage, and so on, up to a total of 22 steps.

- **Integrated, Intelligent, and International Platform for Environmental Technologies (3iPET):** In addition to the GATPPC-based approach, the Foreign Economic Cooperation Office (FECO), MEE, invites a call for proposals on environmentally sound technologies for the prevention and control of pollutants to air, water, and soil through the Integrated, Intelligent, and International Platform for Environmental Technologies (3iPET). The 3iPET is to promote environmental sustainability through technological innovation. Information on the 3iPET is publicly available. The 3iPET is not only specific to industry but also to the type of pollutant that the techniques can prevent and control. More details about the 3iPET is given in Box 1.

Box 1: International, Intelligent, Integrated Platform for Environmental Technology (3iPET)

The Foreign Environmental Cooperation Center (FECO) under the Ministry of Ecology and Environment (MEE) of China sets up the 3iPET (official website http://www.3ipet.cn) for exchange and cooperation in environmental protection technology at home and abroad. 33 domestic hubs and 10 international technology centers have connected with 3iPET for sharing the advanced technologies used in prevention and control of air, water, and soil, as well as other aspects of environmental protection, like energy conservation, emission reduction, and cleaner production.

On the 3iPET website, more than 1,000 innovated environmental technologies are listed including award-winning top 100 technologies (Environmental Protection Technology Contest held by 3iPET). The technologies that show strong application advantages in the industry and advanced knowledge are preferred in the contest. This encourages many small technology centers to invest their attention to improve environmental protection technologies. Moreover, the matchmaking services in the platform connect tech-demanding enterprises at home and abroad to advanced environmental protection technologies. This creates a larger market for the environmental protection industry.

Each year, the International Clean Summit and the 3iPET Annual Conference collaborate in order to promote the exchange and cooperation of environmental protection technologies at home and abroad. A number of special conferences is also held during the summit, which usually consists of analyzing global environmental technology development trends, summarizing annual 3iPET achievements, and technological knowledge exchange.

Source: Norwegian Energy and Environmental Consortium (2018)

- **Bluetech Clean Air Alliance[1]:** In 2015, Bluetech Clean Air Alliance (BCAA) established a Bluetech Award which aims to identify and bring the cutting-edge, advanced, and high-performance international clean air technologies that are financially viable and have proven effective in improving air quality in China. The annual award invites submissions of applications for clean air technologies from across the globe. BCAA has developed a rigorous assessment methodology based on practical, real-life results, and scientific basis. The winning technologies get support from the BCAA in accessing business, research, and governmental resources to help accelerate their rapid application and development in China. Since 2015, more than 300 technologies from over 20 countries have been assessed through the Award. BCAA has established an international network of more than 100 collaborators (Box 2) and provided 28 Bluetech Awards and 14 Bluetech Future Stars in 6 technology fields, namely, monitoring, ultra-low emission control, coal pollution control, indoor air, control of VOCs, and diesel engine pollution control. Many of the award-winning technologies are now being used in China contributing significantly to air quality improvements while also helping in mitigating climate change effects.

- **Air Quality Standards**: China approved the new Ambient Air Quality in 2012, as shown in Table 5 (GB 3095-2012). The current environmental standards specify air quality standards in two functional areas. Class I defines areas that are nature conservations, scenic spots, and other areas that need special protection; Class II defines residential areas, cultural areas, industrial areas, and countryside as well as mixed areas for commerce, transportation, and residents.

Table 5. National Ambient Air Quality Standards of China

Pollutants	Average Time	Class I	Class II
$PM_{2.5}$ ($\mu g/m^3$)	Annual	15	35
	Daily	35	75
PM_{10} ($\mu g/m^3$)	Annual	40	70
	Daily	50	150
O_3 ($\mu g/m^3$)	8-hourly	100	160
	Hourly	160	200
SO_2 ($\mu g/m^3$)	Annual	20	60
	Daily	50	150
	Hourly	150	500
NO_2 ($\mu g/m^3$)	Annual	40	40
	Daily	80	80
	Hourly	200	200
CO (mg/m^3)	Daily	4	4
	Hourly	10	10

Source: Government of China (2016)

- **Five-Year Plan (FYP):** China establishes a series of time-binding targets for major air pollutants every five years. This includes SO_2, NO_x, and NH_3. Binding targets are initially

[1] World Intellectual Property Organization (WIPO)

set at the national level and are later allocated to provincial and municipal governments based on their economic developments, local air quality, and previous progress in achieving FYP. The previous targets were mostly over-achieved, and the 13th FYP (2016-2020) requires 338 major cities to meet at least Class II Air Quality Standards (AQI <100) for 80% of the year. Details of the 14th FYP and a comparison with the 13th FYP are given in Box 3.

Box 2: Bluetech Collaboration Network

- China Association of Environmental Protection Industry – Committee of Vehicle Emission Control
- China Association of Environmental Protection Industry – Committee of VOCs Pollution Control
- Chinese Society of Environmental Sciences – Professional Committee for Pollution Prevention and Control of Volatile Organic Compounds
- Xiamen Environment Protection Vehicle Emission Control Technology Center
- The Chemical Industry and Engineering Society of China – Water Borne Coatings Committee
- China Electric Vehicle Charging Technology and Industry Alliance
- China Highway and Transportation Society
- 3iPET International Platform for Environmental Technology
- TEDA Low-carbon Economic Promotion Center
- China Machinery & Environmental Industry Development Center
- ESCO Committee of China Energy Conservation Association
- IE Expo
- Japan International Cooperation Agency
- Japan External Trade Organization
- IVL Swedish Environmental Research Institute Beijing Representative Office
- Air & Waste Management Association (US)
- US-China Clean Tech Center
- UK Trade & Investment
- Clean Air Alliance UK
- VERT Association (Switzerland)
- Swiss Clean Technology Association
- World Future Council (Germany)
- France Chamber of Commerce and Industry
- Clean Cluster Denmark
- China Culture Desk (Austria)
- Italian Chamber of Commerce
- International Laboratory for Air Quality and Health (Australia)
- Commonwealth Scientific and Industrial Research Organization (Australia)
- New Zealand Trade & Enterprise
- International Council for Local Environmental Initiatives (Republic of Korea)

Source: World Intellectual Property Organization (WIPO)

Box 3: 14th Five-Year Plan (2021-2025) and comparison with the 13th FYP (2016-2020):

The Five-Year Plan (FYP) is a comprehensive policy blueprint that shapes China's economic, social, and environmental developments in the next five years. Since 1965, China has implemented 14 FYPs and the current 14th FYP (2021-2025) has 19 sections and 65 chapters, compared to 20 sections and 80 chapters in the 13th FYP.

The 14th FYP introduces 20 binding indicators on economic and social development. The current FYP focuses on air quality improvement and emission reductions, in particular, the emission reduction of two ozone (O_3) precursors, namely, volatile organic compounds (VOCs) and nitrogen oxide (NO_x) by 10% of their total emissions. The coordinated control of particulate matter ($PM_{2.5}$) and O_3 will be strengthened for effectively curbing the increasing O_3 and eliminating heavily polluted weathers.

Industrial pollution prevention projects are carried out during the 14th FYP. The 850 million tons of cement clinker, 460 million tons of coking capacity, and 4,000 kilns from the non-ferrous industry are undergoing clean product transformation, and 530 million tons of steel production capacity is undergoing ultra-low emission transformation. To effectively regulate VOCs, key industries such as petrochemicals, chemicals, coatings, medicine, packaging, and printing industries are undergoing governance changes and transformation. To cope with climate warming, the 14th FYP has set two binding targets for carbon dioxide (CO_2) and energy consumption.

Table 6. Environmental-related indicators in 13th and 14th Five Year Plans.

Indicator		13th FYP (2016-2020)	Actual Achievements (2020)	14th FYP (2021-2025)	Characteristics
Main air pollutant emission reduction (%)	SO_2	-10			
	COD (for water)	-10		-8	
	NO_x	-15		-10	
	Ammonia nitrogen	-15		-8	
	VOCs			-10	
Cumulative reduction of CO_2 emissions per unit of GDP (%)			18.8	18	Binding
Cumulative reduction of energy consumption per unit of GDP (%)				13.5	Binding
Air quality	Share of days with good air quality in cities at the prefectural level and above (%)	87	87	87.5	Binding
	Reduction of $PM_{2.5}$ concentration that exceeds 35 $\mu g/m^3$ in substandard cities at or above Prefecture-level (%)	18	28.8	10	

Source: Xinhua News Agency (2021), available at: http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm and Xinhua News Agency (2016), available at: http://www.gov.cn/xinwen/2016-03/17/content_5054992.htm

- **Air Pollution Tax:** China enacted a Law on Pollution Protection Tax in 2018, making the major pollutants (SO_2, NO_x, COD, NH_3, VOCs) collectible as an incentive for companies to reduce air pollutant emissions. The air pollution tax varied from 1.2 to 12 Chines Yuan per pollutant equivalent (RMB/Kg) of emissions, making the pollution tax impossible to ignore to the non-compliance who would rather pay the tax than upgrade their polluting facilities. The Jing-Jin-Ji area has been set at the maximum tax amount allowed under the law. Shanghai, Jiangsu, Shandong, and Henan also have a relatively higher air pollution tax. In contrast, Liaoning, Jilin, Anhui, Jiangxi, Fujian, and Northwestern China have employed a minimum tax level within that range (Xiurong Hu et al. 2019)

- **The Air Pollution Action Plan**: China released the Air Pollution Action Plan in 2013. It helped the nation to make significant improvements in its air quality between 2013 and 2017, reducing $PM_{2.5}$ levels by 33% in Beijing and 15% in the Pearl River Delta. In Beijing, this meant reducing $PM_{2.5}$ levels from 89.5 μg/m³ down to 60 μg/m³. The city achieved an annual average $PM_{2.5}$ level of 58μg/m³– a drop of 35%. (Zhang, Laney. 2014)

2.5. Key BAT Technologies (or similar concepts) deployed in transport, industry, and residential sectors

(A) Transport Sector

- **Stringent emission standards for on-road vehicles:** The vehicle emission standards have been stringent six times targeting both heavy and light-duty gasoline vehicles as well as diesel vehicles since the 1990s. The current standards implemented are the China Standard VI which limits NO_x emission by 77% and particulate matter by 67% compared to the previous standards. (Government of China, 2020)
- **Improve fuel quality:** The gasoline standards have been improved in line with the vehicle emission standards. Compared with China Gasoline IV (50 mg/kg sulfur) in 2018, China gasoline III emits much higher NO_x by 36%, CO by 25%, and HC by 13%. According to the National Standards Committee, the consumption of gasoline V from 2020 would reduce NO_x emissions by 300,000 tons each year. (National Energy Administration, 2013)
- **Install Urea-based Selective Catalytic Reduction Converters:** Heavy-duty diesel trucks (HDDT) are required to install urea-based selective catalytic reduction converters to reduce excessive NO_x before exhaust emissions to meet the Emission Standards IV.
- **Install Real Drive Emission Test (RDE):** Vehicles are required to install RDE to meet the Emission Standards VI which greatly improves the emission control level during the actual drive and prevents cheating behavior from exceeding the actual excessive emissions.
- **Promote eco-friendly vehicles:** To achieve long-term sustainability, China has put attention to innovations in green-energy vehicles lately. Beijing is one of many Chinese cities that has embraced electric vehicles. In just eight years, Shenzhen has become the first city in the world to electrify all of its 16,359 public buses, with Shanghai and Hangzhou on a similar trajectory. In the future, taxis, trucks, and other vehicles will be electrified. China has become a leader in electric transit, owning 99% of the world's 385,000 electric buses, a figure that's expected to swell to 600,000 by 2025. Large cities like Shanghai, Shenzhen, and Guangzhou restricted the number of cars on the road and started introducing all-electric bus fleets. (Office of the State Council, 2020)

(B) Industrial Sector

- **Stringent industrial emission standards**: Industries such as iron and steel, cement, brick, glass, and chemical industries have stringent emission standards. The cement plant emissions were 800 mg/m^3 for NO_x and 50 mg/m^3 for particulate matters (GB 4915-

2004), and when the new standards come out in 2014, the emission standards were stringent up by 50%. (State Council, 2013)

- **Use "Ultralow" standards for power plants**: In 2015, China implemented the ultralow standards for coal-fired plants, bringing down emissions by 60% to the level of gas-fired plants by 2020. In just two years, over 70% of power plants operated according to the ultralow standards. (Government of China)

- **Revamp permitting systems**: The pollutant discharge permitting system has been revamped in 2016, followed by a series of administrative regulations that help clarify the rules for polluters about what is legal and what is not legal as well as coordinate better with other environmental regulations (standards, EIA, environmental taxes). The permitting system covers a wide range of subjects, including thermal power, paper, textiles, petrochemical, glass, ferrous and nonferrous metals industries.

- **Install NMVOC emission control facility**: The petrochemical industries are required to install the Leak Detection and Repair (LDR) Programme and cut VOC emissions by 30% by 2017. (Government of China, 2019)

- **Invest in green energy:** To control air pollution in Beijing-Tianjin-Hebei region, China with financial assistance from Huaxia Commercial Bank and World Bank implemented an innovative air pollution control programme in Jing-Jin-Ji region under its Air Pollution Control Action Plan and the 13th Five-Year Plan (2016-2020) for energy efficiency and clean energy. China financed 27 projects worth 1.3 billion USD. This programme helps to reduce coal consumption by improving energy efficiency in the industries and increasing renewable energy supply. It was estimated that about 2.5 million tons of emission reduction of carbon dioxide (CO_2) would be achieved at the end project with a significant reduction in emissions of air pollutants through air pollution control measures, such as installing equipment to remove particulate matters, flue gas desulfurization, and denitrification, replacing coal with natural gas and expanding clean energy vehicles. (People's Daily, 2016)

(C) Residential Sector

- **Replace residential coal with electricity:** Residential regions in China have undergone an energy transition from coal and biomass to electricity and gas. To facilitate this transition, the government has cut down the cost of electric heating for the residents.

- **Strengthen regulations and standards for indoor air pollution:** Building design and construction, indoor decorations, and air conditioning can be significant sources of air pollution. China revised the indoor air pollution regulations to cut down the air pollution emission.

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3. JAPAN

3.1 Overview of national regulations, policies, and similar measures relating to BAT

Japan started realizing air pollution problems in 1890s around industrialized regions and cities. However, in the early 1930s, industrial development was rapid and caused serious air pollution problems. The first statutory limits on particulate matters were established in 1932 in the Osaka Prefecture. Three decades later, the Air Pollution Control Act was enacted in 1968, followed by the total volume control for SO_x standards in 1974 and NO_x standards in 1981. Japan's air quality has gradually improved since then and the pollutant emission limits have been strengthened frequently. Table 7 lists Japan's national regulations and policies since 1962. (TransportPolicy.net)

Table 7. List of national regulations and policies

No.	Name of Law or Policies	Year of Enactment	Purpose
1.	Smoke and Soot Law	1962	To control dust and smoke emissions from factories in designated areas
2.	Basic Law for Environmental Pollution Control	1967	To put forth pollutants' emission responsibility and introduction of environmental quality standards
3.	Air Pollution Control Act	1968	To regulate emissions of soot and smoke, oxides of sulfur, VOCs, and particulates from industries, automobile exhaust, and other business activities
4.	Air Quality Standards	1970	To regulate ambient concentration levels of CO, SO_2, O_X, SPM, and NO_2 (see Table 9)
5.	The Automobile NO_x Law (The Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas)	1992	To regulate the volume of emissions of NO_x from automobiles and establish standards for NO_x emissions from the automobiles registered in a specific area
6.	Environmental Impact Assessment (EIA) Law	1997	To consider environmental protection properly by conducting EIA of large-scale projects
7.	The Automobile NO_x-PM Law	2001	To decrease the concentration of PM as well as NOx from road vehicles in the nonattainment areas.
8.	The offroad vehicle law	2005	To reduce emissions from non-road special motor vehicles

Source: Botta, E. and S. Yamasaki (2020)

Air Pollution Control Act (1968)

Japan enacted the Air Pollution Control Act (APCA) in 1968, which has been amended several times by adding relevant legislations, such as the introduction of national uniform emission control and direct penalty in 1970, strengthening of automobile exhaust gas in1973, introduction of control of asbestos emission from facilities in 1989, measures for hazardous air pollutants in 1996, VOCs emission control in 2006, and BAT control of mercury emission in 2018. The APCA contains 6 Chapters and 37 Articles. The purpose of the APCA is to protect air quality through multiple measures, targeting both stationary and mobile emission sources. (MoE, Japan, 1968)

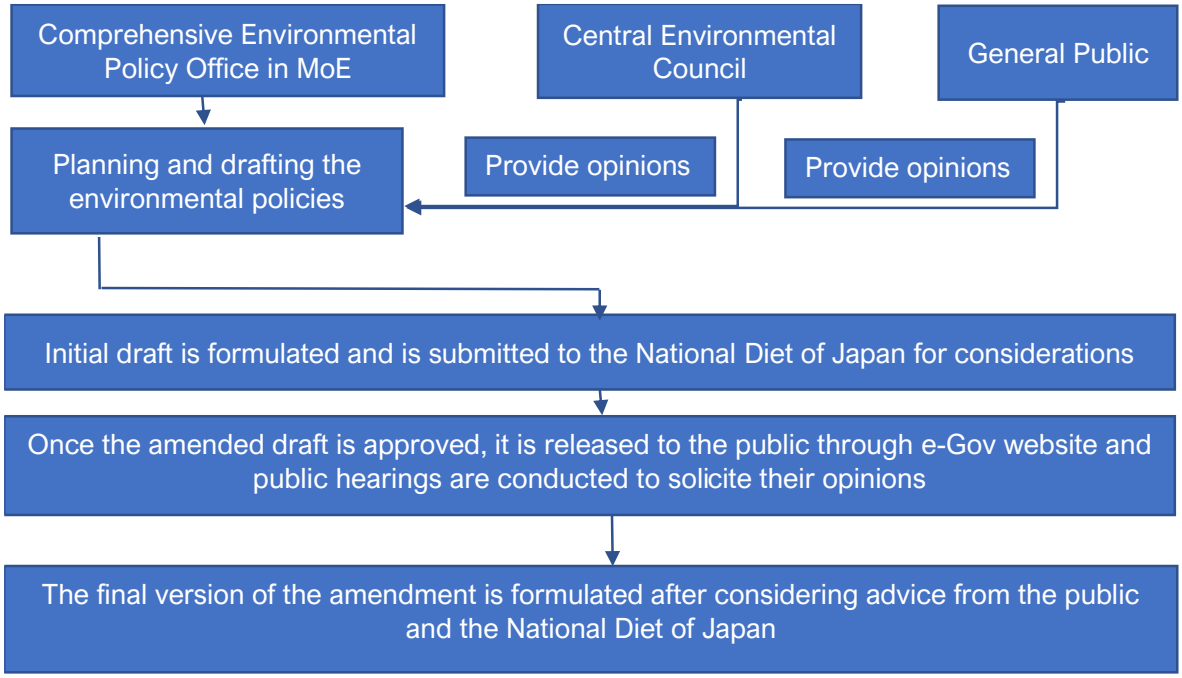
The key points of the Act are as follows:

- The Act covers various air pollutants to regulate, categorizing them into soot and smoke including sulfur oxide and nitrogen oxide, volatile organic compounds (VOC), particulate matter, and other hazardous air pollutants. And this act prescribes emission standards for each type.
- For mobile sources of air pollution, in addition to the APCA, various other laws also regulate emissions of substances from automobiles, which includes the regulation of emissions of nitrogen oxides and exhaust particulate matter.
- The APCA instructs the Ministry of the Environment (MoE) to set the emission limits for vehicles and limits on the amount of regulated substances contained in the fuels.
- The APCA also defines traffic control measures.
- The APCA instructs certain categories of pollutant-emitting facilities not to emit designated substances beyond the emissions standards.
- Although there is no general clean-up obligation, if a large amount of pollutants has been discharged by accident, the discharger must take measures immediately and remedy the damage.
- Part of (not all) Penal Provisions are introduced here. The discharge of soot and smoke emissions that violate the emissions standards can be subject to a term of imprisonment of up to six months, or a fine of up to JPY500,000; failure to comply with an order issued by the prefectural Governor can be subject to a term of imprisonment of up to one year, or a fine of up to JPY1 million; and failure to accurately measure and report emissions can be subject to a fine of up to JPY300,000.
- The APCA sets emission standards and prohibits certain facility operators, such as factory operators, from emitting air contaminating pollutants exceeding the set limits. Regulators have the authority to audit, investigate and inspect possible violations, and issue administrative orders to correct non-compliance.

3.2 National processes of and approaches to specifying and establishing BAT (or similar concepts)

There is no reference to BAT documents in the policies and practices of Japan, except for the introduction of BAT for control of mercury emission in 2018. The process of specifying and

establishing Japan's environmental legislation is conducted under the Ministry of the Environment (MoE). The Environmental Policy Office of the MoE is responsible for planning, drafting, and promoting basic policies related to environmental conservation including air pollution control and management. Experts from the Central Environmental Council (CEC) act as an advisory body to the MoE by reviewing environmental-related laws and providing opinions on them. The general public is also encouraged to submit their opinions through the e-Gov website[2] during the whole process. The initial draft is submitted to the National Diet of Japan for consideration. In order to pass the draft, both the House of Representatives and the House of Councilors need to approve it. Flowchart 2 illustrates the process of specifying and establishing environmental laws and policies in Japan.



Flowchart 2. Process of specifying and establishing environmental laws and policies in Japan

3.3 Approaches to evaluating the effectiveness of policies and practices of BAT (or similar concepts)

Japan's national air quality monitoring network (as of March 2021) has 1,827 air quality monitoring stations across the country, including 1,434 ambient air quality monitoring stations (AAQMS) and 393 roadside air quality monitoring stations (RsAQMS).[3] The real-time local air quality data of $PM_{2.5}$, SPM, SO_2, NO, NO_2, photochemical oxidants (O_x), and non-methane hydrocarbon (NMHC) is synchronized to the National Government data and published in real-time from Atmospheric Environmental Regional Observation System (AEROS) (MoE, Japan, n.d.b). Table 8 provides national annual average levels of key air pollutants from 2010 to 2019 of the Japanese fiscal year (from April to next March), while Figure 2 shows the time series of national average concentration levels of key air pollutants obtained from the AAQMS. The air

[2] https://public-comment.e-gov.go.jp
[3] https://www.env.go.jp/content/900400269.pdf

quality data shows that the national annual average concentrations levels of key air pollutants are decreasing gradually, except for O_X. The photochemical oxidant concentration has remained relatively steady for some years. Air quality data are used for evaluating the effectiveness of air pollution control and prevention policies.

Table 8. The annual average concentration levels of key air pollutants obtained from AAQMS

Pollutants	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
$PM_{2.5}$	$\mu g/m^3$	15.1	15.4	14.5	15.3	14.7	13.1	11.9	11.6	11.2	9.8	9.5	8.3
SPM	$\mu g/m^3$	21	20	19	20	20	19	17	17	17	15	14	12
O_X	ppm	0.048	0.044	0.046	0.047	0.047	0.048	0.047	0.048	0.047	0.047	0.046	0.047
SO_2	ppm	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001
NO_2	ppm	0.011	0.011	0.011	0.01	0.01	0.01	0.009	0.009	0.009	0.008	0.007	0.007
CO	ppm	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3

***Note**: Japanese fiscal year (from April to next March).*

Data Source: (MoE, Japan, n.d.a)

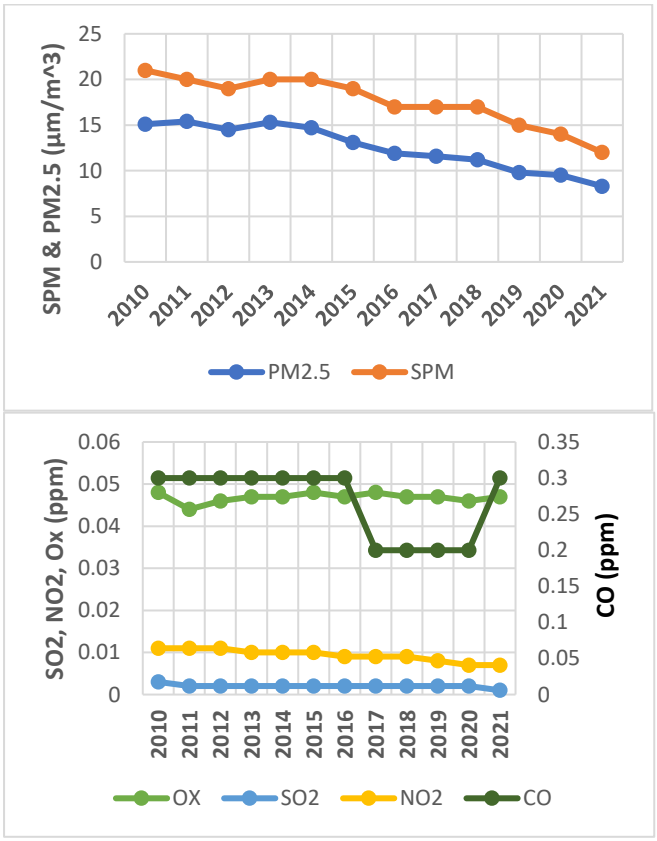


Figure 2. National annual average concentration levels of key air pollutants at AAQMS

Note: years in the figures are Japanese fiscal year (from April to next March).

Data Source: (MoE, Japan, n.d.a)

To evaluate the effectiveness of the air pollution policies and legislation, the government of Japan also conducts a survey every year. The purpose of the survey is to obtain basic data for air pollution control administration by grasping the current enforcement status of the Law. Information is collected about the status of soot and smoke-emitting facilities and specified particulate-emitting works.

3.4 Examples of BAT (or similar concepts) implementation in air pollution control and management

- **Environmental quality standards:** MoE establishes the following environmental quality standards (or air quality standards) under various legislations. Table 9 lists the air quality standards with the year of notification.

Table 9. Environmental Quality Standards in Japan - Air Quality

Pollutants	Average Time	Standards	Unit	Year of Notification
Sulfur Dioxide (SO_2)	Daily	0.04	ppm	16 May 1973
	Hourly	0.10	ppm	
Carbon Monoxide (CO)	Daily	10	ppm	20 February 1970
	8-Hourly	20	ppm	
Suspended Particulate Matters (SPM) – PM_{10}	Daily	0.10	mg/m^3	11 January 1972
	Hourly	0.20	mg/m^3	
Nitrogen Dioxide (NO_2)	Daily	0.04 – 0.06	ppm	11 July 1978
Photochemical Oxidants	Hourly	0.06	ppm	8 May 1973
Benzene	Annual	0.003	mg/m^3	4 February 1997
Trichloroethylene	Annual	0.20	mg/m^3	4 February 1997
Tetrachloroethylene	Annual	0.20	mg/m^3	4 February 1997
Dioxins (PCDDs, PCDFs and coplanar PCBs)	Annual	0.60	pg-TEQ/m^3	27 December 1999
Dichloromethane	Annual	0.15	mg/m^3	20 April 2001
Fine Particulate Matter ($PM_{2.5}$)	Annual	15	$\mu g/m^3$	9 September 2009
	Daily	35		

Data Source: Environmental Quality Standards in Japan (MoE, Japan, n.d.c)

- **BAT for emission standard for mercury**: With the amendment in the APCA in 2018, BAT was introduced for the determination of the upper limit of emission for mercury to comply with the Minamata Convention on Mercury which came into effect in 2017 (Takiguchi and Tamura, 2018).

- **Information for reducing emission exposure to $PM_{2.5}$:** To avoid exposure to $PM_{2.5}$, an improvement is being done in forecasting or predicting $PM_{2.5}$ emission with accuracy and issuance of alerts.

- **Emission control of volatile organic compounds (VOCs)**: In 2005, Japan adopted an amendment to the Air Pollution Law (MoE, 2005) and instructed the MoE to study the VOC emitting facilities, emission standards, and measuring methods. This legislation aims for optimal reduction of VOCs emissions. Details of the VOCs emission control policy of Japan are given in Box 4.

Box 4: Japan's emission control policy on volatile organic compounds (VOCs) (Matsumoto et al., 2015)

Japan has been focusing on reduction of VOCs since early 2000s. Article 17-2 of the Air Pollution Control Act stipulates that both legal emission controls and voluntary approaches should be taken to reduce emissions of VOCs. It was the first time Japan has adopted the "mix" policy structure. Within 10 years, the "mix" policy paid off which successfully reduced the VOCs emissions by 44.1% in 2010 compared to 2000, far exceeding the 30% reduction target.

Regarding the regulatory measures, the amended Air Pollution Control Act (APCA) set the VOC emissions standards for large-scale facilities with VOCs emissions larger than 50 tons per year. The regulated facilities include drying facilities for painting, drying facilities for photogravure or offset printing, drying facilities for adhesives, etc. Moreover, the new APCA instructed the emitting facilities to measure their VOCs emissions twice a year. In 2016, more than 60% of the VOCs emitting facilities have been inspected.

On the other hand, industry associations that formulate voluntary action plans are active at the local level. A relatively high number of companies has participated to collectively reduce VOCs emissions. This includes small and medium-sized companies that are not under the APCA legal control. In 2018, there were 41 industry associations and 25,500 companies that actively participated to reduce VOCs emissions at the local levels. Participants were required to set reduction targets according to their emission status and submit an action plan to the industry association. To incentivize the companies that perform well in terms of air pollution emissions, Japan's biggest printing industry organization, i.e., Japan Federation of Printing Industries (JPFI), certifies the printing companies that produce high quality and low polluting products with the Green Printing Certification Label. The Japanese government also plays a role to support emitting facilities to reach their reduction targets by lowering taxes, financing upgraded equipment, providing funds with lower interests, etc.

3.5 Key BAT technologies (or similar concepts) deployed in transport, industry, and residential sectors

(A) Transport

- **Zero Emissions Tokyo Strategy**: In 2020, the Tokyo Metropolitan Government launched a "Zero Emissions Tokyo Strategy – contribution to net zero CO_2 emission by 2050" intending to contribute to climate change mitigation and air pollution reduction with a focus on reducing emissions of GHGs, SLCPs, and air pollutants from various sectors including transport. The government is working to increase hybrid buses and trucks with over 30 vehicles. Details of the Zero Emission Tokyo Strategy are given in Box 5.

- **Global Facility to Promote Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth (QI-ESG)**: In 2018, the Japan Bank for International Cooperation (JBIC) launched a Global Facility to promote Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth (QI-ESG) to increase financing through private sector partnerships for environmentally friendly infrastructure development (JIBC, 2018). It is expected from the initiative to reduce GHG and air pollution through the use of renewable energy, energy savings, and green mobility solutions and conversion of conventional petrol-fueled vehicles into electric vehicles for sustainable transportation.

- **Hydrogen-powered buses**: In 2017, the Tokyo Metropolitan Government started hydrogen-powered buses in the city. They have zero emissions and actively filter fine particulate matter. (Toyota, 2017)

- **New fuel efficiency standards**: In 2015, new fuel efficiency standards for small cargo vehicles were notified making them over 23.4% more fuel-efficient in 2022 than standards for 2015. (ICCT, 2015)

- **Entry bans on diesel vehicles**: In 2003, Saitama, Chiba, Tokyo, and Kanagawa prefectures had a ban on the traffic of diesel vehicles whose emission levels do not meet the PM standards. Non-conforming vehicles were replaced with the ones that meet the standards or equipped with PM filters certified by the prefectural governments.

- **Promotion of clean fuels**: Clean fuels such as compressed natural gas (CNG) and liquefied petroleum gas (LPG) are promoted to use in electric and hybrid vehicles.

Box 5: **Zero Emission Tokyo Strategy**

In May 2019, Tokyo announced the Zero Emission Tokyo Strategy, which pledged to achieve zero carbon dioxide (CO_2) emissions by 2050. To achieve this ambitious goal, the Bureau of Environment in Tokyo created a way forward, i.e., "The 2030 Targets Plus Actions" to ensure the achievement of existing targets and accelerate the zero-carbon emissions progress. Since there is a lot of synergy between decarbonization and air pollution prevention, the efforts for Japan to reach zero CO_2 emissions would certainly improve the local air quality. The Zero Emission Tokyo Strategy includes making renewable energy the major power source, promoting Zero-Emission Vehicles (ZEV), expanding the use of hydrogen energy, circulating materials without wasting them, etc.

To make renewable energy a major energy source, Tokyo has drawn up a series of targets as well as strategies, such as local production and consumption of renewable energy which does not impose a heavy load on the power grid. It is important for improving energy efficiency and local resilience to tackle climate change. Tokyo Government has created subsidies and incentives in taxation systems to promote installation of solar panels and storage batteries as well as a proper recycling process of solar panels. Additionally, the Government provided support to expand the use of renewable energy in businesses, industries, and households. This includes supporting the expansion of RE100 declaration businesses in Tokyo, strengthening Cap & Trade Programme and Tokyo Green Building, establishing the framework for the power purchase agreement (PPA), and building a business model to promote household-base renewable energy purchases. The use of thermal energy is also promoted in the areas where decarbonized electricity cannot reach, and a mechanism that can distribute decarbonized thermal energy territorially will be built. As many countries have found out the excellent features of hydrogen-energy, replacing hydrogen energy with fossil fuels or natural gas seems to be a "silver bullet" to climate warming in the transport sectors. The Tokyo Government also continues to promote the use of hydrogen energy in all fields.

Table 10. Targets of the Zero Emission Tokyo Strategy

Chapter	Targets	Status quo	2030 Actions	2050 Carbon Free
Renewable Energy	Installations of solar power generation equipment	572-MW (2018)	1.3GW	Renewable source as the major power source
	Renewable energy usage	15.3% (2018)	50%	
	Reduction of energy consumption compared to 2000	24.2% (2018)	50%	
Hydrogen Energy	Adoption of residential fuel cells	62000 (2019)	1,000,000	Full use of CO_2-free hydrogen in all fields
	Adoption of commercial and industrial fuel cells	2,500 kW (2019)	30MW	
	Number of Full Cell buses	43 (2019)	300	
	Number of hydrogen stations	17 (2019)	150	

Data source: Tokyo Metropolitan Government Bureau of Environment (2019, 2021); C40 Cities (2020)

(B) Industry

Promotion of BATs (Best Available Technologies) in power sector: The Federation of Electric Power Companies of Japan (FEPC), including 12 electric power-related companies and Power Producer and Supplier (PPS) companies, has adopted the use of economically

achievable BATs in power generation from Fiscal Year 2013 with a target of approximately 4.2 Mt- reduction of CO_2 per year from power sector and set a nationwide emission factor target at approximately 0.37kg-CO_2/kWh (end-user) by 2030. (FEPC, 2015)

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4. MONGOLIA

4.1 Overview of national regulations, policies, and similar measures relating to BATs

Mongolia enacted the "Law on Air Pollution Fee" in 2010 and the "Law on Air" in 2012 for control and prevention of air pollution in the country.

Law on Air Pollution Fee (2010)

The government of Mongolia approved the "Law on Air Pollution Fee"[4] in 2010, which later was amended in 2012, 2015, 2018, and 2019.

- The purpose of the Law is to regulate the imposition of a compensatory fee on entities for polluting the air and the amount of fees for the action.
- The entities included for the payment of air pollution fee are raw coal mining entities, organic solvent producers, organic solvent importing entities, transport facilities, vehicle owners, owners of major stationary air polluting source, and any person and organization that produce air pollution (Article 4).

Law on Air (2012)

The Government of Mongolia enacted a comprehensive legislation – the "Law on Air"[5] in 2012 for air pollution control and prevention. The Law has been amended in 2013, 2015, 2017, 2018, and 2019. It has 5 Chapters and 28 Articles that provide an overall institutional framework and functions for air pollution control and prevention in Mongolia:

- The law aims to regulate air pollution control and prevention by minimizing the discharge of polluting substances into the air and putting control on it (Article 1).
- The law provides the rights to the Parliament (The State Great Khural) to approve the legislation on air protection including approving of required budget and disbursement of the fund (Article 4) and to the Government to approve the National Programme on Air Protection, establish a National Committee for management and implementation of air pollution reduction policy and action plans, and promote and encourage citizens, business enterprises and organizations to reduce air pollution (Article 6).
- The law provides the provision to establish the State Central Administrative Organization to implement the state policies including rules, regulations, instructions, guidance, and national programmes for air protection, develop standards, provide professional guidance to air quality professional organizations, organize air quality monitoring, adopt instructions and procedures for monitoring and provide professional guidance, create a database on air monitoring, issue the permits to regularize major air polluting stationary sources and approve the list of dangerous polluting substances (Article 7).

[4] Law of Mongolia (2010)
[5] Law of Mongolia (2012)

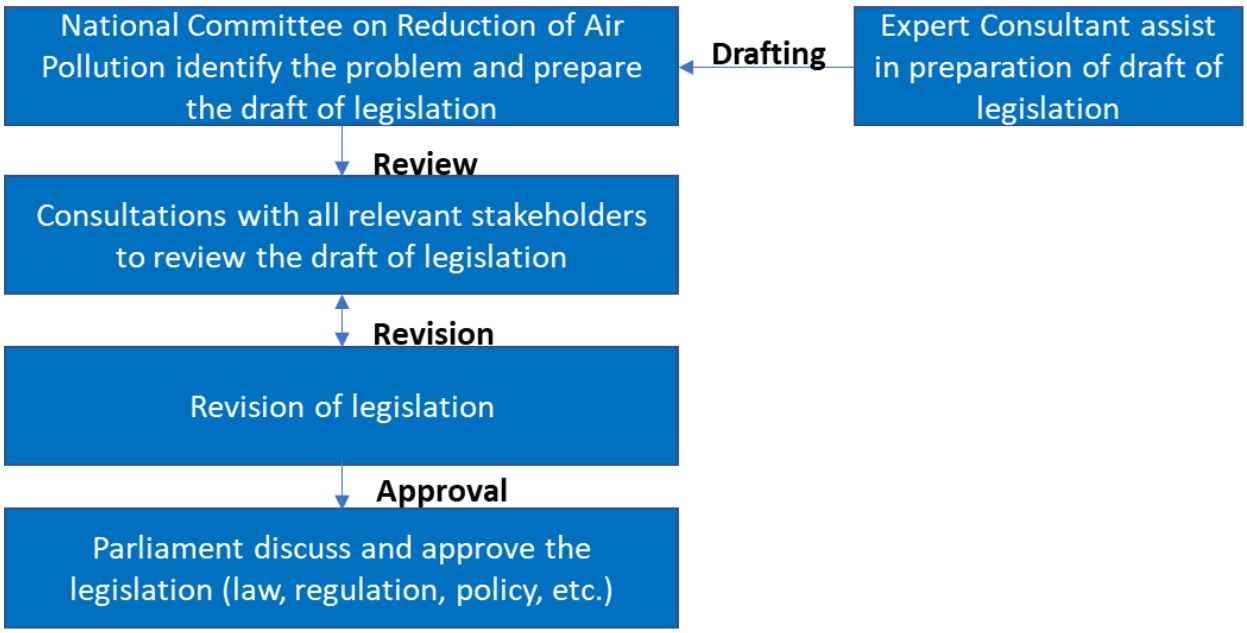
- The law provides the provision to establish the Local Administrative and Self-governing Organizations to implement and monitor air legislation and decisions in their respective territory, develop plans and measures for reducing air pollution using the local funds, ensure continuous functioning of the national air quality monitoring network, monitor sources of air pollution with local professionals, conduct a census on air quality, compile emission data, implement procedures issued by the state central administrative organization for air quality improvement, publish daily air quality data and forecast in cities, villages, and other settlements, and provide insulation materials, improved stoves, semi-coke, and LPG to low-income people (Article 8).
- The law instructs the citizens, business entities, and organizations to comply with the laws and legislations on the air and decisions of local self-governing bodies and state administrative organizations including meeting requirements specified in the rules and procedures on air protection, equip with monitoring devices to monitor air pollutants from sources, and assess their impacts and submit reports to the local branch of the professional unit.
- The law instructs the State Central Administrative Organization to establish a professional unit with duties and responsibilities of conducting air quality monitoring and assessment and branch offices of the professional unit at the local level. The duties of the professional unit are to implement the national programmes on air quality management (Article 10), establish, maintain, and operate the national air quality monitoring network, conduct air quality monitoring and research, and provide data and information on air quality including negative impacts on air, acidic precipitation, ozone layer, and changes in greenhouse gases (Article 11).
- The law provides a list of activities that reduce air pollution which includes expanding energy sources and power transmission to the network of ger districts, establishing air quality improvement zones in ger districts, delivering electricity and services at discounts to households in ger districts, promoting and supporting households, business entities, and organizations to use advanced equipment and technologies for air pollution reduction, providing favorable condition for households, business entities and organizations to move from city to rural areas, promoting the use of electric and geothermal energy for heating instead of raw coal, imposing liability to officials, business entities, organizations and individuals for violation of laws and legislations, and promoting integrated efforts for reducing air pollution (Article 13).
- The law provides the provision to establish air quality improvement zones and impose a ban on the open burning of waste or any activities that cause air pollution including the burning of raw coal and other air polluting substances (Article 15).
- The law provides the provision to develop air quality standards with maximum permissible limits and emission limits from stationary and mobile sources of air polluting substances (Articles 17 and 18).

- Environmental Impact Assessment (EIA): The law provides the provisions on a requirement of EIA before the construction of buildings, industrial, and services activities (Article 21).
- The law provides the provisions for business entities and organizations to conduct air quality monitoring and clean the air (Article 23).
- The law provides the provisions for citizens, business entities, and organizations to pay a fee for generating air pollution (Article 29).
- The law provides the provisions to punish the violators of the law including terminating or changing the production types of the business entity or organization that has repeatedly violated any applicable emissions standard and maximum level (Article 31).

4.2 National processes of and approaches to specifying and establishing BAT (or similar concepts)

The National Committee on Reduction of Air Pollution of the Ministry of Environment and Tourism is responsible for the preparation of the draft of legislation for air quality management including the implementation of short-term and medium-term activities outlined in the National Programme on Air Protection.

Flowchart 3 illustrates the national process adopted by the Government of Mongolia for formulating the legislation on air pollution control regulations and policies. In the first stage, the experts of the National Committee on Reduction of Air Pollution identify the environmental problem (e.g., air pollution) for which legislation is to be made. The experts of the National Committee on Reduction of Air Pollution prepare a draft of the legislation. For the preparation of the draft, the National Committee on Reduction of Air Pollution often engages an expert consultant to assist them in the preparation of the legislation draft. In the second stage, the National Committee on Reduction of Air Pollution organizes consultation workshops inviting all stakeholders including all ministries, representatives of industries, local bodies, and civil society organizations. During the stakeholder consultations, the draft of the legislation is discussed and invites suggestions and recommendations. In the third stage, the National Committee on Reduction of Air Pollution revises the draft of legislation incorporating suggestions and recommendations and circulates it to all stakeholders again for further comments and recommendations. After further revision, the draft of legislation is submitted to the parliament for debate and approval. The parliament approves the legislation and publishes it in the gazette.



Flowchart 3. National process adopted by the government of Mongolia for making air pollution control laws, regulations, and policies

Source: Ministry of Environment and Tourism (2018)

4.3 Approaches to evaluating the effectiveness of policies and practices of BAT (or similar concepts)

The Government of Mongolia established a network of 40 ambient air quality monitoring (AAQM) stations across the country including 18 monitoring sites in Ulaanbaatar. At these AAQM stations, monitoring of six air quality parameters (SO_2, NO_X, CO, O_3, PM_{10}, $PM_{2.5}$) is conducted. The air quality monitoring data are used to evaluate the effectiveness of the air pollution control regulations or policies. The professional units, which were established under the "Law on Air (2012)", have the responsibilities of air quality monitoring and drawing conclusions on the status of air quality and the effectiveness of the air pollution control policies and regulations.

4.4 Examples of BAT (or similar concepts) implementation in air pollution control and management

- **National Programme for Air and Environmental Pollution Reduction (NPRAEP):** The Government of Mongolia approved the National Programme for Air and Environmental Pollution Reduction in 2017. The programme envisages 60 measures, and, among them, over 50 measures are focused on air pollution reduction from various sources. Under this programme, the government has a plan to decrease air pollution by 80% by 2025 by prohibiting the use of unprocessed coal everywhere, except in thermal power plants in Ulaanbaatar. Details of the NPRAEP are given in the Box 6.

Box 6: National Programme for Air and Environmental Pollution Reduction (NPRAEP)

The Government of Mongolia introduced the NPRAEP in March 2017. NPRAEP aims to address the challenges of increasing air and environmental pollution and to ensure a healthy and safe living environment for citizens. The programme is for two phases (first 2017-2019 and second 2020-2025). The most significant target is the reduction of air and environmental pollution by 80% by 2025 which requires $3.7 billion. The government hopes to get internal loans and grants and private sector funding.

Objectives of NPRAEP

1. To implement effective policies
2. To introduce environmentally friendly technologies and a ban on using raw coal
3. To undertake comprehensive measures toward reducing vehicle emissions
4. To define the management, coordination and financing and to set an incentive system for air and environment pollution reduction activities
5. To increase citizen's participation and accountability in the reduction of environmental pollution

Evaluation criteria to achieve the objectives	Groups of actions to achieve evaluation criteria
1. Decrease in the average level of pollutants compared to the level measured in 2016 (baseline) 2. Number of consumers who met the conditions for the night-time electricity tariff 3. Number of households with the technical capacity to use electric heaters of 2.5 kW 4. Number of households with the technical capacity to use electric heaters of 4 kW 5. Number of newly connected households with electricity 6. Number of households with replaced raw coal use with refined fuel 7. Volume of refined fuel production 8. Number of discharged heating boiler where consumers are transferred to centralized engineering supplies 9. Number of people who moved to remote district or countryside 10. A workspace created in the remote district or countryside 11. Supported targeted households 12. Sub-centres with engineering infrastructure 13. No. of the ger districts households that provide technical support to the engineering network 14. Housing supply for ger area households and number of households moved to a new apartment 15. Population covered by improved sanitation 16. Urban population covered by improved sanitation 17. Gas fuelled vehicles 18. Percentage of fuel that meets the euro-5 standard 19. Total no. of seats on a train that may be equipped with electric heating 20. Number of waste processing and power generation plants 21. Decrease in respiratory system illness 22. Reduction of cardiovascular disease 23. Decrease in pneumonia related ilnlness 24. Additional areas planted with grasses in the ger area and public property 25. Percentage of green areas in urban areas	**Highly ranked actions** • Housing developments in ger district (assuming private sector funding for the construction of residential buildings and houses) • Improved building/ger insulation and greening buildings • Coal gasification • Connect consumers to central heating supplies (assuming needed infrastructure is possible and more ger area houses use electric heaters, instead of coal) • Gas supply master plan (assuming this will lead to a change in the energy mix and significantly increase the gas supply) • Environmentally friendly buildings • Revise and enforce environmental measures and standards • Reduce pollutants from vehicles • Environmental monitoring and awareness building **Mid-ranked actions** • Expanding heating supply and extension of a grid. • Use of alternative energy/fuels for trains • Development of standards for home appliances and gas heaters and establishment of 'Green Fund' • Establish environmentally friendly technology and exhibition centre • Green urban planning initiatives • Protect river systems and surrounding areas • Reduction in tariffs etc. • Establish Anti-Air Pollution Fund • Improved institutional and methodological arrangements • Prohibition of raw coal and use of alternative fuel sources • Roads, production and mining • Improvements to sanitation and other facilities • Environmental protection research and development • Improved road fuels and network **Low-ranked actions** • New forms of heating for the ger district • Extension of power transmission/distribution network (to connect over 200,000 households to be able to use electric heaters) • Improved environmental actions: water supply, garbage collection, waste disposal, recycling • Human settlement development

Source: UNDP (2019)

- **Air Pollution Tax:** The Law on Air Pollution Tax in 2010 (amended in 2018) regulates the imposition and payment of air pollution fines and sets four types of fines on coal burning, automobiles, organic substances, and other sources. The amount of fine imposed on extracted raw coal is 1-2 tugriks/kg and on produced or imported organic solvents are 10-30 tugriks per kilogram. While air pollution fine on transport facilities is based on CO_2 emission (g/kg), vehicles are divided into 6 categories; A: 121-180 (g/kg CO_2) - 1800 tugriks; B: 181-250 (g/kg CO_2) - 2100 tugriks; C: 251-350 (g/kg CO_2) - 3500 tugriks; D: 351-500 (g/kg CO_2) -5000 tugriks; E: 501-750 (g/kg CO_2) – 7500 tugriks; F: 751 (g/kg CO_2) or more - 9500 tugriks.

- **Polluters to Pay**: The Law on Air (2012) provides a provision for charging an air pollution fine to the emitters (citizens, business entities, and organizations). The amount of compensation payable depends on the natural resources which have been affected by air pollutants emitted, and the compensation fine is normally about 2 to 5 times the intrinsic value of the resources damaged (M. Aldrich and C. Melville, 2017).

- **National Ambient Air Quality Standards (NAAQS):** The government of Mongolia has approved the NAAQS, as shown in the following table 11.

Table 11. National ambient air quality standards in Mongolia

Pollutants	Average Time	NAAQS
TSP (µg/m^3)	24-hr	150
	1-yr	100
PM_{10} (µg/m^3)	24-hr	100
	1-yr	50
$PM_{2.5}$ (µg/m^3)	24-hr	50
	1-yr	25
SO_2 (µg/m^3)	24-hr	50
	1-yr	20
NO_2 (µg/m^3)	24-hr	50
	1-yr	40
O_3 (µg/m^3)	8-hr	100
CO (ppm)	24-hr	2.6

Source: EANET (2020)

- **Ulaanbaatar Air Quality Improvement Programme**: With the support from the Asian Development Bank (ADB 2021), the government of Mongolia implemented a programme for air quality improvement in Ulaanbaatar by integrating urban, energy, and transport systems. Details of the Ulaanbaatar Air Quality Improvement Programme are given in Box 7.

Box 7: Ulaanbaatar Air Quality Improvement Programme

Programme Description
- Programme: Ulaanbaatar Air Quality Improvement Programme
- Duration: March 2018 to December 2020

- Objectives: to boost public health and living standards by improving the air quality in Mongolia's capital city.
- Activities:
  - increasing the efficiency of the National Programme
  - implementing urgent measures
  - establishing integrated mechanisms of urban, energy, and transport systems
- Program Financing: ADB provided $290 million.
- Rational
  - The average concentration levels of PM2.5, PM10, and sulfur dioxide in Ulaanbaatar are up to 10 times higher than the limits recommended by the WHO.
  - Government of Mongolia (GOM) adopted the NPRAEP in 2017
  - Ulaanbaatar's hazardous level of air quality had impacted public health severely.
  - GOM's initiatives were not working properly

So, GOM and ADB designed a programme to support the economy and reduce inequalities.

Programme Outputs

- Policy actions focused on strengthening the institutional framework for implementing immediate mitigation measures,
- Developed and implemented an education and outreach programme
- Ulaanbaatar's ambient air quality monitoring network was conducted
- Developed an energy efficiency standard for electric stoves and heaters and an emission standard for lower-emitting fuels for cabinet approval
- Key measures on air pollution reduction and health protection implemented
- Mechanisms for environmentally sound and integrated urban, energy, and transport systems implemented.

Key Considerations of the Programme:

- Gender Equity: Ensuring Women's participation (50%), priority for a household headed by women, gender analysis, vaccination of pregnant women and newborns
- Safeguards: the safeguard measures were considered for the environment, involuntary resettlement, and indigenous peoples. The policy actions did not cause involuntary resettlement of or adverse impact on indigenous people
- Evaluation of performance: Relevance, effectiveness, efficiency, sustainability, development impact, the performance of executing agencies, the performance of ADB

Source: ADB (2021)

- **Ban on the use of raw coal**: The Government issued a resolution prohibiting the use of raw coal in Ulaanbaatar city on 15 May 2019 as part of the NPRAEP objectives and introduced the refined coal or upgraded briquettes at a subsidized price close to the price of raw coal in June 2021. Six central districts in Ulaanbaatar are set as pilot regions to prohibit the use of raw coals in households, companies, and industries, except for enterprises with special licenses. Relevant measures were taken. Tavan Tolgoi Fuel LLC which is a state-owned fuel company has established an upgraded refined-fuel factory with an annual production of 600,000 tons, from which over 450,000 tons of briquette coal was fully supplied to ger households. (Jun, 2021)

4.5 Key BAT technologies (or similar concepts) deployed in transport, industry, and residential sectors

(A) Transport

- **Use of gas and diesel combined fuel**: Public transport vehicles were encouraged to shift to gas and diesel combined fuel consumption. 124 big public buses were equipped with gas and diesel fuel facilities. Toxic fume filters were fitted in 1,523 cars, and 18 trolleybuses and duo buses were assembled for public service. The Government set up two centers for conducting a technical inspection of vehicles and 11 vehicles fully equipped with mobile repair service equipment. (EANET, 2020)

(B) Industry

- **Focus on renewal energy**: The Government of Mongolia set out energy production and supply goals for 2015-2030 with a target to increase the renewable energy share to 25% by 2025 and 30% by 2030. (State Great Hural of Mongolia Resolution, 2016)

(C) Residential

- **Master Plan for Ulaanbaatar City**: A master plan for decreasing air pollution in Ulaanbaatar city was approved in 2018. The Government has approved a regulation to cut night-time electricity tariffs for the Gers district households during the cold period.

- **Discount Bank Loans**: Discounted bank loans are provided on products such as electric heaters, insulation materials, improved stoves, and electric cars.

- **Upgraded briquette coal production:** The refined or upgraded briquette coal factory has been operating since November 2018. The factory is predicted to supply about 200,000 households in ger areas in the central 6 districts of Ulaanbaatar city. About 200,000 households are provided indoor carbon monoxide measuring devices.

- **Low power products:** The Government provides households with low power consumption products and incentives like reducing electricity costs to encourage citizens to use electric heating.

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5. REPUBLIC OF KOREA

5.1 Overview of national regulations, policies, and similar measures relating to BAT

Over the past three decades, the Republic of Korea has experienced a rapid industrialization that caused air pollution in the country. The first air pollution-related legislation, i.e., the Clean Air Conservation Act was enacted in 1990, which was entirely amended in 2007 and further amended in subsequent years. The last amendment in the Clean Air Conservation Act was in 2022. The Republic of Korea also passed the Environmental Impact Assessment Law in 1993 and the Act on Integrated Control of Pollutant-Discharging Facilities (or the IPPC Act) in 2015, which was enforced in 2017.

Clean Air Conservation Act (2022)

The Clean Air Conservation Act (2022) in effect has overall 7 Chapters and 95 Articles and aims to prevent air pollution that causes harm to people and the environment by implementing multiple measures. The key points of the Act are as follows:

- The Act instructs the Minister of Environment (MoE) to install an air quality monitoring network and regularly monitor the level of air pollution in the country (Article 3).
- The Mayor or the Governor can issue an alert regarding the level of air pollutants exceeding the set environmental standards and restricting the movement of automobiles and working hours (Article 8).
- The government or business operators need to consider the topographical and meteorological conditions when implementing developmental plans to prevent hindrance to air circulation (Article 10).
- The Act instructs the MoE to establish and implement a comprehensive plan to improve the atmospheric environment (air quality) every ten years which must include the current and future outlook of the air pollutant emissions, setting goals, and measures to reduce air pollution emissions (Article 11).
- The Act instructs the MoE to draft the Permissible Emission Levels (Article 16), conduct a survey of emission sources and estimate emission quantities of air pollutants nationwide for the rational establishment and implementation of comprehensive plans (Article 17).
- The MoE may, in cases of a zone which he or she deems likely to pose a serious harm to the health and property of the residents and the birth and breeding of animals and plants because its condition of air pollution exceeds the Environmental Quality Standards, or a zone densely crowded with places of business within a special measures area, regulate the total quantity of pollutants emitted from the places of business located in such zones(Article 22).
- The Act instructs the emitting entities to obtain a permit or file a report before the emission of air pollutants. To obtain a permit, the entity must satisfy the permissible emission levels set by the MoE (Article 23).

- Based on the emission quantities, businesses are classified into five categories (Article 25).
- The Act instructs the emitting entity to install air pollution prevention facilities if the emission quantity exceeds the permissible emission levels. An operation commencement report to the local government is required to be submitted before the air pollution prevention facility operates (Article 26).
- The emitting entity is required to install a measuring device that synchronizes the measured results with the MoE. The results are later regularly disclosed on the MoE's official website. The agent managing the measuring devices is responsible for assuring authenticity and data accuracy (Article 32).
- The MoE may impose/collect dues to prevent the damage caused to the atmospheric environment by the emissions of air pollutants (Article 35).
- The Act instructs the MoE to regulate sulfur contents in the fuels (Article 41).
- In the case of heavily polluted weather, the MoE/Mayor/Governor may restrict the manufacturer to sell and use fuel if the pollution is deemed to be caused by fuel (Article 42).
- The Act instructs an entity that emits VOCs within a special-measure area or an air quality control area to file a report to the Mayor/Governor. (Article 44).
- The Act instructs automobile manufacturers to comply with permissible levels of air pollutants set by the MoE (Article 46). The state may provide technical and financial support or subsidies to automobile manufacturers for manufacturing low-pollution automobiles (Article 47).
- The Act instructs the automobile manufacturers to obtain certification from the MoE for the exhaust gases and needs to maintain it to meet the permissible emission level (Article 48) and the average level of exhaust gases from each model of the vehicle should meet the standards prescribed by the MoE (Article 50). Motor vehicle manufacturers are required to have inspection by MoE on their in-use motor vehicles operated within the period of emission guarantee for their compliance with permissible emission levels (Article 51).
- The Act strengthens the penalty of non-compliance up to 5% of the total sales, (1) if the manufacturer does not obtain the certification before selling; (2) if the certification is obtained by fraud; and (3) if the vehicles sold are different in details from the certification (Article 56).
- Where the Mayor/Do Governor or the head of a Si/Gun deems necessary to improve air quality or reduce the emission of climate/ecosystem-changing substances in the district under his or her jurisdiction, he or she may limit the driving or operating in the district for the motor vehicles or construction which satisfy the emission levels of air pollutants and order the owner of motor vehicles and construction machinery to take measures including retrofit or replace or recommend early scrapping of motor vehicles (Article 58).

- The Act instructs the MoE to determine and announce an annual target for low-emission motor vehicles to be supplied by a person who manufactures or imports motor vehicles to sell them in a certain quantity (Article 58-2).
- The Act instructs the vehicle manufacturer to install idling control devices to prevent air pollution caused by vehicle exhaust (article 59). The MoE may perform an occasional checkup of vehicle exhaust's air pollutant content (Article 61).
- The Act provides provisions on the penalty of imprisonment of 5-7 years or by a fine not to exceed 30-100 million won for altering emission facilities or operating a business without reporting (Articles 89 and 90).

Environmental Impact Assessment Act (2017)

The Environmental Impact Assessment (EIA) Act was first introduced in 1993 to strengthen the implementation of the Clean Air Conservation Act and weave other environmental protection legislations together. The key points of the EIA Act (2017) are as follow:

- The Act instructs 18 activity sectors that need to conduct an environmental impact assessment (EIA) before obtaining a construction permit. The sectors are mostly infrastructure developments, including urban development projects, energy sources, harbor development, road, railroad, airport constructions, etc. (Article 9 and Article 22).
- The Act and the Act on Environment Health (Article 13) instructs the industrial sites to conduct the "Health Impact Assessment" in addition to EIA (Article 8).
- The Act provides opportunities for residents near the work site to comment on the potential exploitation and development projects through public hearings and meetings before and after the EIA report is drafted and then the EIA consultation is initiated (Article 11 and Article 13).
- The Act increases transparency by publishing the EIA reports and basic data on the information support system of the project proponent for information to the public and the government (Article 66).

Act on the Integrated Control of Pollutant-Discharging Facilities (or the IPPC Act 2015), enforced in 2017

The IPPC Act (2015) aims to promote the development of environmental technologies by integrating the control by medium to reduce emissions of pollutants and establishing a system under which the best techniques or technologies for pollution control can be applied to meet the environmental standards of each business entity.

- The Act instructs the state to implement policies for systematic control of discharging facilities, promote the development of the best available techniques (BAT) and apply those in industries to reduce the emissions of pollutants, including air pollutants (Articles 3 and 26).
- The Act instructs the MoE to introduce technically and economically applicable control techniques (best available techniques or BATs) in designing, installing, and operating

discharging facilities that can effectively reduce the discharge of pollutants (Article 24). The MoE may conduct a survey on the current technologies for introducing the BATs (Article 25)

- The Act instructs the MoE to promote the research and development of technologies, distribute BATs, and the MoE may provide subsidies for the research and development of technologies (Article 26).
- The Act instructs the MoE to establish and operate an integrated environmental permit system to electronically process applications filed for a permit or a permit for modification (Article 28).

BAT Reference Documents (BREFs)

The Republic of Korea has developed BAT Reference Documents (BREFs) for the following industrial sources, as listed in Table 12.

The published BREFs can be downloaded at the website of the Integrated Environmental Permission System (http://ieps.nier.go.kr).

Table 12. Numbers of BAT and Associate Emission Level (AEL) in BREFs

#	Sector	BREFs in Published in	Integrated Law Enforced in	Standard	No. Process	No. of BAT			AEL	
						Total	General	Raw material /Process/ Product	No.	No. of Pollutants
1	Power generation and steam	2016	2017	Raw Material	8 including coal	53	14	39	29	7(PM, SOx, NOx, COD, SS, TN, TP)
2	Waste incineration	2016	2017	Raw Material	5 including household waste	56	44	12	49	5(PM, SOx, NOx, CO, HCl)
3	Steel	2017	2018	Process	8 including	127	20	107	23	10 (PM. SOx, NO_X, F, HCl, NH3, COD, SS, TN. TP)
4	Nonferrous metals	2017	2018	Product	5 including copper	98	24	76	11	3 (PM, SOx, NOx)
5	Organic chemistry	2017	2018	Product	41 including ethylene	305	57	248	20	4 (PM, SOx, NOx, CO)
6	Petroleum refining	2018	2019	Process	26 including demineralization	62	33	29	29	7 (PM, SOx, NOx, NH_3, H_2S, CO_2, Benzene)
7	Inorganic chemistry	2018	2019	Product	14 including chloralkaline	79	23	56	8	4 (SOx, NOx, HCl, Pb)
8	Fine chemistry	2018	2019	Product	12 including dyes	159	88	71	4	3 (CN, Benzene, Cr)
9	Fertilizer and N comp.	2018	2019	Product	10 including fertilizers	57	23	34	9	5 (PM, SOx, NOx, NH_3, F)
10	Pulp and Paper	2019	2020	Product	8 including chemical pulp	55	27	28	24	7 (PM, SOx, HCl, COD, SS, TN, TP)
11	Electronic comp.	2019	2020	Product	6 including display	66	34	32	11	6 (NOx, F, CN, HCl, HC, TN)
12	Semiconductors	2019	2021	Product	4 including semiconductors	74	31	43	16	7 (NOx, NH_3, F, HCl, Formaldehyde, TN, TP)
13	Textile dyeing	2019	2021	Process	3 including pretreatment	50	15	35	13	10 (PM, SOx, HCl, COD, HC, Cd, Phenol, COD, SS, TN)

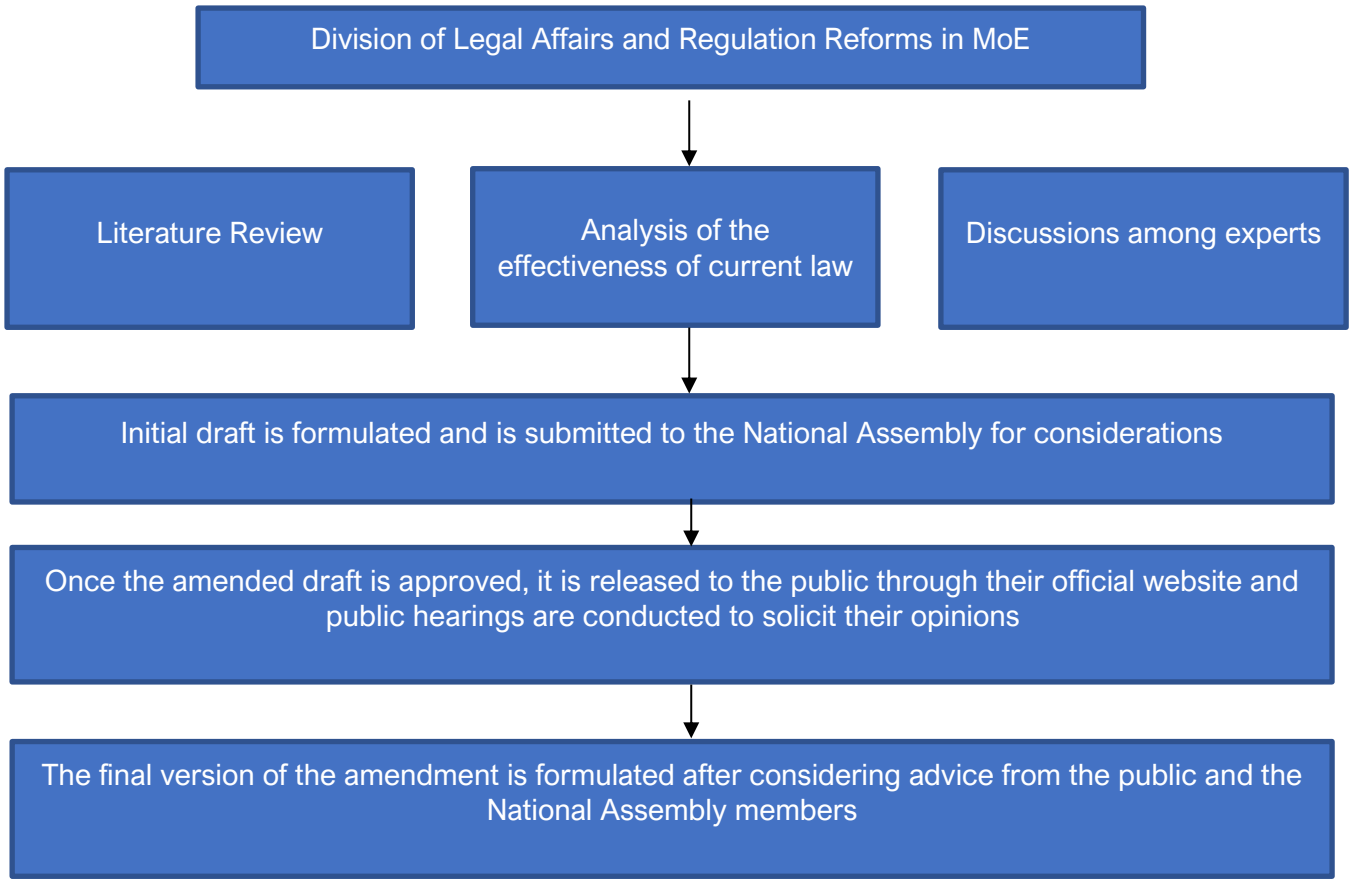
14	Slaughter and meat processing	2020	2021	Process	2	65	30	35	1	4 (COD, SS, T-N, T-P))
15	Manufacture of alcoholic beverages	2020	2021	Process	6	40	17	23	1	5 (PM, COD, SS, T-N, T-P)
16	Plastic Industry	2020	2021	Process	6	52	24	28	1	2 (PM, hydrocarbon)
17	Auto parts equipment manufacturing industry	2020	2021	Process	6	45	19	26	6	4 (Cr, Phenol, hydrocarbon, hydrogen chloride)
18	Boiler systems	2019	2021	Products	3 (boiler system)	34	28	6 (fuel management)	3	3 (PM, SOx, NOx)
19	Waste treatment	2022	2022	Process	13	55	16	39	4	1 (PM)
20	Power generation and steam (II)	2022	2022	Raw Material	8 including coal	32	28	4	6	4 (NOx, Formaldehyde, Hg, Ni)
21	Waste Incineration (II)	2022	2022	Raw Material	5 including household waste	57	28	27	3	3 (Pb, Cr, F)
22	Production of cement	2022	2023	Process	7	29	18	11	1	7 (PM, NOx, Hydrogen Chloride, Pb, THC, Phenol, Formaldehyde)

Source: Integrated Environmental Permission System. Available at http://ieps.nier.go.kr, accessed on July 31st, 2023.

5.2 National processes of and approaches to specifying and establishing BAT (or similar concepts)

The process of specifying and establishing environmental legislation in the Republic of Korea is conducted under the MoE. The Division of the Legal Affairs and Regulation Reforms of the MoE conducts a literature review and gathers relevant environmental data before drafting the initial new legislation or amendment or enacting the environmental laws. The initial draft is submitted to the National Assembly, after which it undergoes deliberation. The National Assembly holds several public hearings after the initial draft is released, and any citizen can submit their opinions online. The final version of the legislation or environmental law is formulated considering the suggestions from the public and the government. It becomes effective as a law through the decree of the President.

Flowchart 4 illustrates the process of specifying or establishing the environmental legislation in the Republic of Korea.



Flowchart 4. National process adopted by the government of the Republic of Korea for making air pollution control laws, regulations, and policies.

Source: *National Assembly of the Republic of Korea*

The approaches to establishing BATs in the Republic of Korea, Articles 24 and 25 of the Act on the Integrated Control of Pollutant-Discharging Facilities (2015), explicitly mention the approach to and process of specifying the BATs. The law defines BATs as techniques comprising of technically and economically applicable control techniques that can effectively reduce the discharge of pollutants, including air pollutants. The techniques must be practically relevant to the business entities with pollutants-reducing capabilities in volume, comparable pricing, ability to reduce or recycle wastes, energy-efficiency, and ability to take preventive measures for control of pollution.

The MoE formulates and distributes the standards for BATs. The data collection of BATs is done by each of the Technical Working Groups (TWGs) which are classified by the type of businesses, consisting of experts representing the MoE, business operators, technique suppliers, and industrial associations. The information on techniques considered for BAT is based on (i) investigation of technical literature on the reduction of pollutants domestically and in foreign countries (such as Europe and the USA), (ii) investigation of environmental management techniques for emission facilities and pollutant emission reduction at a specific installation; and (iii) analysis of the management standards for each type of industry. Facility-specific information is gathered through a questionnaire distributed online to all industrial operators regulated as well as to the TWG members.

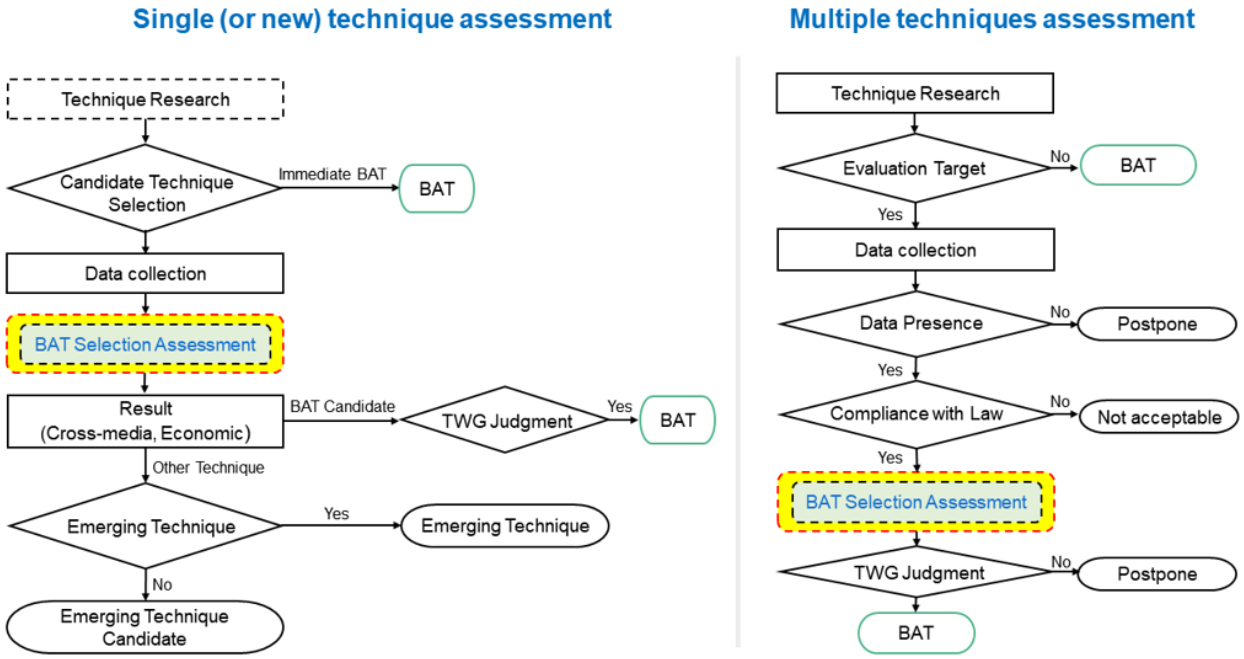


Figure 3. BAT Selection Assessment Process

Source: *NIER, Republic of Korea*

5.3 Approaches to evaluating the effectiveness of policies and practices of BAT (or similar concepts)

The national air quality monitoring network in the Republic of Korea includes more than 610 stations in 162 cities and counties across the country and monitors 11 types of air quality information, such as city air quality, road-side air quality, suburb air quality, national atmospheric background, harmful materials, and $PM_{2.5}$ concentration, etc. The local real-time air quality data, such as PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3, are synchronized to the National Ambient Air Quality Monitoring Information System (NAMIS) and later published on the Air Korea Website (https://www.airkorea.or.kr/web).

To evaluate the effectiveness of air pollution control policies and regulations, air quality monitoring data from the national air quality monitoring network is used. Table 13 showed the annual average concentration levels of key air pollutants nationwide from 2010 to 2019 and Figure 4 showed the time series of those key air pollutants for the same years. The annual concentration levels of PM_{10}, $PM_{2.5}$, NO_2, SO_2, and Pb are showing decreasing trends from 2010 onwards which showed that the policies and regulations related to reducing the concentration levels of these key air pollutants are effective. On the other hand, the annual concentration level of O_3 is showing an increasing trend which means that the policies and regulations regarding reducing the precursors of O_3, such as emissions of volatile organic carbons (VOCs) need attention.

Table 13. Annual average concentrations of the major pollutants national wide

Pollutants	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
$PM_{2.5}$	$\mu g/m^3$	49	47	41	45	46	46	48	44	40	42
PM_{10}	$\mu g/m^3$	51	50	45	49	49	48	47	45	41	41
O_3	$\mu g/m^3$	0.023	0.024	0.025	0.026	0.027	0.027	0.027	0.029	0.027	0.030
SO_2	ppm	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.004	0.004	0.004
NO_2	ppm	0.025	0.024	0.023	0.024	0.024	0.023	0.023	0.022	0.02	0.018
CO	ppm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Pb	$\mu g/m^3$	0.041	0.044	0.047	0.039	0.030	0.024	0.024	0.019	0.018	0.020

Data Source: Air Korea, Atmospheric Environment Monthly/Annual Report

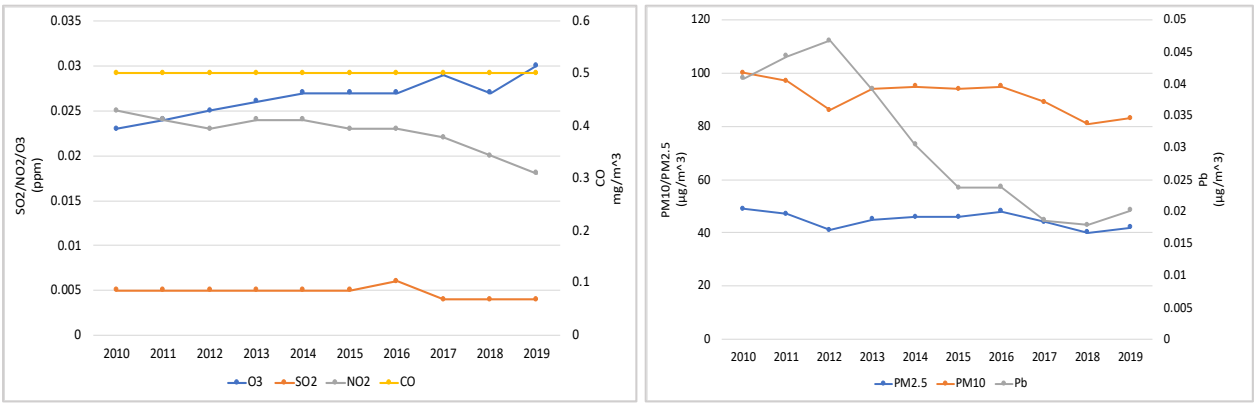


Figure 4. Annual average concentration trends of key air pollutants in the Republic of Korea from 2010 – 2019

(Gaseous air pollutants in the left panel and particulate matter (PM) in the right panel).

Data Source: Air Korea, Atmospheric Environment Monthly/Annual Report

Evaluations of BATs are also done through a combination of preventive, process-integrated, and end-of-pipe approaches. The evaluation of BATs includes investigation based on (i) information provided by industries and experts of the TWGs; (ii) basic data analysis as well as close investigation and analysis of emission status of pollutants relevant to each BAT; and (iii) a detailed results of emission impact analysis. The evaluation of BATs is done considering technical, environmental, and economic aspects, with a strong focus on environmental quality, such as the environmental impacts of various techniques in the areas surrounding the industrial installations.

5.4 Examples of BAT (or similar concepts) implementation in air pollution control and management

- **Cap-and-Trade System:** The Seoul Metropolitan Area (SMA) has implemented the Cap-and-Trade System of air pollutants since 2008. Yearly emission allowances (NOx, SO_x, and TSP) are allocated to both large- and low-emitting entities, requiring them to restrict their emissions within the allowance while allowing them to trade surplus allocations. By 2013, the cap trade system affects 6% and 23% of the NO_2 and SO_2 emissions in SMA.

The fines for exceeding their allocations are 285,000 KRW (approx. $223) per ton of NO_2 and 180,000 KRW (approx. $140) per ton of SO_2. (OECD, 2020)

- **Comprehensive Plan on Fine Dust Management**: The Republic of Korea established a Comprehensive Plan on Fine Dust Management with an ambitious aim of lowering the annual $PM_{2.5}$ annual average level by 35% or more by 2024. This corresponds to achieving the average level of 16 $\mu g/m^3$ in 2024, compared to 26 $\mu g/m^3$ of 2016. For this, emission cap regulation has been expanded to the nationwide-scale and reduction of fine dust from coal-fired power generation. Details of Comprehensive Plan on Fine Dust Management are provided in Box 8.

Box 8: Comprehensive Management Plan on the Fine Dust Management (2020-2024)

The government of the Republic of Korea finalized a Comprehensive Management Plan on the Fine Dust (2020-2024) in November 2019 which presents the fine dust policy direction. The plan is statutory under the Special Dust Special Act, which inherits and strengthens existing measures established in 2017 and 2018. The plan consists of 42 major tasks and 177 sub-tasks in five areas, namely, (1) domestic reduction, (2) international cooperation, (3) national health, (4) policy base, and (5) communication and public relations. It aims to reduce the level of $PM_{2.5}$ by more than 35 percent compared to 2016 by 2024 and to improve the annual average concentrations of fine dust nationwide from 26 $\mu g/m^3$ observed in 2016 to 16 $\mu g/m^3$ in 2024. Seasonal management systems such as limiting the operation of class 5 vehicles in high concentration periods (December – March) will be implemented and operations of old coal power plants will be gradually stopped. Management of emission sources will be strengthened by expanding the total emission system of Air Quality Control Zone, and old diesel vehicles will be reduced. Sector-wise emission reduction targets for the fine dust illustrated in the plan are given below in Table 14.
Source: *Ministry of Environment, Republic of Korea (2019)*

Table 14. Target and Key Measures

Target: Lower Annual Average Concentration of PM2.5 by 35% or more from the level of 2016 * PM2.5 Annual Average Level (Nationwide) :26 $\mu g/m^3$ in 2016 to 16 $\mu g/m^3$ in 2024		
Domestic Emission Reduction	Industry	- Expand total emission cap regulation nationwide - Strengthen regular check and inspection of business facilities
	Transportation	- Increase supply of low-emission vehicles, reduce old diesel vehicles - Strengthen control on ships and ports - Strengthen control on old construction machinery
	Power Generation	- Reduce fine dust from coal-powered generation

		- Promote transition to eco-friendly energy (mid- to long- term)
	Agriculture Daily Surroundings	- Strengthen control on livestock industry environment - Increase supply of low-NOx boilers
Public Health Protection	Public Health Protection	- Implement Fine Dust Seasonal Management System during highly polluted period - Strengthen management of indoor air quality
International Cooperation	East Asia Air Quality Cooperation	- Promote joint agreement on reducing fine dust in the region - Promote more practical collaborative projects
Policy Base & Communications	Scientific Approach, Practices, Public Participation and Communications	- Implement multi-ministerial R&D projects to solve fine dust issues - Reach consensus in the society through participation and deliberation

Source: *Ministry of Environment, Republic of Korea (2023b)*

Box 9: Fine Dust Seasonal Management System

The Seasonal Fine Dust Management System aims to mitigate the intensity and frequency of high-concentration fine dust during a period when fine dust concentration is anticipated to be high. It is a stronger measure than the usual responses which simultaneously protect the citizen's health. The system was introduced at the 3rd Fine Dust Special Measures Committee which took place on November 1st, 2019, following the public policy suggestion from the National Council on Climate and Air Quality in September 2019. A total of 28 action tasks were chosen to be implemented, including suspending or capping operations of coal-fired power generation.

The Seasonal Management System stipulates a break-in period from December to March with the amendment of the Special Act on the Reduction and Management of Fine Dust in March 2020. As reported in the 4th Fine Dust Seasonal Management System report (22 May 2023), the national average concentration of $PM_{2.5}$ during the 4th seasonal management system was 24.6 μg/m^3, a 26% improvement compared to the average concentration of the same period before the system was introduced (33.4 μg/m^3, Dec 2018 to Mar 2019).

In addition, during the 4th seasonal management period, Korea experienced 18 more number of "good" air quality days (15 μg/m^3 or less, $PM_{2.5}$), 38% increase compared to the same period before the system was introduced (13 days). On the other hand, the number of "poor" air quality days (36 μg/m^3 or more, $PM_{2.5}$) decreased to 20 days compared to the same period before the system (35 days), showing 43 % of reduction in the poor air quality days.

Source: Ministry of Environment, Republic of Korea (2023b)

- **Seoul Metropolitan Air Quality Control Master Plan:** The Seoul Metropolitan Area government has established a series of concentration targets every 10 years that aim to improve the city's air quality. From the First Master Plan in 2005-14, Seoul was required to

reduce air pollutant emissions by half compared to 2001 levels in 2014. In the Second Master Plan (2015-24), $PM_{2.5}$ and ozone concentration targets were added.

- **BAT-Associated Emission Level (BAT-AEL):** The Republic of Korea established the emission level associated with BATs. To determine usual operating data, it excludes the outliers based on Rosner's test. And then, it calculates the upper limit values and lower limit values associated with each BAT by the classification of business facilities. The MoE, based on the upper limit values, passes the ordinance for the emission limits.

- **Air quality standards:** The Clean Air Conservation Act has formulated ambient air quality standards, as shown in Table 15. The standards were strengthened for NO_2 in 2007, and a new standard for benzene was passed in 2010. The enforcement decree for stringent $PM_{2.5}$ fine dust was passed in 2018.

Table 15. National Ambient Air Quality Standards in the Republic of Korea

Pollutants	Average Time	Standards	Unit
PM_{10}	Annual	50	$(\mu g/m^3)$
	Daily	100	
$PM_{2.5}$	Annual	15	
	Daily	35	
O_3	8-hourly	0.06	(ppm)
	Hourly	0.1	
SO_2	Annual	0.02	
	Daily	0.05	
	Hourly	0.15	
NO_2	Annual	0.03	
	Daily	0.06	
	Hourly	0.1	
CO	8-hr	9	
	Hourly	25	
Pb	Annual	0.5	$(\mu g/m^3)$
Benzene	Annual	5	

Source: Air Korea

- **Environmental Exhibition (ENVEX)**: Since March 1979, the Republic of Korea has annually organized a large-scale International Exhibition on Environmental Technology & Green Energy where hundreds of Korean and global companies working on environmental and green energy technologies exhibit their products. It exhibits environmental technologies on water, air, waste, measurement devices, eco-friendly products, seawater desalination, chemicals, government policies and projects, etc. In the case of air-related products and technologies, it includes harmful gas treatment, flue-gas desulfurization (FGD), denitrification treatment, TMS, indoor air quality improving equipment, and other equipment. While the exhibition of carbon-neutral technologies includes green car industry products, hydrogen, solar energy, wind, hydro and geothermal energy, marine and biogas, etc. In 2021, a total of 243 companies including 210 Korean, 2 Swiss, 1 New Zealander, 7 German, 2 Canadian, 1 Spanish, 5 Japanese, 2 Chinese, 1 British, 4 American, 2

Norwegian, 1 Austrian, 3 French, 1 Dutch, and 1 Indonesian participated in the exhibition. Out of the total items exhibited, 16% items were related to air.[6]

5.5 Key BAT technologies (or similar concepts) deployed in transport, industry, and residential sectors

(A) Transport Sector

- **Stringent emission standards for on-road vehicles**: In 2009, the Republic of Korea adopted California's non-methane organic gases (NMOG) fleet-average system (FAS) for gasoline vehicles. (Park, J.-H. Et al. 2012). Since 2014, heavy-duty diesel vehicle emissions have been regulated under Euro 6, which is even more stringent than Euro 5 for diesel engines. NO_x emissions are required to reduce by 55% from 180 mg/kg to just 80 mg/kg. (The International Council on Clean Transportation (ICCT), 2016)

- **Install Selective Catalyst Reduction (SCR) for diesel vehicles:** With the introduction of stricter permissible NOx level on diesel vehicles in 2014, automobile manufacturers install the SCR to reduce NOx for diesel vehicles which rely on injection of urea solution.

- **Promote eco-friendly vehicles:** In the Comprehensive Action Plan on Fine Dust, subsidies are provided for the purchase of eco-friendly vehicles such as electric and hydrogen-powered cars. In 2017, there were only 83 hydrogen-powered cars on the market in the Republic of Korea. A year later, the market already had 731 cars. By 2020, about 5,843 hydrogen-powered cars were in the market, and there were 70 hydrogen charging stations. (Ministry of Environment, Republic of Korea, 2020 A)

- **Introduce real-driving emissions (RDE) standards:** Despite the strengthening of vehicle emission standards and test methods, the actual emissions from on-road vehicles is still large compared to the emission standards. To reduce the discrepancy, the Republic of Korea introduced the RDE standards in 2016.

(B) Industrial Sector

- **Strengthen regulations for power plants:** The Plant Regulations (Boilers and Power Generations) have been strengthened every year since its establishment in 2000. In 2015, the permissible concentration of NO_x for power plants has been reduced to almost half of the previous year's limit.

- **Methane capture and power generation:** the Republic of Korea has taken steps to prevent methane emissions of 550 m^3 from landfills, which is equivalent to 900,000 tons of CO_2 emissions reduction per year by turning landfill gas into an energy source of 50MW capacity from a landfill gas power generation facility, since March 2007. (KDI, 2017)

[6] ENVEX Environmental Exhibition, Features of ENVEX, Available at: https://www.envex.or.kr/eng/about/features.asp

- **Strengthen the management of fugitive VOCs:** Rules for checking VOC leakage and loss were introduced, and the permissible level of fugitive VOC has been gradually reduced from 2,000 ppm to 500 ppm in 2018-2019. (OECD, 2020)

- **Retrofit the power plants with Selective Catalyst Reduction (SCR) and flue gas desulfurization (FGD):** The government is taking measures to retrofit power plants with SCR and FGD to remove excess NO_X and SO_2.

- **Replace turbines to boost power efficiency:** The government replaces the turbines of several power plants to increase power efficiency and expand the capacity of circulation pumps to reduce emissions.

- **Replace outdoor coal storage facilities:** By 2024, the outdoor coal storage facilities will be replaced by indoor coal storage facilities.

- **Increase the share of green energy**: According to the Comprehensive Action Plan on Fine Dust, the government instructs to decrease the share of coal-fired power plants by evaluating the new coal-fired power plants in the early stage of construction to see if they have the potential to convert the resources into eco-friendly resources in electricity production. The share of renewable energies will increase when implementing this strategy.

Table 16. BATs for Coal-fired Power Plants in the Republic of Korea

BAT No.		BAT	Application rate
15	a	Integrated combustion process ensuring high boiler efficiency and including primary techniques for NOx reduction (e.g. air staging, fuel staging, low-NOx burners (LNB) and/or flue-gas recirculation)	95
	b	Combustion optimisation	86
NOx, NH_3, CO			
16	a	Combustion optimisation	95
	b	Combination of other primary techniques for NO_X reduction (e.g. air staging, fuel staging, flue-gas recirculation, low-NOx burners (LNB))	95
	c	Combined techniques for NOx and SOx reduction	14
SOx, HCl, HF			
17	a	Fuel choice	100
	b	Boiler sorbent injection (in-furnace or in-bed)	18
	c	Duct sorbent injection (DSI)	5
	d	Spray dry absorber (SDA)	-
	e	Wet flue-gas desulphurization (wet FGD)	64

BAT No.		BAT	Application rate
	f	Combined techniques for NO_X and SO_X reduction	32
	g	Wet scrubbing	18
	h	Replacement or removal of the gas-gas heater located downstream of the wet FGD	36
Dust and particulate-bound metal emissions to air			
18	a	Cyclone	32
	b	Electrostatic precipitator (ESP)	91
	c	Bag filter	23
	d	Boiler sorbent injection (in-furnace orin-bed)	18
	e	Dry or semi-dry FGD system	14
	f	Wet flue-gas desulphurisation (wet FGD)	68
Mercury emissions to air			
Co-benefit from techniques primarily used to reduce emissions of other pollutants			
	a	Bag filter	9
	b	Electrostatic precipitator (ESP)	91
	c	Selective catalytic reduction (SCR)	82
	d	Dry or semi-dry FGD system, Wet flue-gas desulphurisation (wet FGD)	68
19	**Specific techniques to reduce mercury emissions**		
	e	Fuel pretreatment	36
	f	Carbon sorbent (e.g. activated carbon or halogenated activated carbon) injection in the flue-gas	5
	g	Use of halogenated additives in the fuel or injected in the furnace	5
	h	Fuel choice	14

Source: Ministry of Environment, Republic of Korea

(C) Residential Sector

- **Replace old boilers**: According to Article 35 of the Special Act on Improvement of Air Quality Control Zone, only certified boilers (class 1 and 2) can be installed for households in the Zone after April 2020.

- **Install air purifiers**: Air purifiers are installed in daycares and elderly care according to the government.

- **Construct monitoring system**: The government constructs a monitoring system for the diseases that are caused by fine dust and establishes a system that will send air pollution alerts to citizens via text message.

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6. RUSSIAN FEDERATION

6.1 Overview of national regulations, policies, and similar measures relating to BAT

The Russian Federation's constitution has ensured the fundamental rights of a favorable environment to every citizen. The Ministry of Natural Resources and the Environment of the Russian Federation is the key state authority with the responsibility to protect the environment. The Russian Federation has adopted more than 4,000 environmental laws and regulations (Saenko and Shiposha, 2022). These environmental legislations have been formulated by different federal laws, governmental regulations and ministerial Acts which are broadly divided into three groups (natural resources, environment protection, and ecological safety provision). These regulations are closely interrelated to each other. Some of the key laws and regulations are briefly illustrated below.

Federal Law (No. 96-FZ) on the Protection of the Atmospheric Air (Air Quality Law) in 1999

For air pollution control and management, the Russian Federation enacted the Federal Law (No. 96-FZ) on the Protection of the Atmospheric Air (Air Quality Law) in 1999. This Federal Law establishes the legal framework for the protection of the atmospheric air, addresses the issues of air quality and air emission limitations concerning the permitting procedure for facilities that emit pollutants, and outlines the control procedures. This Law provides provisions on the prevention of the irreversible consequences of atmospheric pollution on the environment, compulsory state regulation of the emissions and their hazardous physical impacts, completeness and reliability of the information, and mandatory observance of the requirements of the national legislation for the protection of the atmospheric air and liabilities.

The Federal Law No. 96-FZ (Air Quality Law 1999) has 10 Sections and 34 Articles. Key points of the law are as follows:

- Section 1 (Articles 1-2) lays down general provisions.
- Section 2 (Articles 3- 8) is about the management of the protection of the atmospheric air.
- Section 3 (Articles 9-20) is about the organization of the activity in the sphere of the protection of the atmospheric air including the setting of ecological standards of the atmospheric air quality and maximum permissible limits of physical impacts for the purpose of determining the safety criteria for human beings, plants and animals, and protected areas; authorization to the federal executive body for issuing the permits for the maximum permissible limits for emissions of pollutants in the atmosphere by stationary sources for environmental protection; and manufacturing and running of transport and other mobile sources which emits pollutants exceeding the established standards.
- Section 4 (Articles 21-22) is about the state registration of the hazardous impact of emissions and their sources.
- Section 5 (Articles 23-27) is about monitoring the atmospheric air.

- Section 6 (articles 28) establishes the economic mechanism for the protection of atmospheric air including the collection of environmental fines from entities for atmospheric pollution caused by the emissions.
- Section 7 (Articles 29 and 30) determines the rights of citizens, legal persons, and social associations.
- Section 8 (Articles 31 and 32) establishes liability.
- Section 9 (Article 33) is on international cooperation.
- Section 10 (Article 34) establishes the modalities of the enactment of the present Federal Law.

The Law on Air Quality introduces restrictions on emissions of pollutants and divides emissions of air pollutants into three categories depending on their hazardous level: Category I, where a special permit is required; Category II, where a special declaration on atmospheric pollution is required; and Category III, where only reporting the emissions is necessary.

There are some specific, established rules for the design, construction, reconstruction, and operation of objects of various industrial facilities; operation of gas purification; production and operation of transport; incineration, etc.

Ministerial Decrees/Orders for the implementation of Federal Law No. 96-FZ on the protection of the atmospheric air (1999)

- Ministerial Decree No. 373 (2000) validates the Regulation on the state registration of hazardous impact on the atmospheric air and the sources thereof.
- Ministerial Decree No. 182 (2000) is on emissions standards and state registration of pollutants.
- Ministerial Decree No. 31 (2001) validates the Regulation on state control over the protection of atmospheric air.
- Governmental Order No. 641-r (2001) regards the certification of emissions into the atmospheric air from non-stationary sources.
- Order No. 84 (2007) regards the Federal Ecological, Technological and Nuclear Supervision Service validating the Regulation on the modalities of issuing authorization for an emission of pollutants into the atmospheric air.
- Order No. 87 (2007) regards the Federal Ecological, Technological and Nuclear Supervision Service validating the Regulation on the modalities of issuing authorization for an emission and discharge of pollutants.
- Order No. 56 (2007) regards the Federal Ecological, Technological and Nuclear Supervision Service validating the form of authorization for an emission of pollutants into the atmospheric air.
- Regional Law No. 82-Z (2019) is on the delimitation of powers between state bodies in the field of protection of the atmospheric air (2019).
- Regional Law No. 10-RZ (2020) is on protection of the atmospheric air (2020).

Federal Law (No. 7-FZ) on the Environmental Protection (2002)

The Russian Federation passed the Federal Law on Environmental Protection in 2002, which was amended several times in 2004, 2005, 2006, 2008, 2011, 2013, 2014, and March 2022. This law sets the fundamental principles of environmental regulation and provides an overall framework for environmental management including imposing general environmental protection requirements related to the construction and operation of various facilities that may be harmful to the environment. The Federal Law (No. 219-FZ) on Environmental Protection (2022) has 16 chapters and 85 Articles. Some key articles relevant to air pollution control and prevention and BATs are briefly summarized below:

- The facilities that have a negative impact on the environment are divided into 4 categories depending on the impact on the environment, toxicity of pollutants, and type of industries (Article 4)
- The law instructs the polluters to pay for the pollution (including polluting atmospheric air) that negatively affects the environment (Article 16).
- The Law instructs to set the permissible emission standards for a stationary source on the basis of environmental quality standards and its maximum permissible concentrations (Article 22).
- This law introduces the use of "Best Available Technologies (BATs) or Best Existing Technologies (BETs) for the purpose of achieving the standards for environmental protection based on the latest science considering social and economic factors (Articles 1 and 23); provision of providing tax benefits for using the BATs (Article 14); and conducting scientific research for the development of BATs for preservation and restoration of the environment, assessment of negative effects of economic activities on the environment, improvement of environmental protection legislation, creation of norms, state standards and other regulatory documents in the field of environmental protection, etc. (Article 70).

Progress on the development of BATs in the Russian Federation

In the Russian Federation, BAT-based policies for the prevention and control of industrial emissions were introduced in 2014 (enforced in 2015) with the amendments to the Federal Law No. 219-FZ on Environmental Protection and related legislative acts including the Federal Law no. 96-FZ on the Protection of the Atmospheric Air (Air Quality Law, 1999) and the Federal Law No. 7-FZ on Environmental Protection (2002). Law 219-FL establishes the principles of environmental regulation for industrial enterprises. It primarily provides stricter environmental requirements for the enterprises with significant negative environmental impact (NEI), classified as Category I under Law 219-FL. All industrial enterprises in the Russian Federation are divided into four categories in terms of their potential negative impact on the environment. Category I includes facilities that have the most significant negative impact on the environment, i.e. major polluters. The criteria for classifying an enterprise into a specific category are set out in a separate regulatory act (Government Decree No.1029 dd 28 September 2015). All industrial enterprises under Category I are subject to a mandatory transition to the best available technologies (BAT). Under Environmental Safety Strategy of the Russian Federation,

approved by Presidential Decree No. 176 dd 19.04.2017, until 2035, reinforcement of BAT implementation has become one of the main mechanisms for implementing state policy in the field of environmental safety. Moreover, in addition to the reduction of the negative impact of enterprises on the environment, the transition to BAT has opened up new growth opportunities for domestic equipment manufacturers. Approximately 50 information and technical reference books on BAT, and several by-laws were developed from 2015 to 2017 in order to implement the Law 2019-FL in the Russian Federation. The government has started the transition to a technological regulation system with the introduction of BATs which are considered to be legally binding. Per plan, the stages of transition to the technological regulation system are as follows:

Table 16. Stages of transition to the technological regulation system

Period	Work stage contents
2015-2017	• The division of companies into four categories according to the degree of their negative impact on the environment • State registration of working companies and category conferment • The development of BREF Reference documents
Since January 2015	• State regulation measures in the field of environmental protection will only apply to the pollutants included in the list established by the Government of the Russian Federation
2019-2022	• The operators of Category I facilities, with the contribution to the total pollutant emission not less than 60%, are required to apply for an integrated permit (IEP)
Since January 2019	• The coming into force of legal requirements to include mandatory programme on eco-efficiency and environmental protection action plans for Category II facilities into IEP
Until January 2025	• The rest of the facilities will have to apply for an IEP

Source: *Berezyuk, M., & Rumyantseva, A. (2015)*

A list of applications of BATs is available at https://docs.cntd.ru/document/420242884 (as amended on November 1, 2021). The list is in the Russian language. The informal translation of the list is given below:

1. Mining and enrichment of iron ores, production of iron, steel, and ferroalloys, production of products for further processing of ferrous metals;
2. Mining and enrichment of non-ferrous metal ores, production of non-ferrous metals;
3. Oil and natural gas production;
4. Production of coal and petroleum products, processing of natural gas;
5. Mining and enrichment of coal and anthracite;
6. Production of electrical and thermal energy through fuel combustion;
7. Disposal and neutralization of waste, including by thermal methods;
8. Disposal of production and consumption waste;
9. Production of pulp, wood pulp, paper, and cardboard;
10. Production of basic organic chemicals;
11. Production of fine organic synthesis products;
12. Polymer production;
13. Production of the main inorganic chemicals - ammonia;
14. Production of inorganic acids, and mineral fertilizers;
15. Production of solid and other inorganic chemicals - oxides, hydroxides, salts;
16. Production of special inorganic chemicals;
17. Production of other essential inorganic chemicals;
18. Treatment of surfaces, objects or products using organic solvents;
19. Coating metals and plastics using electrolytic or chemical processes;
20. Production of glass, and ceramic products;
21. Production of cement, lime, magnesium oxide, magnesium hydroxide, and magnesium chloride;
22. Production of textile products (washing, bleaching, mercerization);
23. Dyeing of textile fibers, bleaching, dyeing of textile products;
24. Tanning, dyeing, dressing of leathers;
25. Breeding of pigs and poultry;
26. Slaughter of animals at meat processing plants, and meat slaughterhouses;
27. Production of food, beverages, milk, and dairy products;
28. Wastewater treatment using centralized wastewater disposal systems of settlements and urban districts;
29. Mining and production of precious metals;
30. Reduction of pollutant emissions, discharges of pollutants during storage and storage of goods (cargo), reduction of pollutant emissions during coal transshipment;
31. Systems of treatment (management) of wastewater and exhaust gases in the chemical industry;
32. Industrial cooling systems;
33. Handling of overburden and containing rocks;

34. Treatment of wastewater and pollutant emissions in the production of products (goods), work, and the provision of services at enterprises;
35. Improving energy efficiency in the implementation of economic and (or) other activities;
36. Production environmental control and its metrological support; and
37. Elimination of accumulated harm to the environment.

6.2 National processes and approaches to specifying and establishing BAT (or similar concepts)

- To process the implementation of the BAT concept, the Russian Federation has a special BAT Bureau formed from 4 ministries, namely the Ministry of Natural Resources and Environment, the Ministry of Energy, the Ministry of Construction, Housing, and Utilities, and the Ministry of Industry and Trade. The BAT Technical Committee was also formed to standardize the execution of BAT policies in the country.
- The Bureau has 4 goals with a timeline of 25 years (2015 -2040) for the implementation of BAT. The first phase started from 2015 to 2021 for new industrial enterprises to comply with BAT. Then the second phase of BAT is to be implemented by 100 “pilot” enterprises (2021-2026). After that, the emission levels of 300 “pilot” enterprises are to be compliant with the technological parameters of BAT (2026-2033) as the third step. The fourth one will involve all large enterprises (15,000) to be compliant with BAT requirements (2033-2040).

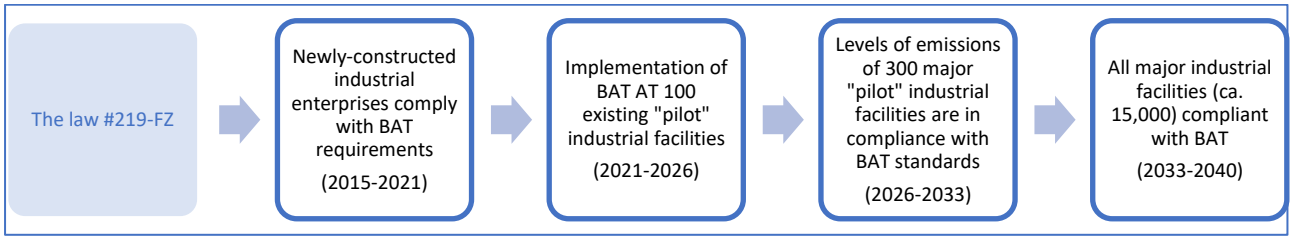

Figure 5. Transition Towards BAT: Timeline

Source: UNECE (2016)

- The Bureau has set the BAT policy to process the activities of implementation of BATs in 8 sectors: 1) Pulp and Paper 2) Fuel and Energy, 3) Chemical, 4) Metallurgy, 5) Petrochemical, 6) Water disposal systems, 7), Food products, animal breeding, and 8) Cement, Ceramics, Glass.
- The Bureau has set the steps of BAT implementation as followings:

1. Adoption of BAT-compliant emission levels;
2. Development of the list of Category I enterprises (subject to BAT compliance);
3. Development of environmental programmes by Category I enterprises;
4. Approval of environmental programmes by Interagency Commission;
5. Positive conclusion by the State;
6. Environmental Expertise after reviewing new construction projects or enterprises after modernization;

7. Integrated environmental permit granting to the enterprise; and
8. Development and publication of industry-specific references.

6.3 Approaches to evaluating the effectiveness of policies and practices of BAT (or similar concepts)

Evaluation of BAT is done by the Technical Working Group (TWGs) interacting with experts, questionnaires, and discussions during meetings and online. TWGs have prescribed five main criteria for the determination of BAT:

- lowest possible negative environmental impacts;
- economic efficiency of its introduction and operation;
- use of resource and energy-saving methods;
- time needed to introduce the technique; and
- successful introduction of the technique in at least two plants that previously had a negative environmental impact.

BAT is evaluated in mainly three aspects:

- Technical aspect: the TWGs evaluate their technical readiness level, safety level, applicability for plants or subsectors that are new, and retrofitting for existing plants (e.g., space availability), interactions with techniques already installed, size, capacity or load from the production lines in relation to the techniques, or the type of fuel or raw materials used in the production process.
- Environmental aspect: environmental assessment of techniques come from companies, sector associations, suppliers or research papers, regarding marker substances or parameters need emissions to water, air and soil, noise energy, raw materials or water
- Economic aspect: the cost in introducing the technique, the cost structure of the technique, running production costs, technical maintenance cost, and revenue and savings on costs.

6.4 Examples of BAT (or similar concepts) implementation in air pollution control and management

A list of BAT applications is already given in section 6.1. The Russian Federation has implemented BATs in the following sectors in accordance to their existing policies:

- **Industrial emissions:** In the Russian Federation, a BAT-based policy to prevent and control industrial emissions was introduced in 2014, determined by amendments to the Federal Law on Environmental Protection-related legislative acts, including the Law on the Protection of the Atmospheric Air.
- **New permissible emissions of hazardous substances (Decree 9 December 2020 No. 2055)**: New permissible emissions of hazardous substances have been introduced on maximum permissible emissions, temporarily permissible emissions, maximum permissible standards of harmful effects on atmospheric air, and permissible emissions of

pollutants into the atmospheric air. The list contains more than 500 types of pollutants, including benzopyrene, ozone, formaldehyde, and phenol (Saenko and Shiposha, 2022).

- **Air protection:** BAT has been used in air protection mechanisms using the following basic requirements:
  - A**n** enterprise can have stationary and\or mobile sources of emission. Stationary sources comprise of those fitted with air protection devices (chimneys, ventilation valves, etc.) and not fitted (storage sites for bulk cargoes, parking lots for cars, etc).
  - Mobile sources include all types of self-propelled vehicles.
  - Provided there are stationary sources of emission, an enterprise must get a permit for the emission of polluting substances.
  - Permit is issued on the basis of a project for maximum permissible emission (MPE) developed by the enterprise.
  - A permit is issued for 5 years by the federal body, and the inspections are carried out according to the schedule. More details of Air Protection Policies are given in Box 9.

- **Law on Conducting Experiment Concerning Establishment of Quotas for Atmospheric Pollutants (2019), enforced in 2020:** The Russian Federation has set temporary quotas for pollutant emissions for 12 major urban industrial areas in the country. The quotas established are based on aggregate calculations of permissible pollutants. Through this legislation, the government is aiming to reduce emissions of air pollutants by at least 20%. The experiment is to be conducted in accordance with a comprehensive plan, including targets, a road map of measures to reduce emissions from the source, and a financing mechanism. Details of the experiment are given in Box 9.

Box 9. Law on Conducting Experiment Concerning Establishment of Quotas for Atmospheric Pollutants (2019), enforced in 2020

Emissions Quota Law

Russian Federation passed a Law on conducting experiments for an establishment of temporary Quotas for Atmospheric Pollutants. It came into effect on January 1, 2020 and remains in force until December 31, 2024. It envisages emissions of atmospheric pollutants in 12 major urban industrial areas of Russian Federation. The quotas established are based on aggregate calculations on permissible pollutants. The Law aims to reduce the number of harmful pollutants by at least 20% in the most polluted areas. The experiment has been conducted in accordance with a comprehensive plan, including targets, a road map of measures to reduce emissions from the source, and a financing mechanism. The highest executive-body official of each constituent component of the Russian Federation is bearing personal responsibility for the implementation of the comprehensive plan and meeting targets.

Structures for the implementation of the experiment:

- A federal air quality monitoring information system provides an information and knowledge-management assistance during the Law's implementation to various government officials, regulated entities, and the public regarding the territories where the experiment is being conducted. The federal government also establishes an operating procedure, including protocols for information exchange and the types of information to be included in the system.
- An interdepartmental council, composed of various federal and state bodies established under the federal environmental-protection regulatory and policy-making body that

coordinate between various government agencies, involved in the implementation of the Law.

Authority of the Government Bodies:
The implementation of the quota-setting experiment is divided between the federal government and the state executive bodies. The federal government will oversee the quality of atmospheric air including performing aggregate calculations, establishing emission quotas, informing the regulated entities, monitoring the public health situation, and determining the list of priority pollutants. Whereas, the state executive bodies are to determine the responsible body for implementing the experiment, work for aggregate calculations to determine the emission quotas for each territory covered in the experiment, draw the list of regulated entities, establish compensation measures, and submit an annual report on the implementation of comprehensive plan.

The process of Setting the Quotas:
The setting of quotas is based on the aggregate calculations with description territory covered in the experiment, a list of pollutants and emission sources, and proposals for allowable limits on emissions. Moreover, the pollutants list is based on their impact on the atmosphere. The quotas are then determined based on the rules set forth by the Russian Federal Service for the Supervision of the Use of Natural Resources. Once the quotas are set, the state executive body of each constituent component of the Russian Federation, within a three-month period, is to amend the comprehensive plans accordingly.

Regulated Entities:
- The Law obligates regulated entities to submit plans and reports for permissible emissions within three months from the date the quotas are set.
- If target is not meet, the compensation measures are applied, and the entity pays for the implementation
- The regulated entities are fully responsible for the implementation.
- The Emissions Quota Law does not include comprehensive economic regulation of air pollutants.

Source: Russian Federation (2019)

6.5 Key BAT technologies (or similar concepts) deployed in transport, industry, and residential sectors

(A) Transport

- Air pollution in the Russian Federation is one of the serious problems associated with the operation of transport. Motor transportation in Russian cities accounts for 40 to 70% of the overall pollutant emissions. Therefore, the estimated impact of vehicles on air quality is an important aspect of urban transport management systems. The Russian Federation has some challenges with air quality due to the transport system (ie. vehicle growth, old vehicles, fuel quality, poor public transport, etc).
- The Government of the Russian Federation has a plan to reduce air pollution by reducing nitrogen dioxide and carbon dioxide emissions from vehicles by a quarter.
- The efforts of the Russian Federation to reduce air pollution from the transport sector in vehicles and rail infrastructure include the Russian Railway's long-term investment strategy to 2025 and the Development of Rail Transport strategy 2030

(https://www.akm.ru/eng/press/the-russian-government-has-approved-a-transport-strategy-until-2030-with-a-forecast-for-the-period-u/)

(B) Industry

- In the Russian Federation, industrial sector contributes to 60% of the country's air pollution. Replacing new equipment with adopting new technologies is a slow process in industries. More than 70% of the country's production assets are more than 25 years old, and the country's environment is significantly affected.
- Environmental policies of the Russian Federation are implemented strictly to reduce pollution. For example, the maximum pollution fine that a company has to pay usually constitutes only a fraction of the cost required to introduce new resource efficiency technologies that would effectively curb pollution in the longer term. The Ministry for Natural Resources and Environment imposed an order in 2018 to confirm that integrated environmental permits will be issued to 300 installations that are considered to be key polluters, contributing to 60% of the total national industrial environmental emissions. These installations will have to submit their applications for permits between 2019 and 2022. The sectors with the highest number of key polluters include municipal wastewater treatment, oil and gas natural exploration, and large combustion plants. About 7,000 other industrial installations are expected to apply for integrated environmental permits by the end of 2024.

(C) **Residential Sector**

- With the Energy Efficiency Action Plan released in 2020, the Russian Federation has taken steps in the residential sector by proposing automated heating controls in new buildings to be required and certain inefficient heating systems to be banned.

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7. SUGGESTIONS AND RECOMMENDATIONS FOR SUBREGIONAL COOPERATION

The countries of North-East Asia are facing serious challenges in dealing with air pollution emitted from transport, industrial operations, power generation, residential, and many other developmental activities. The countries are making sincere efforts in air pollution control and management by implementing a number of control measures to limit emissions from sources. Air pollution follows no political boundary, can easily transport from the source region to distant places and cause harmful impacts. Therefore, considering the transboundary impacts of air pollution, it needs cooperation among the countries of Northeast Asia for making joint efforts in the mitigation of regional air pollution. In this context, a subregional cooperation on advanced air pollution mitigation technologies or BATs could be the way forward. Following are some suggestions for establishing the subregional cooperation among the countries of Northeast Asia:

1. **Establishing information sharing platform:** Every country of Northeast Asia has some uniqueness in the advancement of technologies and policies which are being implemented in various sectors of air pollution control and management. An information-sharing platform may be established where information on the advanced technologies and policies related to air pollution control and management could be shared.
2. **Establishing an experience sharing and learning forum**: An experience sharing and mutual learning forum could be established where countries could share their experiences on air pollution control and management and learn from each other on the advanced air pollution technologies and policies.
3. **Evaluation of BATs**: Some countries of Northeast Asia have established BATs in a number of sectors. For example, Japan has established BATs for mercury reduction and CO_2 emission reduction in power sectors, the Republic of Korea has developed BATs reference documents for a number of industries, and China has developed GATPPCs. A comparative evaluation of these existing BATs in the region could be done under NEACAP, and countries could adopt suitable BATs to use in their countries.
4. **Developing regional guidelines on BATs**: The air pollution emission sources in most Northeast Asian countries are almost the same. Considering the transboundary impacts of air pollution and the determination of countries for air pollution management, it would be a good idea to develop regional guidelines on the advanced technologies (or BATs) and policies. This will result in some uniformity at the regional level for air pollution control and management, and the issues related to transboundary could be addressed efficiently.
5. **Technologies sharing or transfer**: Some countries in the region are relatively advanced in the implementation of technologies and policies, as noted that the pollution level in some countries is declining continuously over the years due to the implementation of technologies and policies. Those technologies could be shared with other countries also.
6. **Capacity building**: Some countries are doing reasonably well in air pollution control and management, whereas some countries are lacking capacities in controlling and managing

air pollution. These countries need assistance in capacity building. The countries that are doing well could assist other countries in their capacity-building efforts.

7. **Establishing a financial assistance mechanism:** It is observed that certain countries have demonstrated commendable progress in the management and control of air pollution, particularly those with robust financial resources. Therefore, the establishment of a financing mechanism to support other countries is deemed beneficial. In this regard, the involvement of both regional and global financial institutions is recommended.
8. **Establishing a crisis management platform**: In some seasons of the year, for example in winter, meteorological conditions favor the accumulation of air pollution at the regional scale. Addressing such a crisis necessitates a regional cooperation in the adoption and implementation of inter-regional crisis management policies.