Annex 2

Stock-taking Study on Potential Priority Areas for CAT II for Discussion at 5th Meeting of Science and Policy Committee of NEACAP

I. Background

1. The 2nd Meeting of NEACAP SPC and TC in June 2020 suggested that the potential priority areas for NEACAP could be divided into Categories I and II in accordance with the first and second Aims and Objectives, respectively, of NEACAP (TOR of NEACAP). Outcomes of Category I meet the first Objective of NEACAP, which is to promote environmental cooperation, including its science, policy, and technical aspects on atmospheric air protection in the transboundary context in the subregion.

- Category I refers to activities that can be started without specific intensive preparatory work and provide immediate benefits for member States. "Policy and technology cooperation" was identified and agreed as the priority area in this Category.
- **Category II** refers to activities which are duly important for building scientific approaches to policy making but **requiring scientific and collaborative preparations as well as a capacity building of experts to initiate the activities**. Methodological research on (i) Emission Inventory, and (ii) Policy scenario and Integrated Assessment Modelling in individual member States was considered to be the potential priority area in this Category, which needs further discussions.

2. Building on this, the SPC-4 in June 2022 suggested the Secretariat to consider preparatory works such as a preliminary stock-taking study on the potential priority areas of Category II to be discussed at SPC-5. The 25th Senior Officials Meeting (SOM-25), which was held in September 2022, approved this suggestion. In this connection, the stock-taking study was developed by the Secretariat, with inputs from resource persons of NEACAP, aiming to support discussions at SPC-5 to be held on 8 September 2023.

3. As the first section of the stock-taking study, the Secretariat proposes potential areas and activities for cooperation among member States under CAT II. Following the suggestion and a summary of each member State's air quality trends and monitoring networks, the stock-taking study proposes a list of emission inventories (EIs) and integrated assessment modellings (IAMs). The list is intended to inform the national experts of SPC about notable EIs and IAMs in the subregion. Lastly, a case study of IAM research collaboration is provided to promote discussions in accordance with the Secretariat's suggestion of potential areas and activities for cooperation at SPC-5.

II. Potential Areas and Activities for Cooperation under CAT II

4. Similar to the outcomes of Category I, outcomes of Category II should meet the second objective of NEACAP, which aims to enhance and further develop information and experience exchange in national and transboundary air pollution matters. To fulfill this objective, the next step for NEACAP should involve identifying and collaborating with institutions that work on the Category II activities. These collaborative efforts may include training and enhancing the expertise of professionals in member States to develop EIs and IAMs. Additionally, NEACAP could produce IAM reports that assess various emission pathway scenarios according to each country's air pollution control policies, while also preparing to achieve the remaining goals and objectives of NEACAP.

5. Furthermore, based on the existing literature published by the academic community in each member country and the collaborative study, such as Air Quality in North-East Asia (AQNEA), following activities under CAT II could be started to provide immediate benefits for member States:

- Conducting capacity building programmes for institutions to effectively assess or address air quality issues;
- Organizing training programmes aimed at enhancing the expertise of professionals in producing IAM reports that evaluate various emission pathways and the capacity of government officials in using IAM reports for evidence-based policies;
- Arranging regular seminars and workshops for modelers, researchers, and policy makers to foster knowledge sharing and exchanging experiences across member States; and
- Collaborating on joint reports that can serve as valuable references for scientific cooperation.

III. Overview of Current Trend: Air Pollution in North-East Asia

National Trends of Air Quality

6. Over the past decade, North-East Asia has exhibited a decreasing trend of air pollution. In China, as shown in Figure 1, the ambient concentration levels of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO have shown decreasing trends from 2000 to 2021. On the other hand, ambient levels of O_3 suggest a subtle increasing trend from 2013 to 2022. According to *the 2020 Report on the State of the Ecology and Environment in China*, 202 out of the 337 cities in China, accounting for about 60% of the total, met the national air quality standards in 2020 (Ministry of the Ecology and Environment of China, 2021). This is a 13.3% increase from that of 2019. With the exception of O_3, the air quality in China has generally improved throughout the past decade according to the Ministry of Ecology and Environment of China (Figure 1).

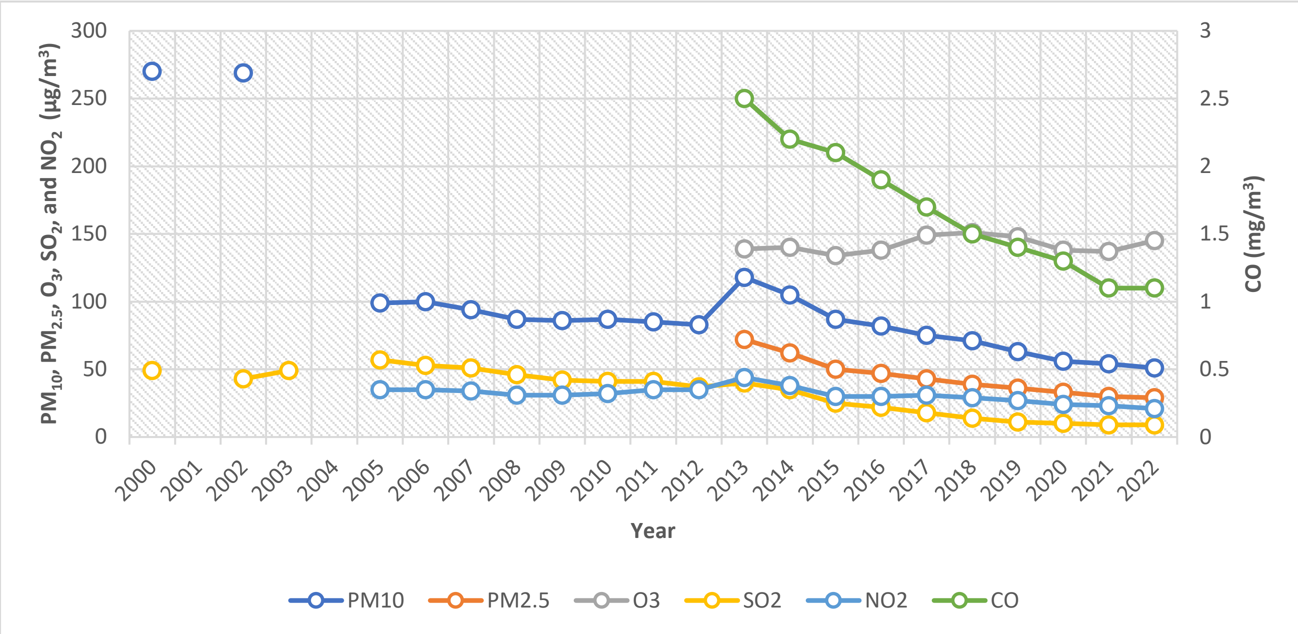

Figure 1. Annual average concentrations of PM_{10}, $PM_{2.5}$, O_3, SO_2, and NO_2 (μg/m^3) and CO (mg/m^3) in China, 2000 – 2022.

Note: 2000, 2002, and 2003 values are mean values of monitored measurements of 343 cities. Values from 2005 to 2012 are mean values of monitored measurements of 113 major cities for air pollution prevention and control. 2013 values are mean values of monitored measurements of 74 cities scheduled to enforce new ambient air quality standards at Stage I. 2013 values are mean values of monitored measurements of 161

cities. Values from 2015 to 2018 are mean values of monitored measurements of 338 cities. Values from 2019 to 2022 are mean values of monitored measurements of 337 cities.
Source: Ministry of Ecology and Environment, *Report on the State of the Ecology and Environment in China*. Available at https://english.mee.gov.cn/Resources/Reports/soe/index.shtml, accessed on July 14th, 2023.

7. In Japan, the average annual concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO in 2021 were 13, 8.3, 2.6, 26.3 (μg/m³), and 0.34 (mg/m³), respectively. As shown in Figure 2, all pollutants exhibit a steady decline from 2000 to 2021. Compared to 2015 values, average annual concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO in 2021 decreased by 54%, 585, 100%, 36%, and 100%, respectively. Figure 2 suggests that Japan's air quality has certainly improved in the past decades in all aspects.

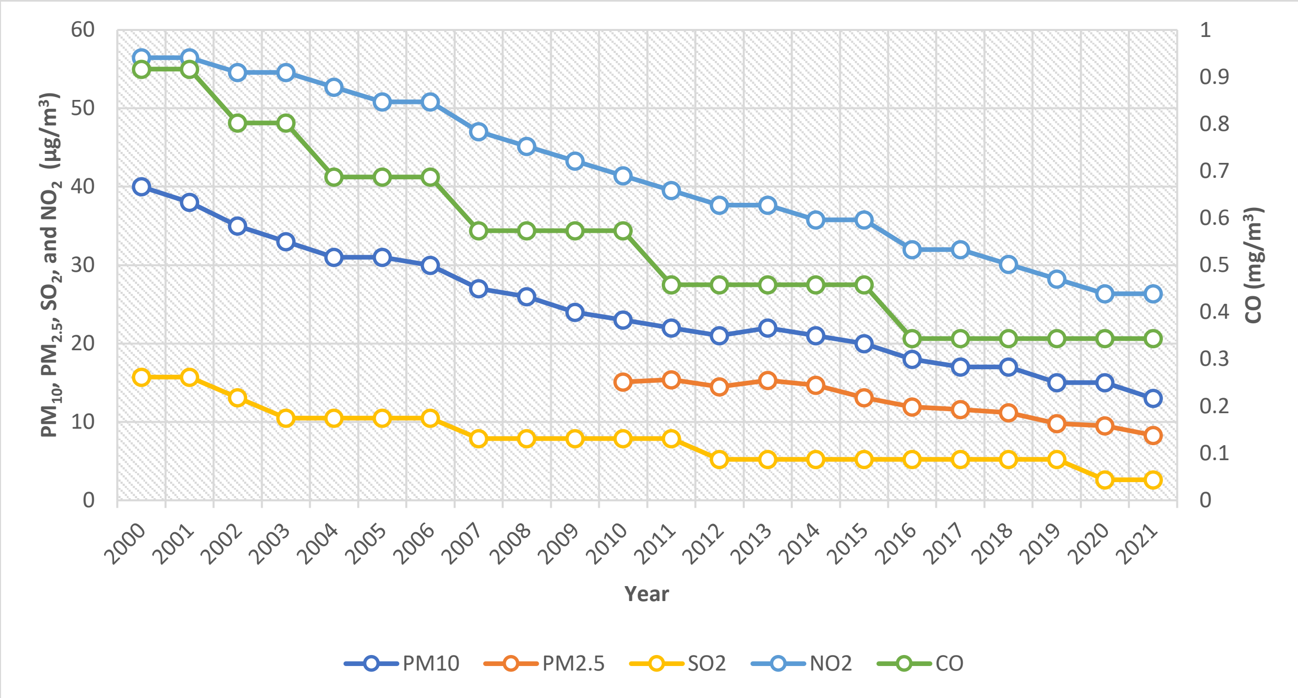

Figure 2. Annual average concentrations of PM_{10}, $PM_{2.5}$, O_3, SO_2, and NO_2 (μg/m³) and CO (mg/m³) in Japan, 2000 – 2021.
Source: Ministry of the Environment, Japan. Available at https://www.env.go.jp/content/000139516.pdf, accessed on July 14th, 2023.

8. In Mongolia, the air quality trend analysis focuses on Ulaanbaatar, which differs from that of China and Japan. While China and Japan have experienced a decline in concentrations of most key air pollutants in the past decade, only the annual concentrations of PM_{10} and $PM_{2.5}$ have shown a decreasing trend in the past decade for Ulaanbaatar. Concentrations of O_3 and NO_2 remained mostly steady from 2011 to 2021. Measurements of SO_2 in the past five years suggest an increasing trend with a record-high of 66 μg/m³ as the annual average concentration in 2021. Similarly, concentrations of CO exhibit an increasing trend in the past decade. Based on the average concentrations of key air pollutants in Ulaanbaatar in the past decade, national efforts to control emissions, particularly, of O_3, SO_2, NO_2, and CO seem to be necessary and immediate.

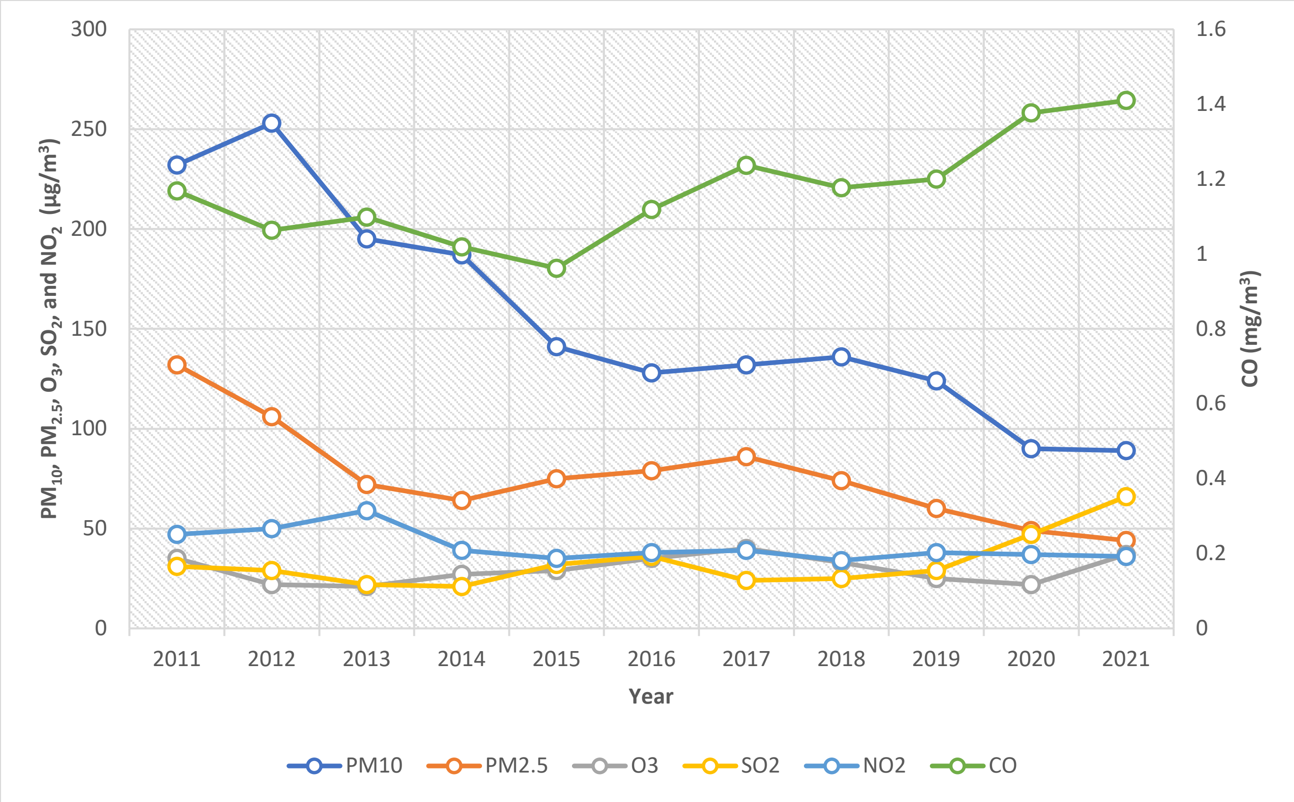

Figure 3. Annual average concentrations of PM_{10}, $PM_{2.5}$, O_3, SO_2, and NO_2 (µg/m³) and CO (mg/m³) in Ulaanbaatar, Mongolia, 2011 – 2021.

Source: Meteorological and Environmental Analysis Department of Mongolia. Available at http://tsag-agaar.gov.mn/, accessed on July 17th, 2023.

9. In the Republic of Korea (ROK), the annual concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO have steadily decreased in the past couple decades, with a concentration of 38, 18, 7.9, 34 (µg/m³) and 0.46 (mg/m³) in 2021, respectively. The evident improvement in the national air quality may suggest that the implemented policies and regulations of air pollution control and prevention are effective. On the other hand, the increasing trend of annual concentration levels of O_3 suggests that further efforts in controlling emissions of volatile organic compounds (VOCs), which are precursors of O_3, are necessary.

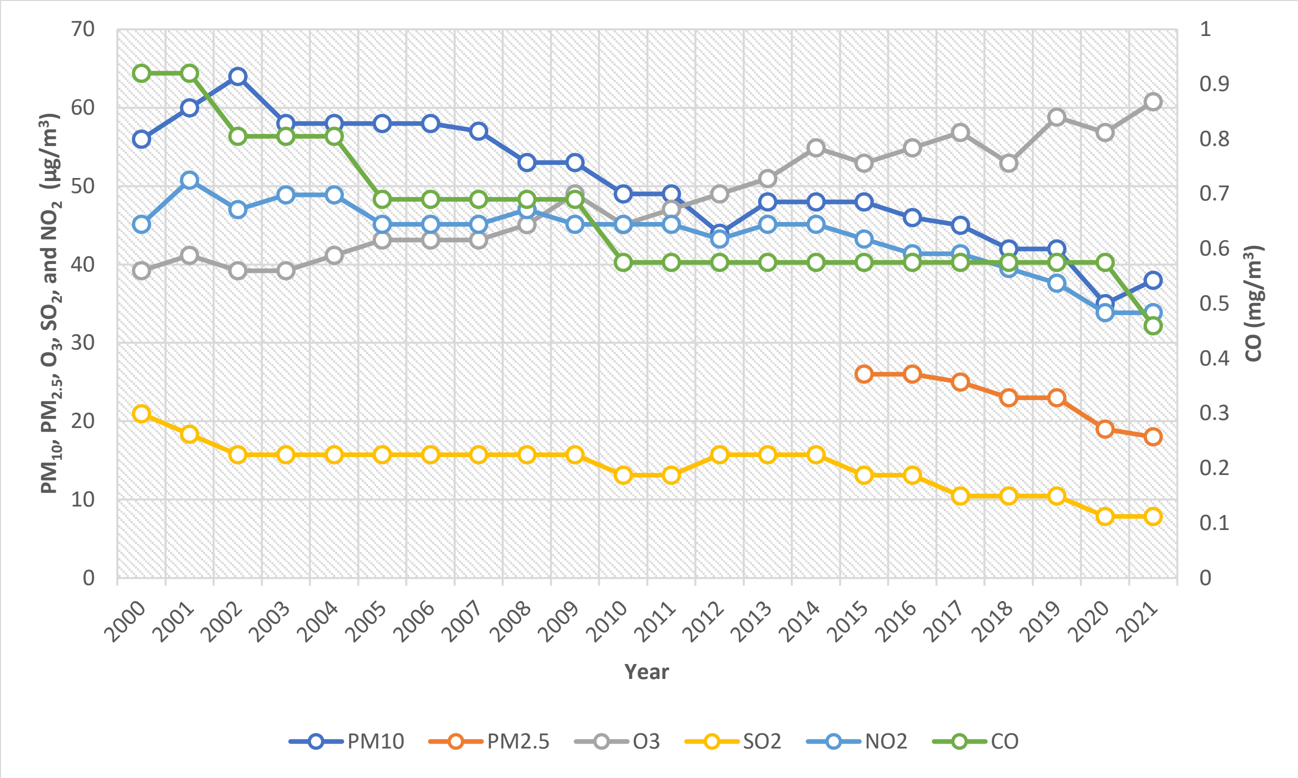

Figure 4. Annual average concentrations of PM_{10}, $PM_{2.5}$, O_3, SO_2, and NO_2 (μg/m^3) and CO (mg/m^3) in the Republic of Korea, 2000 – 2021.

Source: Air Korea, Ministry of Environment, ROK. Available at https://www.airkorea.or.kr/web/

10. According to *Review of State and Pollution of the Environment in the Russian Federation for 2021*, annual average concentration levels of air pollutants decreased from 2017 to 2021 in the Russian Federation (Federal Service for Hydrometeorology and Environmental Monitoring, 2022). Table 1 indicates average changes of each pollutant per year from 2017 to 2021. Besides sulfur dioxide, which has a net 0% change in concentration, all other key air pollutants display a decreasing trend in the past five years. Among the four key air pollutants shown in Table 1, PM_{10} had the greatest decrease in concentration during the indicated time period.

Table 1. Number of Monitored Cities and Average Changes in Concentrations of Pollutants per Year (%) in the Russian Federation

Pollutants	Number of cities monitored	Average change in concentration of pollutants per year (%)
PM_{10}	308	-14
Sulfur Dioxide (SO_2)	228	0
Nitrogen Dioxide (NO_2)	234	-13
Carbon Monoxide (CO)	221	-8
Benz(a)pyrene	147	-16
Formaldehyde	158	+6

Source: *Review of State and Pollution of the Environment in Russian Federation for 2021* (2022). Available at https://www.meteorf.gov.ru/upload/iblock/dc8/Obzor_2021.pdf.

11. Similar trends were observed in Moscow, Russian Federation for PM_{10}, NO_X, and CO as

shown in Figure 5. Besides the noticeable peaks in the past few years, the three air pollutants, PM_{10}, NO_X, and CO, generally exhibit a decreasing trend from 2005 to 2020, with an average percent change of -1.7%, -2.6%, and -4.0% per year, respectively. Similar to the trends observed in ROK, however, concentrations of O_3 remained mostly constant from 2007 to 2020, excluding a sudden increase in 2011. This trend suggests a lack of emission control of VOCs.

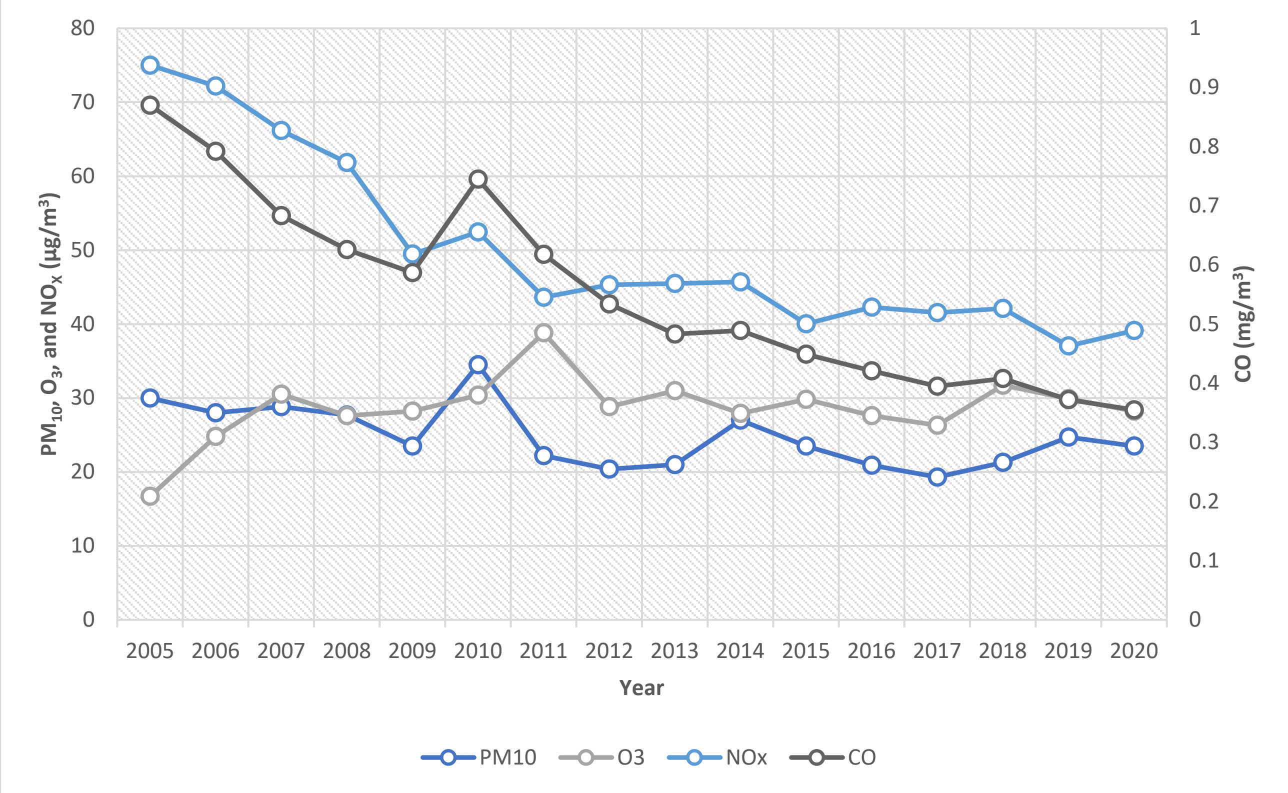

Figure 5. Annual average concentrations of PM_{10}, O_3, and NO_X (µg/m³) and CO (mg/m³) in Moscow, Russian Federation, 2005 – 2020.
Source: Elansky et al (2022).

12. The progress in air quality of each country in North-East Asia has been made with intensified national actions and enactments to meet the national ambient air quality standards specific to each member State. Using these standards, governments analyze and keep track of air pollution in the nation and set future goals. The national air quality standards set by each country participating in NEACAP differ, as listed in Table 2.

Table 2. National Air Quality Standards and WHO Guidelines

Pollutant	Sampling time	China		Japan	Mongolia	ROK	Russian Federation	WHO	
		Zone I	Zone II					AQGs	IT-4
PM_{10} (μg/m³)	Hourly	-	-	200	-	-	-	-	-
	24h average	50	150	100	100	100	60	45	50
	Annual mean	40	70	-	50	50	40	15	20
$PM_{2.5}$ (μg/m³)	24h average	35	75	35	50	35	35	15	10
	Annual mean	15	35	15	25	15	25	5	25
O_3 (μg/m³)	Hourly average	160	200	0.06 ppm (117.8 μg/m³)	-	0.1 ppm (196.3 μg/m³)	-	-	-
	8h max	100	160	-	100	0.06 ppm (=117.8 μg/m³)	30	100	120***
SO_2 (μg/m³)	Hourly average	150	500	0.1 ppm (262.3 μg/m³)	-	0.15ppm (393.4 μg/m³)	-	-	-
	24h average	50	150	0.04 ppm (104.8 μg/m³)	50	0.05ppm (131μg/m³)	50	40	50***
	Annual mean	20	60	-	20	0.02ppm (52.4 μg/m³)	-	-	-
NO_2 (μg/m³)	Hourly average	200	200	-	-	0.1 ppm (187.5 μg/m³)	-	-	-
	24h average	80	80	0.04-0.06 ppm (75 – 113 μg/m³)	50	0.06 ppm (113 μg/m³)	40	25	50***
	Annual mean	40	40	-	40	0.03 ppm (=56 μg/m³)	-	20+	20**
CO (mg/m³)	Hourly average	10	10	-	-	25 ppm (28.6 mg/m³)	-	-	-
	8 hours average	-	-	20 ppm (22.9 mg/m³)	-	9 ppm (10.3 mg/ m³)	-	-	-
	24h average	4	4	10 ppm (11.5 mg/m³)	2.6	-	-	4	7*

Notes: (1) Zone I refers to areas which require special protection (i.e. more stringent environmental standards), such as natural reserves and scenic spots; Zone II refers to residential areas, commercial-traffic-residential mixed area, cultural districts, industrial areas and rural areas (2) AQGs refer to WHO's air quality guidelines (3) IT-4 refers to interim target - 4 (4) IT-4 were not set for some pollutants; * refers to IT-1; ** refers to IT-2; *** refers to IT-3 (5) Differences in sampling and measurement techniques are not considered in the table.
Source: MEE of China (Available at https://english.mee.gov.cn/Resources/standards/Air_Environment/quality_standard1/201605/t20160511_337502.shtml), MOE of Japan (Available at https://www.env.go.jp/en/air/aq/aq.html), MOE of ROK (Available at https://www.airkorea.or.kr/eng/contents/contentView/?pMENU_NO=160&cntnts_no=16), Meteorological and Environmental Analysis Department of Mongolia (Available at http://tsag-agaar.gov.mn/), OECD, and WHO (Available at https://www.who.int/publications/i/item/9789240034228)

Seasonality of Air Quality

13. Besides the annual trends of air pollution in each member States, China, Japan, Mongolia, ROK, and the Russian Federation share similar seasonal trends of air pollution, particularly for PM_{10} and $PM_{2.5}$. While the degree of effect varies by country, air pollutant, and season, all member States experience, or have experienced, seasonal trends in air quality. Because increased concentrations of air pollutants, such as $PM_{2.5}$, O_3, SO_2, NO_2, or CO, pose a greater risk to the environment and human health, countries implemented national policies to prevent and control the seasonal trend. These

implementation plans and regulations are specific to each country as the cause of seasonal trends in air quality varies by each member State. Causes of the observed trend include, but are not limited to, an increased use of coal, increased transboundary long-range pollution due to a change in wind pattern, change in temperature, and other geographical-specific reasons. As an example, monthly concentrations of PM_{10}, $PM_{2.5}$, SO_2, and NO_2 in the recent decade in Ulaanbaatar, Mongolia suggest a noticeable seasonal trend of elevated concentrations.

14. As evident by the bell-curve in each graph of Figure 6, concentrations of PM_{10}, $PM_{2.5}$, SO_2, and NO_2 are disproportionately high in the winter season (especially in December and January) in Ulaanbaatar, Mongolia. Due to its unique topographic characteristic that causes the extreme cold air in the winter season to be trapped in the city by the surrounding mountains, the city requires extensive coal combustion for heating in residential "Ger" areas.

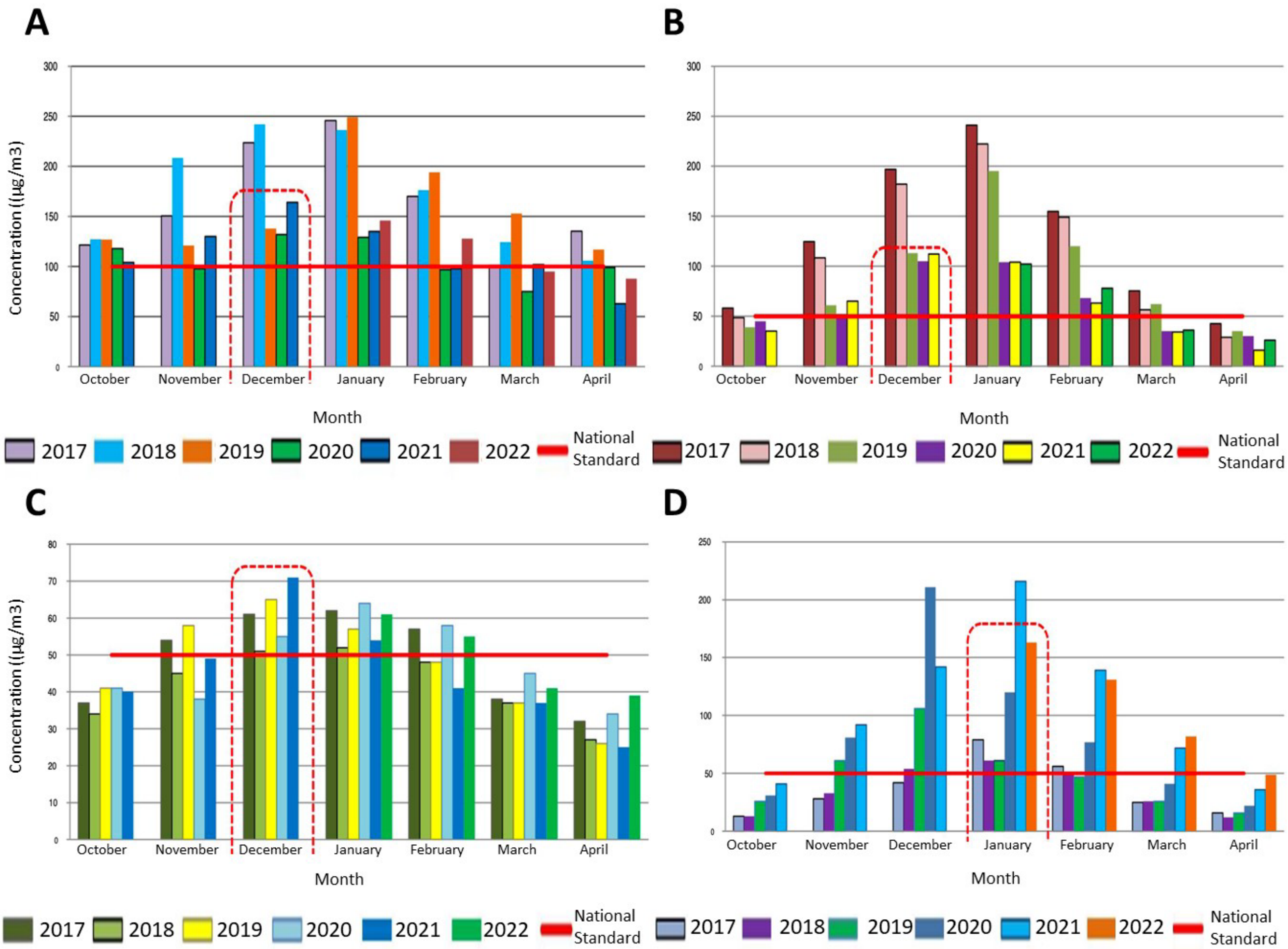

Figure 6. Monthly average concentrations of (A) PM_{10}, (B) $PM_{2.5}$, (C) SO_2, and (D) NO_2 (μg/m^3) in Ulaanbaatar, Mongolia in the cold seasons (October – April), 2017 - 2022.

Source: The Ministry of Environment and Tourism of Mongolia. Available at http://agaar.mn/index?lang=en, accessed on July 15th, 2023.

National Air Quality Monitoring Network

15. Accurate monitoring of the air quality provides valuable data for effective management of air pollution and development and evaluation of policies aimed at reducing air pollution. In China, the

air quality monitoring network spreads over 5,000 monitoring stations at the national, provincial, prefectural, and country levels. These stations are divided into subcategories, as illustrated in Table 3. As per the provision in the *Atmospheric Pollution Prevention and Control Law* (2016), the China National Environmental Monitoring Centre (CNEMC) has the responsibility to operate more than 1,436 air quality monitoring stations. The local air quality data, such as ambient concentration levels of PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, and CO, meteorological parameters, and visibility, are synchronized to CNEMC for enhancing the credibility of the information obtained. The website (http://www.cnemc.cn/) of CNEME releases daily reports of ambient air quality in the 337 major cities. The daily reports include Air Quality Indices (AQI), concentration data on primary pollutants, air quality grades, etc.

Table 3. National air quality monitoring network of China

Scope of monitoring	Number of Monitoring Centres	Range of pollutants monitored
Urban area air quality	1,436 national monitoring centres across 337 cities	PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, CO, meteorological parameters, visibility, etc.
Regional (incl. rural area) air quality	96 regional monitoring centres	PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, CO, meteorological parameters, visibility, etc.
Background air quality	15 monitoring centres	PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, CO, meteorological parameters, visibility, acid deposition, GHG, black carbon, VOCs, etc.
Atmospheric particle composition and photochemical substances	38 monitoring spots across 2+26 cities	$PM_{2.5}$, VOCs

Source: China National Environmental Monitoring Centre. Available at http://www.cnemc.cn/, accessed on June 20th, 2023.

16. There are approximately 1,900 national air quality monitoring networks in Japan, including 1,434 ambient air quality monitoring stations (AAQMS) and 393 roadside air quality monitoring stations (RsAQMS). The real-time local air quality data of SPM (PM_{10}), $PM_{2.5}$, SO_2, NO, NO_2, photochemical oxidants (Ox), and non-methane hydrocarbon (NMHC) is synchronized to the National Government data and published in real-time from Atmospheric Environmental Regional Observation System (AEROS: https://soramame.env.go.jp/).

Table 4. Nationally Monitored Air Pollutants and the Number of Monitoring Stations in Japan

Pollutants	No. of Monitoring Stations as of 2018		
	Total	AAQMS	RsAQMS
SPM (PM_{10})	1,703	1,314	389
$PM_{2.5}$	1,088	849	239
Ozone (O_3)	1,193	1,165	28
Nitrogen Oxides, Nitrogen Dioxide (NOx, NO_2)	1,658	1,260	398
Sulfur Dioxide (SO_2)	1,010	960	50
Carbon Monoxide (CO)	293	60	233

Source: Ito, A. et al. (2021). https://www.mdpi.com/2073-4433/12/8/1072.

17. Mongolia's national air quality monitoring network has 42 air quality monitoring stations across the country, including 15 stations in Ulaanbaatar. The network measures up to 6 primary pollutants such as PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, and CO. The local real-time air quality data are synchronized to the National Agency Meteorology and the Environmental Monitoring (NAMEM) and the Information & Research Institute of Meteorology, Hydrology and Environment (IRIMHE) and later disseminated via Air Quality website (http://agaar.mn/index).

Table 5. Air Quality Monitoring Stations and Monitored Pollutants in Mongolia

Region	Number of monitoring stations	Pollutants Measured	Name of Air Quality Monitoring Stations*
National	40	PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, CO	-
Ulaanbaatar	15	PM_{10}	UB-1, UB-2, UB-3, UB-4, UB-5, UB-7, UB-8, UB-12, Zuragt, Tolgoit, Nisekh, Amgalan, Bayankhoshuu
		$PM_{2.5}$	UB-2, UB-3, UB-4, UB-12, Zuragt, Tolgoit, Nisekh, Amgalan, Bayankhoshuu
		O_3	UB-1, UB-4, UB-5, UB-8, Zuragt, Tolgoit, Nisekh, Amgalan, Bayankhoshuu
		SO_2	All stations
		NO_2	All stations
		CO	UB-1, UB-2, UB-4, UB-5, UB-7, UB-8, Zuragt, Tolgoit, Nisekh, Amgalan, Bayankhoshuu

*UB refers to Ulaanbaatar
Source: *Air Quality Monitoring in Mongolia* (Davaanyam, E. and Gantsetseg, B., 2020). Available at https://www.unescap.org/sites/default/files/9.%20Air%20Qulaity%20Monitoring%20in%20Mongolia_IRIMHE.pdf.

18. The national air quality monitoring network in ROK spreads more than 885 stations (as of 2021) in 162 cities and counties across the country and monitors 13 types of air quality information, such as city air quality, road-side air quality, suburban air quality, national atmospheric background, harmful materials, $PM_{2.5}$ concentration, etc. The local real-time air quality data, such as ambient levels of PM_{10}, $PM_{2.5}$, O_3, SO_2, NO_2, and CO, 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).

Table 6. Nationally Monitored Air Pollutants and Number of Monitoring Stations in the Republic of Korea

Pollutants	Number of Monitoring Stations	
	Total	Effective Stations*
PM_{10}	504	473
$PM_{2.5}$	504	477
Ozone (O_3)	504	475
Sulfur Dioxide (SO_2)	504	474
Nitrogen Dioxide (NO_2)	504	473
Carbon Monoxide (CO)	504	471

All pollutants	885	-

* refers to stations that are able to collect 75% of the time stamps annually.
Source: Air Korea, Ministry of Environment, ROK. Available at https://www.airkorea.or.kr/web/, accessed on July 6th, 2023.

19. The ROK government continuously enhances air quality monitoring systems to ensure better air quality data. To complement the ground-based monitoring networks, the ROK government launched the Geostationary Environment Monitoring Spectrometer (GEMS) in February 2020 as world's first geostationary satellite instrument dedicated to air quality monitoring. GEMS monitors air quality over North-East Asia, Southeast Asia, and part of South Asia. The UV-Visible hyper spectrometer measures atmospheric composition and climate components including SO_2, NO_2, O_3, HCHO, and aerosols. GEMS data can be accessed at the Environmental Satellite Center (https://nesc.nier.go.kr/en/html/datasvc/index.do).

20. The Russian Federation's national air quality monitoring network regularly measures concentration levels of air pollutants in 221 cities at 620 points. Some of the air pollutants observed in the network include PM_{10}, SO_2, NO_X, and CO. In addition to the monitoring stations managed by the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), the Moscow Ecological Monitoring (MEM) network consists of 56 air monitoring stations in Moscow, with 10 stations located outside of the city to measure background pollution level. MEM measures concentration levels of air pollutants including PM_{10}, O_3 NO_X, CO, etc.

Table 7. Air pollution Monitoring Network in the Russian Federation

Network	Year	Number of Stations	Range of pollutants monitored
National air quality monitoring network, Roshydromet	2017	613	PM_{10}, SO_2, NO_X, CO, N_2O, benzo(a)pyrene, and formaldehyde
	2018	611	
	2019	611	
	2020	612	
	2021	620	
Moscow Ecological Monitoring (MEM) network	2002	11	PM_{10}, O_3, NO_X, CO, nonmethane hydrocarbons (NMHCs), CH_4
	2020	56	

Source: *Review of State and Pollution of the Environment in Russian Federation for 2021* (2020); Elansky et al (2022)

IV. Emission Inventories

21. Emission inventories provide policymakers and the public with a systematic set of data to understand key sources of pollution, change in their levels over time, and how sources are likely to contribute to pollution in the future. The following provides the latest updates of currently existing notable emission inventories at national and regional levels.

National Level Emission Inventories in North-East Asia

22. **Multi-resolution Emission Inventory (MEIC)**: MEIC is a technology-based bottom-up air pollutant and anthropogenic greenhouse gas inventory, which is developed and maintained on the basis of a cloud computing platform developed by Tsinghua University. MEIC is a comprehensive model that includes source categorization, emission factor database, technology-based methodology, and high-resolution emission processing system in the cloud computing platform. The MEIC inventory includes six types of anthropogenic emission sources, including stationary combustion, industrial processes, mobile source, solvent use, agriculture, and waste treatment. The current version of MEIC estimates emissions using data collected from more than 700 anthropogenic sources since 1990 and is updated yearly. More information on MEIC is available at http://meicmodel.org.cn/ (last access: 31 July 2023).

23. **Clean Air Policy Support System (CAPSS):** CAPSS is an emissions inventory system developed by National Air Emission Inventory and Research Centre, ROK to estimate air pollutant emissions at the administrative district level. The National Air Emission Inventory and Research Center (NAIR), which was established in December 2019 under the *Special Act on the Reduction and Management of Fine Dust of ROK*, releases the National Air Pollutant Emissions Inventory every year. Updated CAPSS are based on the analysis of collected emissions data, which is produced and managed by various organizations and gone through experts' verification. CAPSS estimates annual emissions of air pollutants, SO_2, NO_x, CO, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, and BC, from point and mobile sources. More information on CAPSS is available at https://www.air.go.kr/eng/contents/view.do?contentsId=34&menuId=90 (last access: 31 July 2023).

24. **Japan Auto Oil Program (JATOP) Emission Inventory Data Base (JEI DB)**: Japan's emissions inventory named as the Japan Auto Oil Program (JATOP) Emission Inventory Data Base (JEI DB) was developed by JPEC (JPEC, 2012a; 2012b; 2012c). JEI DB includes vehicle emissions in 2000, 2005, and 2010 and non-vehicle emissions in 2000 and 2005 for SO_2, NO_x, CO, NMVOC, PM_{10}, and NH_3, with monthly variations and spatial resolution of 1km (Shibata and Morikawa, 2021).

Subregional Level Emission Inventories in East and North-Eastern Asia Subregion

25. **Regional Emission inventory in Asia (REAS)**: REAS Version 1.1 is an emissions inventory for countries in Asia for 1980 – 2020. REAS is the first emissions inventory for countries in Asia to integrate historical, present, and projected future emissions using a consistent methodology. REAS provides emissions in 2000, historical emissions for 1980–2003, and projected emissions for 2010 and 2020 of SO_2, NO_x, CO, NMVOC, black carbon (BC), and organic carbon (OC) from fuel combustion and industrial sources (Ohara et al., 2007). REAS version 3.2.1 introduces significant updates from the REAS version 2.1. These updates encompass (a) a wider range of target years, spanning from 1950 – 2015, (b) extensive historical activity data sets derived from international and nation statistics, as well as relevant proxy data, and (c) emission factors and information on emissions controls obtained from various literature sources. More information on REAS version 3.2.1 is available at https://www.nies.go.jp/REAS/index.html (last access: 31 July 2023)

26. **Comprehensive Regional Emissions inventory for Atmospheric Transport Experiment (CREATE):** CREATE was developed to support various aircraft filed campaigns, air quality modeling, and integrated assessment modeling research. For anthropogenic emissions, it has 54 fuel classes, 201 sub-sectors and 13 pollutants, including CO_2, CH_4, N_2O, SO_2, NO_X, CO, NMVOC, NH_3, OC, BC, PM_{10}, $PM_{2.5}$, and mercury. Since CREATE emissions framework is developed using Integrated climate and air quality Assessment Modeling (IAM) frameworks (i.e., GAINS) and fully connected with comprehensive emission processing/modeling systems (i.e., SMOKE, KU-EPS, and MEGAN), it can be effectively used for various climate and air quality integrated modeling analysis and field experiments. For the field campaigns, CREATE provides modeling of the emission inventory to collaborating air quality models, such as CMAQ, WRF-Chen, CAMx, GEOS-Chem, MOZART, for forecasting and post-analysis modes (Woo et al., 2013; Woo et al., 2018; Woo et al., 2020a; Woo et al., 2020b). More information on CREATE is available at http://aisl.konkuk.ac.kr/#/emission_data/create_emission_inventory (last access: 31 July 2023).

Emission Inventories in support of Northeast Asian Research Collaborations

27. **Asian emission inventory (MIX)**: The MIX inventory is developed for the years of 2008 and 2010 to provide model-ready emissions dataset to support the Model Inter-Comparison Study for Asia (MICS-Asia) and the Task Force on Hemispheric Transport of Air Pollution (TF HTAP). Emissions are estimated for all major anthropogenic sources in 29 countries and regions in Asia. Five emissions inventories are incorporated into MIX as a mosaic inventory: MEIC for emissions data in China, a high resolution NH_3 emission inventory by Peking University (PKU-NH3 inventory; Huang et al., 2012), an emissions inventory developed by Argonne National Laboratory (referred to as ANL-India hereafter; Lu et al., 2011; Lu and Streets, 2012), CAPSS for emissions data in ROK (Lee et al., 2011), and REAS v2.1 for rest of countries in Asia. REAS v2 is used as the default where local emission data is absent. More information on MIX is available at http://meicmodel.org.cn/?page_id=87&lang=en (last access: 31 July 2023).

28. **Korea-United States Air Quality (KORUS-AQ)**: KORUS-AQ emission inventory was developed for the year 2016 in support of NIER/NASA KORUS-AQ aircraft field campaign. Emissions are estimated for all major anthropogenic sources and biogenic sources in Asia (Woo et al., 2020b). Five emission inventories are combined to develop a mosaic inventory, as listed in the following: CREATE for Asia, CAPSS for ROK, MEIC for China, JEI for Japan, ANL-India for India. The KORUSv5 EI geographically covers all of Asia and uses the Sparse Matrix Operator Kernel Emissions (SMOKE-Asia) emission processing (Woo et al., 2012) and SAPRC-99 chemical mechanism (W. Carter, 1999). The inventory reports CO, NH_3, NO_x, $PM_{2.5}$, PM_{10}, SO_2 and VOCs on a 0.1-degree grid for Asia and a 3 km grid resolution for ROK. More information on KORUS-AQ emission is available at http://aisl.konkuk.ac.kr/#/emission_data/korus-aq_emissions (last access: 31 July 2023).

29. **Joint Research Project for Long–range Transboundary Air Pollutants in Northeast Asia (LTP)**: LTP inventory is the Northeast Asia regional emission inventory based on the submission of national emission from China, Japan, and ROK and Asian emissions inventory - CREATE. LTP was established in 1996 to promote common understanding of transboundary movement mechanism of

air pollutants among the ministries of environment of ROK, China, and Japan. The objectives of the LTP project are to study the state of air quality, influence of neighboring countries, and policy making of each country to improve air quality. As KORUS-AQ EI, LTP inventory also uses SMOKE-Asia emissions processing system to generate modeling emissions inventory. The inventory includes air pollutants, such as CO, NH_3, NO_X, PM2.5, PM_{10}, SO_2 and VOCs. The information on LTP project modeling and emission is described in Kim et al. (2021).

30. **AQNEA v1.0 emission inventory**: AQNEA v1.0 EI was developed for the base year 2019 in support of AQNEA air quality modeling and Integrated Assessment Modeling (IAM). Emissions are estimated for all major anthropogenic sources and biogenic sources in 6 North-Eastern Asian countries including China, Democratic People's Republic of Korea (DPRK), Japan, Mongolia, ROK, and the Russian Federation. Four emission inventories are combined to develop a mosaic inventory, as listed in the following: Tsinghua university (ABaCAS group) emissions for China, JEI for Japan, CAPSS for ROK, and GAINS-ECLIPSE for other countries in Asia. The AQNEA v1 EI also includes biogenic emissions using MEGAN model and emissions modelling using SMOKE-Asia (Woo et al., 2012). The inventory reports CO, NH_3, NO_x, $PM_{2.5}$, PM_{10}, SO_2 and VOCs on a 0.1-degree grid for Asia and a 3 km grid resolution for ROK. The information of AQNEA v1.0 emission is described in Woo et al. (2021).

Table 8. List of emissions inventories in North-East Asia

Inventory	Geographical Scope /Type	Spatial Resolution	Temporal Resolution	Years	Sector / chemical
National Level Emission Inventories in North-East Asia					
MEIC	China/Activity	0.25°x0.25°	Monthly	1990-2020	Anthropogenic: SO_2, NO_x, CO, NMVOC, NH_3, CO_2, $PM_{2.5}$, BC, OC
JEI-DB	Japan/Activity	1kmx1km	Monthly	2000, 2005, 2010	Anthropogenic: CO, NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, SO_2
CAPSS	ROK/ Activity	1kmx1km	Annual	1999-2020	Anthropogenic: CO, NO_x, NMVOC, NH_3, TSP, PM_{10}, $PM_{2.5}$, BC, SO_2
Subregional Level Emission Inventories in East and North-Eastern Asia Subregion					
REAS v3	Asia + Russian Federation /Activity (Mosaic)	0.25°x0.25°	Annual/ Monthly	1950-2015	Anthropogenic: SO_2, NO_x, CO, NMVOC, PM_{10}, $PM_{2.5}$, BC, OC, NH_3, CH_4, N_2O, and CO_2 Soil NO_x and others
NIER/KU -CREATEv3	Asia + Russian Federation /Activity	Variable grid	Annual	2015	Anthropogenic/Biomass Burning/Biogenic CO_2, CH_4, N_2O, CO, NO_x, NMVOC, NH_3, PM_{10}, $PM_{2.5}$, SO_2
Emission Inventories in support of Northeast Asian Research Collaborations					
MICS-Asia (MIX)	Asia + Russian Federation /Mosaic	0.25°x0.25°	Monthly	2008, 2010	Anthropogenic: SO_2, NO_x, CO, NMVOC, NH_3, CO_2, $PM_{2.5}$, PMC, BC, OC
KORUS-AQ	Asia + Russian Federation /Mosaic	0.1°x0.1°	Monthly	2015	Anthropogenic/Biogenic: SO_2, NO_x, CO, NMVOC, NH_3, CO_2, $PM_{2.5}$, PM_{10}, BC, OC
LTP	China, Japan, ROK, and other Asia	0.1°x0.1°	Monthly	2017(China),2015(Japan, ROK)	Anthropogenic/Biogenic: SO_2, NO_x, CO, NMVOC, NH_3, $PM_{2.5}$, PM_{10}

AQNEA	China, DPRK, Japan, Mongolia, ROK, and Russian Federation	0.1°x0.1°	Monthly	2019	Anthropogenic: SO_2, NO_x, CO, NMVOC, NH_3, $PM_{2.5}$, PM_{10}

V. Integrated Assessment Models (IAMs)

31. Integrated Assessment Models (IAMs) play a crucial role in scientific and policy research by facilitating future pollutants emission scenarios and examining control strategies across various sectors and regions. Consequently, this section presents the most recent developments in the application of IAMs at national and subnational levels in North-East Asia. Recent research trends involve integrating energy or economic models with chemical transport models, health models, and earth system models. This integration allows for the analysis for short-term control strategies and long-term pathways concerning both air pollutants and greenhouse gases. In several countries within North-East Asia, IAMs have been employed to offer scientific support for cost-effective analysis and the development of clean air solutions at the national level.

GAINS model

32. Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) is an integrated assessment model developed by the International Institute for Applied Systems Analysis (IIASA). Based on the Regional Air Pollution Information and Simulation (RAINS) model, GAINS is used to assess cost-effective response strategies for combating air pollution, including fine particles and ground-level ozone, under the Convention on Long-range Transboundary Air Pollution (CLRTAP) (Klimont 2023). The model quantifies various pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NOx), ammonia (NH_3), non-methane volatile organic compounds (VOCs), particulate matter ($PM_{2.5}$, PM_{10}), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N2O), fluorinated gases (HFCs, PFCs, and SF6), and black and organic carbon (BC) and organic carbon (OC).

33. The GAINS model takes in input data such as activity pathways, emission factors, and control strategies. The output data can be presented in the form of data tables, charts, and maps displaying pollutant concentrations, optimized control strategies, and associated costs. GAINS allows users to perform online operations using real-time emission scenarios with time intervals of every five years, in specific geographic areas like Asia, Europe, East Asia, and South Asia for open use and in Italy, Vietnam, the Indo-Gangetic Plain, the Beijing-Tianjin-Hebei Urban Agglomeration, and ROK for collaborative use. Users can also upload data to modify customized emission scenarios for simulation in specific areas. The scenario mode provides estimates of regional costs and environmental benefits of various emission control strategies based on source and impact tracing (Klimont 2023). Additionally, GAINS develops "optimization" mode which identifies where emission can be reduced most cost-effectively (Klimont 2023).

34. GAINS has been widely used by the academic community to develop climate policy scenarios, assess effective control of menthane emissions from wastewater processing and fossil fuel production and use, and estimate economic and health benefits of controlling air pollutants (Radu et al., 2016; Höglund -Isaksson et al., 2020; Chen et al., 2015). GAINS also supports smaller-scale research, such as GAINS-CITY, conducted at the city level. GAINS-CITY estimates the effectiveness of national air quality policies in the context of small cities using local data (Lieu et al., 2013).

ABaCAS model

35. Air Benefit and Cost and Attainment Assessment System (ABaCAS) is an integrated framework developed jointly by Tsinghua University, South China University of Technology, and the U.S. Environmental Protection Agency (EPA) for analyzing the costs and benefits of air pollutant control strategies (Wang et al., 2023). It consists of nine support tools: ABaCAS Streamlined Edition (ABaCAS-SE), ABaCAS Optimized Edition (ABaCAS-OE), International Control Cost Estimate Tool (ICET), Response Surface Model – Visualization Analysis Tool (RSM-VAT), Software of Model Attainment Test – Community Edition (SMAT-CE), Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE), Multi-pollutant Air Quality Planning Tool (NEXUS), Model-Visualization Analysis Tool (Model-VAT), and Data Fusion Tool (DFT).

36. ABaCAS is based on more detailed bottom-up emission inventories of CO_2 and multiple air pollutants including mercury and chlorine (Li et al., 2023; Wu et al., 2023). It accepts similar input data as GAINS as well as the emission scenarios produced by GAINS. ABaCAS outstands in simulating nonlinear chemical interactions of multiple secondary aerosols (Xing et al., 2020). The newly coupled Chemical Transport Model (CTM) in ABaCAS is based on two-dimensional volatility-basis set (2D-VBS) aerosol module and full-volatility organic emission framework (Chang et al., 2022).

37. ABaCAS specializes in simulating the nonlinear interactions of multiple pollutants under the LEast-COst optimization (LE-CO) process (Xing et al., 2019). Huang et al. (2020) further updated the ABaCAS-OE version by adding a genetic algorithm (GA), which is a machine-learning algorithm, into the LE-CO module. With the updated computational capability, ABaCAS provides analysis of cost-effective mitigation strategies based on various air quality goals. After the strategy analysis, BenMAP-CE further calculates the potential health benefits of the control strategies. The ABaCAS model is an effective policy tool for decision makers to make an informed, scientific decision on air pollution control measures.

GCAM-China

38. The Global Change Analysis Model (GCAM) is an open-source community model developed by the Joint Global Change Research Institute (JGCRU). It serves as a partial-equilibrium multisector integrated assessment model, encompassing economic, energy, land-use, water, emissions, and climate systems. GCAM has gained significant recognition for its usage in the Intergovernmental Panel on Climate Change (IPCC) scenarios, socio-economic pathways (SSPs).

39. GCAM-China, which is built based on GCAM, provides a more detailed and refined analysis specific to the Chinese region. It offers province-level approaches, which provides comprehensive examination of the interdependences between energy, agriculture, forestry and other land use (AFOLU), water, emissions, and climate systems. The model covers 31 provinces, further divided into specific grid regions, from the present day up to the year 2100, using 5-year time periods.

40. The input data for GCAM-China consists of scenario assumptions encompassing socioeconomic factors (such as population, labor participation, and labor productivity), characteristics of energy and agricultural technologies, energy, and other resource data. As the output, the model generates key scenario results, including analysis of the energy system, prices and supplies of agricultural and forest products, land use and land use change, water demands and supplies for all agricultural, energy, and household uses, and emissions of 24 greenhouse gases and short-lived species (CO_2, CH_4, N_2O, halocarbons, carbonaceous aerosols, reactive gases, and SO_2). GCAM-China has been instrumental in assessing the deployment of carbon capture, utilization, and storage (CCUS)

across different provinces, which enables the realization of a low-carbon energy mix and the achievement of local air quality goals (Yu et al. 2019). In addition to the estimation of energy efficiency and benefits of reduced air pollution resulting from low-carbon energy mix, GCAM-China assesses benefits of air pollutant control strategies on public health as well (Li et al. 2020, Dong et al. 2023).

The Asia-Pacific Integrated Model (AIM)/ Integrated Model of Energy, Environment and Economy for Sustainable Development (IMED)

41. The Asian-Pacific Integrated Model (AIM) is a large-scale computer simulation model developed by the National Institute of Environmental Studies of Japan. The AIM aims to evaluate policy options for addressing climate change, specifically in the Asia-Pacific region. Its main goals are to reduce greenhouse gas emissions and mitigate the impacts of climate change. The Asia-Pacific Integrated Modeling/Computable General Equilibrium (AIM/CGE) model, an extension of AIM, focuses on analyzing climate change mitigation and its effects. While its primary purpose is to address climate change, the AIM model can also be applied to tackle other environmental issues such as local air pollution issues. The air pollutant modules within AIM follow a bottom-up approach (Hanaoka et al., 2018). Benefits of air quality improvement from carbon mitigation was assessed in ROK (Kim et al., 2020).

42. The Integrated Model of Energy, Environment, and Economy for Sustainable Development (IMED), which is derived from AIM/CGE, is developed by the Laboratory of Energy & Environmental Economics and policy (LEEEP) at Peking University. IMED aims to determine the complex interaction between multiple modules involving energy, environment, climate, health, and socioeconomic systems and uncover the different impacts across regional and temporal scales. IMED consists of three key modules: IMED|CGE, IMED|HEL, and IMED|TEC. IMED|CGE is a top-down computable general equilibrium model, mainly including production, market, and income expenditure modules. IMED|HEL is the health module that quantifies the effects of indoor and outdoor air pollution on mortality and morbidity. IMED|TEC is a bottom-up technology optimization model to estimate emissions and energy consumption through cost-minimization technology portfolios and material flow processes.

GUIDE-Korea

43. GHGs and Air pollutants Unified Information DEsign System for Environment (GUIDE) is developed by Konkuk University consortium in 2019 (Wang, 2019, Woo et al., 2020b). Based on economy and energy mitigation and projection, air quality simulation with emission reduction regulations, and cost-benefit analysis, GUIDE models strategies to effectively manage GHGs and air pollutants. Using RSM and BenMAP model, GUIDE provides an integrated air quality assessment, including 7 air pollutants (CO, NO_x, NH_3, SO_2, PM_{10}, $PM_{2.5}$, VOCs) and six Kyoto GHGs (CO_2, CH_4, N_2O, 3 F-gases), for 17 regions in ROK.

44. The GUIDE model is used for national policies and academic research of integrated management system of GHG and air pollution emission in ROK (Woo et al, 2021; Jang et al, 2023). GUIDE serves as a scientific foundation of the national climate change adaptation and the Cleaner Air in Seoul plans. Furthermore, the GUIDE model is also used for emissions projection and control strategies development of ROK, with other IAMs, such as GCAM/MESSAGE-China, GAINS-Japan, and GAINS-Asia, in the Air Quality in North-East Asia(AQNEA) project (Woo et al., 2022b). The Konkuk university consortium is currently expanding the GUIDE IAM to a global level (GUIDE-

Global) to support global GHG mitigation and adaptation (i.e., air pollution) with a focus on Northeast Asia. Simultaneously, a local level IAM of GUIDE (GUIDE-Local) is under development to support local implementation plans of GHG and air pollutant mitigation in ROK (Woo et al., 2022a).

Table 9. List of Integrated Assessment Models in North-East Asia

IAM	Energy model	Air quality model	Advantages	Limitations
GAINS	Exogenous	EMEP	Propose rich control measures on air pollutants or GHGs; cost + benefit	Exogenous socio-economy and energy pathways
ABaCAS	GCAM	RSM/CMAQ	Generate emission pathways under socio-economic assumptions & policies; cost + benefit; optimization under certain air quality goal.	Insufficient consideration on non-CO_2 GHGs
GUIDE	METER	RSM-ROK	Energy and Air Quality IAMs are in a hybrid IAM model; GHGs included	Limited to ROK. Global and local models are being developed.
IMED	AIM (CGE)	GEOS-Chem	Interaction with macro-economy; cost + benefit	no optimization, lack of technology representation

VI. A Case Study of IAM Research Collaboration

45. The Air Quality in North-East Asia (AQNEA) project is an example of collaborative research in Integrated Assessment Modelling (IAM). AQNEA is a notable multi-national cooperative effort addressing the issues of air pollution in North-East Asia. While AQNEA consists of energy related database, policies, and scenarios in addition to those of air pollution, this section will focus only on the air pollution related aspects. The project brings together researchers from Konkuk University (ROK), Sookmyung Women's University (ROK), National Institute for Environmental Studies (Japan), Tsinghua University (China), Kyoto University (Japan), and Beihang University (China), International Institute for Applied Systems Analysis (IIASA). The ultimate goal of AQNEA is to develop comprehensive management and improvement strategy in air quality in North-East Asia based on scientific integration while supporting domestic policies and international cooperation. The specific objectives of the project include the development of mid-term and long-term emission reduction scenarios, analysis of following domestic and transboundary benefits in North-East Asia, projection of emission-related activities, establishment of a policy database, and prediction of the impacts on air quality through integrated assessment modeling (IAM) systems (Woo et al., 2022b).

46. AQNEA consists of two stages, of which the first is nearly completed. **Stage 1** focuses on

conducting integrated assessments using the national IAMs where available. Development of databases of policy and technology and emission inventories of the countries involved in the project were conducted. Based on the national policies and emission data, AQNEA provides impact scenarios of each country. The outcome of AQNEA's Stage 1 relies on several IAMs independently developed by participating research groups: MESSAGEix, ABaCAS, AIM, and METER, GUIDE for China, Japan, and ROK, respectively. **Stage 2** of AQNEA focuses on the integration of the above IAMs as part of the GAINS model of IIASA and analysis of regional emission reduction scenarios based on the national data. Figure 7 outlines the process of AQNEA from extracting data from the IAM data sources to analyzing activity, emissions, costs, and impacts of air pollution in the GAINS model.

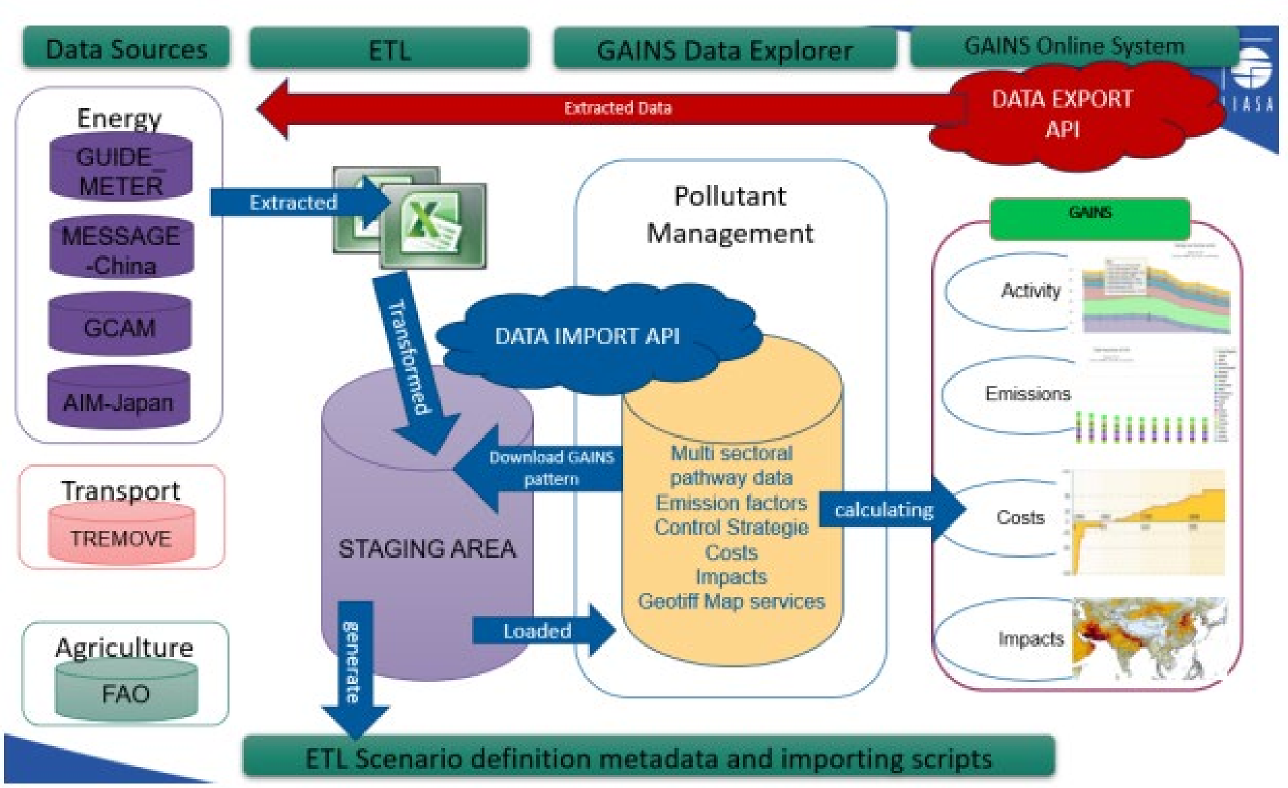

Figure 7. Process of developing national, regional, and global emission inventories, and scenario pathways to be incorporated in the GAINS model.
Source: AQNEA – IIASA report

47. As part of an outcome of Stage 1, AQNEA successfully organized a database that encompasses the energy and air pollution-related national policies of China, Japan, and ROK. Figure 8 illustrates a chronological overview of these policies, including measures for achieving carbon-neutrality, which is a core objective for regulations and plans of these countries. The policy database includes various policies such as *13th and 14th Five Year Plans and the Air Pollution Prevention Action Plan for China, Air Pollution Control Act and Green Growth Strategy through Achieving Carbon Neutrality in 2020 in Japan, and Comprehensive Plan on Fine Dust Management and 2nd Air Quality Management Plan in Seoul Metropolitan Area for Republic of Korea.*

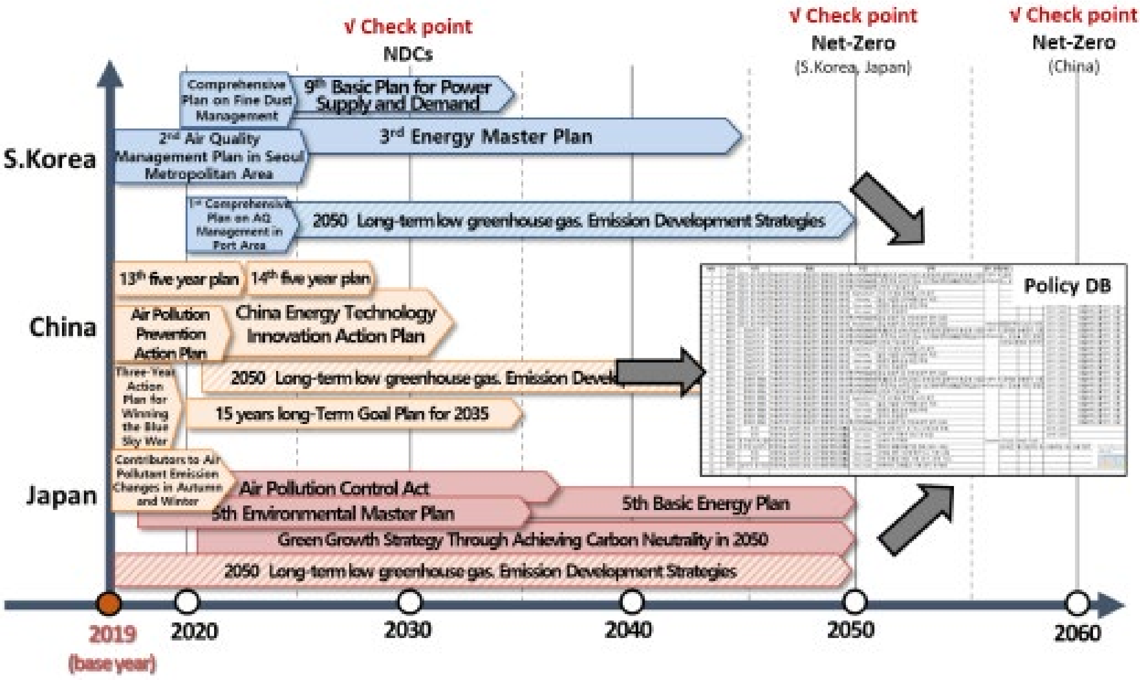

Figure 8. A chronological overview of the national policies of the Republic of Korea, China, and Japan included in the policy database.

Source: AQNEA – IIASA Report and *2022 AQNEA Annual Report (Woo et al., 2022b)*

48. Using the AQNEA's network of IAMs, listed above, the emission inventory of participating countries has been established. Furthermore, using the AQNEA's network of IAMs, AQNEA modelled each country's emissions in three different scenario pathways based on each country's historical trends of emissions and relevant policies. Figure 9 illustrates each country's expected air pollutant emissions according to three scenario pathways. For all countries, the three scenario pathways are baseline scenario with 2019 emissions and current legislations (BASELINE_CLE), Nationally Determined Contribution targets and Current Legislation of air quality control (NDC_CLE) scenario, and net-zero targets and maximum feasible reduction of air quality control (Net-Zero_MFR) scenario. As seen in Figure 9, all pollutants are forecasted to decrease with the NZE_MFR scenario the most. The NDC_CLE scenario suggests a decrease in all pollutants as well compared to the baseline scenario but not as extreme as the Net-Zero_MFR scenario.

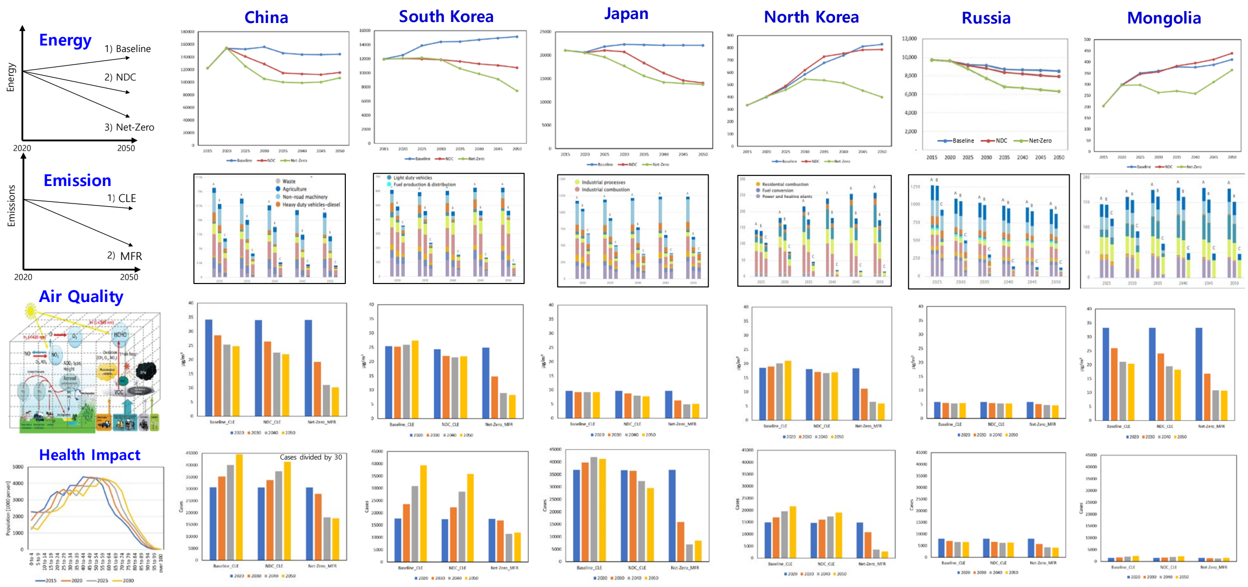

Figure 9. AQNEA predicted energy in 2050 with the baseline, old-NDC, and net-zero scenario for the member states (China, ROK, Japan, DPRK, the Russian Federation, and Mongolia). Air pollutant emissions of CO_2, CO, SO_2, NOx, $PM_{2.5}$, VOC, and NH_3 were projected with the Current Legislation (CLE) and Maximum Feasible Reduction (MFR) scenarios in link with energy scenarios. Projected air quality (third row) and health impacts (fourth row) are also assessed and presented.

Source: AQNEA – IIASA report and *2023 AQNEA Keynote at CMAS-Asia-Pacific* (presentation, J.-H. Woo, 2023)

49. As an outcome of Stage 2, AQNEA will create a platform where one can easily access, import, and process the data from various sources in a unified format. AQNEA plans to provide this platform as an initiation point of international cooperation in addressing the issues of air pollution in the region.

50. The scientific community of North-East Asia has utilized IAM to develop policy scenarios based on the mitigation efforts of air pollution control and prevention. Most of these IAMs are limited to national level analysis and fail to incorporate the efforts of North-East Asia as a whole subregion. The AQNEA project incorporates these individually developed EIs and IAMs of each member State and provides a potential application of IAMs to further perform a comprehensive subregional analysis. By employing a multidisciplinary approach with experts from various fields and incorporating up-to-date information on emissions, energy systems, technologies and government policies in key sectors, methodologies of AQNEA could assist member countries in formulating effective air pollution control strategies at sub-regional and national levels within North-East Asia.

VII. Conclusion

51. As previously mentioned, AQNEA aims to establish a platform via GAINS at IIASA as an initial step of international cooperation addressing air pollution in North-East Asia. NEACAP could leverage this platform to encourage interested institutions to participate in IAMs focusing on emission pathways and cost-effective control measures specific to respective country and the subregion.

52. Based on the existing studies by academic community in each member country and the collaborative study, AQNEA, NEACAP could conduct capacity building programs for institutions to

effectively assess or address air quality issues, organize training programmes aimed at enhancing the expertise of professionals and government officials in producing IAM reports that evaluate various emission pathways, arrange seminars and workshop for modelers, researcher, and policy makers to share knowledge and experiences and collaborate on joint reports that can serve as references for scientific cooperation.

53. Cooperation and transparency in scientific research are considered essential for effective international cooperation on air pollution. The secretariat, together with member States, aims to emphasize the long-term goal of shared assessments, scientific projects, data reporting, and transparency to foster trust and strengthen solidarity among Northeast Asian countries in addressing air pollution. By promoting an objective and goal-oriented dialogue based on scientific evidence, the region can work towards effective solutions.

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