

Mongolia

**Department of Against Air and Environmental Pollution
of the Capital City (DAAEP)**

Ministry of Environment and Tourism (MET)

**Capacity Development Project
for
Air Pollution Control
in Ulaanbaatar City Phase 3
in Mongolia**

Project Completion Report

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Japan International Cooperation Agency (JICA)

SUURI-KEIKAKU CO., LTD

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Abbreviation

Abbreviation	English
ADB	Asian Development Bank
APAF	Air Pollution Against Fund
APRD	Air Pollution Reducing Department of the Capital City (Currently DAAEP)
AQMS	Air Quality Monitoring System
BAU	Business as Usual
BCB	Biomass blended Coal Briquette
CA	Capacity Assessment
CAA	Clean Air Asia
CD	Capacity Development
CEMS	Continuous Emission Monitoring System
CFWH	Coal Fired Water Heater
CLEM	Central Laboratory of Environment and Metrology
CO	Carbon monoxide
CO ₂	Carbon dioxide
C/P	Counterpart
C/P-WG	Counterpart Working Group
DAAP	Department of Against Air Pollution of the Capital City (Currently DAAEP)
DAAEP	Department of Against Air and Environmental Pollution of the Capital City
DPF	Diesel Particulate Filter
EC	Elemental Carbon
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HOB	Heat Only Boiler
IACC	Inspection Agency of Capital City
IRIMHE	Information and Research Institute of Meteorology, Hydrology and Environment:
JCC	Joint Coordinating Committee
JCM	Joint Crediting Mechanism
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
KOICA	Korea International Cooperation Agency
MASM	Mongolian Agency for Standardization and Metrology
ME	Ministry of Energy
MET	Ministry of Environment and Tourism
MMHI	Ministry of Mineral and Heavy Industries
MNS	Mongolian National Standard
MRPA	Mineral Resources and Petroleum Authority
MRTD	Ministry of Road and Transport Development
NAMEM	National Agency for Meteorology and Environment Monitoring
NCEPR	National Committee for Environment Pollution Reduction
NO	Nitric oxide
NO ₂	Nitrogen dioxides

Abbreviation	English
NO _x	Nitrogen oxides
NPREP	National Program on Reducing Environment Pollution
NRTC	National Road Transport Center
NUM	National University of Mongolia
OC	Organic Carbon
OJT	On the Job Training
PDM	Project Design Matrix
PM	Particulate Matter
PM ₁₀	Particulate Matter with diameters that are generally 10 micrometers and smaller
PM _{2.5}	Particulate Matter with diameters that are generally 2.5 micrometers and smaller
PMF	Positive Matrix Factorization
PTD	Public Transportation Department of the Capital City
PWE	Population-Weighted Exposure
R/D	Record of Discussions
RSD	Remote Sensing Device
SDC	Swiss Agency for Development and Cooperation
SO ₂	Sulfur dioxides
SO _x	Sulfur dioxides
TCC	Traffic Control Center of Ulaanbaatar City
TPP 2, 3, 4	Thermal Power Plant No. 2, No. 3 and No. 4
TSP	Total Suspended Particulates
TTT	Tavan Tolgoi Tulsh LLC
UB	Ulaanbaatar
UBCAP	Ulaanbaatar Clean Air Project
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
WB	The World Bank
WRF Model	Weather Research and Forecasting Model

Summary

(1) Background of the Project

Ulaanbaatar (UB) city, the capital of Mongolia, has been covered by serious air pollution, especially by dust from combustion of low-quality coal. It has been especially severe in winters because of heating demand. The major emission sources causing the severe air pollution in winter seasons in UB city are coal combustions at (1) 3 old coal fired plants for heat and electricity supply (Power Plant No. 4, No. 3 and No. 2), (2) approximately 200 Heat Only Boilers (hereinafter HOBs) for heating major buildings in Ger areas, (3) Coal Fired Water Heaters (hereinafter CFWHs) for smaller buildings in Ger areas, and (4) 200,000 to 300,000 Ger stoves utilized at households in Ger areas(2023¹). In addition, other emission sources such as increasing automobile traffics and resuspension of road dust, etc. have been in concern.

Under these circumstances, the Government of Mongolia requested the Government of Japan to provide technical assistance. In response, JICA supported Mongolia by two Projects, namely ‘Capacity Development Project for Air Pollution Control in UB City (hereinafter referred to as “the Project Phase 1”)’ from March 2010 to March 2013 and ‘Capacity Development Project for Air Pollution Control in UB City Phase 2 (hereinafter referred to as “the Project Phase 2”)’ from December 2013 to June 2017. Major activities of the two phases included updating and expanding the members of C/P-WG of the Projects including DAAEP², PM speciation analysis and PM apportionment study, elaboration of emission control measures and preparation of standard methodology to calculate air pollutant emissions. However, there were major issues newly identified in capacity development for solving air pollution control.

Having these backgrounds, the Government of Mongolia requested ‘Capacity Development Project for Air Pollution Control in UB City Phase 3 (hereinafter referred to as “this Project”)’ of the Project in May 2017. The Government of Japan approved the implementation of the Project in June 2017. JICA dispatched detailed planning survey from August to September 2017, and the Mongolian side agreed the plan of the Project generally.

In the beginning, the Project was agreed to be implemented for 4 years and 6 months from November 2018 to April 2023 by the Minutes of Meeting (M/M) of 1st First Joint Coordinating Committee (JCC) meeting on 12 December 2019. However, the project duration was necessary to be extended because

¹ http://ubstat.mn/download-jobtable=khun_amiin_too_khoroogoor_2023_on-2024.xlsx

² At the beginning of the project, it was Air Pollution Reducing Department (APRD) of the capital city. However, by Decree No. 100 dated on 21 March 2019, the structure of the City of Ulaanbaatar was changed, and APRD was changed to Department of Against Air Pollution of the capital city (DAAP). Furthermore, by Mayoral Decree A/1307 dated on 28 December 2021, the name of the organization was changed from DAAP to Department of Against Air and Environmental Pollution of the Capital City effective 1 January 2022.

activities were necessary to be paused in response to COVID-19 pandemic, as for 5 years and 9 months from November 2018 to July 2024 as agreed in the Minutes of Meeting (M/M) of 4th JCC meeting on 22 February 2021.

Outline of the phases is listed in Table 1 below.

Table 1 Outline of the Projects

Phase 1	➤ From March 2010 to March 2013, for 3 years ➤ Capacity development for 19 organizations, including AQDCC (currently DAAEP) ➤ For stationary sources monitoring, boiler registration & management, measures on thermal power plants exhaust and energy efficiency improvement, development and usage of air quality simulation model, and etc. ➤ With provision of necessary equipment (702 million MNT)
Phase 2	➤ From December 2013 to June 2017, for 3 years and 6 months ➤ Capacity development for 22 organizations, including AQDCC (currently DAAEP) ➤ For stationary & mobile sources monitoring, air quality monitoring, boiler registration & management, PM speciation analysis & PM apportionment study, etc. ➤ With provision of necessary equipment (2,754 million MNT)
Phase 3 (This Project)	➤ From September 2018 to July 2024, for 5 years and 9 months ➤ Capacity development for 14 organizations, including DAAEP ➤ For maintaining capacities developed in the previous two phases, improving planning through understanding air pollution of UB and pilot projects ➤ With provision of necessary equipment (680 million MNT)

(2) Mongolian National Policies that Significantly Affect Project Activities

1. **Ban on Raw Coal Use in Ulaanbaatar City**

According to Cabinet Decision of the Mongolian Government No. 62 on 28 February 2018 "The Ban on Raw Coal Use", from 15 May 2019, citizens and companies are prohibited to use raw coal in the most Khoros³ of Bayangol, Bayanzurkh, Songinokhairkhan, Sukhbaatar, Khan-Uul, and Chingeltei Districts of UB City except some organizations that were permitted to use it exceptionally.

Based on this Decision, from 2019 except 2023, Air Quality Improvement Area Enforcement Regulation has been updated yearly, and the number of Khoros where raw coal is prohibited to be used has been increasing.

³ "Khoroo" is the administrative sub-division of districts in UB City.

2. Introduction of Electric Buses and Cleaner Exhaust Buses (i.e. Euro V Emission Standard Buses) for Public and School Transportation in Ulaanbaatar City

For renewal of 400 buses in 2009, some Mongolian engineers proposed to procure cleaner exhaust buses such as Euro-III. However, since this proposal was rejected, The Mongolian Government procured 400 buses without any certificate on exhaust cleanness. Since they were necessary to be used for 12 years, retrofits were proposed and realized as trial basis, such as installation and operation of Diesel Particle Filters. However, in 2014, cleaner exhaust (Euro IV) buses were produced and introduced in Mongolia even though 20 buses. From 2019, the Mongolian Government started to renew public transportation buses in Ulaanbaatar City with Euro-V emission standard buses and electric buses. Among approximately 1,200 buses for public transportation in UB city, 904 Euro V buses, 59 electric buses, and 75 school Euro III buses for schools were introduced by January 2024. For 2024, UB City has a plan to introduce 150 electric buses and 50 small buses. UB city plans to continue use cleaner exhaust buses and electric buses. In response to the request of PTD, Mongolian and Japanese sides agreed reinstallation of DPFs to other public buses as an additional activity of this Project. However, most buses have been renewed with cleaner exhaust buses, number of buses suitable for retrofit by DPF installation decreased rapidly.

3. Regulation to Sell Low Sulfur Automotive Fuel

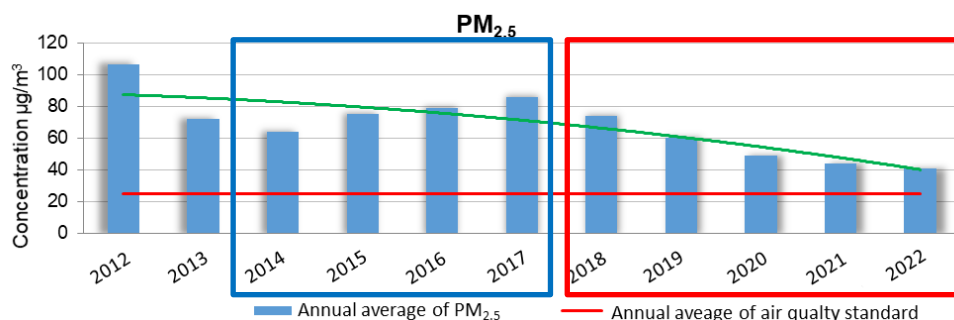
In Mongolia, high-sulfur automotive fuel was sold, which damages clean exhaust automobiles. In order to introduce low-sulfur fuel (Euro 5 fuel), the Project conducted the following activities: calculation of SO₂ emission reductions if low-sulfur fuel is introduced, support for legal framework amendment of the Mongolian Government through introduction of the history of low-sulfur fuel and laws in Japan, and inspection of sulfur content of fuel at petrol stations in cooperation with Ministry of Mineral and Heavy Industries (MMHI). As a result, Mongolian Air Law was amended on 22 April 2022 by adding a new article as Article 16.1.6 to provide retail and sale of the highest grade fuel of Mongolian National Standards (hereinafter referred to as “MNS”) and to ban the retail and sale, etc. of lower grade fuel in Air Quality Improvement Area of UB City.

(3) Overview of the Air Quality in Ulaanbaatar City

Air pollution in UB City is particularly severe in winter (from October to April) when heating is indispensable. As noted in 1-3-1, Mongolian government banned use of raw coal in UB City and requested to use improved fuels in 2019. In UB City, concentrations of sulfur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter (PM₁₀ and PM_{2.5}), carbon monoxide (CO), and ozone (O₃) are measured using automated measuring equipment at 17 locations around Ger districts, major road sides, apartment areas, and industrial areas. Ambient air quality standard of Mongolia is defined as MNS 4585:2016.

Annual averages of PM_{2.5} concentration from 2012 to 2022 were 1.6 to 4.2 times over the annual average ambient air quality standard for PM_{2.5} (25 µg/m³). It has been decreased constantly from 2017 (Figure 1).

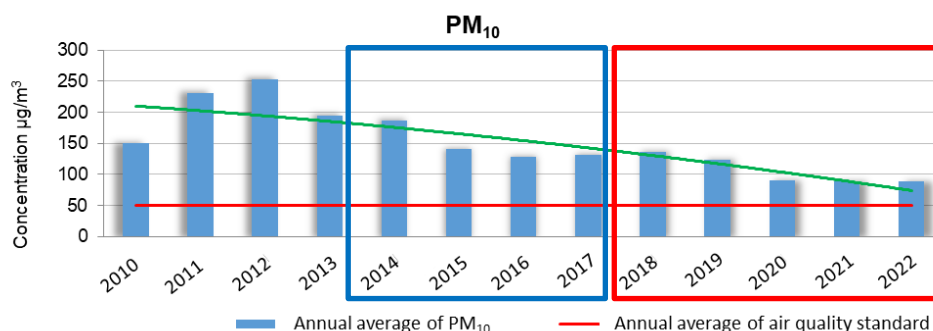
Annual averages of PM₁₀ concentration from 2010 to 2022 were 1.8 to 5.0 times over the annual average ambient air quality standard for PM₁₀ (50 µg/m³). It was highest in 2012, then decreased constantly from 2013 (Figure 2).



Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 1 Annual Average Concentration of PM_{2.5} at AQMSs in UB City



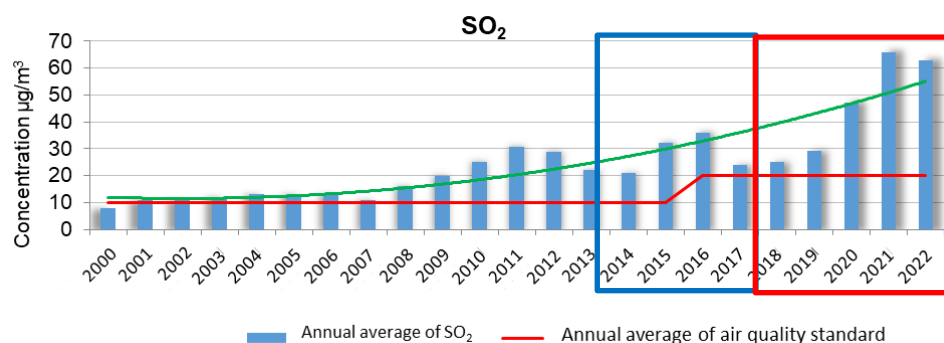
Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 2 Annual Average Concentration of PM₁₀ at AQMSs in UB City

Annual averages of SO₂ concentrations from 2000 to 2022 were 1.1 to 3.3 times over than the annual average ambient air quality standard for SO₂ (20 µg/m³). It decreased in 2017, then increased gradually in 2020 and 2021 (Figure 3).

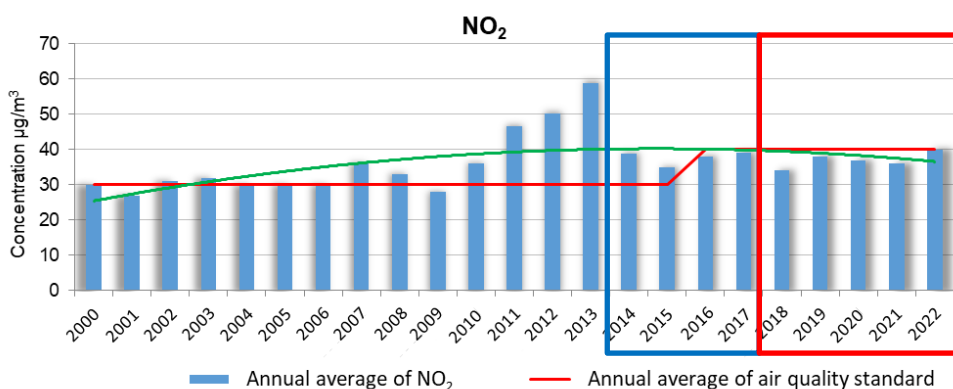
Annual averages of NO₂ concentrations were increased from 2009 until 2013, and then decreased in 2014. It has not been over the annual average of ambient air quality standard (40 µg/m³) from 2016 (Figure 4).



Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 3 Annual Average Concentration of SO₂ at AQMSs in UB City

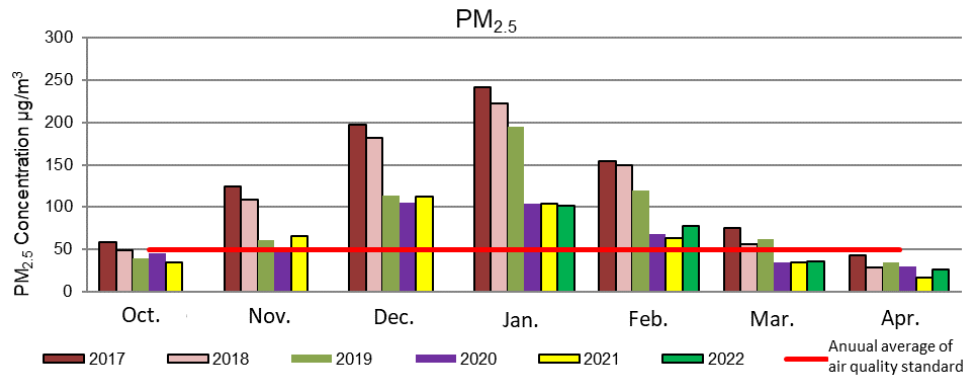


Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 4 Annual Average Concentration of NO₂ at AQMSs in UB City

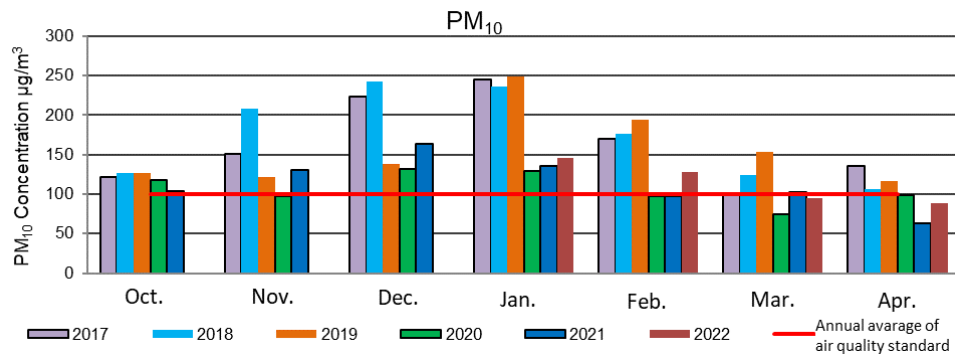
Figure 5 to Figure 8 show the monthly average concentrations in UB City in winters (from October to April), when air pollution is particularly severe. The concentrations of both PM₁₀ and PM_{2.5} have dropped significantly from October 2019, compared to before March 2019. On the other hand, SO₂ concentrations increased significantly. PM concentration improvement is estimated to be caused by using improved fuels of which volatile matter is low, as the result of ban of raw coal use in May 2019. However, SO₂ concentration increased due to the high sulfur content in the improved fuel.



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

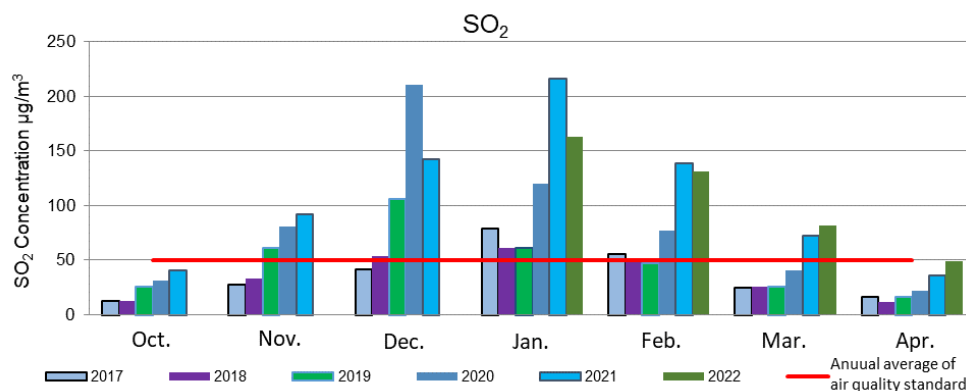
Figure 5 Monthly Average Concentration in Winters of PM_{2.5} at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

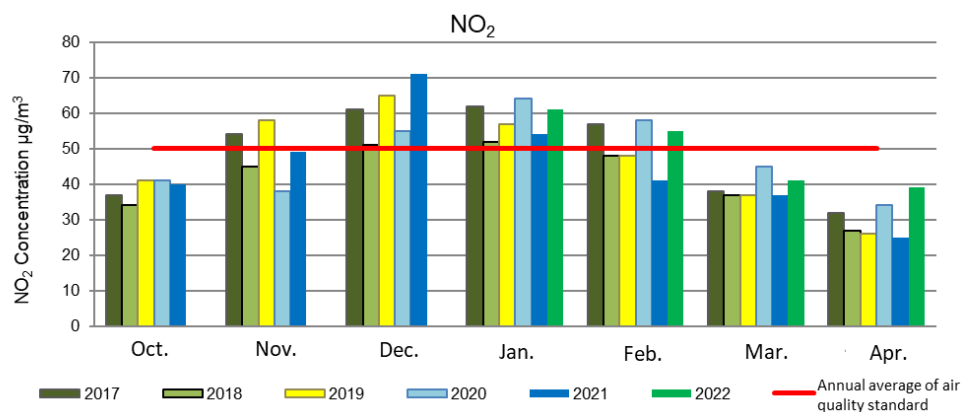
Figure 6 Monthly Average Concentration in Winters of PM₁₀ at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

Figure 7 Monthly Average Concentration in Winters of SO₂ at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

Figure 8 Monthly Average Concentration in Winters of NO₂ at AQMSs in UB City

(4) Overall Goal, Project Purpose and Output of the Project Phase 3

Overall Goal and Project Purpose of the Project Phase 3 are shown in Table 2.

Table 2 Overall Goal and Project Purpose of the Project Phase 3

Objective
Overall Goal
Emission reduction at major emission sources is enhanced towards air quality improvement in Ulaanbaatar City.
Project Purpose
Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attentions to implementation of effective pollution control measures and to the necessary coordinating mechanism of DAAEP and the relevant agencies.

Expected Outputs of the Project Phase 3 are shown in Table 3.

Table 3 Expected Outputs

Outputs
Output 1: Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.
Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO ₂ , and NO _x throughout the year are strengthened.
Output 3: Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.
Output 4: Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies
Output 5: Air pollution control measures are enhanced for PM, SO ₂ and NO _x emission reduction at major sources.
Output 6: Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.

In the beginning, the Project was agreed to be implemented for 4 years and 6 months from November 2018 to April 2023. However, the project duration was necessary to be extended because activities were necessary to be paused in response to COVID-19 pandemic, and the Project was implemented for 5 years and 9 months from November 2018 to July 2024. The project implementing organizations are 14 relevant organizations, including DAAEP, Ministry of Environment and Tourism (MET) and the C/P-WG.

(5) Project Activities and Outputs

After international supports such as by Japan, Mongolia has been able to identify the current status of air pollution, analyze the structure of air pollution problems, and publicize environmental information to a certain extent, and is currently in the process of studying and implementing air pollution control measures. It would be categorized as the second phase of cooperation in the cluster strategy "Realization of Sound Environmental Quality through Appropriate Environmental Regulations and Pollution Control Measures"⁴ of "JICA Clean City Initiative," which is JICA's issue-specific project strategy in the field of environmental management (JICA's Global Agenda).

The relationship between each output and the air quality cycle is shown in Figure 9. Output 1 and Output 2 are emission monitoring at major sources, inventory preparation using emission monitoring data, air quality monitoring, understanding of pollution structure by air quality model, and evaluation of the implementation of countermeasures by air quality model. Output 3 is the formulation of air pollution control measures in relation to Output 4; Output 4 is strategies, policies, and decision-making related to air pollution based on Outputs 1 and 2; and Output 5 is the implementation of air pollution control measures. Output 6 is to strengthen the legal framework, resource allocation, and

⁴ https://www.jica.go.jp/english/activities/issues/env_manage/index.html

coordination of relevant agencies as a common platform for the active functioning of the cycle through the interaction of each step.

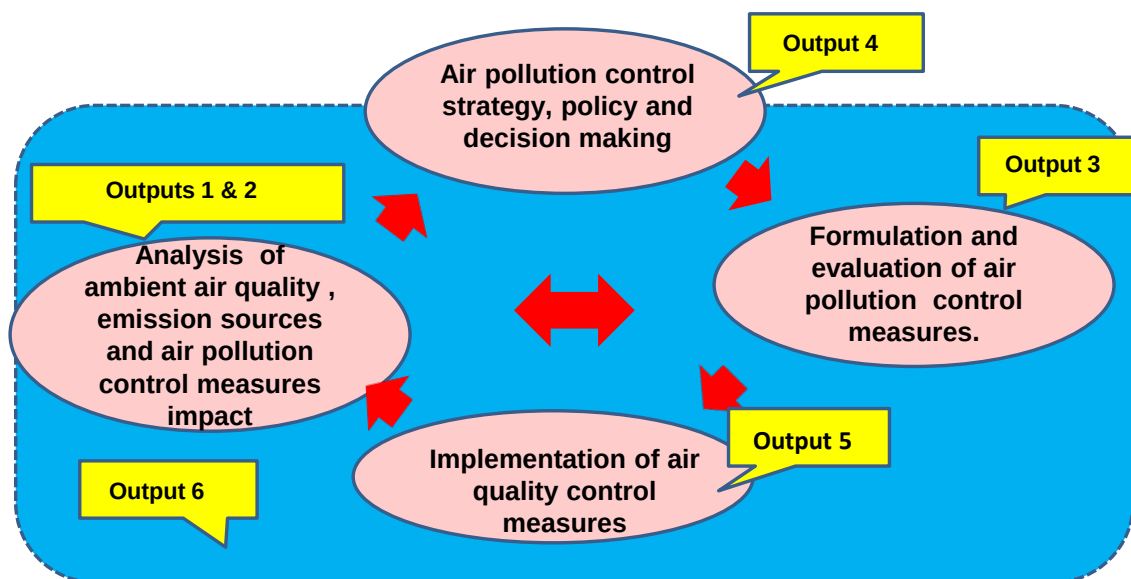


Figure 9 Air Quality Management Cycle

1. Emission Monitoring at Major Emission Sources (Output 1)

Emission monitoring at major sources is necessary to assess the current status of air pollution. Mongolian side became to measure emissions by themselves through the Projects. Specific achievements are as follows.

- As for the exhaust measurements at the stationary source, measurement system has been maintained and Mongolian side became able to carry out emission measurement by their own capability. During this Project, flue gas was measured at 240 boilers, including at the thermal power plants.
- In April 2022, DAAEP received ISO 17025:2017 laboratory accreditation for emission gas measurement of stationary emission sources. In addition, Ministry of Energy (ME) and the producers of the improved fuels requested exhaust measurements in the combustion test laboratory of DAAEP, and their results are used for the selection and further improvement of improved fuels.
- TPP3 and TPP4 are continuously utilizing CEMS. CEMS is also used to manage boiler operations. CEMS is maintained well generally for example by calibration, parts replacement and trouble-shooting. CEMS measurement results are submitted to NAMEM and other organizations.
- In Mongolia, 10-20% of all vehicles do not meet emission standards for vehicle inspection, which is one of the reasons for the severe air pollution caused by vehicles. A remote sensing device (RSD) survey has revealed that diesel particulate filters (DPFs) are not installed in diesel vehicles,

and that the proportion of vehicles with high concentrations of PM is considerably much higher than that in Japan.

- High sulfur content in gasoline and diesel oil has a negative impact on the various air pollution control measures installed in modern vehicles. As a result of the fuel survey, it was found that fuels with sulfur content more than 1,000 ppm were sold commonly, and it was reaffirmed that the awareness-raising activities to promote Euro 5 fuels (low sulfur fuels) is necessary.
- Mongolian side requested re-training of on-board measurement system for vehicle exhaust, and relocation of DPFs. Mongolian and Japanese sides decided to add these activities to this Project, and carried out these training and replacement. For the on-board emission system, capacity development was carried out through the verification of emissions before and after eco-driving and the effect of an additive. Relocation of DPFs were carried out for two buses.

2. Air Quality Monitoring and Understanding of Pollution Structure (Output 1 and 2)

Air quality monitoring, air pollutants emission inventories and air quality simulation modelling are necessary to study the current state and the structure of air pollution. Air quality information should be open to public in order to aware citizens about air pollution. Through this Project, capacity of maintenance of the Air Quality Monitoring Stations (AQMS) were improved, and air pollution structure was analyzed. Specific achievements are as follows.

- The staff for AQMS operation and maintenance succeeded continuous air quality monitoring by not only operation and maintenance works for AQMS, but also by solving various troubles. By year-around continuous air quality data, it is found that PM_{2.5} significantly exceeded its annual average air quality standard, especially terrible in Ger area in winter. Intensive operation and maintenance works increased ratio of effective hourly data of AQMS analyzers to 81% or more. Air quality has been continuously shared to public in real time through <http://agaar.mn/> and some smartphone applications.
- PM sampling and composition analysis during winter season revealed that the contribution of carbon from coal combustion, especially condensable particles consisting of organic carbon (OC) was significant during the Project Phase 2, when raw coal was used. In this Project, it was found that the introduction of improved fuels reduced the amount of condensable particles consisting of organic carbon.
- By air quality simulation model, it is found that small stoves used in detached houses and Ger (including Ger stoves and improved stoves) contribute to SO₂ and PM concentrations significantly, while the contribution from power plants and HOBs is small.
- Data obtained at AQMSs showed that PM concentration in the ambient air quality decreased and SO₂ concentration increased after the introduction of improved fuels in 2019, which was attributed to the ban on raw coal use and switch to the use of improved fuels. The results of the simulation model and PM composition analysis confirmed this.

3. Preparation of Standards Necessary for Technical Evaluation of Effectiveness of Air Pollution Control Measures (Output 3)

The project prepared standards for technical evaluation of effectiveness of air pollution control measures. Specific achievements are as follows.

- In 2022, ME prepared and submitted an amendment proposal of MNS for improved fuel quality standard to Mongolian Agency for Standardization and Metrology (MASM). It was authorized as MNS 5679:2022 by the Director of MASM on 17 October 2022. This standard became effective on 18 October 2022. The supervising agency responsible for quality control of improved fuels confirms that the improved fuels meet this this standard.
- Combustion tests of improved fuels requested by ME and improved fuel manufacturers have been conducted according to the protocol established in the Project Phase 2. There have been no objections about the protocol in these tests. Although Mongolian side had no specific idea to formalize the measurement method, JET explained the necessity of formalization. Under JET's advice, DAAEP concluded that the protocol was sufficient as a standard, and proposed it for UB City. UB City started the process to formalization in March 2024.
- Although Mongolia had laws regarding gas fuel usage, they were not enough about safeness in gas usage. IACC has provided guidance to the general public on safe usage of gas fuel, but its content is a brief summary of recommendations for LP gas usage and notes for gas appliances usage. In order to create an environment in which gas fuel can be used safely, it is important not only to regulate gas utilities, but also to promote voluntary efforts by gas service providers and to encourage general consumers. In Mongolia, it was considered as important to develop safety guidelines for gas service providers focusing on the advancement of voluntary safety systems and measures to inform and educate the general public. Therefore, referring to the Japanese law on gas safety assurance and regulations for gas utility companies, the safety guidelines for the promotion of gas fuel use in Mongolia were prepared by extracting the contents related to safety that are considered particularly necessary for the promotion of gas use in Mongolia in the future. The safety guidelines were submitted to ME in June 2024.

4. Strategy, Policy and Decision Making on Air Pollution (Output 4)

Based on the results of the analysis and evaluation of the air quality and air pollutant sources obtained through this Project, Mongolia has been building a system to enable Mongolian side to formulate its own science-based strategies and policies and to make its own decisions. Specific results of the recommendations for decision-making bodies are as follows.

- JET studied the air pollution situation in 2018 when raw coal was used and in 2020 after the introduction of the improved fuel and the air pollution control measures of the pilot project. Based on the results of increased SO₂ concentrations with the introduction of the improved fuel,

JET, together with NAMEM, recommended in seminars and at the JCC to use low sulfur coal or to blend desulfurizing agents with the improved fuels when improving the improved fuels.

- NAMEM analyzes air pollution using AQMS data and submits weekly, monthly, winter, and annual reports to National Bureau of Statistics, NCEPR, and MET.
- In November 2023, presented to Deputy Governor of UB City the results of the evaluation of air pollution control measures through fuel conversion from raw coal to the improved fuel, which was implemented as a national policy of the Mongolian Government, and made recommendations on the effectiveness of such measures.
- The Project presented the results of a comparison of improved fuels for household to the Deputy Governor of UB City in April 2024. Specifically, the Project presented a comparison between TTT's improved fuel in use and the Biomass Blended Coal Briquette (BCB) developed by the Project, a comparison between BCB introduction and stove replacement, and their effect.

5. Implementation of Air Pollution Control Measures (Output 5)

To promote air pollution control by business entities, the following activities were implemented. In addition, several pilot projects were developed, as described below.

- In December 2020, JET explained to DAAEP that it is necessary to add a desulfurizer to TTT's improved fuel, because TTT's improved fuel has higher sulfur content than Baganuur coal and it will increase air pollution of SO₂, based to the comparison of sulfur content between Baganuur coal and TTT's improved fuel. TTT was advised to blend the desulfurizer with TTT's improved fuel through DAAEP.
- In June 2022, in response to the request of the president of TTT, the minister of ME, the president of TTT, DAAEP, and JET held a meeting in which JET presented some opinions on TTT's improved fuel. JET requested the minister of ME that desulfurizer must be included in the improved fuel for the winter of 2022, since reduction of SO₂ should be prioritized, considering that SO₂ concentrations in winter of 2022 was higher than before.
- In March 2024, JET explained to TTT the environmental performance of BCB and the possibility of introducing BCB in Mongolia, based on the fuel test results of BCB produced by the pilot project.
- TPP3 and TPP4 keep trying to achieve a balance in their operation between the emission standard and heat and electric supply by blending several different types of coal.

6. Enhancement of the Platform of Air Quality Management Cycle (Output 6)

In this Project, efforts have been made to build a system that enables Mongolian side to propel the atmospheric environment cycle on its own, with an emphasis on strengthening the cooperative and

collaborative framework of the organizations concerned. Specific achievements in strengthening the legal and institutional framework are as follows.

- MMHI prepared a draft regulation on Euro 5 fuel based on JET's proposal and proposed it to the National Parliament. It was resulted as the provision on Euro 5 fuels, "Only fuels with the highest MNS rating shall be sold within the Air Quality Improvement Area of the UB city, and the retail, sale, etc. of fuels below that rating shall be prohibited," was added as Section 16.1.6 of the revised Law of Air, dated 22 April 2022.
- Almost every year from 2019, DAAEP drafted revision of the Rules on Air Quality Improvement Area and submitted them to the UB Mayor's Board of Directors Committee, for example by referring to the evaluation of pollution control plan (introduction of improved fuels throughout UB City) in the Project Phase 2. The Minister of Environment and Tourism and the UB Mayor have enacted them.
- Air pollution control measures have been decided as governmental decisions such as NPREP. NCEPR have been deciding budget, implementation period, implementing agencies and/or organizations etc. for each air pollution control measure. According to NCEPR's assignment, agencies and/or organizations carried out air pollution control measures. However, there was a possibility that this cycle is stopped from 2024 because NCEPR concluded that air pollution control for UB City will be efficient by UB city instead of national level organization, and then NCEPR was dissolved in December 2023. After some discussions, a new decision was made in April 2023 assigning UB City, NAMEM, etc. as the authorities for NPREP. The cycle will be continued by this assignment.
- In Mongolia, the roles of related organizations were not clear in the process from emission inventory development to evaluation of proposed measures using air quality simulation model. JET proposed to settle "Joint Implementation Agreement on Evaluation of Air Pollution Mitigation Proposals using Simulation Model," which was signed by DAAEP, NAMEM, and the National University of Mongolia (NUM) in April 2023.
- As a part of the Asia-Pacific Regional Action Programme for Air Pollution, The United Nations Economic and Social Commission for Asian and the Pacific (UNESCAP) and MET held the High-Level Forum on Clean Air on 2 and 3 March 2003 in Mongolia. MET requested the donors to collaborate with each other on air pollution control measures. In order to encourage their collaboration, MET requested the donors to attend the sub-meeting in prior to the Forum, which was organized by UNICEF in February 2023 as "Air pollution, scientific evidences and solutions Science and technology conference".

[Pilot Projects]

Pilot Projects were selected, planned, executed and then evaluated by the procedure shown in Table 4 according to the pilot projects activities agreed in PDM.

Table 4 Procedures for Activities Related to Pilot Projects

	Activity in PDM	Content
1	3-3	DAAEP and the relevant agencies elaborate implementation plans and terms of reference for pilot projects such as improved fuel, HOB, traffic signal control, eco-driving, RSD, smoke belching program based on portable emission device, DPF, low sulfur fuel and low emission vehicles.
2	4-3	The relevant agencies discuss and endorse the selection of pilot projects.
3	5-4	The relevant agencies with JICA Experts implement pilot projects according to the implementation plan by Activity 3-3
4	5-5	The relevant agencies with JICA Experts evaluate pilot projects results in terms of emission reduction, air quality improvement and exposure to citizens, and extract lessons learned.
5	5-6	The relevant agencies with JICA Experts report the pilot projects results to NCEPR.
6	4-2	Relevant agencies with pilot projects elaborate technical guidelines and utilizes them.
7	4-5	NCEPR, or the sections of the relevant agencies in charge of allocating funds for air pollution control in the Mongolian Government such as the Environment and Climate Fund utilizes the Outputs of the Projects and pilot projects implementation and assessment.
8	4-4	NCEPR and the relevant agencies approve large scale investments based on pilot projects implementation and assessment
9	6-8	Relevant agencies of pilot projects with JICA Experts develop an operational guideline for elaboration, implementation and evaluation of air pollution control measures based on pilot projects implementation.

1) Selection and Agreement of the Pilot Projects

Following 6 pilot projects were proposed for this Project in accordance with the Mongolian national policy.

According to the outputs of the Project Phase 2, it was found that air pollution was especially severe in winter in the Ger area, and its main reason was emissions from small household stoves (both of traditional Ger stoves and improved stoves) used in Gers and houses. After raw coal supply was stopped and “improved fuel” was started to be used widely, air pollution was mitigated but still severe. Therefore, further improvement of the “improved fuel” for household use was selected as one of the pilot projects.

The following five measures were selected for automobile emissions because it is better to reduce emissions from vehicles as soon as possible, although automobiles are replaced in a decade by new automobiles with new emission control technologies.

1. Operational changes in signal control to ease traffic congestion and reduce air pollutant emissions;
2. Introduction of low-sulfur fuels, because high-sulfur fuels that were commonly used in UB deteriorate emission reduction technologies in the automobiles in UB quickly;

3. Eco-driving, which contributes significantly to reduce air pollution emissions at the time of start moving, since the largest percentage of pollutants is emitted at the time of start moving of vehicle;
4. Widespread installation of PM reduction devices (DPF, etc.) to reduce PM emissions from diesel vehicles; and
5. Introduction of RSD to measure vehicle exhaust running on road instantly and continuously to identify high emission vehicles to control, as it was not realistic to control many vehicles on road by stopping and inspecting vehicles one by one.

Through discussions with related organizations and at JCCs, these 6 pilot projects were selected and agreed for implementation.

2) Implementation and Output of the Pilot Projects

Summary of implementation and output of the pilot projects is described here. Details of the significance, implementation, and output of the pilot projects are described in 3-6-4.

1. Further Improvement of the Improved Fuel for Household Use

Citizens had complained to continue to use the improved fuel because it is not easy to start fire. Emission reduction of Volatile Organic Materials (VOC) is important for further reduction of ambient PM because VOC was the major component of ambient PM of winter highly polluted days. Blending biomass was one of the highest potential solutions to solve these issues. Therefore, Biomass Blended Coal Briquette (BCB) was produced as a method of further improvement of the improved fuel.

By test combustion of BCB, it is confirmed that BCB is better than the current improved fuel made by TTT in terms of fire starting, combustibility, and desulfurization. Air pollutant emission by using BCB in the improved stove satisfied all the emission standards for stoves in MNS 5216:2016.

Feasibility of BCB was studied also. 650,000 tons of improved fuel is necessary for UB City. The total of yearly biomass supply capacity from Tuv, Khentii, Selenge, and Bulgan Provinces is 200,000 tons, of which 115,000 tons can be supplied from Tuv Province next to UB City. It is enough to produce 650,000 tons of improved fuel for UB City. However, production cost would be 22% higher than the cost of TTT's plan for improved fuel in 2023, which is the major issue to replace the current improved fuel with BCB.

2. Traffic Signal Control

Experts of UB City Traffic Control Center (TCC), together with JETs, reviewed the light hours by time of day at 17 intersections in the central area of UB City based on the results of traffic volume counting surveys, adjusted the light cycle at 10 of these intersections, and examined the changes in

traffic conditions before and after the signal adjustments in terms of traffic volume, congestion length, travel time, and signal intervention. The results showed positive effects of the signal adjustments. In order to improve traffic fundamentally, not only by light cycle adjustment, but also combinations of measures such as other methodology of changing traffic signals, changing traffic lanes, enhancing road network, enhancing public transportation, controlling traffic demand, and improving driving manners are necessary.

3. Low Sulfur Fuel

High-sulfur fuels were commonly sold for vehicles in Ulaanbaatar. Although it was not problem legitimately in UB, it deteriorate emission reduction technologies of the automobiles in UB quickly. In order to slow down deterioration to reduce emissions from vehicles, activities to introduce and promote low-sulfur fuels were implemented with MMHI. This included studying the sulfur content of fuel sold at petrol stations, estimating reduction possibility of SO₂ emission to publicize legislation and dissemination activities, and developing legislation and dissemination activities in Mongolia through introduction of the Japanese introduction process and legislation.

Based on the study, it was found that fuels with high sulfur content of over 1,000 ppm were commonly sold. Dissemination activities were conducted to promote introduction of Euro 5 fuels (low sulfur fuels). Regarding the introduction of low sulfur fuel (Euro 5 standard fuel), new article 16.1.6 were inserted into Air Law by the amendment on 22 April 2022, which stipulates the use of Euro 5 standard (K5 in Mongolia) fuel within the air pollution improvement area in UB city. This means that the pilot project was upgraded to full-scale implementation.

However, Euro 5 fuel is more expensive than regular fuel. Therefore, although the sales volume of Euro 5 fuel has been gradually increasing, it still has not been widely used.

4. Eco-Driving

Eco-Driving is an environmentally friendly way of driving a car in order to reduce emission of carbon dioxide (CO₂) that is the major cause of global warming, and emissions of air pollutants that are one of the causes of air pollution. Since the largest percentage of pollutants are emitted when any car starts moving, eco-driving, which greatly contributes to reducing air pollution emissions at the time of starting moving, is effective. In order to promote eco-driving, eco-driving training was implemented and its effect was measured by the on-board emission measurement system and eco-driving support devices.

The results of the eco-driving program for three vehicles (a passenger gasoline vehicle, a passenger hybrid vehicle, and a light-duty truck with diesel fuel) showed a reduction in air pollutant emissions.

5. PM Reduction Equipment (DPF)

JET explained to MRTD PM reduction effect of retrofit by DPF installation using the on-board emission measurement system. JET drafted an evaluation procedure to identify valuable DPF models, held discussions with MRTD, and agreed to proceed with the development of vehicle regulations requiring retrofit of diesel vehicles by installation of PM reduction devices (DPFs, etc.) as a full-scale project. However, installation of DPFs is not proceeding well because they are expensive and costly to operate, according to MRTD.

The PM reduction effect of the DPF model tested was confirmed to be very high based on the reduction of black smoke during driving and gauze tests with and without the DPF. On the other hand, it was reconfirmed that daily operation of the DPF model tested is not feasible without assignment of additional workers to regenerate DPFs.

6. Introduction of RSD

It was not realistic to control many vehicles on road by stopping and inspecting vehicles one by one. In order to identify high emission vehicles efficiently, RSD was proposed to be tested as a pilot project. In order to introduce operation regulations in Mongolia using RSD, DAAEP and JET installed RSD and measured exhaust of vehicles by RSD, NRTC measured opacity, and the traffic police stopped vehicles for opacity measurement. From the data acquired by RSD measurements and opacity measurements, correlation between the two measurement methods was clarified, and the emission standard values for RSD corresponding to the emission standard specified in the MNS (40% in opacity) were determined.

In preparation for the introduction of the operation regulation using RSD emission standard value for full-scale project, RSD emission standard value corresponding to the emission standard (40% opacity) specified in the MNS was proposed as 25. Draft legislation and technical guidelines for RSD measurement were prepared since Mongolia does not own RSD equipment and legislation is not yet in place.

After this Project, it will be necessary by MRTD to obtain RSD, and to prepare and start vehicle exhaust control by roadside inspections using RSD. It means that regulations should be prepared and authorized for examples as MRTD Ministerial Decree and/or UB Mayor's Decree to obtain RSD, to start roadside inspection, and to request the users or owners of vehicles of which exhaust exceed the standard to pay penalties, and/or to satisfy the standard by service maintenance, installation of PM reduction device if the vehicle is diesel vehicle without PM reduction device, or renewal with vehicle of which exhaust does not exceed the standard.

(6) Achievement of Objectively Verifiable Indicators

Two to five indicators were agreed for each output to evaluate the level of achievement in this Project. Based on these indicators, it was confirmed that the Project has achieved the output indicators from

Output 1 to Output 6, except for Indicator 3-1 and Indicator 6-2. In addition, it was confirmed that the Indicator 1 of the Project Purposes was achieved, while the other indicators of the Project Purposes were partially achieved. Details of indicators achievement are shown in Table 5.

Table 5 Achievement of Objectively Verifiable Indicators of Project Purpose and each Output

Objectively verifiable indicators for Project Purpose	Description	Status of achievement
Project Purpose: Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attentions to implementation of effective pollution control measures and to the necessary coordinating mechanism of DAAEP and the relevant agencies.		
1. One of pilot projects are adopted as full scale implementation by relevant authorities.	As a result of the pilot project, Air Law was amended on 22 April 2022 by adding a stipulation in Article 16.1.6 to provide retail and sale of the highest grade fuel of MNS and to ban the retail and sale, etc. of lower grade fuel in Air Quality Improvement Area of UB City.	Achieved
2. At least one case of lessons learned from the pilot projects are utilized by the decision makers.	- Not only at the 10 intersections targeted in the pilot project, but also at other traffic signals in UB City, the use of the acquired technology reduced the number of interventions at traffic signals by the TCC and the number of traffic control operations by traffic police officers ignoring the lights of traffic signals. In addition, a standard of up to 240 seconds of intervention time by traffic police could be set. Thus, the lessons learned, while temporary, were used by the decision-making bodies. - However, the implementation of the system was only temporary, and there are still issues that need to be addressed before it can be spread throughout UB City and produce tangible outputs.	Partially Achieved
3. Relevant laws, regulations and standards on air pollution control measures are implemented in UB City. (At least establishment of one MNS, and/or 70% of compliance in the dust emission standards of existing MNS; MNS 5043:2016 (General technical requirement of heat water boiler under 4.2 MW) and MNS 5919:2008 (Emission limit value and measurement method of power plant, steam boiler))	- A provision 16.1.6 was added to the Air Law, to obligate the fuel provider to sell only Euro 5 standard fuel with low sulfur content and to prohibit the retail of fuel with lower quality within the air quality improvement area in UB City. Although laws and regulations have been established, there are still issues to be addressed in terms of compliance. - The results of emission measurements at 240 sites conducted by DAAEP during the project period showed that Dust emission standards were achieved at more than 70% of the sites.	Partially Achieved

Objectively verifiable indicators of output	Description	Status of achievement
1. Output 1: Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.		
1-1. During the Project duration, at least 50 % of inspections for boiler registration based on emission measurements (including standard and simplified methodologies) are implemented by DAAEP and IACC.	DAAEP performed the flue gas measurement at 206 boilers from November 2018 to December 2022. This number represents 50.7% of all registered HOBs (406 locations).	Achieved
1-2. The emission measurement reports are submitted to the Deputy Governor of UB City at least 3 times during the Project duration.	DAAEP prepares an annual report on its activities, including the name of the facility and the results of emission measurements. DAAEP has been reported in January 2019, January 2020, January 2021, January 2022, January 2023 and January 2024.	Achieved
1-3. Emission monitoring for the major pollution sources and air quality monitoring information are shared regularly among the relevant agencies through coordination between DAAEP and NAMEM.	As for emission monitoring information, DAAEP annual report is shared at the website of DAAEP, including stack gas measurement report of TPP2, TPP3, TPP4 and HOBs. Data of continuous emission monitoring system (CEMS) has been shared to the relevant agencies by MET, by keeping the online information system, and by sharing user name and password for relevant agencies. Air quality monitoring information are shared regularly among the relevant agencies by annual report and the website: Agaar.mn.	Achieved
1-4. The CEMS measurement is compared with the standard measurement once in a year.	DAAEP measured exhaust gases of TPP3 and TPP4 periodically. The result was compared with CEMS data in 2023, when necessary information had been accumulated and shared.	Achieved
1-5. Distribution of emission measurements from vehicles in UB City is prepared based on the study with RSD at least once a year.	RSD survey was carried out in May and June 2023 to create an actual distribution of vehicle emission for vehicles traveling in UB City.	Achieved
2. Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO₂, and NO_x throughout the year are strengthened.		
2-1. The results of PM apportionment study are reported at least three times during the Project.	The results of the composition analysis were reported at a seminar in Mongolia on 26 August 2022, at a lecture in the training course in Japan in 11 November 2022, and at a seminar in Mongolia on 12 April, 2023. In the final seminar in April 2024, C/P by themselves explained their activity and the results of analysis to the participants including for other C/P group members.	Achieved

2-2. Pollution structures are assessed at least 3 times during the Project duration including emission inventory, simulation model, PM speciation, receptor model, air quality monitoring, and population exposure throughout the year.	Air pollution structures were assessed in October 2010 for the case 2018 and 2020. BAU scenario in 2023 was assessed in March 2024. The evaluation of air quality and population exposure was carried out in September 2023 and March 2024.	Achieved
3. Output 3: Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.		
3-1. Drafts of emission measurement methods and quality standards of improved fuel for households in area are submitted to MASM.	The quality standards of improved fuel for households was has been revised in MNS 5679-2019 and MNS 5679-2022. The standards for emission gas measurement methods are currently being considered by the UB City Urban Standards Control Bureau.	Partially Achieved
3-2. At least three of implementation plans of the pilot projects are prepared.	In the 3 rd JCC, changes in implementation plans and location for pilot project of improved fuel was approved. The vehicle pilot projects were discussed with C/P-WG from May 2019, and the implementation plans of pilot project regarding traffic signal control, eco-drive, RSD, DPF, low-sulfur fuel, and low-emission automobiles were approved.	Achieved
4. Output 4: Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies.		
4-1. Analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) are presented to decision makers at least 2 times.	1) At the 8th JCC in December 2022, JET evaluated an air pollution control measure by converting raw coal to improved fuel, implemented as a Mongolian national policy based on the evaluation of the air pollution structure in 2018 and 2020, and recommended for further improvements of improved fuel. 2) In November 2023, JET presented the Deputy Governor of UB City the evaluation result of air pollution control measure by converting raw coal to improved fuel implemented as a Mongolian national policy and recommended the effectiveness of air pollution control measures. 3) JET explained the detailed air pollution structure of PM₁₀ in the seminar on PM₁₀ simulation model considering condensable particle matter in January 2024. 4) JET explained the setting of BAU scenario for 2027 as a target year and the setting of air pollution control measure scenarios based on the result of pilot projects and the evaluating result at the seminar on 13 March 2024. 5) In April 2024, JET presented the compared results of improved fuels for household to the Deputy Governor of UB City. Specifically, the result presented by JET	Achieved

	compared TTT's existing improved fuel and BCB produced by the Project and compared result of the air pollution control measures between produced BCBs and changing stoves. Then, JET recommended the effectiveness of air pollution control measures. 6) JET explained the setting of air pollution control measure scenarios based on the result of Pilot Projects and the evaluated result at the final seminar on 18 April 2024.	
4-2. Results of pilot project implementation and other Project results are utilized for the revision of NCEPR and for decision making on implementation/non-implementation of pollution control measures at least once.	In September 2022, NCEPR was planning to introduce an additive as the air pollution control measure for automobile. JET surveyed the emission reduction effect of the additive using on-board emission measurement system and submitted a report to NCEPR secretariats. As the result, NCEPR decided not to introduce the additive for automobile measure.	Achieved
5. Output 5: Air pollution control measures are enhanced for PM, SO₂ and NO_x emission reduction at major sources.		
5-1. At least three pilot projects selected by C/P-WG are implemented	Six Pilot Projects was implemented from July 2019 to March 2023, including improved fuel for households, traffic signal control, low sulfur fuel, eco-driving, PM reduction unit such as DPF, and RSD.	Achieved
5-2. The results of each pilot project (emission reduction, improvement of ambient air quality and population exposure for PM, SO ₂ and NO _x) are presented to the relevant agencies.	The seminar on the evaluation result of air pollution control measures based on the result of Pilot Projects was held with Mongolian side on 13 March 2024. The evaluation result of emission reduction, improvement of ambient air quality and population exposure were presented.	Achieved
6. Output 6: Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.		
6-1. At least three of drafts on laws and regulations, such as fuel regulations, MNS emission standards and ordinances of UB City, are submitted.	The following four points were submitted and approved. 1) A draft addendum/update to No. 62 Cabinet Decision of 2018 of the Government of Mongolia on the ban on the use of raw coal 2) The Air Quality Improvement Areas Enforcement Regulations 3) The UB Mayor's Decree No. A/346 of 2022 on Carbon Monoxide Poisoning Risk Prevention 4) A provision 16.1.6 of the Air Law to obligate the fuel provider to sell only Euro 5 standard fuel with low sulfur content and to prohibit the retail of fuel with lower quality within the air quality improvement area in UB City	Achieved

6-2. More than 3 air pollution control measures and technologies are funded by the sections of the relevant agencies in charge of allocating funds for air pollution control by utilizing technical appraisal guideline provided by the Project.	The Technical Review Guidelines were completed in June 2024, but NCEPR was dissolved at the end of December 2023. No department or area of responsibility for air pollution control has yet been determined, and no department responsible for allocating funds has yet been determined.	Partially Achieved
6-3. At least three agreements are made on demarcation of roles of the relevant agencies for air pollution control measures in the Project.	Four agreements were made as shown below; 1) A working group was established to audit and measure automobile emissions and to review and evaluate measures to reduce smoke (exhaust gas) emissions, by the Decree of the Minister of Road Transport and Development of Mongolia on 13 November 2019. 2) A working group was established to perform implementation of sampling of Particulate Matter (PM) in the ambient air Quality of Ulaanbaatar and defined its role by NAMEM Director General Order A/199 on November 19, 2021. 3) The "Joint Implementation Agreement on the Sharing of Roles in Preparing Emission Inventory, operating Simulation Models, and Evaluating Air Pollution Control Measures" requested by JET at the 6 th JCC in December 2021 was signed on 11th April 2023. 4) A working group was established to revise the technical requirement for Improved Solid Fuels MNS 5679:2019 by Minister Decision of Energy A/54 on 16 February 2022.	Achieved
6-4. The operational guideline is distributed to relevant agencies.	Based on the result of pilot projects, the operational guideline was elaborated in May 2024. Mongolian side distributed the completed operational guideline to relevant agencies.	Achieved

(7) Output through the Project Phase 1 to 3, and Its Collateral Effect

1) The Flue Gas Measurement at Stationary Source

Before the Project Phase 1, flue gas of most of the stationary sources had not been checked officially with emission standards because Mongolian public sectors had no way to compare them with emission standards. In order to solve this issue, necessary equipment was provided to DAAEP and human resources were developed with standard measurement method.

As collateral effects, DAAEP recognized need to conduct on their own fuel combustion tests during the Project Phase 2 and constructed a fuel combustion laboratory with the provided equipment. DAAEP considered obtaining ISO 17025 accreditation, which is able to guarantee measurement accuracy. DAAEP received laboratory accreditation of the flue gas measurement at stationary sources on 28 April 2022.

DAAEP became the only one organization in Mongolia that is capable of performing flue gas measurement including Dust measurement from HOBs and thermal power plants, which is recognized widely in Mongolia. DAAEP was requested to measure boiler flue gas not only from UB City but also from Selenge Province, Dundgovi Province, Erdenet City, and Darkhan City, and DAAEP performed it in those locations.

Since DAAEP is the only organization capable of performing the flue gas measurement when household fuels for stove are burned, after 2021, there are more and more requests for DAAEP to measure solid fuels at the fuel combustion laboratory. DAAEP performed 70 combustion tests of improved fuel and middling by request of ME, UB City, TTT, and other manufacturers in 2022, and 66 tests of improved fuels and igniters by request of ME, NCEPR, and UB City Council, TTT, and other manufacturers in 2023.

2) Air Quality Monitoring

In 2009, DAAEP started operating and maintaining 4 AQMSs after providing and training by “Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH”, German Development Cooperation. In 2010, NAMEM/CLEM started operating and maintaining 6 AQMSs with a loan from France. In order to avoid duplication of international aids, JICA and UB City agreed on the first Project activities without providing or training on AQMS. However, the results of the Project Phase 1 revealed that the operation and maintenance of AQMSs, and use of AQMSs data were insufficient, they agreed on activities regarding AQMS in the Project Phase 2 and this Project, and then improved as follows;

1. Development and operation of air quality disclosure system: Air quality disclosure system <http://agaar.mn/> was developed in 2014 as a component of the Project Phase 2, by cooperation of NAMEM, CLEM, DAAEP, JET, etc., and a contract with an IT company AstVision LLC paid by Mongolia Government. Air quality display devices were installed and operated at roadsides near AQMSs, and at the entrances of MET, NAMEM, UB City Hall, etc. This caused side effects as follows;
 - (i) Switching to stable data connection: NAMEM/CLEM contracted WiMAX wireless service of ULUSNET brand for all the AQMSs inside ULUSNET service area. Analog telephone line was contracted, and dial-up modem was installed for Urgakh Naran AQMS, which was outside of ULUSNET service area. Dial-up connection of Urgakh Naran AQMS was often failed, which was not suitable for air quality disclosure system. It was solved by replacing the dial-up modem with mobile-data modem, and then setting up VPN network for NAMEM/CLEM AQMSs. Maintenance of this AQMS was improved because most of the station conditions became able to be checked remotely via VPN through mobile data connection. This methodology (VPN through mobile data connection) was applied to all the other AQMSs when ULUSNET service was stopped in 2017.
 - (ii) Regarding operation and maintenance of AQMSs by DAAEP, not only technical issues of analyzers and data transfer, but also of administrative issues were commonly found, such as

- payment delay for electricity and data communication bills, or short of consumable parts caused by procurement delay. Air quality display devices made managers and deputy Governors to check data from AQMSs easily, which triggered them to solve administrative issues quickly.
2. Quantitative understanding of air pollution in the Ger districts: It was estimated that air pollution in Ger districts would be more serious than that in apartment areas because pollutants are likely to accumulate more seriously under inversion layer condition in narrower valley. However, in 2009 and 2010, AQMSs were installed inside apartment areas, or on the borders between the Ger and the apartment areas, but not within the Ger districts. Two AQMSs were installed about 100 m apart on either side of 4-n Zam (“the west intersection”), which was not effective distribution to understand air pollution of the city. First, two AQMSs (Tolgoit and Amgalan) were opened in the Ger districts by relocation of the existing AQMSs. Later in 2016, Bayankhoshuu AQMS was installed within the Ger districts, by which it was proved that air pollution in the Ger districts is significantly higher than air pollution in the apartment area.
 3. Collaboration among stakeholders: The expert of CLEM for AQMS has accumulated wide variety of know-hows, by operation and maintenance of AQMS by EANET trainings⁵ and by utilizing experts of equipment suppliers. He solved various problems and gave trainings to his colleagues and potential colleagues. The current DAAEP staff for AQMS operation and maintenance started without any know-hows after 2020 because there was less than one-week training from the previous staff. In addition, he did not have any connection to experts of suppliers. Through this Project, he understood that he can solve problems with support of CLEM experts, suppliers, JET, etc.

3) Emission Inventory and Simulation Modeling

Before the Project Phase 1 began, emissions by source had not being calculated. The capacity building through the Project Phase 1 to this Project has improved the capacity to prepare emission inventories, and DAAEP has been able to calculate air pollutant emissions almost every year since 2014 and elaborate annual emission inventory reports. The emission inventories have been used as input data for 72-hour air pollution forecast model constructed by IRIMHE as well as for dispersion simulation model in this Project.

In addition, an emission inventory manual was elaborated under the Integrated Programme for Better Air Quality in Asia (IBAQA Programme) by Clean Air Asia (CAA), which was implemented in Mongolia for three years from 2016 to 2018. The Emission Inventory Manual, which is currently being used by the provinces in Mongolia, uses the emission calculation methodology from the activities in the Project Phases 1 and 2. For emission factors for coal combustion sources, the manual includes values from the Project Phase 2 report, which reflect actual emissions in Mongolia.

⁵ Acid Deposition Monitoring Network in East Asia (EANET). The expert of CLEM for operation and maintenance of AQMS is also responsible on the EANET analyzers in Mongolia, and trained well through EANET activities.

NAMEM has published the Emission Inventory Manual as the official manual for Mongolia. Currently, emissions from HOBs and other sources in provinces other than UB City are calculated. In the future, NAMEM intends to make it possible to calculate emissions from small stoves for household in each province.

Since the results of dispersion simulation in the Project Phases 1 and 2 revealed that the main source of PM₁₀ and PM_{2.5} in winter was from small stoves for household in Ger districts, JET had proposed to the Mongolian side to introduce improved fuel as main air pollution control measure in winter. As a result, the Mongolian Cabinet Decision No. 98 National Program for Reduction of Air and Environmental Pollution on 20 March 2017 included the supply of improved fuel that meets standards to Ger districts, and the Mongolian Cabinet Decision No. 62 on 28 February 2018 banned the use of raw coal after 15 May 2019.

(8) Capacity Assessment (CA)

Capacity of individual level increased as shown in the below.

- UNICEF held “Air pollution, scientific evidences and solutions Science and technology conference” in February 2023. CLEM, IRIMHE, and other C/P-WG members made presentations in the conference.
- In the “The High-level Forum on Clean Air by the Asia-Pacific Regional Action Program for Air Pollution”, two members of NAMEM, one of the main C/P of the Projects, presented status on air pollution in Mongolia and the network of air quality monitoring.
- The Final seminar of this Project was held in April 2024, and DAAEP, TCC, MRTD, NAMEM, and other C/P-WG members prepared presentation materials and presented project activities at this seminar.

According to the following facts, it can be concluded that capacity of organizational level has been steadily strengthened through independent efforts by the Mongolian side.

- DAAEP has significantly increased the budget compared to the Project Phase 2, and by which DAAEP has purchased consumables and standard gases for flue gas measurement for stationary sources and AQMS, and repaired and renewed damaged equipment.
- Mongolian side have air quality distribution data in more detail by installation, operation and maintenance of additional 8 AQMSs.
- DAAEP applied to Mongolian National Accreditation System (MNAS), accreditation body in Mongolia, for ISO 17025:2017 laboratory accreditation for the flue gas measurement at stationary sources, and DAAEP received laboratory accreditation on 28 April 2022.
- High-level Forum on Clean Air by the Asia-Pacific Regional Action Program for Air Pollution was organized by MET with UNESCAP and UNEP on 2 to 3 March 2023.

According to the following facts, it can be concluded that capacity of social level has improved significantly from the following.

- In comparison to the Project Phase 2, Mongolian side became to consider that combustion tests should be performed for solid fuels evaluation and test results should be used as basis for evaluation. In fact, 66 combustion tests of improved fuels and fire starters were performed at DAAEP's fuel combustion laboratory by request of ME, NCEPR, TTT, and other companies in 2023.
- UB City had been implementing inspections to confirm that boilers meet emission standards based on results of the flue gas measurements, and a similar approach is now being taken for flue gas measurements in provinces. With public recognition of the flue gas measurements of DAAEP, there have been requested from localities other than UB City to perform the flue gas measurements for boilers, and DAAEP performed it in Selenge and Dundgovi provinces and Erdenet and Darkhan cities.

In order to assess changes of capacities of members of C/P and C/P-WG individually objectively, Capacity of individual level was assessed 7 times throughout the Project Period by interviews and monitoring. Capacity of organizational and social levels were assessed 3 times in March 2022, March 2023 and April 2024, by questionnaire to the managers of DAAEP and NAMEM, the C/P and the key organization of C/P-WG. Results of CA is shown in Table 6.

Table 6 Results of CA

Level	Advanced Sectors of Capacity Development	Low Sectors of Capacity Development
Individual	• Flue gas measurement at stationary sources • Operation and maintenance of AQMS • Emission measurements of automobile • PM source apportionment analysis • Development of Emission inventory	
Organizational	• Secure budget for DAAEP • Flue gas measurement at stationary sources by DAAEP • PM source apportionment analysis by CLEM and NAMEM • Collaboration between DAAEP and other agencies • Collaboration with donors	• Challenges remain in emission measurements of automobile • Challenges remain in securing support personnel to maintain organization of DAAEP to update emission inventory
Social	• Solid fuel evaluation based on combustion test results • Inspection of flue gas measurement at stationary sources	• Challenges remain programs to train personnel in emission measurements of automobile and emission inventory and simulation.

Table 7 shows the number of human resources who have been trained in this Project from November 2018 to April 2024.

Table 7 Number of Trained Human Resources

Year	Administrative official	Administrative officials, residents, and workers
FY 2018	34 persons	38 persons
FY 2019	54 persons	54 persons
FY 2020	100 persons	100 persons
FY 2021	68 persons	69 persons
FY 2022	61 persons	84 persons
FY 2023	67 persons	97 persons
FY 2024	26 persons	31 persons

Note: FY = Fiscal Year of JAPAN, from April until March

(9) Priority Measures identified and summarized by this Project

Based on the facts identified through this Project for Capacity Development for DAAEP and related organizations and, priority measures to solve air pollution in medium- to long-term are summarized in Table 8.

Table 8 Measures for Solving Air Pollution of Ulaanbaatar

1. Countermeasures for Large scale and medium scale stationary source	(1) Power plant countermeasures ➤ Measures to increase supply capacity of power and hot water ➤ Inspection, and operation and maintenance of air pollutant concentrations of flue gas of existing thermal power plants ➤ Installation of full package of air pollution control measures for new heat and/or power plant ➤ Improving capacity and efficiency of electricity distribution (2) HOB counter measures ➤ Closing HOBs by connecting buildings to central hot water supply network ➤ Installation and maintenance of flue gas cleaning equipment such as cyclone or scrubber ➤ Building additional large-scale heat supply facility to closing HOBs
2. Countermeasures for small scale stationary source	(1) Further improvement of improved fuel for household ➤ Promote further improved fuel through the steps below ➤ Combustion test for any further improved fuel at least 3 times at DAAEP's fuel combustion test chamber in order to know representative data of any fuels ➤ Selecting improved fuel of which PM and SO₂ emission factors is lowest, and starting and continuing fire is not difficult in the stoves for household, among the tested fuels ➤ BCB tested by this Project is the best currently (2) Stoves for household ➤ Prohibiting sale and use of traditional type stoves that don't satisfy MNS 5216:2016 (3) Introduction of alternative fuel for household ➤ LPG and/or pipeline gas and/or ➤ Improvement of LPG distribution and/or installation of gas pipes in UB city, safety guidelines for gas, safety education for gas users ➤ Electrification
3. Countermeasures for automobile	Preventing air pollution caused by automobile emissions and preventing the spread of economic losses due to time loss in traffic jams ➤ Popularization of Euro 5 fuel and low emission vehicles ➤ Implementation of emission regulations using RSD ➤ Application of signal control for all the signals in UB city ➤ Measures through road improvement ➤ Improvement of road signs and lane division ➤ Optimization of road structure, review of road network ➤ New construction of next-generation transportation system ➤ Metro, Monorail, BRT, etc.

Table 9 shows capacities developed by the Project Phases 1 to 3 of this Project and its utilization that is recommended to be done by Mongolian side from now.

Table 9 Activities through this Projects and its Recommendation of Utilization by Mongolian Side from Now

	Activities through this Projects	Recommendation of Utilization by Mongolian Side from Now
Capacities	➤ Measurement of air pollutants in stationary emission sources	➤ Maintenance of monitoring team
		➤ Securing the cost of updating measuring equipment
	➤ Air Quality Monitoring	➤ Maintaining the operation and maintenance team
	➤ Release of air quality information	➤ Securing maintenance costs and renewal costs of analytical equipment
	➤ Regular update of emission inventory	➤ Maintaining the emission inventory update team
Air pollution control measures	➤ Manufacture of improved fuel	➤ Further improvement of fuel
	➤ Combustion test of various modified fuels in combustion test chamber	➤ Further cost reductions
		➤ Securing procurement costs for improved fuel
	➤ Basic understanding of operational changes in signal control	➤ Change in signal control and operational changes to the entire UB city
	➤ Understanding of low-sulfur fuels and their necessity, as well as the vehicle specifications of low-emission vehicles and the necessity for their widespread use	➤ Further Promotion of Euro 5 fuel
	➤ Understanding eco-driving	➤ Activities to raise awareness among citizens and businesses using the equipment provided
	➤ Measures against high-emission vehicles by the pilot operation of RSD	➤ Procurement of RSD and development of legislation to regulate automobile emissions using the same equipment
		➤ Continuously securing a budget for air pollution control
		➤ Future development of city gas network

(10) To Achieve the Overall Goal after Project Completion

1) Prospects for achieving the overall goal

Table 10 shows the overall goal of the Project and its indicators.

Table 10 The Overall Goal of the Project and Its Indicators

Overall goal of the Project	Emission reduction at major emission sources is enhanced towards air quality improvement in UB City.
Indicator 1	PM ₁₀ 43% and SO _x 65% of emissions from small stoves for household and automobile is reduced compared with the BAU baseline.
Indicator 2	The outputs of the Project will be reflected in the policies and strategies of the next "National Program to Reduce Air and Environmental Pollution" and related laws and regulations.

The Project is expected to contribute to strengthening measures to reduce air pollutants in UB city. In addition to the measures to reduce air pollution being implemented by the Mongolian side, measures utilizing the results of the Project can be expected to reduce pollutants emissions further.

Indicator 1 of the overall goal can be achieved if BCB developed and tested further in the pilot project will be used commonly instead of the current improved fuel, low-sulfur fuel will be fully in UB City, public buses will be fully replaced by low-emission vehicles and their exhaust will be kept as clean as original, and any high emission vehicles over than vehicle emission standard will not be used inside UB City by full-scale usage of RSD.

Indicator 2 of the overall goal is expected to be achieved by Mongolian side continuing their efforts to solve air pollution even after the Project, for example, by any of the pilot projects will be adopted in the next "National Program for Air and Environmental Pollution Reduction", or the emission measurement method that was developed by this Project for improved fuels will be standardized.

2) Issues on achievement of Overall Goal 1

Table 11 summarizes the issues of budgetary measures and legal development for the Mongolian side to implement the three pilot projects as full-scale projects. Since air pollution countermeasures require some budget, budgetary measures are particularly necessary.

Table 11 Budgetary Measures and Legal Development

Pilot project name	Necessary budgetary measures	Necessary legal development
BCB	➤ Additional cost to manufacture BCB that will be enough for UB City ➤ Budget to renovate the improved fuel manufacturing equipment for BCB	➤ Quality standard for blend of biomass and coal is necessary although there is individual standard for coal and biomass ➤ Emission standard for fuels for household use
Dissemination of low-sulfur fuel and low-emission vehicles for public buses	➤ Procurement costs to renew all the public buses to Euro V or VI ➤ Budget for Euro 5 fuel for Euro V or VI buses	➤ Improvement of necessary laws for the dissemination of low-emission vehicles
Operation of RSD	➤ RSD procurement budget (approx. 200,000 EUR)	➤ Improvement of the legal system associated with the introduction of RSD

3) Necessary implementation framework on the Mongolian side to achieve the overall goal and necessary future implementation plan

Through the capacity development by measurement and pilot projects, the Project found that emission reduction of PM₁₀ by 43% and SO_x by 65%, as agreed as Overall Goal 1, can be achieved by the three above. In order to achieve the emission reduction systematic and steadily, it is recommended to be included in the next national program.

(i) BCB

It is essential for UB City to establish a manufacturing system and for DAAEP to continue the current delivery and sales system for the current improved fuel.

It is required to establish a manufacturing system, such as a warehouse for storing biomass and a new facility for drying and crushing biomass, and renovating the existing manufacturing line into a manufacturing line for BCB.

Although it has been found that enough quantity of biomass can be supplied from the surrounding province, it is necessary to secure suppliers and establish a delivery system so that biomass can be supplied continuously and stably.

The current improved fuel requires expensive binder imported from China. Potatoes, which are the raw material for the binder, are produced in large quantities in Mongolia. It is desirable to support domestic manufacturers and use domestically produced binders for the development of the manufacturing industry in Mongolia.

Stable procurement and the establishment of a delivery system can also be expected to reduce the cost of manufacturing improved fuel using biomass.

(ii) Dissemination of low-sulfur fuel and low-emission automobiles

Import of Euro 5 fuel is increasing. However, it is a challenge to contract a certain import volume because its demand in Mongolia is not expected. It is desirable for MMHI to continue educating consumers in order for importers to increase the amount of Euro 5 fuel procured and imported, which has been supported by this Project, to increase source countries for stable imports, and to encourage construction of the refinery in Mongolia.

Most of the cars registered in Mongolia are imported used cars. Emission standard for new vehicle production or import, such as Euro-V or Japan-2009, is not yet enforce in Mongolia. Therefore, it is desirable for MRTD to promote emission standards and legislation for new and used cars to increase the share of low-emission vehicles.

(iii) Automobile on-road inspection using RSD

With the introduction of RSD, it will be possible to inspect a large number of vehicles without a significant burden on inspectors compared to the current on-road inspections. Therefore, it is desirable to establish a legal system to regulate high-emission vehicles through on-road inspections using RSD and opacity meters, and to establish these on-road inspection systems by MRTD.

Photos

Air Pollution Condition in UB City	
	
Smoke from burning coal by stoves and covering the sky over Ger district (9 December 2018)	Traffic jam at an intersection in the evening (26 September 2022)
	
Air pollution in Yarmag region in winter (7 December 2022)	Air quality monitoring in Ger district on clean day (23 September 2022)
Kick-off Seminar, JCC	
	
Kick-off seminar (10 December 2018)	1 st JCC (12 December 2018)
	
7 th JCC (9 June 2022)	11 th JCC (16 May 2024)

Public Awareness and Public Relations



Deputy leader Mr. Sawaki interviewed by Mongolian media
(Broadcasted on 13 March 2019)



DAAEP expert explains measurement devices to Mongolian media
(Broadcasted on 13 March 2019)



Leader Mr. Tabata interviewed by Tokyo Broadcasting System (TBS)
(Broadcasted on 13 February 2024)



Mr. Sato explained the necessity of introducing Euro 5 fuel to Mongolian media
(Broadcasted on 23 April 2024)

Discussion of Deputy Governor and Related Agency

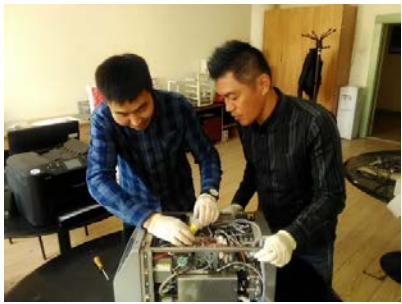
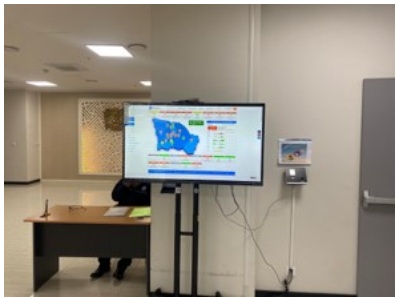


Discussion with Deputy Governor
(9 November 2023)



Discussion with CLEM
(5 February 2024)

Output 1 Capacity Development of Emission Monitoring on Emission Sources and Air Quality Monitoring

	
Maintenance of flue gas measurement device (29 May 2019)	Installation of flue gas measurement equipment (12 February 2020)
	
JET presents a certificate to the staff member in charge. (18 November 2021)	Automobile exhaust gas measurement sensor (9 November 2021)
	
On-board automobile exhaust gas measurement device (16 November 2021)	Seminar on analyzing measurement data of automobile exhaust gas (21 October 2019)
	
Maintenance of devices by DAAEP expert (22 February 2022)	Air pollution information display at the entrance of new UB City Hall (10 April 2024)

Output 2 Capacity Development to Analyze and Evaluate Pollution Structure



Installation of the PM sampler
(23 November 2021)



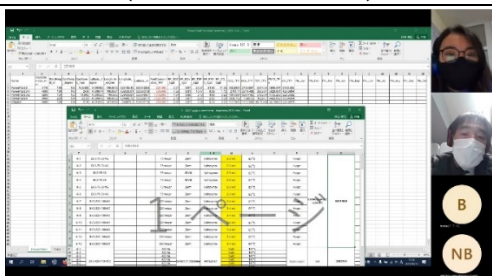
Collecting filter papers from the PM sampler
(24 November 2021)



Participants of training in Japan
(22 November 2022)



Final Seminar on PM source apportionment
(22 December 2023)



Online lecture on updating emission inventory
(12 January 2022)



Lecture on executing simulation model
(11 March 2022)



Lecture on emission inventory to DAAEP expert
(3 March 2023)



Seminar on evaluation of air pollution control measures based on the data derived by pilot projects
(21 March 2024)

Output 3~6 Improved Fuel Pilot Project	
	
Improved fuel made by TTT (21 February 2022)	Granted crusher (8 December 2021)
	
Crush of sawdust by crusher (30 August 2022)	BCB sample made by the Pilot Project (13 September 2022)
	
Ger camp site verification survey in 2022- 2023 winter season (January 2023)	Fuel combustion test at a Ger (December 2022)
	
Preparation of combustion test of BCB (1 November 2023)	Lecture on combustion test of BCB by Mr. Koyanagi (1 November 2023)

Output 3~6 Pilot Projects for Automobile

	
Traffic Condition Survey (19 September 2019)	X-ray Fluorescence Sulfur-in-Oil Analyzers (11 November 2021)
	
Relocation of DPF (4 June 2022)	Exhaust test by opacity meter (7 June 2022)
	
Improving signal control system (20 January 2023)	RSD survey (31 May 2023)
	
Drive recorder for eco-drive evaluation (28 June 2023)	Introduced Euro V bus (12 April 2024)

Final Seminar (18 April 2024)



Greeting by DAAEP director



Presentation by Mr. Barkhasragchaa (CLEM)



Presentation by Mr. Jargalbaatar (DAAEP)



Presentation by Mr. Adiya-Ochir (DAAEP)



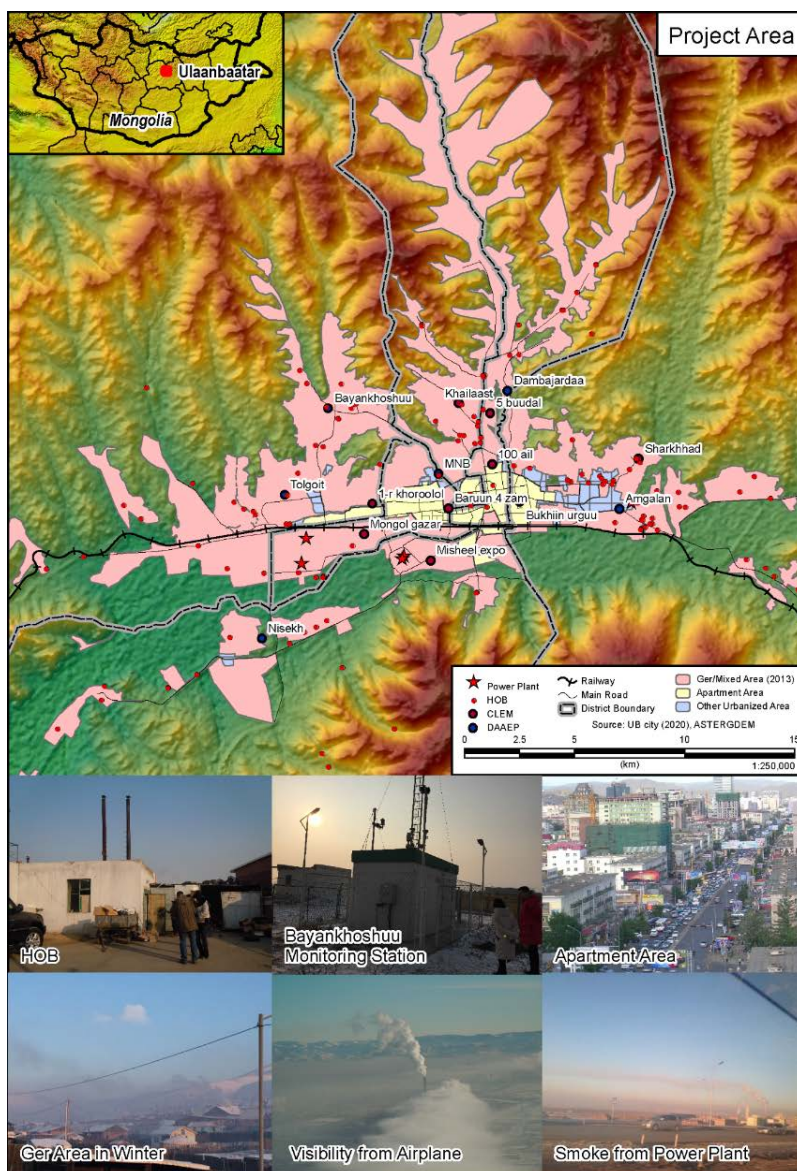
Presentation by Mr. Sawaki (JET Deputy leader)



Presentation by Mr. Tabata (JET Leader)

Target Area of the Project Phase 1 to 3

Ulaanbaatar City (UB City) has a population of approximately 1.64 million in 2023. UB City is divided into nine districts. Most of them live in the six districts (Bayangol, Bayanzurkh, Songinokhairkhan, Sukhbaatar, Chingeltei, and Khan-Uul). The average elevation of UB City is 1,300 m above sea level and it is surrounded by mountains to the south and north, shaping an elongated basin stretching from east to west. In the flat area around Sukhbaatar Square, many high-rise buildings and apartments are located (apartment area: yellow). On the other side, detached houses and Gers are densely built around the apartment area (Ger districts: pink). UB City is called the coldest capital city in the world, with an average temperature of minus 20 degrees Celsius in winter. In the winters, air pollutants tend to accumulate in the city due to weak winds and little rain and snow. On the other hand, the average temperature in summer is relatively hot, reaching nearly 20 degrees Celsius, thus there is a large annual variation.



1 Outline

1-1 Background of the Project

Ulaanbaatar (UB) city, the capital of Mongolia, has been covered by serious air pollution, especially by dust from combustion of low-quality coal. It has been especially severe in winters because of heating demand. The major emission sources causing the severe air pollution in winter seasons in UB city are coal combustions at (1) 3 old coal fired plants for heat and electricity supply (Power Plant No. 4, No. 3 and No. 2), (2) approximately 200 Heat Only Boilers (hereinafter HOBs) for heating major buildings in Ger areas, (3) Coal Fired Water Heaters (hereinafter CFWHs) for smaller buildings in Ger areas, and (4) 200,000 to 300,000 Ger stoves utilized at households in Ger areas(2023⁶). In addition, other emission sources such as increasing automobile traffics and resuspension of road dust, etc. have been in concern.

Under these circumstances, the Government of Mongolia requested the Government of Japan to provide technical assistance. In response, JICA supported Mongolia by two Projects, namely ‘Capacity Development Project for Air Pollution Control in UB City (hereinafter referred to as “the Project Phase 1”)’ from March 2010 to March 2013 and ‘Capacity Development Project for Air Pollution Control in UB City Phase 2 (hereinafter referred to as “the Project Phase 2”)’ from December 2013 to June 2017. Major activities of the two phases included updating and expanding the members of C/P-WG of the Projects including DAAEP⁷, PM speciation analysis and PM apportionment study, elaboration of emission control measures and preparation of standard methodology to calculate air pollutant emissions. However, there were major issues newly identified in capacity development for solving air pollution control.

Having these backgrounds, the Government of Mongolia requested ‘Capacity Development Project for Air Pollution Control in UB City Phase 3 (hereinafter referred to as “this Project”)’ of the Project in May 2017. The Government of Japan approved the implementation of the Project in June 2017. JICA dispatched detailed planning survey from August to September 2017, and the Mongolian side agreed the plan of the Project generally.

In the beginning, the Project was agreed to be implemented for 4 years and 6 months from November 2018 to April 2023 by the Minutes of Meeting (M/M) of 1st First Joint Coordinating Committee (JCC) meeting on 12 December 2019. However, the project duration was necessary to be extended because activities were necessary to be paused in response to COVID-19 pandemic, as for 5 years and 9

⁶ http://ubstat.mn/download-jobtable=khun_amiin_too_khorogoor_2023_on-2024.xlsx

⁷ At the beginning of the project, it was Air Pollution Reducing Department (APRD) of the capital city. However, by Decree No. 100 dated 21 March 2019, the structure of the City of Ulaanbaatar was changed, and APRD was changed to Department of Against Air Pollution of the capital city (DAAP). Furthermore, by Mayoral Decree A/1307 dated 28 December 2021, the name of the organization was changed from DAAP to Department of Against Air and Environmental Pollution of the Capital City effective 1 January 2022.

months from November 2018 to July 2024 as agreed in the Minutes of Meeting (M/M) of 4th JCC meeting on 22 February 2021.

1-2 Restrictions on the Project Activities

The global pandemic of COVID-19 caused suspension of international flight, and outside activities inside Ulaanbaatar. Therefore, from March 2020 to October 2021 when JET was impossible to travel to Mongolia, Japanese side tried its best to continue the Project remotely in Japan, where the Mongolian side tried its best under the restriction circumstances on outside activities.

1-3 Mongolian National Policies Particularly Relevant to Project Activities

1-3-1 Ban of Raw Coal Use in Ulaanbaatar City

From 2019, it is prohibited for most of boiler and stove users to use raw coal, and improved fuel manufactured by TTT Company is supplied as alternative fuel. Target Khorooos⁸ and target users has been expanded year by year. Usage of any solid fuel was prohibited in some Khorooos, and its target Khorooos has been increased. Details are as follows;

- 1) Utilization of raw coal by citizens and organizations was prohibited originally from 15 May 2019
 - In the most Khorooos of 6 central districts of UB City except 3 remote districts.
 - Any fuel users except of some organizations that has special permission for electricity and/or heat production.
 - By Cabinet Decision of Mongolian Government No. 62 dated on 28 February 2018, and Air Quality Improvement Areas Enforcement Regulation for 2019 as Joint Order No. A/433-A/820 of the Minister of Environment and Tourism and the Mayor of UB dated on 14 August 2019.
- 2) Tightening in 2020
 - Khoroo 20 of Bayanzurkh District, Khoroo 21 of Songinokhairkhan District, and Khorooos 12, 13 and 14 of Khan-Uul District were added to the target Khorooos.
 - By Cabinet Decision of Mongolian Government No. 189 dated on 27 May 2020, and Air Quality Improvement Areas Enforcement Regulation for 2020 as Joint Order No. A/604-A/112 of the Minister of Environment and Tourism and the Mayor of UB dated on 12 October 2020.
- 3) Tightening in 2021

⁸The khoroo is an administrative division that corresponds to a town under a city or district.

- Air Quality Improvement Areas Enforcement Regulation for 2021 as Joint Order No. A/322-A/780 of the Minister of Environment and Tourism and the Mayor of UB dated on 13 October 2021.

4) Tightening in 2022

- Nalaikh District of UB City in addition to the original 6 central districts.
- Khorroos where usage of any solid fuel is prohibited were increased from 57 to 73.
- Any fuel users except TPPs, Amgalan Heat Station and Selbe Heat Station.
- By Cabinet Decision of Mongolian Government No. 233 dated on 8 June 2022, and Air Quality Improvement Areas Enforcement Regulations for 2022 as Joint Order No. A/424-A/1353 of the Minister of Environment and Tourism and the Mayor of UB dated on 17 October 2022.

1-3-2 Introduction of Electric Buses and Cleaner Exhaust Buses (i.e. Euro V Emission Standard Buses) for Public and School Transportation in Ulaanbaatar City

In 2009, the Mongolian Government procured 400 buses and renewed old buses. At that time, engineers proposed to procure cleaner exhaust buses such as Euro III emission buses, which was not written in the specification prepared by Mongolian side. As the result, buses without any exhaust control were delivered. Recently, the Mongolian Government procured buses with Euro-V emission standard, and renewed old public transportation buses in Ulaanbaatar City. At January 2024 among approximately 1,200 public transportation buses in UB city, 904 Euro V buses, 59 electric buses, and 75 school buses for schools (Euro III) were introduced by January 2024. In 2024, UB city plans to procure 150 electric buses and 50 small buses. UB city plans to continue procuring Euro V buses and electric buses.

In response to the request of PTD, The JCC accepted to add a new activity to transfer DPFs installed on public buses. However, buses with high PM emission, which is suitable to retrofit by installation of the existing DPFs, has been decreased significantly because they have been renewed with clean exhaust buses.

1-3-3 Regulation to Sell Low Sulfur Automotive Fuel

In Mongolia, high-sulfur automotive fuel was commonly sold, which damages all the exhaust control equipment of automobiles in Mongolia. In order to promote low-sulfur fuel (Euro 5 fuel) in Ulaanbaatar, this Project conducted the following activities: calculation of SO₂ emission reduction potential by selling low-sulfur fuel instead of the high sulfur fuel currently sold, supporting counterparts for developing regulations for UB City through introduction of the history of low-sulfur fuel and laws in Japan, and checking sulfur content of fuel sampled at petrol stations. These activities were conducted with MMHI. Finally, Mongolian Parliament amend the Air Law dated 22 April 2022

by adding Article 16.1.6 to provide retail and sale of the highest grade fuel of Mongolian National Standards (hereinafter referred to as “MNS”) and to ban the retail and sale, etc. of lower grade fuel in Air Quality Improvement Area of UB City.

1-4 Overview of the Air Quality in Ulaanbaatar City

National Agency for Meteorology and Environmental Monitoring (NAMEM) publishes annual reports on air pollution in UB City every year. The annual report for 2022 is shown in Annex 2-2-1-5. Air pollution in UB City is particularly severe in winter (from October to April) when heating is used. As noted in 1-3-1, Mongolian government banned use of raw coal and requested using improved fuels in 2019.

In UB City, concentrations of sulfur dioxide (SO₂), nitrogen dioxide (NO₂), particulate matter (PM₁₀ and PM_{2.5}), carbon monoxide (CO), and ozone (O₃) are measured using automated measuring equipment at 17 locations in Ger districts, major road sides, residential areas, and industrial areas. Ambient air quality standards for each air pollutant of Mongolia is defined as MNS 4585:2016 (Table 1-4-1).

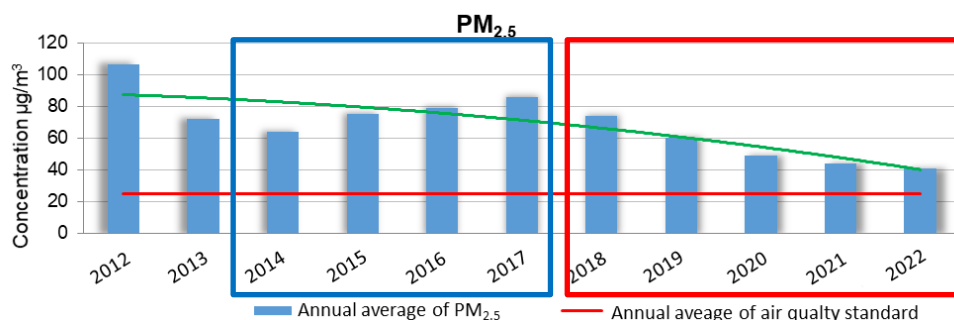
Table 1-4-1 Ambient Air Quality Standards Defined as MNS 4585:2016

Pollutant	Averaged Measuring Time	Unit	Standard Value
SO ₂	20 minutes average	µg/m ³	450
	24 hours average	µg/m ³	50
	Annual average	µg/m ³	20
CO	20 minutes average	µg/m ³	60,000
	Hourly average	µg/m ³	30,000
	8 hours average	µg/m ³	10,000
NO ₂	20 minutes average	µg/m ³	200
	24 hours average	µg/m ³	50
	Annual average	µg/m ³	40
O ₃	8 hours average	µg/m ³	100
TSP	20 minutes average	µg/m ³	500
	24 hours average	µg/m ³	150
	Annual average	µg/m ³	100
PM ₁₀	24 hours average	µg/m ³	100
	Annual average	µg/m ³	50
PM _{2.5}	24 hours average	µg/m ³	50
	Annual average	µg/m ³	25

Annual average of PM_{2.5} ambient air quality concentration in 2022 at AQMSs in UB City was 41 µg/m³, 7% decrease from 2021. Annual averages of PM_{2.5} concentration from 2012 to 2022 were 1.6

to 4.2 times over the annual average ambient air quality standard for $PM_{2.5}$ ($25 \mu\text{g}/\text{m}^3$). It has been decreased constantly from 2017 (Figure 1-4-1).

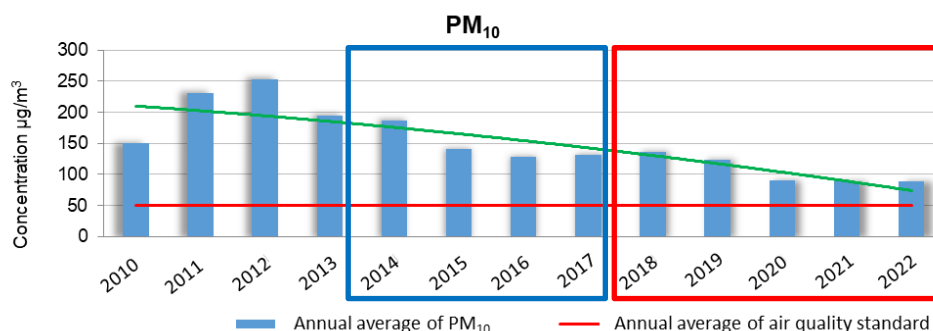
Annual average of PM_{10} ambient air quality concentration at AQMSs in UB City was $88 \mu\text{g}/\text{m}^3$ in 2022, almost same as in 2021. Annual averages of PM_{10} concentration from 2010 to 2022 were 1.8 to 5.0 times over the annual average ambient air quality standard for PM_{10} ($50 \mu\text{g}/\text{m}^3$). It was highest in 2012, then decreased constantly from 2013 (Figure 1-4-2).



Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 1-4-1 Annual Average Concentration of $PM_{2.5}$ at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

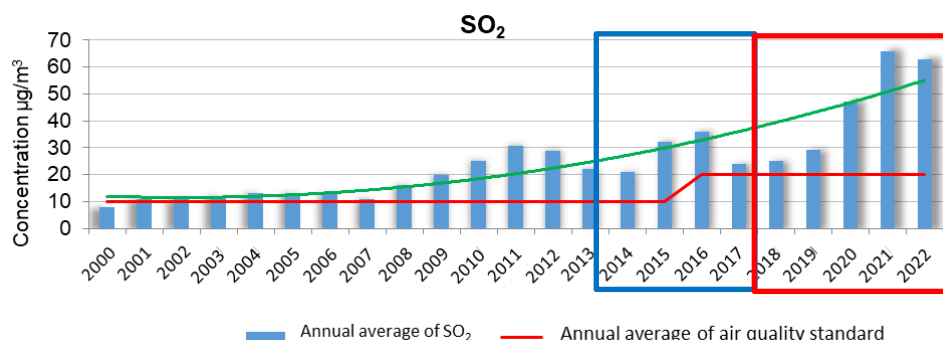
Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 1-4-2 Annual Average Concentration of PM_{10} at AQMSs in UB City

Annual average of sulfur dioxide (SO_2) ambient air quality concentration at AQMSs in UB City was $63 \mu\text{g}/\text{m}^3$ in 2022, 4% decrease from 2021. Annual averages of SO_2 concentration from 2000 to 2022 were 1.1 to 3.3 times over than the annual average ambient air quality standard for SO_2 ($20 \mu\text{g}/\text{m}^3$). It decreased in 2017, then increased gradually in 2020 and 2021 (Figure 1-4-3).

Annual average of nitrogen dioxide (NO_2) ambient air quality concentration of AQMSs in UB City was $40 \mu\text{g}/\text{m}^3$ in 2022, 4% increase from 2021. Annual averages of NO_2 concentrations were increased

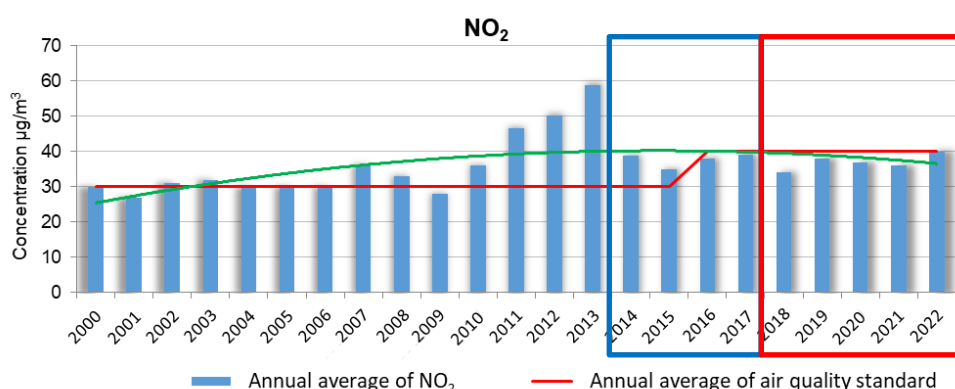
from 2009 until 2013, and then decreased in 2014. It has not been over the annual average of ambient air quality standard ($40 \mu\text{g}/\text{m}^3$) from 2016 (Figure 1-4-4).



Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 1-4-3 Annual Average Concentration of SO₂ at AQMSs in UB City

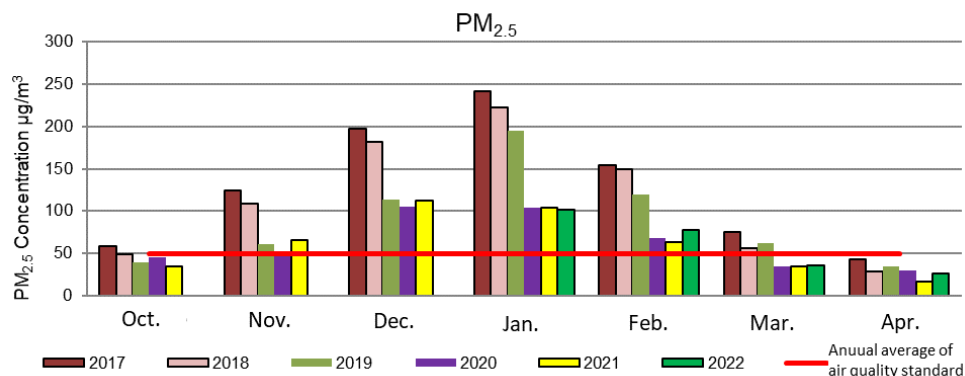


Source: Air Quality Annual Report for 2022 (NAMEM)

Note: Rectangles were overlaid by these Projects. (Blue for the Project Phase 2, and Red for this Project)

Figure 1-4-4 Annual Average Concentration of NO₂ at AQMSs in UB City

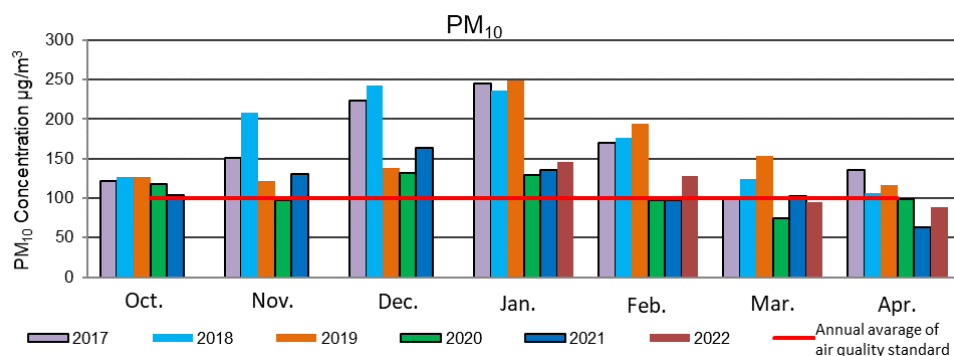
Figure 1-4-5 ~ Figure 1-4-8 show the monthly average concentrations in UB City in winter (from October to April), when air pollution is particularly severe. The concentrations of both PM₁₀ and PM_{2.5} have dropped significantly from October 2019, compared to before March 2019. On the other hand, SO₂ concentrations increased significantly. PM concentration improvement is estimated to be caused by using improved fuels of which volatile matter is low, as the result of ban of raw coal use in May 2019. However, SO₂ concentration increased due to the high sulfur content in the improved fuel.



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

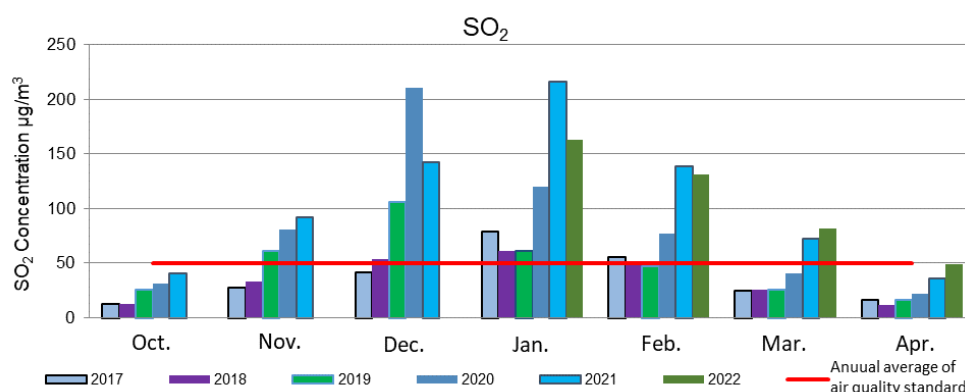
Figure 1-4-5 Monthly Average Concentration in Winter of PM_{2.5} at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

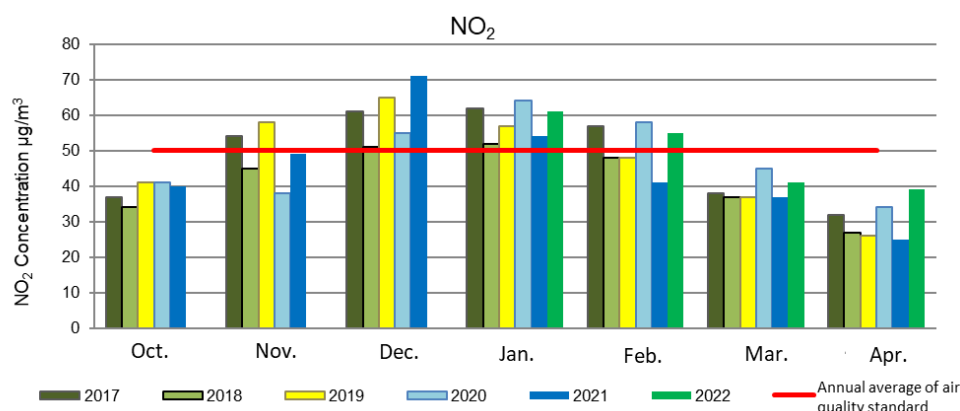
Figure 1-4-6 Monthly Average Concentration in Winter of PM₁₀ at AQMSs in UB City



Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

Figure 1-4-7 Monthly Average Concentration in Winter of SO₂ at AQMSs in UB City

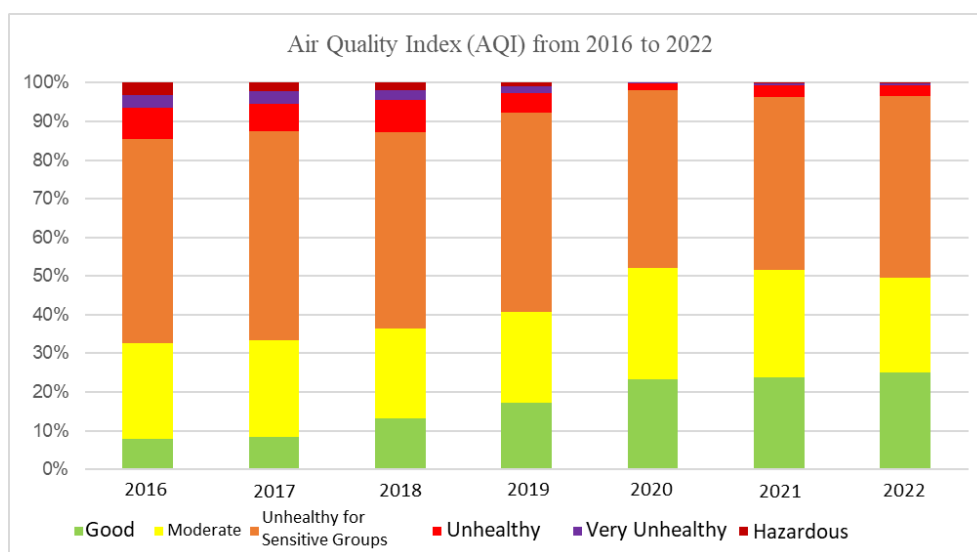


Source: Air Quality Annual Report for 2022 (NAMEM)

The Project Phase 2: December 2013 to June 2017, this Project: November 2018 to July 2024

Figure 1-4-8 Monthly Average Concentration in Winter of NO₂ at AQMSs in UB City

Figure 1-4-9 shows the frequency of Air Quality Index (AQI) from 2016 to 2022. The ratios of AQI below 100 (“Good” and “Moderate”) are in slightly upward trend, leading the appearance of air pollution to be improving slightly.



Source: Air Quality Annual Report for 2022 (NAMEM)

Figure 1-4-9 Air Quality Index (AQI) from 2016 to 2022

1-5 Project Framework

1-5-1 Relations with Related Projects

Figure 1-5-1 shows relations between this Project and all the other Projects of JICA related. Equipment for exhaust and air quality measurements was provided in the Project Phase 1 from 2010 to 2013 and in the Project Phase 2 from 2013 to 2017. Capacity Development by these projects made

Mongolian side to investigate pollution sources such as by flue gas measurements at stationary sources and emission measurements of automobiles. Also in these projects, JET strengthened C/Ps capacity to establish a system and strengthen analytical capacity to develop emission inventories and implement dispersion simulation models to understand air pollution structure. Air quality information became open to public online by Integrated Ambient Air Quality Monitoring Information System, enabling citizens to monitor status of environmental pollution. These activities can be categorized in Stage 1 in JICA global agenda for environmental management “JICA Clean City Initiative”.

By identifying remaining capacity issues through these Projects, this Project has re-evaluated the current situation after the ban of raw coal use, analyzed air pollution structure, identified high potential solution to accelerate to solve air pollution, implemented pilot projects, and made recommendations based on the pilot. These activities can be categorized in Stage 2 of JICA global agenda for environmental management “JICA Clean City Initiative”.

Outline of the Project Phase 1 to 3 are listed in Table 1-5-1.

Table 1-5-1 Outline of the Projects

Phase 1	➤ From March 2010 to March 2013, for 3 years ➤ Capacity development for 19 organizations, including AQDCC (currently DAAEP) ➤ For stationary sources monitoring, boiler registration & management, measures on thermal power plants exhaust and energy efficiency improvement, development and usage of air quality simulation model, and etc. ➤ With provision of necessary equipment (702 million MNT)
Phase 2	➤ From December 2013 to June 2017, for 3 years and 6 months ➤ Capacity development for 22 organizations, including AQDCC (currently DAAEP) ➤ For stationary & mobile sources monitoring, air quality monitoring, boiler registration & management, PM speciation analysis & PM apportionment study, etc. ➤ With provision of necessary equipment (2,754 million MNT)
Phase 3 (This Project)	➤ From September 2018 to July 2024, for 5 years and 9 months ➤ Capacity development for 14 organizations, including DAAEP ➤ For maintaining capacities developed in the previous two phases, improving planning through understanding air pollution of UB and pilot projects ➤ With provision of necessary equipment (680 million MNT)

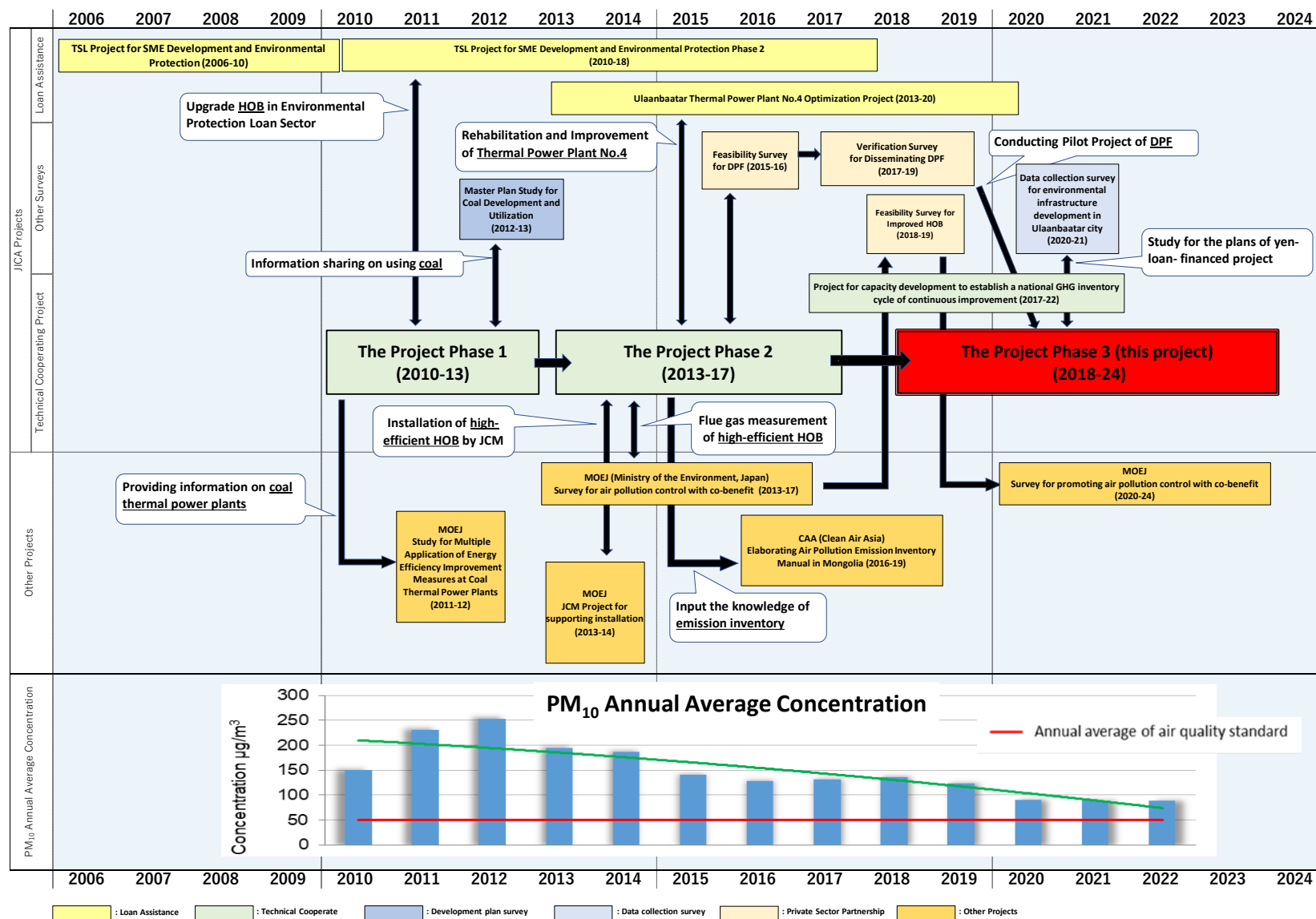


Figure 1-5-1 Relations with Related Projects

In order to understand backgrounds, activities and outcomes of this Capacity Development Project, relations with other projects are described here in the fields of bus exhaust retrofit by DPF, administration on HOBs, and emission inventory.

[Relations with other Projects for Diesel Exhaust Particulate Filter (DPF)]

For renewal of UB City public buses in 2009, engineers of UB City proposed to cleaner exhaust buses such as Euro III. However, the Mongolian Government opened a tender without exhaust specification, and 400 buses without any emission standard certificates were delivered, and started to be used. At the time of the Project Phase 1, it was found that public buses were the main emission source of PM on roads. Although renewal with cleaner exhaust buses such as Euro III or V standard should be the principal method to reduce air pollutant emissions, buses procured in 2009 was difficult to be replaced before 2021 because of regulations of Mongolia related to transportation. In order to reduce air pollutant emissions quantitatively as soon as possible, JET, Mongolian academicians and engineers of National Bus Company No. 2 (of UB City) proposed to retrofit the public buses without any emission standard by DPF suitable for the fuel used in Ulaanbaatar. In response to the above, Mongolian side agreed, and the Project “Feasibility Study with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of Particulate Matter (hereinafter referred to as “PM”) from Diesel Buses by DPF” (2015-16) was started. Capacity Development Project Phase 2 measured the effectiveness of the proposed DPF by the on-board emission measurement system jointly with this feasibility study, and the effectiveness were reported in the Project Phase 2 and the feasibility study.

Because of the good results of the proposed DPF, year around test in operation and maintenance was started as another Project “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of Particulate Matter (hereinafter referred to as “PM”) from Diesel Buses by DPF” (2017-2019). DPFs were installed, operated and maintained on 24 public buses in UB City. Through this project, the installation of DPFs was confirmed to be effective in reducing PM emissions, and feasible even in cold winter with high sulfur diesel oil.

Mongolian side decided the 24 buses to be out of service in 2021. According to a request by Mongolian side for the 6th JCC meeting, it was agreed to relocate DPFs as an additional activity of this Capacity Development Project, in the condition that DPFs will be maintained and managed by the Mongolian side.

[Relations with other Projects for HOB]

As a collaboration with “Co-benefits Approach Pollution Control Study Project” (2013-2017) by Ministry of the Environment, Japan and “Feasibility Survey for Local Production and Sales of Improved Heat Only Boiler for Public Facilities in Mongolia” (2018-2019) by JICA, this Capacity Development Project measured flue gas of the HOBs installed in those surveys and shared the results of the measurement results.

As a collaboration with “Joint Crediting Mechanism Project of Installation of high-efficiency Heat Only Boilers in 118th School of Ulaanbaatar City” by Ministry of the Environment, Japan, this Capacity Development Project measured flue gas of the HOBs in 118th school and shared the measurement results.

As a collaboration with “Two Step Loan Project for Small and Medium Scale Enterprises Development and Environmental Protection in Mongolia (TSL) Phase 2” (2010-2018) by JICA, Mr. Mr. Tabata, the leader of this Capacity Development Project, was assigned as the official member of the two-step loan project in charge of the environment. In TSL Phase 2, in order to promote environmental projects further, environmental assessments were conducted on HOBs and other environmental projects that were candidates for loans, before and after the projects were implemented. The assessment results were used to select projects according to environmental benefits.

[Relations with other Projects for Emission Inventory Manual]

“Integrated Programme for Better Air Quality in Asia” (IBAQ) was implemented by Clean Air Asia in Mongolia from 2016 to 2018. It elaborated the emission inventory manual for Mongolia. The emission calculation methodology and emission factors developed and improved in this Capacity Development Project Phase 1 and 2 were referred to the manual to calculate emission of the entire country of Mongolia because the methodology was ready to apply for Mongolia, and the emission factors were developed by the flue gas measurement data in Mongolia, reflecting the actual emissions in Mongolia. Because Mr. Nakata knew emission calculation methodology and emission factors of Mongolia, he was assigned for the IBAQ Project, elaborated emission inventory manual, and explained it to relevant organizations.

As shown Figure 1-5-1, relation with other Project was considered as important in order to make outcomes for Mongolia. The capacity of flue gas measurement at stationery sources was developed by the phased of this Project, which supported air pollution control of HOBs by co-benefit projects with GHG emission reduction. Air pollutant emission reduction by retrofits of public buses were proposed by the Project Phase 1, tested by the Feasibility Study supported by the Project Phase 2, verified in operation and maintenance by the Verification Study, then handled as one of the Pilot Project of this Project. Calculation methodology and emission factors for emission inventory was developed and improved by the Project Phase 1 and 2, and then expanded to the entire country of Mongolia through the IBAQ Project.

1-5-2 Objective of the Project

The objective of the Project is to improve effective air pollution control measures in UB City and to enhance cooperation mechanism of air pollution control measures program between national and city

level, and emission reduction of major emission sources is enhanced to improve air quality in UB City.

1-5-3 Project Name

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

1-5-4 Overall Goal and Project Purpose

Overall Goal and Project Purpose in the Project are shown in Table 1-5-2. Some of the Objectively Verifiable Indicators (hereinafter referred to as “OVI”) in PDM ver. 0.0 did not specify numerical targets (temporarily placed as “XX”). Therefore, C/Ps, JET, and JICA discussed and revised PDM, and finally Overall Goal and Project Purpose in the Project was organized.

Regarding the emission reduction ratio in OVI 1 of Overall Goal in the Project, the target year was set as 2027, which is three years after the completion of the Project. Among the 6 Pilot Projects, it was assumed that further emission reduction by further improvement of improved fuel such as biomass mixed coal briquettes, BCB, low sulfur fuel for UB vehicles and renewal of public buses by EURO-V emission standard buses, and efficient control of high emission vehicles by using RSD will have been fully effective by 2027.

Assuming that these three scenarios will be fully effective by 2027, SO_x and PM₁₀ emissions from small stove for household and automobiles were calculated to be reduced by 65% and 43% respectively compared to emissions in BAU scenario (Figure 1-5-2). JET suggested these reduction ratio as OVI of Overall Goal of the Project at the 11th JCC and Mongolian side agreed it.

At the 11th JCC, in order to enable appropriate evaluation of air pollution control measure efforts on the Mongolian side after the completion of the Project, JET suggested an additional OVI. This indicator is “The results of the Project are reflected in the policy and strategy, such as the next NPREP (National Program on Reducing Environment Pollution) and related laws and regulations.” Mongolian side approved it. The document related to the setting Overall goal is shown in Annex 1-5-1.

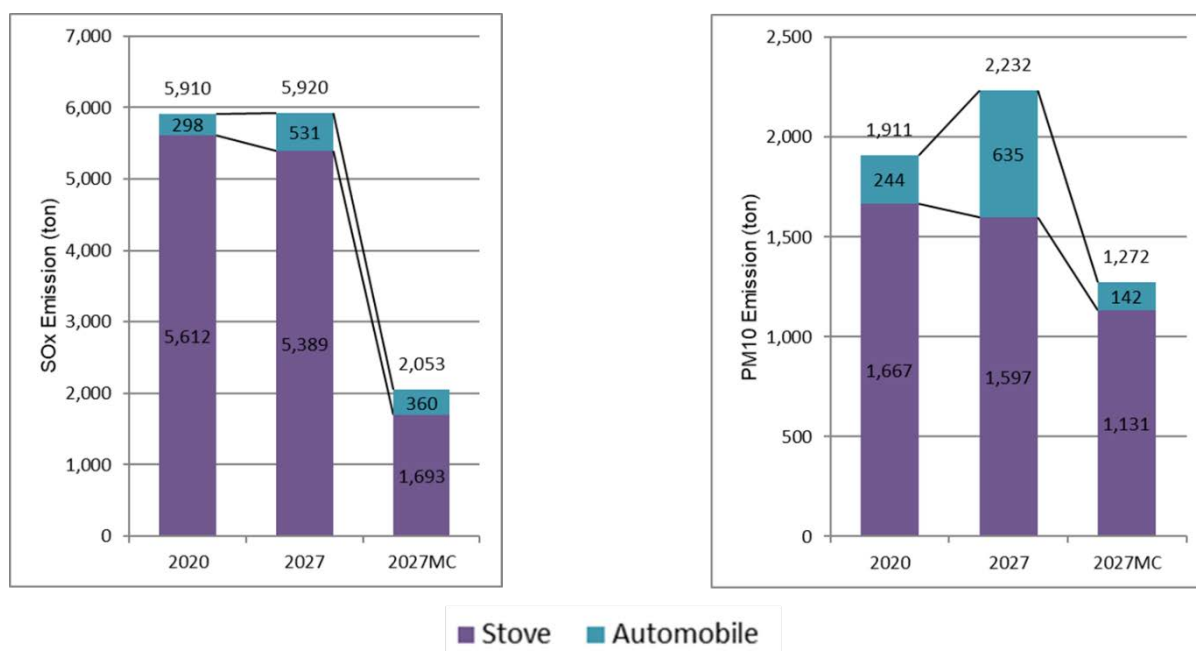


Figure 1-5-2 Reduction of SO₂ and PM₁₀ Emissions by Pilot Projects

Table 1-5-2 Overall Goal and Project Purpose

Objective	Objectively Verifiable Indicators
Overall Goal	
Emission reduction at major emission sources is enhanced towards air quality improvement in Ulaanbaatar City.	1. Emission from small stoves for household and automobiles will be reduced by 65% in SO_x and 43 % in PM₁₀, compared with BAU case. 2. The results of the Project are reflected in the policy and strategy, such as the next NPREP (National Program on Reducing Environment Pollution) and related laws and regulations.
Project Purpose	
Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attentions to implementation of effective pollution control measures and to the necessary coordinating mechanism of DAAEP and the relevant agencies.	1. One of pilot projects are adopted as full-scale implementation by relevant authorities. 2. At least one case of lessons learned from the pilot projects are utilized by the decision makers. 3. Relevant laws, regulations and standards on air pollution control measures are implemented in UB City. (At least establishment of one MNS, and/or 70% of compliance in the dust emission standards of existing MNS; MNS5043:2016 (General technical requirement of heat water boiler under 4.2MW) and MNS5919:2008 (Emission limit value and measurement method of power plant, steam boiler))

1-5-5 Outputs

Outputs of the Project were discussed and agreed as shown in Table 1-5-3. Some of OVIs in PDM ver. 0.0 do not specify numerical targets (temporarily placed as “XX”). C/Ps, JET and JICA discussed the PDM structure and OVIs considering the difficulty of setting expected numerical targets for project monitoring, and made thorough revisions of Outputs as shown as below.

Table 1-5-3 Outputs

Outputs	Objectively Verifiable Indicators
Output 1	
Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.	1-1. During the Project duration, at least 50% of inspections for boiler registration based on emission measurements (including standard and simplified methodologies) are implemented by DAAEP and IACC. 1-2. The emission measurement reports are submitted to Project Leader of UB city in charge of air and environmental pollution at least 3 times during the Project duration. 1-3. Emission monitoring for the major pollution sources and air quality monitoring information are shared regularly among the relevant agencies through coordination between DAAEP and NAMEM. 1-4. The CEMS measurement is compared with the standard measurement once in a year. 1-5. Distribution of emission measurements from automobiles in UB City is prepared based on the study with RSD at least once a year.
Output 2	
Capabilities to analyze and evaluate pollution structure of PM, SO ₂ , and NO _x throughout the year are strengthened.	2-1. The results of PM apportionment study are reported at least three times during the Project. 2-2. Pollution structures are assessed at least 3 times during the Project duration including emission inventory, simulation model, PM speciation, receptor model, air quality monitoring, and population exposure throughout the year.
Output 3	
Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.	3-1. Drafts of emission measurement methods and quality standards of improved fuel for households in Ger area are submitted to MASM. 3-2. At least three of implementation plans of the pilot projects are prepared.
Output 4	
Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies	4-1. Analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) are presented to decision makers at least 2 times. 4-2. Results of pilot project implementation and other Project results are utilized for the revision of NCEPR and for decision making on implementation/non-implementation of pollution control measures at least once.

Outputs	Objectively Verifiable Indicators
Output 5	
Air pollution control measures are enhanced for PM, SO ₂ and NO _x emission reduction at major sources.	5-1. At least three pilot projects selected by C/P-WG are implemented 5-2. The results of each pilot project (emission reduction, improvement of ambient air quality and population exposure for PM, SO ₂ and NO _x) are presented to the relevant agencies.
Output 6	
Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.	6-1. At least three of drafts on laws and regulations, such as fuel regulations, MNS emission standards and ordinances of UB City, are submitted. 6-2. More than 3 air pollution control measures and technologies are funded by the sections of the relevant agencies in charge of allocating funds for air pollution control by utilizing technical appraisal guideline provided by the Project. 6-3. At least three agreements are made on demarcation of roles of the relevant agencies for air pollution control measures in the Project. 6-4. The operational guideline is distributed to relevant agencies.

1-5-6 8 Pairs of Basic Strategies and Policies for Project Implementation

For implementing this project, C/P and JET discussed on basic strategies and policies, and agreed as 8 pairs of strategies and policies as shown in Table 1-5-4. These strategies and policies were taken into consideration through the Project implementation.

Table 1-5-4 8 Pairs of Basic Strategies and Policies

No.	Basic Strategy	Basic Policy
1	The Project focuses on capacity development of air pollution control measures by the Mongolian side.	The Project focused on implementing pilot projects relating to improved fuel and mobile emissions.
2	The Project maintains and supports capacities that were developed through the previous Projects Phase 1 and 2.	In order to maximize the efficiency of input of JET, insufficient points of the Project Phase 1 and 2 were provided by complementary capacity development of the Project.
3	The Project improves and supports sophistication of the capacity of Mongolian side.	PM sampling was conducted in UB city and PM speciation analysis was conducted in Japan. In addition, formulation of equipment and laboratory plan for PM speciation in Mongolia was supported in order for the Mongolian side to be able to conduct PM section analysis by themselves.
4	Capacity development on air pollution control measures such as evaluation of air pollution structure for winter	By using emission inventory, simulation, and results of PM apportionment study, the health impact to citizen was evaluated from exposure to the citizens. Capacity development

	and warm season, and exposure to citizen will be strengthened to reduce health impact on UB citizen caused by air pollution.	on air pollution control measures is enhanced by the evaluation results.
5	Enhancement of cooperation mechanism on air pollution reduction program between national and city level	Technical validation was evaluated for full-scale projects on air pollution control measures conducted by the Mongolian side and for high validation investment, technology advices was provided.
6	Coordination effect between JICA and other related Japanese projects is enhanced.	If possible, the Project implemented to coordinate the following projects. Relevant project list - JICA Supports for Japanese Small and Medium size Enterprises Overseas Business Development “Emission Reduction of Particulate Matter (PM) from Diesel Buses by DPF Suitable for Ulaanbaatar Condition” (October 2017 - September 2019) - JICA Supports for Japanese Small and Medium size Enterprises Overseas Business Development “Feasibility Survey for Local Production and Sales of Improved Heat Only Boiler for Public Facilities in Mongolia” (March 2017 - February 2012) - JICA Yen Loan “Fiscal, Social and Economic Reform Development Policy Loan” (already financed in December 2017) - JICA Knowledge Co-Creation Program “Capacity Building towards Air Quality Management” - Ministry of Environment, Japan “Co-benefits Approach Pollution Control Study Project” (July 2018 - March 2019) - JICA training course titled as “Capacity Building towards Air Quality Management” - JICA training course titled as “Control of Air Pollution from Automobiles”⁹ - Co-benefits Project of Ministry of the Environment Japan (July 2018 - March 2019)
7	Cooperation continuation of the relating donors	Cooperation was continued with Asian Development Bank (ADB) and the World Bank (WB). For example, renewal of some AQMS equipment was advised by JET and then procured by UBCAP of WB.
8	Development continuation of desirable air quality management cycle	Air quality management cycle is shown in Figure 1-5-3. The cycle is composed of four cycles. 1) Analysis of air quality emission sources and evaluation of air pollution control measures, 2) Air pollution control strategy, policy, and decision making, 3) Evaluation of air pollution control measures, 4) Implementation of air pollution control measures The Project focuses on implementing Step 3 and Step 4. Step 1 and Step 2, which were capacity developments, were already conducted in the Project Phase 1 and 2, thus the

⁹ As of June 2024, this training course has been discontinued.

		complementary capacity development of the Project provided to complement the technical deficiencies of the Project Phase 1 and 2. Regarding the above platform of air quality management cycle, JET deeply kept in touch with the Mongolian relevant agencies, thus the platform on air pollution control measures was strengthened in order for the Mongolian side to conduct air quality management cycle by themselves. The platform was composed of legal framework, resource allocation, and coordination mechanism of the relevant agencies. In addition, development of laws and regulations by the Mongolian side was supported to implement the investment on air pollution control measures. JET coordinated with the relevant agencies to be able to conduct spontaneous development of laws and regulations by the Mongolian side.

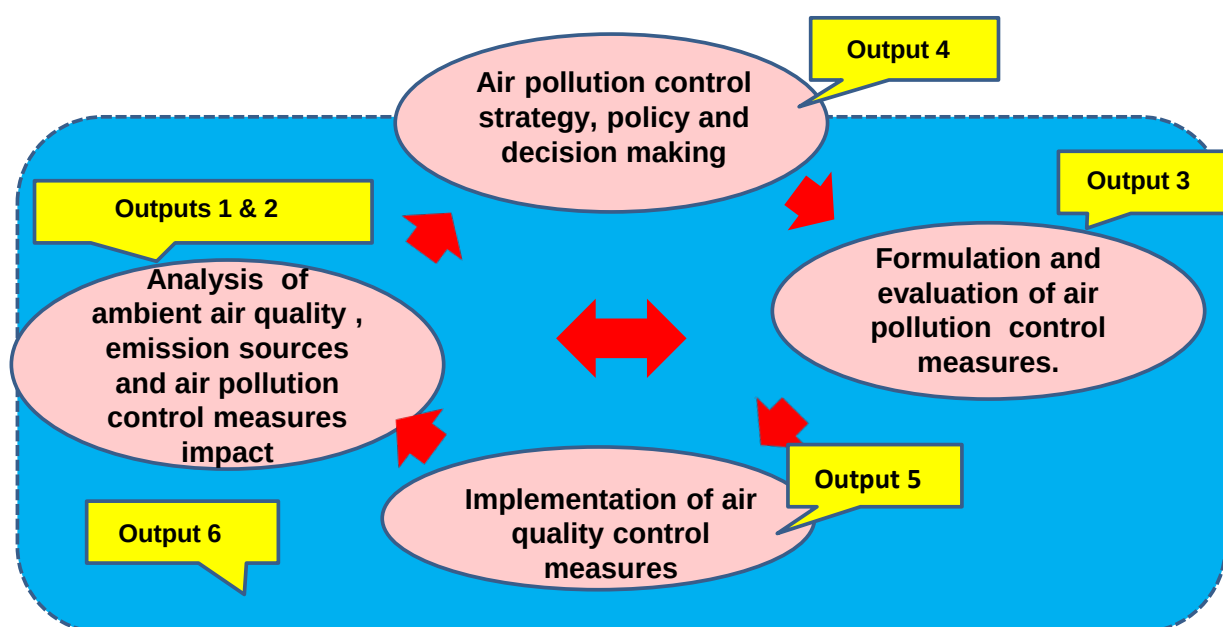


Figure 1-5-3 Air Quality Management Cycle

1-5-7 Organization

DAAEP, MET and relevant agencies included in C/P-WG

1-5-8 Project Duration

At the beginning of the Project, duration of the Project was agreed as 4 and a half years from November 2018 to April 2023. It became 5 years and 9 months from November 2018 to July 2024, by extending for 1 year and 3 months in response to impacts of the global pandemic of COVID-19.

1-5-9 PDM Amendment

1-5-9-1 1st Revision (PDM Ver. 0.0 to 1.0)

A Study on formulation of detailed plan for project was conducted in September 2017, and the Project was initiated in November 2018, more than a year later. Therefore, the PDM was revised (Ver.1.0) at the 1st JCC in December 2018 to bring the project activities in line with the current work of relevant agencies. The main change is a restructuring of the organizations to which activities are targeted. Details are provided in Annex 1-4-1.

1-5-9-2 2nd Revision (PDM Ver. 1.0 to 1.1)

At the 2nd JCC in June 2019, based on Cabinet Order No. 100 dated 21 March 2019, the number of Deputy Governors was reduced from four to two persons, and four Project Leaders, who have the exact same level of authority as Deputy Governor, were nominated as a replacement. Accordingly, Deputy Governor was replaced Project Leader in charge of the air and environmental pollution. In addition, Organization name “Air Pollution Reducing Department of the Capital City” was changed to “Department of Against Air Pollution of the Capital City”. Therefore, the PDM was revised (Ver. 1.1) at the 2nd JCC in December 2018. Details are provided in Annex 1-4-2.

1-5-9-3 3rd Revision (PDM Ver. 1.1 to 1.2)

At the 3rd JCC in December 2019, objectively verifiable indicators of Outputs in PDM were finalized. PDM was revised (Ver. 1.2). Details are provided in Annex 1-4-3.

1-5-9-4 4th Revision (PDM Ver. 1.2 to 1.3)

At the 4th JCC in February 2021, the project duration, important assumptions, etc. were amended in response to impacts of COVID-19 pandemic. A law on Special Government Funds dated 13 November 2019, abolished the Air Pollution Action Fund (APAF) with a consequent review the Activity 6-5. In addition, Activity 1-3-3 “Automobile emission measurement using an on-board emission measurement system” was added by request of the Mongolian side, and means of verification were amended. Therefore, PDM was revised (Ver. 1.3). Details are provided in Annex 1-4-4.

1-5-9-5 5th Revision (PDM Ver. 1.3 to 1.4)

At the 5th in June 2021, Activity 1-4-10, Data transfer system of air quality monitoring data on AQMS granted by Seoul City, Korea, was added by request of the Mongolian side. Therefore, PDM was revised (Ver. 1.4). Details are provided in Annex 1-4-5.

1-5-9-6 6th Revision (PDM Ver. 1.4 to 1.5)

At the 6th JCC in December 2021, Activity 1-3-4, related to the relocation of the DPF, was added by request of the Mongolian side. In addition and objectively verifiable indicators of project purpose in PDM were finalized. Therefore, PDM was revised (Ver. 1.5). Details are provided in Annex 1-4-6.

1-5-9-7 7th Revision (PDM Ver. 1.5 to 1.6)

At the 7th JCC in June 2022, Organization name “Department of Against Air Pollution of the Capital City” was changed to “Department of Against Air and Environmental Pollution of the Capital City”. Therefore, PDM was revised (Ver. 1.6). Details are provided in Annex 1-4-7.

1-5-9-8 8th Revision (PDM Ver. 1.6 to 1.7)

At the 8th JCC in December 2022, according to Mayoral Order B/86 dated 8 June 2022, the Project Leader in charge of the air and environmental pollution was changed to Deputy Governor of Capital City in Charge of Social Sector, Green Development and Air and Environmental Pollution. The position of the Project Leader was abolished. Organization name “Public Transportation Service Department of the Capital City” was changed to “Public Transportation Department of the Capital City”. Therefore, PDM was revised (Ver. 1.7). Details are provided in Annex 1-4-8.

1-5-9-9 9th Revision (PDM Ver. 1.7 to 1.8)

At the 9th JCC in June 2023, due to the abolishment of IACC by Mayoral Order A/1649 “Partial Measures Related to the Abolition of Inspection Agency of the Capital City” dated 30 December 2022, the activities related to IACC were amended. In addition, Activity 3-2, Safety standards for gas, was amended. PDM was revised (Ver. 1.8). Details are provided in Annex 1-4-9.

1-5-9-10 10th Revision (PDM Ver. 1.8 to 1.9)

At the 11th JCC in May 2024, objectively verifiable indicators and means of verification of Overall Goal in PDM were decided. PDM was revised (Ver. 1.9). Details are provided in Annex 1-4-10.

1-5-9-11 Others

The project duration was revised since some activities were significantly delayed from the original plan due to impacts of COVID-19 pandemic, and Minutes of Meeting for R/D amendment was signed in June 2021. Therefore, the project duration was amended from 4 and a half years to 5 years and 9 months.

1-5-10 Activity Implementation Schedule

Activity implementation schedule is shown in Figure 1-5-4.

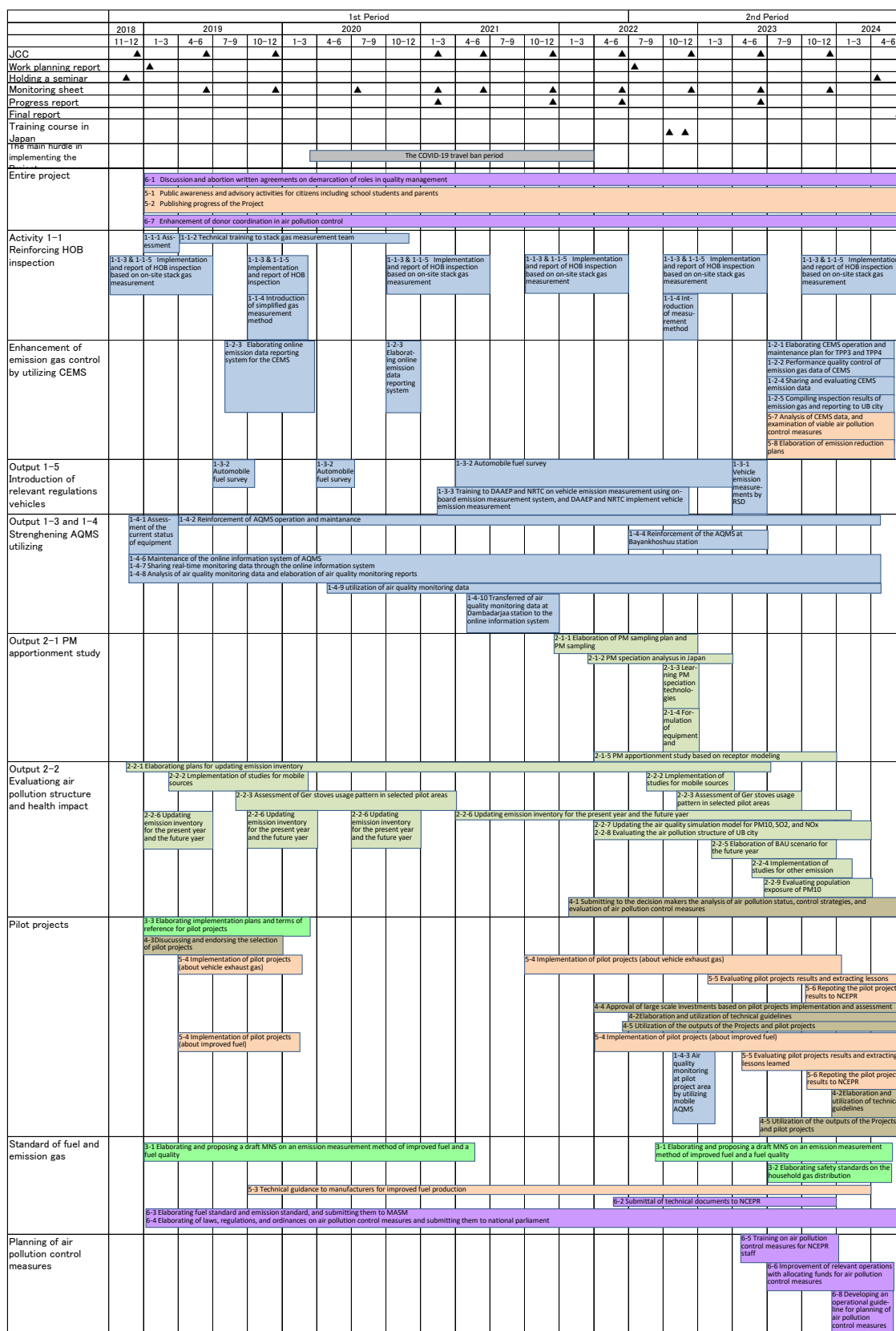


Figure 1-5-4 Activity Implementation Schedule

2 Project management

2-1 Project Implementation Structure

Implementation structure of the Project is shown in Project was managed as described below.

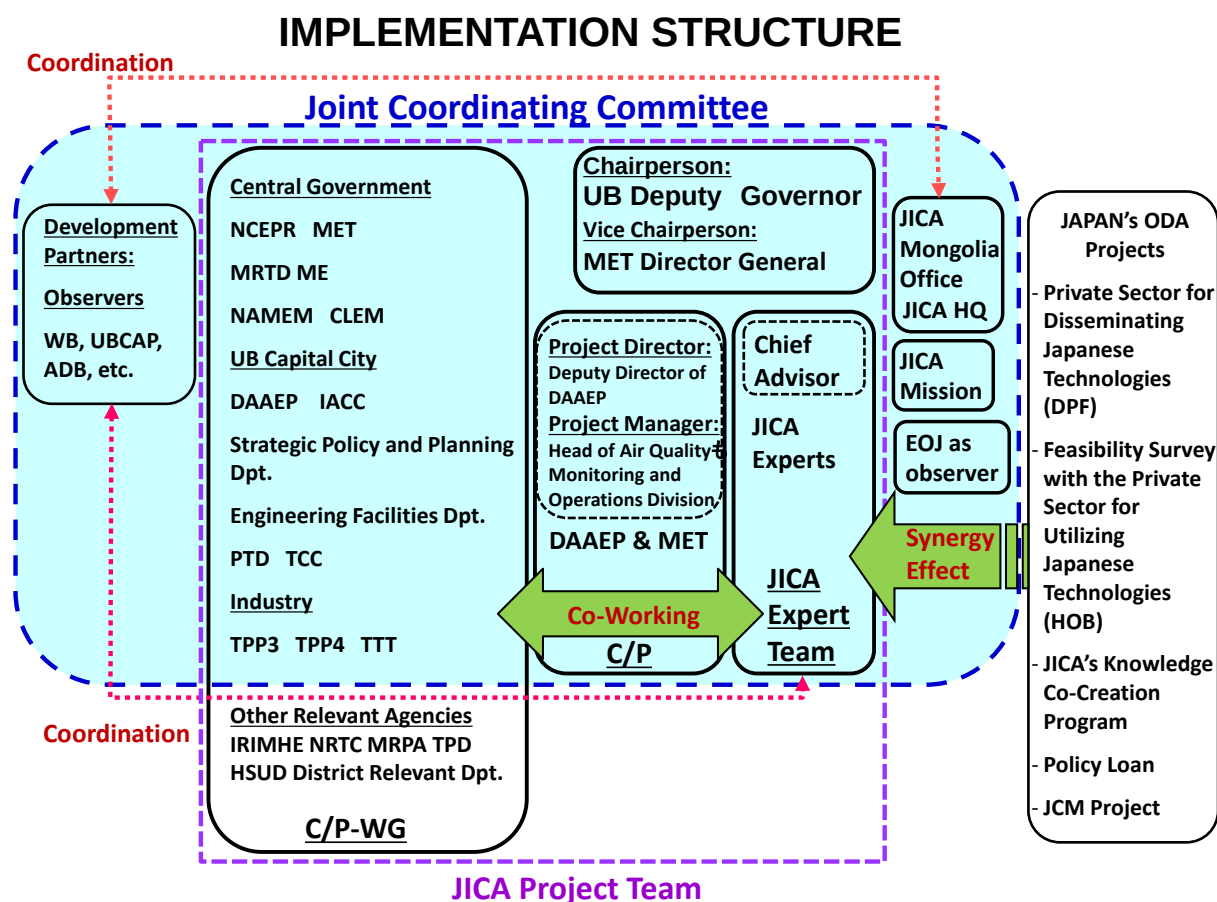


Figure 2-1-1 Implementation Structure

2-1-1 Project Director

Project Director was responsible for overall administration and implementation of the Project, and necessary coordination with other relevant agencies.

Project Director was assigned to Ms. Tsatsral BATMUNKH, Director in APRD (Currently DAAEP), originally. However, directors of DAAEP has changed six times, and currently Mr. Batshagai BAYSGALAN served from July 2023.

2-1-2 Project Manager

Project Manager was responsible for the managerial and technical matters of the Project.

In the R/D signed in June 2018, the Deputy Director of APRD (Currently DAAEP) was served as Project Manager. However, at the 1st JCC on 12 December 2018, Mr. Galymbek KHALTAR, Head of Air Quality Management Division, was assigned as acting Project Manager. Currently Mr. Davaajargal served from January 2020 because of the change of Head of Air Quality Management Division.

2-1-3 Joint Coordination Committee (JCC)

Joint Coordination Committee (JCC) was a project coordination committee to be held jointly by Japanese side and the Mongolian side every half or one year, to review project progress, to discuss pending issues, and to decide on important changes to the project. It was chaired by Deputy Governor of Capital City (Refer to 2-4 for the record of holding the JCC).

In the beginning of the Project, JCC was chaired by Mr. Batbayasgalan. J. Then, Deputy Governors has changed six times, and currently Ms. Nominchimeg ODSUREN served from October 2023.

Successive chairpersons in the Project were shown in Table 2-1-1.

Table 2-1-1 Successive Chairpersons

Chairpersons of JCC	Mr. Batbayasgalan J.	Deputy Governor of Capital City -Mar. 2019
	Ms. Munkhjargal D.	Project Reader of Capital City Mar. 2019 - Jan. 2021
	Mr. Tumurtumuu Z.	Project Reader of Capital City Jan. 2021 - Nov. 2021
	Mr. Ikhbayar D.	Project Reader of Capital City Nov. 2021 - Jan. 2022
	Mr. Battur P.	Project Reader of Capital City Jan. 2022 - Jun. 2022
	Mr. Tumurtumuu Z.	Deputy Governor of Capital City Jun. 2022 - Oct. 2023
	Ms. Nominchimeg O.	Deputy Governor of Capital City Oct. 2023 - Currently

Vice chairperson was Head of Environment Resource Operation Department of MET. In the beginning of the Project, vice chairperson was Mr. Nyamdavaa Then, Vice chairperson has changed eight times, and currently Mr. Enkhmunkh served from November 2023.

Successive chairpersons in the Project were shown in Table 2-1-2.

Table 2-1-2 Successive Vice Chairpersons

Vice Chairperson of JCC	Mr. Nyamdavaa G.	Environment Resource Operation Department of MET -May 2019
	Mr. Tsogtsaikhan	Environment Resource Operation Department of MET May 2019 - Jun. 2020
	Mr. Batmunkh	Environment Resource Operation Department of MET Jun. 2020 - Mar. 2021
	Mr. Batsansar	Environment Resource Operation Department of MET Mar. 2021 - Aug. 2021
	Mr. Enkhbat A.	Environment Resource Operation Department of MET Aug. 2021 - Dec. 2022
	Ms. Uranchimeg U.	Environmental Policy Coordination Department of MET Jan. 2023
	Mr. Enkhbat A.	Environmental Policy Coordination Department of MET Jan. 2023 - Feb. 2023
	Mr. Boris B.	Environmental Policy Coordination Department of MET Feb. 2023 - Nov. 2023
	Mr. Enkhmunkh G.	Environmental Policy Coordination Department of MET Nov. 2023 - Currently

2-1-4 Organization

As shown in Figure 2-1-1, DAAEP was the main implementing agency. Some activities were implemented with MET.

2-1-5 Counterpart Working Group (C/P-WG)

Counterpart Working Group (C/P-WG) is a group established to execute the Project with relevant organization efficiently. As shown in Figure 2-1-1, central government, MRTD, NAMEM, CLEM, IRIMHE and TCC, UB city agencies, IACC, TCC, PTD, and TPP3 and TPP4 are the member of C/P-WG. Other organization could be involved as (or excluded from) C/P-WG after discussion between JICA and Counterpart whenever modification was necessary.

2-1-6 JICA Expert Team (JET)

JET gave necessary technical guidance, advice and recommendations to DAAEP MET and C/P-WG. The diagram of JET structure is shown in Figure 2-1-2.

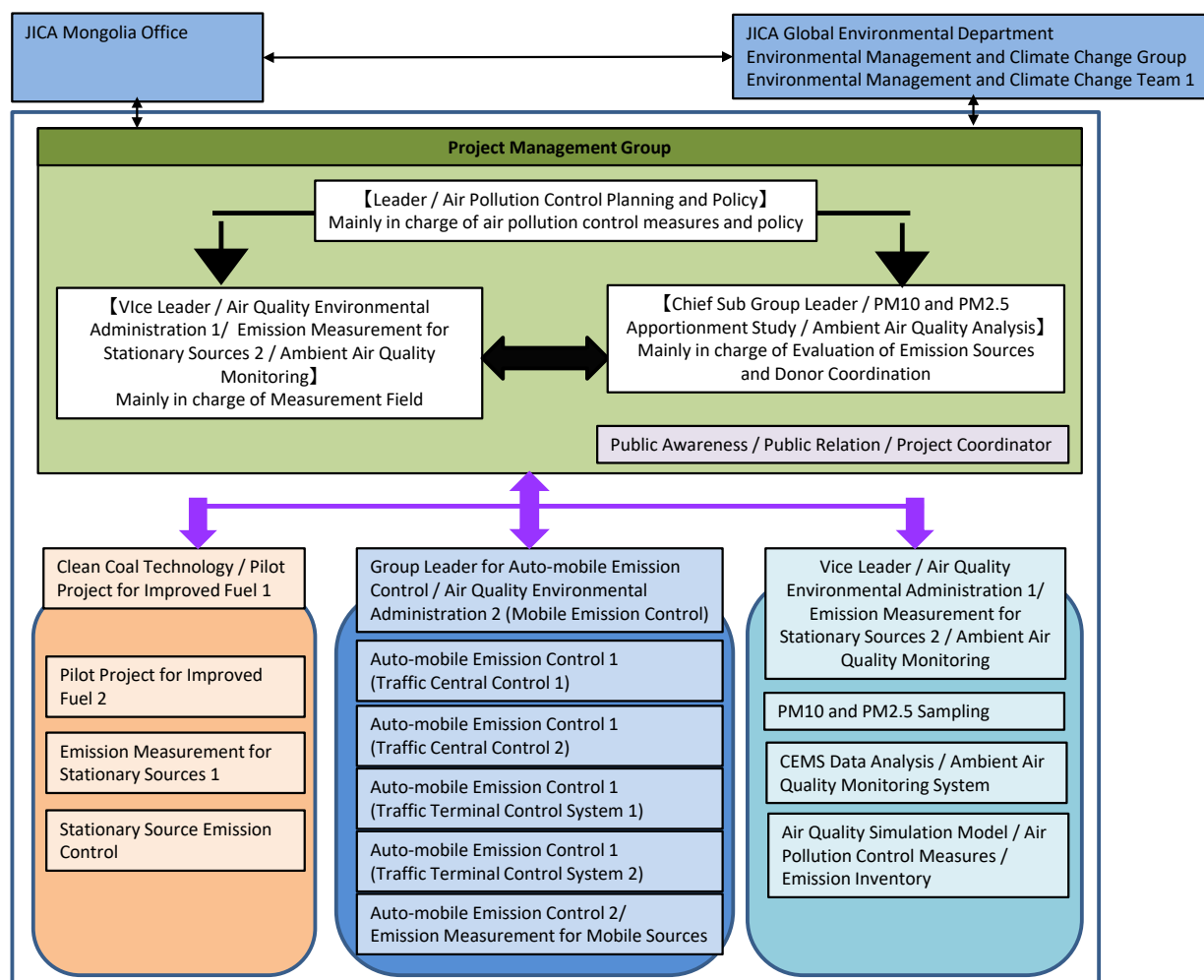


Figure 2-1-2 Diagram of JET Structure

2-2 Activities of JICA Experts

2-2-1 Activity Record of JICA Experts

Roles and activity records of JICA Experts is shown in Table 2-2-1.

Table 2-2-1 Activity Record of JICA Experts

	Name	Organization	Field	Man · Month	
				In Mongolia	In Japan
1	Toru TABATA	SUR	Chief Advisor / Air Pollution Control Planning and Policy	6.73	3.10
2	Natsuji SAWAKI	SUR	Sub Leader / Air Quality Environmental Administration 1 / Emission Measurement for Stationary Sources 2/ Ambient Air Quality Monitoring	13.63	4.00
3	Ei EDO	SUR	Chief Sub Group Leader / PM ₁₀ and PM _{2.5} Apportionment	7.30	1.15

	Name	Organization	Field	Man • Month	
				In Mongolia	In Japan
			Study / Ambient Air Quality Analysis		
4	Hajime ENDO	SUR (JCOAL)	Clean Coal Technology / Pilot Project for Improved Fuel 1	8.26	3.05
5	Yasuo OTAKA	SUR (JCOAL)	Pilot Project for Improved Fuel 2	0.37	0.00
6	Eiji YAMASHITA	SUR (JCOAL)	Pilot Project for Improved Fuel 2	1.60	0.00
7	Nobuhiro KOYANAGI	SUR (JCOAL)	Production of Improved Fuel	2.14	0.35
8	Shinya NAKATA	SUR	Air Quality Simulation Model / Air Pollution Control Measures Evaluation / Emission Inventory	8.83	3.93
9	Tadayoshi USUI	SUR (JFE-TEC)	Emission Measurement for Stationary Sources 2 / PM ₁₀ and PM _{2.5} Sampling	4.53	0.00
10	Hiroyuki MAEDA	SUR	CEMS Data Analysis / Ambient Air Quality Monitoring System	1.87	1.70
11	Atsushi SATO	SUR	Group Leader for Auto-mobile Emission Control / Air Quality Environmental Administration 2 (Mobile Emission Control)	4.83	0.50
12	Yoshimi TANAKA (predecessor)	SUR (JTMTA)	Auto-mobile Emission Control 1 (Traffic Central Control 1)	0.23	0.00
13	Toshiharu YOSHIDA (successor)	SUR (JTMTA)	Auto-mobile Emission Control 1 (Traffic Central Control 1)	0.00	0.50
14	Motoyoshi NODA	SUR (JTMTA)	Auto-mobile Emission Control 1 (Traffic Central Control 2)	1.77	0.20
15	Yusei IWAKI (predecessor)	SUR (JTMTA)	Auto-mobile Emission Control 2 (Traffic Terminal Control System 1)	0.47	0.25
16	Susumu MIYATA (successor)	SUR (JTMTA)	Auto-mobile Emission Control 2 (Traffic Terminal Control System 1)	1.07	0.00
17	Toru MATSUMURA	SUR (JTMTA)	Auto-mobile Emission Control 2 (Traffic Terminal Control System 2)	1.54	0.55
18	Jun OKABE	SUR	Auto-mobile Emission Control 2/ Emission Measurement for Mobile Sources	9.27	0.50
19	Shinichi TANAKA	SUR (GEC)	Stationary Source Emission Control	0.97	0.50
20	Sho FUKUCHI	SUR	Public Awareness / Public Relation / Project Coordinator	1.73	0.00

	Name	Organization	Field	Man • Month	
				In Mongolia	In Japan
21	Jun OKABE	SUR	Counterpart Training in Japan 1	0.00	0.30
22	Ei EDO	SUR	Counterpart Training in Japan 1	0.00	0.15
Total				76.73	20.73

SUR: SUURI KEIKAKU Co., Ltd., JCOAL: Japan Carbon Frontier Organization, JFE-TEC: JFE Techno-Research Corporation, JTMTA: Japan Traffic Management Technology Association, GEC: Global Environment Centre Foundation

2-2-2 Training in Japan

Counterpart training programs in Japan are listed in Table 2-2-2 and Table 2-2-3.

Table 2-2-2 First training in Japan

Subject	PM composition Analysis
Period	9 to 23 November 2022
Participant	8 members
Outline	< Lecture > “Course Explanation”, “Introduction for PM Source Apportionment Study using Receptor Model”, “PM Source Apportionment Study”, “Introduction of Laboratory Equipment for PM Component Analysis at Osaka Metropolitan Univ.”, “Introduction of actual cases of PM collection and chemical composition analysis in Osaka City” < Exercise > “Practice of PM Component Analysis at Osaka Metropolitan Univ.” < Discussion/Presentation > “Wrap-up of training, Planning for preparation of equipment for PM composition analysis, and Preparation for Presentation”, “Presentation and Discussion on Plan for preparation of equipment for PM composition analysis through this course”

Table 2-2-3 Second training in Japan

Subject	Traffic Control
Period	7 to 21 December 2022
Participant	8 members
Outline	< Lecture > “Course Explanation”, "Self-introduction and Challenges in the Assigned Department for Trainees", "Fundamentals of Traffic Management", "Problems Associated with the Development of a Transportation Society in Japan in the Past and Changes in their Responses ", "Fundamentals of Traffic Engineering", "Fundamentals of Traffic Regulation", "On-site Inspection of Traffic Regulation", "Fundamentals of Traffic Control", "Traffic Volume Survey Practice and Signal Pattern Confirmation", "Visit to Yamanashi Prefecture Traffic Control Center, Traffic Situation Observation", "Visit to Saitama Prefecture Traffic Control Center, Traffic Situation Observation" "Signal Adjustment Practice". < Tour of a facility > "Visit to Japan Signal (Traffic Signal Manufacturer)", "Visit to VICS (Automobile Information and Communication System) and JARTIC (Japan Road Traffic Information Center)", "Visit to Minatsu, LTD. (Traffic Signal Construction Contractor)" < Discussion/Presentation > “Preparation for Presentation”, “Presentation and Discussion through of the Training”

2-2-3 Equipment Procured by Japanese Side

Equipment procured by Japanese side is shown in Table 2-2-1.

Table 2-2-1 Equipment Procured by JICA

No.	Equipment	Catalog No.	Qty.	Unit	Destination	Date provided
1	Heating sampling prove	B60-HP	2	pcs	DAAEP	Oct. 2019
2	Sensor for portable gas analyzer TESTO340		2	Set	IIAC	Feb. 2020
3	PM _{2.5} / PM ₁₀ dual samplers	Murata MCAS-SJ-M4	2	Set	CLEM	Oct. 2021
4	X-ray fluorescence sulfur analyzer	Horiba SFLA-60	1	pcs	MRPA	Nov. 2021
5	PC	Dell Inspiron 5402	2	Set	DAAEP	Nov. 2021
6	PC	Dell Inspiron 5402	1	Set	NAMEM	Nov. 2021
7	Opacimeter		1	pcs	MRTD	May 2022
8	Pulverizer	Nara Machinery, M-5A	1	Set	ME	Jun. 2022
9	Sensor for portable gas analyzer TESTO340		1	Set	IIAC	Nov. 2022
10	Drive recorder	Datatec SR Connect	20	Set	MRTD	Aug. 2023
11	Eco-drive analysis software	Datatec PK4006A1FL_W10	5	Set	MRTD	Aug. 2023

2-2-4 Output by Local Contract

Nine local contracts were implemented in this Project. Their outputs are shown below.

(1). Traffic Count and Travel Speed Survey

In order to update automobile emission inventory, traffic count and travel speed survey was conducted in 2019 and 2022 of this Project.

Hourly traffic counts by automobile type were counted at maximum 45 points in autumn and winter by some staffs at on-site points and by video camera recording. In traffic speed survey, three cars were driven four round trips a day on each route. Travel speeds were calculated using the driven time on each road link. These survey results were utilized for updating automobile emission inventory.

(2). Traffic Condition Survey

In order to confirm the effect of signal control in pilot project, traffic condition surveys were conducted in 2019, 2022, and 2023.

In the surveys, traffic count of intersections, traffic jam length, a number of automobiles accessed by allowed lights, and a number of “dead green” and “excess green” were collected at 17 intersections in UB City. At the same time, cameras were used to capture the conditions at the intersections for later use in traffic intensity. These collected data were utilized for technical transfer of signal control.

(3). Survey on Improved Fuel Usage

This survey was conducted from 2019 to 2020 to investigate the real usage condition of improved fuel.

The survey covered about 500 households in Moringiin Davaa area regarding stove types and fuel types being used. Each household was asked to use TTT's improved fuel, which was put into use in 2019, and the evaluation result of seven parameters, such as ignition status and odor compared to raw coal was compiled. The results of the study were used to determine methods for the production and combustion testing of further improved fuel “biomass blended coal briquettes” (BCB) in this Project.

(4). Survey on Small Stove Usage

In order to determine the actual usage of small stove for household, a survey of 84 households in UB City was conducted in January, April, and June 2023 to record fuel input time and amount of fuel input for a week. Prior to the survey, information on stove type, building type, and stack height was collected. The survey results were used as input information for the calculation of the emissions from small stove for household, and for dispersion simulation.

(5). Biomass Supply Survey

Issues for production and dissemination of BCB were studied in Improved Fuels Pilot Project to reduce air pollutants. In order to verify the feasibility of procuring the biomass needed to produce BCB enough for use by households in UB City during winter season, this study investigated potential sources of biomass, volume available in Mongolia, and total costs and issues associated with them, for summarizing issues of the production, marketing, and dissemination of BCB. The survey results were used to calculate the costs required for the introduction of BCB.

(6). Component Analysis of PM

In Activity 2-1-1, component of ambient air PM collected in UB City was analyzed in Japan. Filters were pretreated and then weighted before and after sampling to calculate weight of PM samples, and carbon, ionic, and metal components were analyzed from the sampled filter. Component analysis of PM₁₀ and PM_{2.5} for source apportionment requires high-precision analytical equipment and a very high technical level. In order to maintain high analytical accuracy, extensive experience in PM analysis is also essential. Therefore, JET commissioned the component analysis of PM₁₀ and PM_{2.5} to Osaka Metropolitan University, which met all of the conditions above.

Mass, carbon components, ionic components, and metal elements, etc. were analyzed for all the 196 samples of PM₁₀ and PM_{2.5}. The analysis results were used to conduct source apportionment of PM by receptor model in Activity 2-1-5, and to control PM dispersion simulation model in Activity 2-2-7.

2-2-5 Technical Cooperation Output

Followings were prepared as technical cooperation outputs of this Project;

- Safety guideline for introducing and promoting gas fuels (Annex 3-4-1)
- Technical guideline of household improved fuel (Annex 3-5-1)
- Technical guideline for traffic signal operations (Annex 3-5-2)
- Technical guideline for Eco-Driving (Annex 3-5-3)
- Technical guideline for PM reduction device (DPF, etc.) (Annex 3-5-4)
- Technical guideline for Remote Sensing Device (RSD) (Annex 3-5-5)
- Technical guideline for technical evaluation of air pollution control measures proposals (Annex 3-7-1)
- Manual for planning, implementing and evaluating air pollution control measures (Annex 3-7-2)
- Training documents and reports made or supported in this Project (Table 2-2-4)

- Related technical data, information and documents used in the process of implementing this Project (Table 2-2-5 and Table 2-2-6)
- News Letters (Table 2-2-7)

Table 2-2-4 Training Documents and Reports Made or Supported in This Project

No.	Seminar date	Content	Remarks
1-1	16 September 2019	The Pilot Project Plan relating to Mobile Emissions	Annex 3-4-2
1-2	From September 2020	Online Training of Developing Emission Inventory	Annex 3-3-2
1-3	25 January 2022	Introduction of the Pilot Project relating to Mobile Emissions	Annex 3-4-3
1-4	17 March 2022	Calculation Result of Emission for 2020	Annex 3-3-3
1-5	5 October 2022	Simulation Result of Air Quality for 2020	Annex 3-3-6
1-6	7 February 2023	Academic seminar sponsored by UNICEF	Annex 3-5-1
1-7	24 January 2024	Improvement Results of PM ₁₀ Simulation Model based on Results of PMF Analysis	Annex 3-3-7
1-8	13 March 2024	Evaluation Result of Air Pollution Control Measures in the Pilot Project	Annex 3-3-8

No.	Contents	Remarks
2-1	Result Report of Traffic Volume Survey and Traffic Speed Survey in 2019	Annex 3-3-5
2-2	Result Report of On-board Emission Measurement Survey	Annex 3-6-5
2-3	Result Report of RSD Survey in 2023	Annex 3-6-7

Table 2-2-5 Related Technical Data, Information and Documents Used in the Process of Implementing this Project (Annex 2-2-1)

No.	Title	Issuing agency
1	Annual Report of Air Quality Monitoring for 2018	NAMEM
2	Annual Report of Air Quality Monitoring for 2019	
3	Annual Report of Air Quality Monitoring for 2020	
4	Annual Report of Air Quality Monitoring for 2021	
5	Annual Report of Air Quality Monitoring for 2022	
6	Annual Report of Air Quality Monitoring for 2023	
7	Annual Report for 2018	DAAEP
8	Annual Report for 2019	
9	Annual Report for 2020	
10	Annual Report for 2021	
11	Annual Report for 2022	
12	Annual Report for 2023	
13	2017 Emission Inventory Report	
14	2018 Emission Inventory Report	
15	2020 Emission Inventory Report	
16	2021 Emission Inventory Report	
17	Ordinances (Table 2-2-6)	Related decision makers or organizations of the Mongolian side

Table 2-2-6 Ordinances (Annex 2-2-2)

No.	Cabinet Ordinance and City Governor Ordinance	Date of issuance	Type
1	No. 62 (Ban of Raw Coal Use)	2018-02-28	Mongolia Cabinet Decision
2	No. 17/10 (Master plan for Reduction of Air Pollution in UB City)	2018-06-28	UB City Council Decision
3	No. A/1202 (JCC Members)	2018-12-12	Governor Decision
4	No. 19/01 (Approval of Measure Plan of NCEPR and the policy for the members)	2019-01-24	Decision of National Committee for Environment Pollution Reduction
5	No. 19/03 (Part of Measure for Reduction of Pollutant from Automobile)	2019-01-24	Decision of National Committee for Environment Pollution Reduction
6	No. 87 (Partial Treatment on Governmental Special Fund)	2019-02-27	Mongolia Cabinet Decision
7	No. 100 (Organizational structure and number of staffs in UB City Offices and Secretarial Divisions of Governor)	2019-03-21	Mongolia Cabinet Decision
8	No. A/239 (Partial Measure for Enforcement of Cabinet Decision)	2019-03-22	Governor Decision

No.	Cabinet Ordinance and City Governor Ordinance	Date of issuance	Type
9	No. A280 (Approval of Activity Plan for Environmental Monitoring)	2019-06-17	Minister Decision of Environment and Tourism
10	No. A/808 (Update of JCC Members)	2019-08-09	Governor Decision
11	No. A433 and No. A820 (Air pollution improvement area, approval of updating enforcement regulation)	2019-08-14	Joint order of the Minister of Environment and Tourism and capital governor/governor of the UB city
12	Revision of the Air Law	2019-11-13	Mongolian National Law
13	Revision of the Air Fee Payment Law	2019-11-13	Mongolian National Law
14	No. 346 (Establishment of a working group to audit and measure automobile emissions and to review and evaluate measures to reduce smoke (exhaust gas) emissions)	2019-11-13	Decree of the Minister of Road Transport and Development of Mongolia
15	No. 20/01 (2020 Action Plan for Environmental Pollution Reduction)	2020-01-24	Decision of National Committee for Environment Pollution Reduction
16	No. B/47 (Decision of Acting DAAP Director)	2020-03-10	Governor Decision
17	No. 189 (Abolishing applicable area of the Decision No. 62)	2020-05-27	Mongolia Cabinet Decision
18	No. 20/03 (Updating members of the Committee)	2020-09-04	Decision of National Committee for Environment Pollution Reduction
19	No. 123 (Conversion of Hot Water and Steam Boilers to Advanced Technology)	2020-10-08	Order of the Deputy Prime Minister of Mongolia
20	No. A604 and No. A1112 (Air pollution improvement area, approval of updating enforcement regulation)	2020-10-12	Joint order of the Minister of Environment and Tourism and capital governor/governor of the UB city
21	No. 21/04 (2021 Action Plan for Environmental Pollution Reduction)	2021-01-19	Decision of National Committee for Environment Pollution Reduction
22	No. B/14 (Decision of Acting DAAEP Director)	2021-01-27	Governor Decision
23	No. B/03 (Decision of Deputy DAAEP)	2021-01-28	Director Order of Department of Against Air and Environmental Pollution of the Capital City

No.	Cabinet Ordinance and City Governor Ordinance	Date of issuance	Type
24	No. A/503 (Update of JCC Members)	2021-06-25	Governor Decision
25	No. A322 and No. A780 (Air pollution improvement area, approval of updating enforcement regulation)	2021-10-13	Joint order of the Minister of Environment and Tourism and capital governor/governor of the UB city
26	No. A/54 (Revision the technical requirement for Improved Solid Fuels MNS 5679:2019, and establishment an Improved Fuels Working Group)	2022-02-16	Minister Decision of Energy
27	No. A/346 (Implementation Bylaws on Carbon Monoxide Poisoning Risk Prevention and Risk Measures)	2022-03-09	Governor Decision
28	Revision of the Air Law	2022-04-22	Mongolian National Law
29	No. 223 (Addition and Update of the Decision No. 62 dated 28 February 2018)	2022-06-08	Mongolia Cabinet Decision
30	No. 350 (On updating the composition of National Commission of the Government, National Committees and the National Council)	2022-09-22	Mongolia Cabinet Decision
31	No. A424 and No. A1353 (Air pollution improvement area, approval of updating enforcement regulation)	2022-10-17	Joint order of the Minister of Environment and Tourism and capital governor/governor of the UB city
32	No. A/1649 (On Certain Measures Related to the Abolition of Inspection Agency of the Capital City)	2022-12-30	Governor Decision
33	No. 17 (Action Strategy of the Ministry of Environment and Tourism, Reorganization of Organizational Structure in accordance with the establishment of the program, organizational structure and limit of the number of capacity)	2023-01-11	Mongolia Cabinet Decision
34	No. A/06 (Update and approval of the DAAEP organizational structure and list of public officials)	2023-01-16	Director Order of Department of Against Air and Environmental Pollution of the Capital City
35	No. 38 (Addition and Update of the Decision No. 350 dated 22 September 2022)	2023-02-01	Mongolia Cabinet Decision
36	No. A/1030 (On some measures to prevent gas poisoning)	2023-09-06	Governor Decision
37	No. 396 (Disbanding NCEPR)	2023-11-01	Mongolia Cabinet Decision
38	No. A/622 and No. A/294 (Establishment of a Joint Working Group on Cabinet Decision No. 396)	2023-12-13	Joint order of the Minister of Environment and

No.	Cabinet Ordinance and City Governor Ordinance	Date of issuance	Type
			Tourism and Minister of Energy
39	No. A/1410 (Establishment of a Working Group on Cabinet Decision No. 396)	2023-12-15	Governor Decision
40	No. A/163 (Approval of National Program for Environment Pollution Reduction cost sharing and transfer of authority)	2024-03-07	Minister Decision of MET

Table 2-2-7 News Letters (Annex 2-2-3)

No.	Vol.	Publication month	Title
1	Vol. 1	February 2019	Project Outline
2	Vol. 2	September 2023	The Initiatives for Improving Traffic Congestion by Signal Control Technology
3	Vol. 3	October 2023	The Initiatives for Improving Various Problems in Automobile Society by Eco-Driving
4	Vol. 4	June 2024	Project Output

2-3 Input from the Mongolian side

2-3-1 Implementation structure of the Mongolian side

Counterpart of DAEPP, counterpart of MET and central government, MRTD, NAMEM, CLEM, IRIMHE and TCC, UB city agencies, IACC, TCC, PTD and TPP3 and TPP4 implemented the project under the administration, coordination and instructions by the Project Manager.

2-3-2 C/P Allocation

The Mongolian side allocated the necessary counterparts for the Project as shown in Table 2-3-1. Although the Project continues for 5 years and 9 month, there were 2 major agencies, NCPER and IACC abolished. In addition, personnel to whom technology was transferred in the project were transferred within the agency or left. However, due to a lack of succession of duties between persons, JET implemented capacity development to new personnel repeatedly.

Table 2-3-1 Allocated C/Ps

	DAAEP	NAMEM/CLEM/IRIMHE/NRTC etc.
Project Director	1. Ms. B. Tsatsral - Sep. 2019 2. Mr. Kh. Galymbek Sep. 2019 - Jan. 2020 3. Ms. Ts. Tsolomon Mar. 2020 - Jan. 2021	

	DAAEP	NAMEM/CLEM/IRIMH E/NRTC etc.
	4. Ms. B. Purevsuren Jan. 2021 - Feb. 2022 5. Mr. G. Davaajargal Feb. 2022 6. Mr. Ts. Ganbold Feb. 2022 - Jul. 2023 7. Mr. B. Batshagai Jul. 2023 -	
Project Manager	1. Mr. Kh. Galymbek - Jan. 2020 2. Mr. G. Davaajargal Jan. 2020	
Flue Gas Measurement at Stationary Sources	1. Mr. Otogonbayar - Feb. 2019 2. Mr. Kh. Gerelchuluun - Dec. 2019 3. Mr. U. Jargalbaatar Nov. 2018 - 4. Mr. Bargil Jun. 2019 - Jul. 2020 5. Mr. S. Altansukh Mar. 2020 - 6. Mr. B. Adiyaochir Sep. 2020 - 7. Mr. Enkhamgalan Mar. 2021 - Jun. 2022 8. Mr. B. Ganzorig Oct. 2022 - Jul. 2023 9. Mr. E. Temuujin Oct., 2022 -	
AQMS	1. Mr. Otgonbayar - Jan. 2019 2. Ms. D. Sanchirbayar Feb. 2019 - Apr. 2020 3. Mr. Nergui May 2020 - Aug. 2021 4. Mr. B. Adiyaochir Sep. 2021 -	
Emission Measurement of Automobiles	1. Mr. O. Altangerel - Dec. 2021 2. Ms. Byambatsetseg Oct. 2021 - Jan. 2023 3. Ms. D. Sanchirbayar Feb. 2023 -	MMHI: 1. Mr. D. Davaabayar - Mar. 2022 2. Ms. Mongolmaa Apr. 2022 - MRTD: 1. Mr. P. Munkhbat - Sep. 2021 2. Mr. Khavi

	DAAEP	NAMEM/CLEM/IRIMH E/NRTC etc.
		Oct. 2021 - TCC: 1.Mr. B. Zolzaya - Dec. 2021 2.Mr. Namuu Jan. 2022 - PTD: 1.Mr. Nyamdorj - Mar. 2022 2. Ms. Tsetsegmaa Apr. 2022 - Dec. 2023 3. Mr. Ulzii Jan. 2024 -
PM Sampling		CLEM: 1. Mr. B. Barkhasragchaa Nov. 2018 - 2. Mr. D. Tumendelger Nov. 2018 - 3. Ms. Batkhshig Nov. 2018 - 4. Ms. Suvd Nov. 2018 -
Emission Inventory	1. Ms. L. Narmandakh - May 2019 2. Ms. Altanzul Sep. 2019 - Jan. 2021 3. Ms. Oyungerel Jun. 2020 - Mar. 2022 4. Ms. Bat-Oyun Mar. 2021 - 5. Ms. Byambatsetseg Mar. 2021 - Jan. 2023 6. Mr. B. Adiyaochir Apr. 2022 -	NAMEM: 1. Sh. Nyamdavaa - Sep. 2022 2. Mr. Bayarmagnai Mar. 2021 - Feb. 2022 3. Ms. E. Amarzaya Sep. 2021 - Mar. 2022 IRIMHE: 1. Mr. E. Davaanyam Mar. 2021 - Mar. 2022
Air Quality Simulation Model	1. Ms. L. Narmandakh - May 2019 2. Ms. Altanzul Sep. 2019 - Jan. 2021 3. Ms. Oyungerel Jun. 2020 - Mar. 2022	NAMEM: 1. Ms. Sh. Nyamdavaa - Sep. 2022 2. Mr. Bayarmagnai Mar. 2021 - Feb. 2022 3. Ms. E. Amarzaya Mar. 2022 - 4. Mr. Gansukh Mar. 2022 - Sep. 2022 IRIMHE: 1. Mr. E. Davaanyam Jul. 2021 - 2. Mr. G. Batjargal

	DAAEP	NAMEM/CLEM/IRIMH E/NRTC etc.
		Jul. 2021 -
PM Source Apportionment		CLEM: 1. Mr. B. Barkhasragchaa Nov. 2018 - 2. Mr. D. Tumendelger Nov. 2018 - 3. Ms. E. Oyuntuya Nov. 2018 - NAMEM: 1. Ms. S. Enkhmaa Nov. 2018 - 2. Ms. E. Amarzaya Sep. 2021 -
Air Pollution Control Measures	1. Mr. Kh.Galymbek - Jan. 2020 2. Mr. G.Davaajargal Jan. 2020 -	MET: 1. Ms. A.Tseepel - Apr. 2019 2. Mr. T. Mjnkhat Nov. 2019 - Jun. 2023 3. Ms. Bolorjargal Dec. 2023 -
External Relevant Agencies Coordination	1. Mr. Kh.Galymbek - Jan. 2020 2. Mr. G.Davaajargal Jan. 2020 -	

2-3-3 Implementations of Undertakings of the Mongolian Side

The Mongolian side implemented undertakings of Mongolian side as agreed in the Record of Discussion as follows. However, there were no rooms available in MET building, and the JET room was not secured in the MET building.

1. Facility

- (1) Provision of necessary office space in DAAEP and MET (including internet access)
- (2) CLEM Laboratory
- (3) Storage Space for Equipment

2. Local cost

- (1) Counterpart expenses such as salary, allowance, travel cost and accommodation
- (2) Project administrative expense

2-4 Joint Coordination Committee (JCC)

Records of Joint Coordination Committee (JCC) is shown in Table 2-4-1 below.

Table 2-4-1 Records of JCC

	Date	Main Subjects Discussed and/or Approved
1 st JCC	Decembers 2018	- Approval of JCC members - Amendment of C/P-WG regarding additional an agency. - Amendment of PDM due to a review of activity target agencies
2 nd JCC	June 2019	- Approval of Monitoring Sheet 1 - Discussion on necessity securing human resources to implement the project - Discussion on provision an equipment provider and the installation and maintenance of the equipment
3 rd JCC	December 2019	- Approval of Progress Report 1 - Approval of Monitoring Sheet 2 - Discussion on PDM regarding objectively verifiable indicators of Outputs - Discussion on expansion C/P-WG - Discussion on pilot project of household improved fuel regarding cancelation of previously planned field verification test in the Ger area community - Discussion on emission inventory and simulation modeling activities regarding trainings again
4 th JCC	February 2021	- Approval of Progress Report 2 - Approval of Monitoring Sheet 4 - Discussion on necessity of extension of the project duration - Discussion on expansion C/P-WG - Discussion on amendment of PDM due to abolishment of Air Pollution Against Fund - Discussion on additional activity of PDM regarding training on automobile emission measurement using an on-board emission measurement system - Discussion on securing necessary human resources to implement the project
5 th JCC	June 2021	- Approval of Monitoring Sheet 5 - Discussion on additional activity of PDM regarding training on automobile emission measurement using an on-board emission measurement system - Discussion on additional activity of PDM regarding the online information system of AQMS
6 th JCC	December 2021	- Approval of Progress Report 3 - Approval of Monitoring Sheet 6 - Discussion on PDM regarding objectively verifiable indicators of Project Purpose - Discussion on additional activity of PDM regarding transfer of DPFs - Discussion on a role sharing in developing emission inventories, implementing simulation models, and assessing air pollution control measures
7 th JCC	June 2022	- Approval of Progress Report 4 - Approval of Monitoring Sheet 7

	Date	Main Subjects Discussed and/or Approved
		- Discussion on issue of transfer of DPF activity - Discussion on securing human resources and succession of duties necessary for the project
8 th JCC	December 2022	- Approval of Monitoring Sheet 8 - Discussion on the role sharing in developing emission inventories, implementing simulation models, and assessing air pollution control measures
9 th JCC	June 2023	- Approval of Progress Report 5 - Approval of Monitoring Sheet 9 - Discussion on activity with IACC due to abolition of IACC
10 th JCC	December 2023	- Approval of Monitoring Sheet 10 - Discussion on continuity of organization on the Mongolian side and continuity of Human resources of the C/Ps - Discussion on PDM regarding objectively verifiable indicators of Overall Goal - Discussion on PDM regarding the Objectively Verifiable Indicators 2 of the Project Purpose
11 th JCC	May 2024	- Discussion on Project completion report - Discussion on PDM regarding objectively verifiable indicators of Overall Goal - Discussion on issue after the Project completion

3 Project Activities and Outputs

3-1 Outline of the Activities

The Mongolian Government is working to study the current status of air pollution, understand the air pollution structure, share air pollution information, and consider and implement air pollution control measures. This is in Stage 2 of the categories classified in JICA global agenda for environmental management “JICA Clean City Initiative”¹⁰.

This section provides an overview of the project activities by output category. Details are described from 3-2.

Air pollution structure was studied through activities for Output 1 and 2, by emission monitoring air quality monitoring, PM component analysis, PMF analysis, updating emission inventory, and then air quality simulation model.

Pilot Project was intended for Mongolian side to practice to study feasibilities of air pollution control measures through activities for Output 3 to 6, as summarized in 3-1-6.

3-1-1 Output 1: Capacity Development of Emission Monitoring on Emission Sources and Air Quality Monitoring and Output 2: Capability Strengthening to Analyze and Evaluate Pollution Structure

1) Source emission monitoring (Activities 1-1 to 1-3)

Emission monitoring at major sources is necessary to assess the current status of air pollution. The Mongolian side has been able to measure emissions by themselves through the project. Specific achievements are as follows.

- As for the emission gas measurements at stationary sources, the Mongolian side have maintained measurement system and measured flue gases by their own. During this Project, flue gas was measured at 240 boilers, including at thermal power plants.
- In April 2022, DAAEP received ISO 17025:2017 laboratory accreditation for emission gas measurement of stationary emission sources. In addition, the Ministry of Energy (ME) and the manufactures of the improved fuels have requested exhaust gas measurements in the combustion test lab, and their results are used for the selection and improvement of improved fuels.
- TPP3 and TPP4 are continuously utilizing CEMS, mainly to comply with emission standards through combustion management of the boilers. Calibration of CEMS, periodical renewal of consumable parts and trouble-shooting are implemented as appropriate. CEMS measurement results are submitted to NAMEM and other organizations.

¹⁰ https://www.jica.go.jp/activities/issues/env_manage/_icsFiles/afieldfile/2024/03/28/cluster_strategy2v2.pdf

- In Mongolia, 10-20% of all vehicles do not meet emission standards for vehicle inspection, which is one of the reasons for the severe air pollution caused by vehicles. A Remote Sensing Device (RSD) survey has revealed that diesel particulate filters (DPFs) are not installed in diesel vehicles, and that the proportion of vehicles with high concentrations of PM is considerably higher than that in Japan.
- High sulfur content in fuel has a negative impact on the various air pollution control measures installed in vehicles. The fuel survey revealed that fuels with sulfur content more than 1000 ppm were commonly sold in the petrol stations, and it was reaffirmed that the awareness-raising activities to promote the introduction of low sulfur fuels such as Euro 5 fuels is necessary.
- The Mongolian side requested re-training of on-board measurement system and relocation of DPFs. The Mongolian and Japanese sides decided to add these activities to the Project, and implemented these training and relocation. For the on-board emission system, capacity development was implemented in order to verify emissions before and after eco-driving and the effect of an additive. Relocation of DPFs were implemented for two buses.

2) Air quality monitoring and understanding of pollution structure (Activities 1-4 and Activity 2)

Air quality monitoring is necessary to assess the current state of air pollution. As same, emission inventories and simulation modeling are necessary to analyze and evaluate the air pollution structure and to evaluate proposals of air pollution control measures. An air quality monitoring information is necessary to be shared to the citizens. Through this Project, capacity of maintenance of the Air Quality Monitoring Stations (AQMS) was developed, and the analysis of air pollution structure was implemented. Specific achievements are as follows.

- The staff in charge continued to maintain the AQMS and to keep monitoring the air quality despite various troubles. The results showed that PM_{2.5} significantly exceeded the annual average of the environmental standard, especially PM_{2.5} in the Ger area in winter. The availability of the AQMS during the project period exceeded 81%, except for the period when maintenance was not possible due to COVID-19. Air quality conditions are published in real time on <http://agaar.mn/> and on the app.
- PM sampling and composition analysis during the winter season revealed that the contribution of carbon mainly from coal, especially condensable particles consisting of organic carbon (OC) components was significant during the Project Phase 2, when raw coal was used. In this Project, it was found that the introduction of improved fuels reduced condensable particles consisting of OC quantitatively.
- The result of the simulation model showed that the contribution to SO₂ and PM concentrations from small stoves used in detached houses and Ger (including Ger stoves and improved stoves) was significant, while the contribution from power plants and HOBs was small.

- As stated in 1-4 above, AQMS showed that after the introduction of improved fuels in 2019, the PM concentration in the ambient air quality decreased and the SO₂ concentration increased, which was attributed to the ban on coal and the switch to the use of improved fuels. The results of the simulation model and PM composition analysis confirmed this. The project encouraged the manufacturer to improve the use of improved fuels. As a result, the manufacturer began to consider switching to low sulfur coal and adding more desulfurizer.

3-1-2 Output 3: Strengthened Capacity for Technical Assessment of Air Pollution Control Measures and Preparation for Implementation of Air Pollution Control Measures

This Project has prepared standards necessary for technical evaluation of the effectiveness of air pollution control measures. Specific achievements are as follows.

- In 2022, ME prepared and submitted draft of revised MNS for a quality standard for improved fuels to the Mongolian Agency for Standardization and Metrology (MASM), and approved as MNS 5679:2022 by the Director of MASM on 17 October 2022. It became effective on 18 October 2022. Organizations involved in control of improved fuels confirm that the improved fuels produced under this standard meet the criteria.
- Regarding the measurement standards, combustion improved fuels requested by ME and improved fuel manufacturers have been conducted using the protocol established in the Project Phase 2. There have been no objections from any clients about the protocol in these tests. Although Mongolian side had no specific idea to formalize the measurement method, JET explained the necessity of formalization. Under JET's advice, DAAEP concluded that the protocol was sufficient as a standard, and proposed it for UB City. UB City started the process to formalization in March 2024.
- In Mongolia, there were not enough regulations regarding safety in gas use. IACC has provided guidance to the general public on the safe use of gas fuel, but its content is limited to a brief summary of recommendations for the use of LP gas and notes for the use of gas appliances. In order to create a circumstance in which gas fuel can be used safely, it is important not only to regulate gas utilities, but also to promote voluntary efforts by gas service providers and to encourage consumers. In Mongolia, development of safety guidelines for gas service providers was considered to be effective, focusing on the advancement of voluntary safety systems and measures to inform and educate the general public. Therefore, referring to the Japanese law on gas safety assurance and regulations for gas utility companies, the safety guidelines for the promotion of gas fuel use in Mongolia were prepared by extracting the contents related to safety that are considered particularly necessary for the promotion of gas use in Mongolia in the future. The safety guidelines were submitted to the ME in June 2024.

3-1-3 Output 4: Support for the Suggestion to Decision Making Agency on Air Pollution Control Measure through the Project Activities

Based on the results of the analysis and evaluation of the ambient air and emission sources obtained through this Project, the Project supported Mongolian side to develop a system to formulate its own science-based strategies and policies and to make its own decisions. Specific results of the recommendations for decision-making bodies are as follows.

- JETs evaluated the air pollution situations for 2018 when raw coal was used, for 2020 after the introduction of the improved fuels currently used, and in case when air pollution control measures of the pilot projects will be fully implemented. Based on the results of increased SO₂ concentrations with the introduction of the improved fuels, JET, together with NAMEM, recommended in seminars and at the JCC to use low sulfur coal or to blend desulfurizing components for further improvement of improved fuels.
- NAMEM analyzes air pollution using AQMS data and submits weekly, monthly, winter, and annual reports to the National Bureau of Statistics, NCEPR, and MET.
- In November 2023, JET presented to Deputy Governor of UB City the results of the evaluation of air pollution control measures through fuel conversion from raw coal to improved fuels, which was implemented as a national policy of the Mongolian Government, and made recommendations on necessity of further improvement of the improved coal.
- The Project presented the comparison result of improved fuels for household to the Deputy Governor of UB City in April 2024. Specifically, the Project presented a comparison between TTT's existing improved fuel and the BCBs improved by the project, and the simulation results if BCB is used instead of the current improved fuel, and if all the stoves are changed to improved stoves, and then recommended further improvement of the current improved fuel.

3-1-4 Output 5: Enhancement of Air Pollution Control Measure for PM, SO₂ and NO_x emission reduction

To promote air pollution control by private sector, following activities were implemented. In addition, several pilot projects were developed as described below.

1) Public awareness to Citizen (Activity 5-1)

- DAAEP has created videos and posters, and then posted them on DAAEP's website, partners' websites, Capital News and TV stations, and Facebook for public awareness and warning activities about CO poisoning when using stoves and wall stoves in home.

2) Project Publicity Activities (Activity 5-2)

- A study tour for local media was organized by JICA Mongolia office in March 2019. The Project was introduced on Mongolian National Broadcasting (MNB) in March 2019. In addition, as part of the Pilot Project's activities to promote and raise awareness of low-sulfur fuel (Euro 5 fuel),

JET's appeal for the need for Euro 5 fuel was broadcasted by National Television of Mongolia (NTV) in October and December 2023 and April 2024.

- The AQMS and the combustion test room of DAAEP, which were provided in the Project Phase 2, was filmed on 31 January 2024. It was broadcasted on 13 February 2024 in the TBS evening news program as a story about Japan's support for improving air pollution in the Mongolian capital, featuring improved fuel (BCB) and future air pollution measures.
- C/P and JET prepared four news letters on the project activities and distributed them to relevant organizations. In addition, 13 posts were made on the Facebook by JICA Mongolia office to disseminate information on the project.

3) Advice on production technology of improved fuel (Activity 5-3)

- In December 2020, JET explained to DAAEP that it is necessary to add a desulfurizer to TTT's improved fuel, because TTT's improved fuel has higher sulfur content than Baganuur coal, according to the comparison table of sulfur content between Baganuur coal and TTT's improved fuel. TTT was advised to blend the desulfurizer with TTT's improved fuel by DAAEP.
- In June 2022, at the request of the president of TTT, the minister of ME who supervises TTT, the president of TTT, DAAEP, and JET held discussions. JET explained its opinions on TTT's improved fuel. JET requested the Minister of ME that desulfurizer must be included in the improved fuel for the winter of 2022, since reduction of SO₂ should be prioritized, considering that SO₂ concentrations in winter had been higher than before installation of improved coal.
- In March 2024, JET explained to TTT the environmental performance of BCB and the possibility of introducing BCB in Mongolia, based on the fuel test results of BCB produced in the pilot project.
- TPP3 and TPP4 keep trying to achieve a balance in their operation between the emission standard and heat and electric supply by blending several different types of coal.

3-1-5 Output 6: Strengthening Legal Framework Resource Allocation and Platform for the Air Quality Management Cycle

In this Project, efforts have been made to build a system that enables the Mongolian side to propel the atmospheric environment cycle on its own, with an emphasis on strengthening the cooperative and collaborative framework of the organizations concerned. Specific achievements in strengthening the legal and institutional framework are as follows.

1) Clarify the demarcation of roles in air quality management related with each Output and Activity of the Project (Activity 6-1)

- In order to implement the PM sampling activities in Activity 2-1-1 of this Project, Working Group for Implementation of Ambient PM Sampling of UB City was established and the roles of

relevant organization were decided by NAMEM Director General Order A/199 dated November 19, 2021.

- In Mongolia, the roles of each organization were not clear in the process from the development of emission inventories to the evaluation of proposed measures using simulation models. Therefore, JET proposed to settle "Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models" which was signed by DAAEP, NAMEM, and the National University of Mongolia (NUM) in April 2023.

2) Preparation and submission of technical documents to the MASM for revision of fuel standards, stationary sources, mobile sources, ordinances, etc. (Activities 6-2 and 6-3)

- DAAEP has prepared a variety of technical documents. The following are the main contents of them.
 1. DAAEP drafted revision of the Rules on Air Quality Improvement Area and submitted them to the UB Mayor's Board of Directors Committee, referring to the evaluation of pollution control plan (introduction of improved fuels throughout UB City) in the Project Phase 2.
 2. DAAEP prepared a technical document on measures against air pollution from vehicles and presented it at a meeting of the National Traffic Police.
 3. DAAEP submitted draft standards operation procedure of emissions measurement for fuel combustion testing of improved fuels to the UB Urban Standards Control Bureau for standardization.
- ME drafted MNS revision and submitted to MASM for quality standards for improved fuels, and approved as MNS 5679:2022 by the Director of MASM on October 17, 2022.

3) Proposal preparation on laws, regulations and ordinances on air pollution control measures, and submission to national parliament / city council (Activity 6-4)

- MMHI prepared a regulation on Euro 5 fuel based on JET's proposal and proposed it to the National Parliament. As a result, provision on Euro 5 fuels, "Only fuels with the highest MNS rating shall be sold within the Air Quality Improvement Area of the UB city, and the retail, sale, etc. of fuels below that rating shall be prohibited," was added as Article 16.1.6 of the amended Law of Air, dated 22 April 2022.
- Revisions of Air Quality Improvement Area Enforcement Regulation have been approved as joint orders by the Minister of Environment and Tourism and the Mayor of UB city almost every year since 2019, and revisions to the Air Pollution Improvement Air Quality Improvement Area Regulations have been implemented.

4) Training on air pollution control measures and technical review guidelines (Activity 6-5)

- JET developed technical review guideline for air pollution control. However, training could not be started because NCEPR was dissolved in end of December 2023, and department in charge of budget allocation on air pollution control is not yet assigned.

5) Improvement of procedures related to allocation of funds for air pollution control (Activity 6-6)

- At the meeting of NCEPR (consisting of ministers, deputy ministers and directors of specialized agencies), implementation measures plan (action plan) and budget amount for each measure were discussed based on NPREP, government decisions, etc. Budget, implementation period, implementing agency, and financial management agency for each measure were approved as NCEPR decisions within the ME ministerial work package determined by the national government. However, in December 2023, NCEPR was dissolved because NCEPR concluded that air pollution control for UB City will be more effective by the initiative of UB City rather than the national government. In March 2024, the authority to approve budget allocation to realize NPREP was officially transferred to UB City, NAMEM, and related agencies. These agencies will lead budget planning and allocation of funds.

6) Enhancement of donor coordination by Mongolian side (Activity 6-7)

- The United Nations Economic and Social Commission for Asian and the Pacific (UNESCAP) held the High-Level Forum on Clean Air as part of the Asia-Pacific Regional Action Programme for Air Pollution on 2 March 2023, hosted by UNESCAP and MET. MET requested the donors to collaborate with each other on air pollution control measures. In prior to the Forum in March 2023, MET also requested the donors to cooperate in the sub-meeting, “Air pollution, scientific evidences and solutions Science and technology conference”, which was organized by UNICEF in February 2023.
- MET is collaborating with Korea on the AQMS with CLEM, and plans to build 22 AQMSs and a new Laboratory.

3-1-6 Pilot Projects

Pilot Projects were selected, planned, executed and then evaluated by the procedure shown in Table 3-1-1 according to the pilot projects activities agreed in PDM.

Table 3-1-1 Procedures for Activities Related to Pilot Projects

	Activity in PDM	Content
1	3-3	DAAEP and the relevant agencies elaborate implementation plans and terms of reference for pilot projects such as improved fuel, HOB, traffic signal control, eco-driving, RSD, smoke belching program based on portable emission device, DPF, low sulfur fuel and low emission vehicles.
2	4-3	The relevant agencies discuss and endorse the selection of pilot projects.
3	5-4	The relevant agencies with JICA Experts implement pilot projects according to the implementation plan by Activity 3-3
4	5-5	The relevant agencies with JICA Experts evaluate pilot projects results in terms of emission reduction, air quality improvement and exposure to citizens, and extract lessons learned.
5	5-6	The relevant agencies with JICA Experts report the pilot projects results to NCEPR.
6	4-2	Relevant agencies with pilot projects elaborate technical guidelines and utilizes them.
7	4-5	NCEPR, or the sections of the relevant agencies in charge of allocating funds for air pollution control in the Mongolian Government such as the Environment and Climate Fund utilizes the Outputs of the Projects and pilot projects implementation and assessment.
8	4-4	NCEPR and the relevant agencies approve large scale investments based on pilot projects implementation and assessment
9	6-8	Relevant agencies of pilot projects with JICA Experts develop an operational guideline for elaboration, implementation and evaluation of air pollution control measures based on pilot projects implementation.

1) Selection and agreement of the pilot projects

Following 6 pilot projects were proposed for this Project in accordance with the Mongolian national policy.

According to the outputs of the Project Phase 2, it was found that air pollution was especially severe in winter in the Ger area, and its main reason was emissions from small household stoves (both of traditional Ger stoves and improved stoves) used in Gers and houses. After raw coal supply was stopped and “improved fuel” was started to be used widely, air pollution was mitigated but still severe. Therefore, further improvement of the “improved fuel” for household use was selected as one of the pilot projects.

The following five measures were selected for automobile emissions because it is better to reduce emissions from vehicles as soon as possible, although automobiles are replaced in a decade by new automobiles with new emission control technologies.

1. Operational changes in signal control to ease traffic congestion and reduce air pollutant emissions;
2. Introduction of low-sulfur fuels, because high-sulfur fuels that were commonly used in UB deteriorate emission reduction technologies in the automobiles in UB quickly;

3. Eco-driving, which contributes significantly to reduce air pollution emissions at the time of start moving, since the largest percentage of pollutants is emitted at the time of start moving of vehicle;
4. Widespread installation of PM reduction devices (DPF, etc.) to reduce PM emissions from diesel vehicles; and
5. Introduction of RSD to measure vehicle exhaust running on road instantly and continuously to identify high emission vehicles to control, as it was not realistic to control many vehicles on road by stopping and inspecting vehicles one by one.

Through discussions with related organizations and at JCCs, these 6 pilot projects were selected and agreed for implementation.

2) Implementation and output of the pilot projects

Summary of implementation and output of the pilot projects is described here. Details of the significance, implementation, and output of the pilot projects are described in 3-6-4.

1. Further improvement of the improved fuel for household use

Citizens had complained to continue to use the improved fuel because it is not easy to start fire. Emission reduction of Volatile Organic Materials (VOC) is important for further reduction of ambient PM because VOC was the major component of ambient PM of winter highly polluted days. Blending biomass was one of the highest potential solutions to solve these issues. Therefore, Biomass Blended Coal Briquette (BCB) was produced as a method of further improvement of the improved fuel.

By test combustion of BCB, it is confirmed that BCB is better than the current improved fuel made by TTT in terms of fire starting, combustibility, and desulfurization. Air pollutant emission by using BCB in the improved stove satisfied all the emission standards for stoves in MNS 5216:2016.

Feasibility of BCB was studied also. 650,000 tons of improved fuel is necessary for UB City. The total of yearly biomass supply capacity from Tuv, Khentii, Selenge, and Bulgan Provinces is 200,000 tons, of which 115,000 tons can be supplied from Tuv Province next to UB City. It is enough to produce 650,000 tons of improved fuel for UB City. However, production cost would be 22% higher than the cost of TTT's plan for improved fuel in 2023, which is the major issue to replace the current improved fuel with BCB.

2. Traffic Signal Control

Experts of UB City Traffic Control Center (TCC), together with JETs, reviewed the light hours by time of day at 17 intersections in the central area of UB City based on the results of traffic volume counting surveys, adjusted the light cycle at 10 of these intersections, and examined the changes in

traffic conditions before and after the signal adjustments in terms of traffic volume, congestion length, travel time, and signal intervention. The results showed positive effects of the signal adjustments. In order to improve traffic fundamentally, not only by light cycle adjustment, but also combinations of measures such as other methodology of changing traffic signals, changing traffic lanes, enhancing road network, enhancing public transportation, controlling traffic demand, and improving driving manners are necessary.

3. Low Sulfur Fuel

High-sulfur fuels were commonly sold for vehicles in Ulaanbaatar. Although it was not problem legitimately in UB, it deteriorate emission reduction technologies of the automobiles in UB quickly. In order to slow down deterioration to reduce emissions from vehicles, activities to introduce and promote low-sulfur fuels were implemented with MMHI. This included studying the sulfur content of fuel sold at petrol stations, estimating reduction possibility of SO₂ emission to publicize legislation and dissemination activities, and developing legislation and dissemination activities in Mongolia through introduction of the Japanese introduction process and legislation.

Based on the study, it was found that fuels with high sulfur content of over 1,000 ppm were commonly sold. Dissemination activities were conducted to promote introduction of Euro 5 fuels (low sulfur fuels). Regarding the introduction of low sulfur fuel (Euro 5 standard fuel), new article 16.1.6 were inserted into Air Law by the amendment on 22 April 2022, which stipulates the use of Euro 5 standard (K5 in Mongolia) fuel within the air pollution improvement area in UB city. This means that the pilot project was upgraded to full-scale implementation.

However, Euro 5 fuel is more expensive than regular fuel. Therefore, although the sales volume of Euro 5 fuel has been gradually increasing, it still has not been widely used.

4. Eco driving

Eco-Driving is an environmentally friendly way of driving a car in order to reduce emission of carbon dioxide (CO₂) that is the major cause of global warming, and emissions of air pollutants that are one of the causes of air pollution. Since the largest percentage of pollutants are emitted when any car starts moving, eco-driving, which greatly contributes to reducing air pollution emissions at the time of starting moving, is effective. In order to promote eco-driving, eco-driving training was implemented and its effect was measured by the on-board emission measurement system and eco-driving support devices.

The results of the eco-driving program for three vehicles (a passenger gasoline vehicle, a passenger hybrid vehicle, and a light-duty truck with diesel fuel) showed a reduction in air pollutant emissions.

5. PM Reduction Equipment (DPF)

JET explained to MRTD PM reduction effect of retrofit by DPF installation using the on-board emission measurement system. JET drafted an evaluation procedure to identify valuable DPF models, held discussions with MRTD, and agreed to proceed with the development of vehicle regulations requiring retrofit of diesel vehicles by installation of PM reduction devices (DPFs, etc.) as a full-scale project. However, installation of DPFs is not proceeding well because they are expensive and costly to operate, according to MRTD.

The PM reduction effect of the DPF model tested was confirmed to be very high based on the reduction of black smoke during driving and gauze tests with and without the DPF. On the other hand, it was reconfirmed that daily operation of the DPF model tested is not feasible without assignment of additional workers to regenerate DPFs.

6. Introduction of RSD

It was not realistic to control many vehicles on road by stopping and inspecting vehicles one by one. In order to identify high emission vehicles efficiently, RSD was proposed to be tested as a pilot project. In order to introduce operation regulations in Mongolia using RSD, DAAEP and JET installed RSD and measured exhaust of vehicles by RSD, NRTC measured opacity, and the traffic police stopped vehicles for opacity measurement. From the data acquired by RSD measurements and opacity measurements, correlation between the two measurement methods was clarified, and the emission standard values for RSD corresponding to the emission standard specified in the MNS (40% in opacity) were determined.

In preparation for the introduction of the operation regulation using RSD emission standard value for full-scale project, RSD emission standard value corresponding to the emission standard (40% opacity) specified in the MNS was proposed as 25. Draft legislation and technical guidelines for RSD measurement were prepared since Mongolia does not own RSD equipment and legislation is not yet in place.

After this Project, it will be necessary by MRTD to obtain RSD, and to prepare and start vehicle exhaust control by roadside inspections using RSD. It means that regulations should be prepared and authorized for examples as MRTD Ministerial Decree and/or UB Mayor's Decree to obtain RSD, to start roadside inspection, and to request the users or owners of vehicles of which exhaust exceed the standard to pay penalties, and/or to satisfy the standard by service maintenance, installation of PM reduction device if the vehicle is diesel vehicle without PM reduction device, or renewal with vehicle of which exhaust does not exceed the standard.

3-2 Output 1: Capacity Development of Emission Monitoring on Emission Sources and Air Quality Monitoring

3-2-1 Activity 1-1: Capacity Development of Boiler Inspection based on Measurement of Emission from Stationary Source

3-2-1-1 Boiler Inspection

- 1-1-1 DAAEP and JICA Experts assess the technical transfer on-site stack gas measurement.
- 1-1-2 DAAEP with JICA Experts re-constructs 2 teams of stack gas measurement.
- 1-1-3 IACC and the relevant agencies with JICA Experts implement HOB inspection based on on-site stack gas measurement.
- 1-1-4 IACC with JICA Experts introduces simplified measurement method by using IACC's portable gas measurement equipment including parallel measurement with JIS method, elaboration of manuals and manufacturer's calibration.
- 1-1-5 DAAEP and IACC with JICA Experts elaborate emission measurement reports.

(1) Activity

1) Activity 1-1-1: Assessment on the capacity of on-site stack gas measurement

DAAEP and JET assessed the capacity of DAAEP for on-site stack gas measurement from December 2018 to March 2019. More than one and a half years have passed since completion of the Project Phase 2. DAAEP was able to perform the flue gas measurement with judgment of site conditions, preparation of equipment and clean up based on manuals, which were elaborated in the Project Phase 2.

DAAEP had a budget for maintenance and repair, and had repaired two automatic isokinetic dust sampling devices (Manufactured by Maruni Science). JET supported repair procedures of the equipment such as transportation, contract, payment, etc. In the middle of February 2019, the repair of the equipment was completed and arrived to DAAEP on 27 February 2019. Also, one emission gas analyzer (HORIBA, model PG350) was repaired in Japan with the budget of DAAEP.

As of April 2024, more than 6 years have passed since the end of the Project Phase 2; DAAEP has been performing the flue gas measurement on their own and has been able to repair the necessary equipment. The equipment provided by the project in 2013 has been in use for more than 10 years; the equipment is aging and new equipment needs to be procured.

The flue gas measurement at stationary sources is not proceeding as planned since ME and NCEPR, and so on, suddenly requested DAAEP to measure improved fuels and igniters on a top-down basis. The staffs have been busy with on-site work, spending a lot of time for measurement data processing. Therefore, the staffs need to carefully read and study the materials prepared in the Project Phase 2, and DAAEP will need to decide the person in charge of combustion test and the person in charge of measurement data processing of the measured result. In particular, data processing of measured data is a desk worker, and thus, it is necessary to secure a regular staff for it.

2) Activity 1-1-2: Re-construction of 2 teams of flue gas measurement

From the beginning of the Project, winter season of 2018, 1 person was in charge of coordination and administration of HOB inspection, other 2 persons were in charge of the flue gas measurement. As of November 2020, persons in charge of the flue gas measurement at stationary sources trained other persons in classroom lecture and on-site based on the materials prepared by the Project Phase 2 on their own. The number of staffs has five including those trained by JET in the Project Phase 1 and the Phase 2, there are enough staffs to perform the flue gas measurement at 2 locations as fuel combustion laboratory and HOBs. Currently DAAEP has four-persons in charge to perform the flue gas emissions measurements for improved fuel combustion and stationary sources.

3) Activities 1-1-3 and 1-1-5: HOB inspection and report based on on-site flue gas measurement

The boiler inspection were smoothly implemented by the cooperation of DAAEP and IACC, and DAAEP reported flue gas measurement results to IACC. However, according to Mayoral Order A/1649 “On Certain Measures Related to the Abolition of Inspection Agency of the Capital City” dated 30 December 2022, IACC was abolished and inspection division was added to DAAEP. Therefore, air quality measurement and operations division of DAAEP performed the flue gas measurement and inspection division elaborated inspection report.

DAAEP performed the flue gas measurement at 57 boilers from October 2018 to end of June 2019, 85 boilers from October 2019 to June 2020, 20 boilers from July 2020 to June 2021, 44 boilers from January 2022 to November 2022 and 27 boilers from January 2023 to December 2023. Total 233 boilers are inspected. The measurement results from Boiler Inspections from October 2018 to December 2023 are shown in Table 3-2-1.

All parameters of 75 boilers (32.2%) met the emission standard. Of the remaining boilers, 74.7% met the emission standard for SO₂, 90.6% for NO_x, 59.7% for CO, and 70.8% for dust.

Table 3-2-1 Flue Gas Measurements Result (Oct. 2018- Dec. 2023)

Unit: mg/m³N

No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
1	Tsogsh LLC	DZH	1.4 MW	None	Baganuur	*d	892	184	3,567	1,563
2	Khash Zumberel LLC	UKHJZ	0.15 MW	None	Sharin Gol	*b	79	151	6,105	150
3	International Youth Center	DZL	2.8 MW	Wet Scrubber	Baganuur	*a	387	199	749	5,627
4	Altan Joloo Trade LLC	MRJ	0.7 MW	None	Baganuur	*b	585	280	3,974	1,920
5	22 toll facility	Kiturami KCR240	0.3 MW	None	Baganuur	*b	615	259	13,136	6,458
6	Munkhbayasakh Casing LLC	Biomin	0.35 MW	Cyclone	Nalaikh	*b	1,056	153	5,759	250
7	Bat Trade C LLC	NRJ-0.25	0.25 MW	None	Baganuur	*b	254	205	7,162	3,417
8	Asia Tulguur LLC	NRJ-0.25	0.25 MW	None		*b	683	176	7,788	268
9	Temuulen Od LLC	DZL	1.2 MW	None	Nalaikh	*d	1,733	129	4,621	391
10	Prodge LLC	ECOSTAR	0.3 MW	Cyclone	Baganuur	*b	195	119	7,972	419
11	No.87 School	MUHT	1.4 MW	Cyclone	Baganuur	*a	321	164	534	1,164
12	Janjin Club	DZL	0.7 MW	Cyclone	Nalaikh	*b	1,231	263	1,670	108
13	Yarmag	DZL	0.7 MW	Cyclone	Baganuur	*b	990	337	5,129	5,186
14	No.65 School	MUKHT	0.7 MW	Cyclone	Baganuur	*b	1,545	383	3,625	1,968
15	No.61 Crossing place	MUKHT	0.7 MW	Cyclone		*b	2,187	487	3,839	2,469
16	Bishreit Trade LLC	NRJ-0.25t	0.25 MW	None		*b	254	205	7,162	3,417
17	MCS Coca Cola LLC No.1 Boiler	DZH	6 t/h	Wet Scrubber	Nalaikh	*d	229	81	836	342
18	MCS Coca Cola LLC No.2 Boiler	DZH	6 t/h	Wet Scrubber	Nalaikh	*d	1,335	366	1,975	704
19	Asian children kindergarden	NRJ-0.25	0.25 MW	None	Baganuur	*b	366	168	4,856	5,361
20	No.42 School	Carborobot 300	0.3 MW	Cyclone	Baganuur	*b	2,178	266	7,488	7,660
21	No.49 School	Carborobot 300	0.3 MW	Cyclone	Baganuur	*b	2,208	266	3,278	1,055
22	No.67 School	Carborobot 300	0.3 MW	Cyclone and Wet Scrubber	Baganuur	*b	220	25	840	120
23	No.72 School	Ecoeffect	0.6 MW	Cyclone	Baganuur	*b	2,165	207	4,227	577
24	No.105 School	Ecoeffect	0.6 MW	Cyclone and Wet Scrubber	Nalaikh	*b	2,564	242	3,853	318
25	No.107 School	Ecoeffect	0.6 MW	Cyclone	Baganuur	*b	2,294	246	3,305	1,392
26	Artsat LLC	Kiturami KCR	0.25 MW	None	Baganuur	*b	316	331	2,553	1,256
27	Vitsamo LLC	DZH	1.4 MW	Cyclone	Nalaikh	*d	886	548	1,967	329
28	Jivertiin orgil LLC	DZL	1.2 MW	None	Baganuur	*a	120	55	5,758	438
29	Jarangad LLC	DZH	1.25 MW	None	Baganuur	*d	195	114	4,063	3,721
30	Modkon LLC	Kiturami KCR	0.20 MW	None	Nalaikh	*b	189	55	9,333	1,816
31	Molor Trade LLC	DZL	1.25 MW	None	Nalaikh	*a	1,307	179	10,233	779
32	MunkhBayasakh Casing LLC	WSG	0.25 MW	None	Baganuur	*b	1,825	173	5,153	690
33	Optimum Progress LLC	NRJ	0.15 MW	None	Baganuur	*b	426	159	2,942	803
34	Promon Trade LLC	SKD	0.15 MW	Cyclone	Nalaikh	*b	656	156	4,231	113
35	No.107 School	Carborobot 300	0.3 MW	Cyclone and Wet Scrubber	Nalaikh	*b	553	60	3,341	340
36	Welfare Center	UHJZ	0.04 MW	None	Baganuur	*c	38	88	31,408	1,107
37	Tugs Buteemj LLC	DZH	1.4 MW	Cyclone and Wet Scrubber	Nalaikh	*d	625	206	7,157	1,129
38	Tumen Shuvuut LLC	Promepei	0.25 MW	Cyclone	Nalaikh	*b	366	153	1,392	3,890

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No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
39	Temuulen Od LLC	WSG	0.25 MW	None	Baganuur	*b	801	296	1,985	1,087
40	UB Buyan LLC	LSG	0.18 MW	Cyclone	Nalaikh	*b	272	25	3,083	679
41	No.65 School	MUKHT	0.7 MW	Cyclone	Nalaikh	*b	647	246	2,865	32,370
42	Tsoba Properties LLC	MUKHT	0.5 MW	Cyclone	Nalaikh	*b	1,322	264	1,756	309
43	SHAB LLC	DZH	1.25 MW	Cyclone and Wet Scrubber	Alag Tolgoi	*d	1,083	250	297	176
44	Shilen Khiits LLC	USPOR	0.09 MW	None	Nalaikh	*c	1,209	291	3,714	480
45	MGL Aqua LLC	CWSN	0.7 MW	Cyclone and Wet Scrubber	Baganuur	*d	1,838	227	2,432	2,904
46	Erdenebulag Khuyag LLC	LS60	0.056 MW	None	Nalaikh	*c	375	202	7,165	315
47	Mongol Eco Makh LLC	DZH	0.7 MW	Wet Scrubber	Baganuur	*d	27	60	1,569	173
48	Mongolia Food LLC	UKHGZ	0.12 MW	None	Nalaikh	*b	100	22	223	107
49	Sayan Uul LLC	DZH	1.25 MW	None	Alag Tolgoi	*d	36	20	7,973	107
50	National psychiatric hospital	BZUI	1.0 MW	None	Baganuur	*a	107	40	356	956
51	Industrial ecology institute of Mongolian University of Science and Technology	DTKH	0.35 MW	None	Nalaikh	*b	32	20	3,256	215
52	SSC Mongolia Food LLC	DZC	1 t/h	Wet Scrubber	Nalaikh	*d	31	100	223	107
53	ESU LLC	DZH	2 t/h	Wet Scrubber	Baganuur	*d	121	109	960	732
54	Sayan Uul	DZH	1 t/h	Wet Scrubber	Alag Tolgoi	*d	272	433	2,694	215
55	Erchis Tal LLC	DZH	1 t/h	Cyclone and Wet Scrubber	Alag Tolgoi	*d	64	237	365	334
56	Erchis Tal LLC	BZUI	1 MW	Cyclone and Wet Scrubber	Alag Tolgoi	*d	40	107	356	956
57	JTSS LLC	DZH	2 t/h	Wet Scrubber	Baganuur	*d	121	57	1,243	983
58	Mongol Eco Meart	DZH	0.7 MW	Wet Scrubber	Baganuur	*b	60	27	1,569	173
59	Artsat Wood	Kiturami KCR250	0.25 MW	None	Nalaikh	*b	331	316	2,553	1,256
60	Tsogsh	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	103	103	845	1,344
61	Innova	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	103	107	1,514	1,344
62	General Etalon	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	1,750	103	1,500	1,344
63	Urguu Meat	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	103	103	1,514	1,344
64	Dun Fan International	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	346	39	195	1,029
65	Tsen Mnankhan	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	217	49	55	2,565
66	Khatan International	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	106	33	46	807
67	Kerano	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	103	103	1,514	1,344
68	Dulguunbars	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	1,751	64	776	768
69	Munkh Bayasakh Case	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	518	423	371	477
70	Mon Ark	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	193	400	592	304
71	Tsan Sentsa	DZH2	2 t/h	Wet Scrubber	Baganuur	*d	834	287	258	1424
72	Ariun Bulag International	DZH2	2 t/h	Multi Cyclone	Baganuur	*d	851	137	1,115	1,572
73	Shilmuust Sumber	DZH2	2 t/h	Multi Cyclone	Baganuur	*d	1,219	344	1,885	2,188
74	Uulen Gou	DZH2	2 t/h	Multi Cyclone	Baganuur	*d	1,012	347	1,872	989
75	Enkhted	DZH2	2 t/h	Multi Cyclone	Nalaikh	*d	132	68	712	872
76	Jhj Mandukhai LLC	DZH2	2 t/h	Multi Cyclone	Nalaikh	*d	1,529	409	1,011	1,833
77	GsDorniin Hugjil LLC	SZL	8 t/h	Cyclone	Tavan Tolgoi	*d	3,048	776	2,782	1,814
78	Munkh Tugrug LLC	DZH	2 t/h	Multi cyclone	Nalaikh	*d	1,260	760	776	1,513
79	Telemen ANU LLC	CZG1	2 t/h	Multi cyclone	Baganuur	*d	1,529	348	1,015	1,947
80	Sain Tsaas LLC	DZH4	4 t/h	Cyclone	Nalaikh	*d	672	599	1,863	2,051
81	Gangan And LLC	LSH	0.7 MW	Cyclone	Alag Tolgoi	*d	802	528	1,785	3,028
82	Optimall LLC	DZH	8 t/h	Cyclone	Baganuur	*d	2,294	246	3,305	1,392
83	Ashika LLC	HP	0.6 MW	Multi Cyclone	Nalaikh	*b	645	233	1,497	455

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No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
84	Mon Green Khas LLC	DZH7	7 t/h	Multi Cyclone	Nalaikh	*d	934	473	7,141	1,985
85	Dujin LLC	Zuan Chi	0.5 t/h	Multi Cyclone	Baganuur	*d	672	198	8,958	6,014
86	Trans Bus LLC	CWSHO		Wet Scrubber	Baganuur	*b	782	325	16,155	613
87	Trans Bus LLC	CWSHO		Wet Scrubber	Baganuur	*b	1,469	371	23,338	514
88	Amgalan Logistic LLC	XT600	0.6 MW	Multi Cyclone	Alag Tolgoi	*b	610	300	2,785	340
89	Japan Mongolian Friendship LLC	HP-16	0.16 MW	Cyclone	Nalaikh	*b	412	363	4,497	560
90	MBC Asia Pacific LLC	DZH	8 t/h	Multi Cyclone	Nalaikh	*d	1,602	184	1,584	1,345
91	Hua Media LLC	LSG	0.7 MW	Cyclone	Baganuur	*b	785	186	3,515	896
92	Mega Wood LLC	Mega Wood	0.7 MW	Multi Cyclone	Alag Tolgoi	*b	610	294	2,785	583
93	Prodge LLC	Ekostar S300	0.3 MW	Wet Scrubber	Baganuur	*b	133	165	7,723	340
94	Agro Trade LLC	OPOP 90D	0.9 MW	None	Alag Tolgoi	*b	1,601	446	822	661
95	Munkh Dulguun Tengis LLC	CLSG-1200	1.2 MW	Multi Cyclone	Alag Tolgoi	*d	1,618	371	2,779	3,105
96	Emeelt Erdene Trade LLC	LSS	0.5 t/h	Multi Cyclone	Tavan Tolgoi	*d	411	182	1,457	1,161
97	Shirev Damba LLC	GLSG1	1 t/h	Multi Cyclone	Tavan Tolgoi	*d	753	391	2,489	1,030
98	Oral Science Research Center" LLC	DOP	0.7 MW	Multi Cyclone	Baganuur	*b	52	481	638	492
99	Myangan Lant LLC	DZH	2 t/h	Multi Cyclone	Baganuur	*d	1,430	776	954	914
100	Nukht LLC	CZML	0.7 MW	Multi Cyclone	Nalaikh	*b	771	212	2,521	812
101	Ochir ord LLC	HP-16	0.7 MW	Multi Cyclone	Baganuur	*b	617	405	5,187	381
102	Anko LLC	GZZ-0137	0.14 MW	Wet Scrubber	Baganuur	*b	545	215	6,915	439
103	Safe Track LLC	SKHGL	MW	Multi Cyclone	Nalaikh	*b	412	146	2,950	624
104	Javkhlant Delger Khangai LLC	LSG	0.5 t/h	Multi Cyclone	Baganuur	*d	314	184	2,647	368
105	Standard Shuudai LLC	DZH	4 t/h	Multi Cyclone	Alag Tolgoi	*d	825	170	2,121	544
106	Dhtn LLC	DZH	2 t/h	Multi Cyclone	Baganuur	*d	1,305	237	1,608	734
107	Chinggis Khan Khuree LLC	Bzui	0.6 MW	Multi Cyclone	Nalaikh	*b	496	159	4,083	615
108	Samsara LLC	CLHS	0.25 MW	Wet Scrubber	Nalaikh	*b	385	385	4,212	457
109	Orkhon Tushee LLC	DZH	6 t/h	Wet Scrubber	Nalaikh	*d	451	345	4,812	597
110	Molor LLC	Eco	0.7 MW	Cyclone	Baganuur	*b	1,395	204	2,179	655
111	Anu Service LLC No. 26 Boiler	Carborobot300	0.3 MW	Cyclone	Baganuur	*b	454	312	3,562	531
112	Anu Service LLC No. 72 Boiler	Carborobot300	0.3 MW	Cyclone and Wet Scrubber	Baganuur	*b	115	68	890	607
113	Anu Service LLC No. 67 Boiler	Carborobot300	0.3 MW	Cyclone	Baganuur	*b	450	463	3,222	678
114	Anu Service LLC No. 105 Boiler	Carborobot300	0.3 MW	Cyclone	Sharin Gol	*b	242	2,564	3,853	318
115	Anu Service LLC No. 107 Boiler	Ecoeffect	0.6 MW	Cyclone	Baganuur	*b	246	2,294	3,305	1,392
116	Chingel LLC	Kiturami KCR250	0.25 MW	Cyclone	Baganuur	*b	340	88	3,897	513
117	Tast Erchim	Kiturami KCR250	0.25 MW	Cyclone	Baganuur	*b	1,201	234	3,200	727
118	Anu Service LLC No. 25 Boiler	Kiturami KCR250	0.25 MW	Cyclone	Sharin Gol	*b	247	397	5,284	398
119	Elemen LLC	UK	0.4 MW	Cyclone	Baganuur	*b	69	494	2,072	323
120	Tsuvshin Undraa	DZL	0.7 MW	Cyclone	Baganuur	*b	59	1,589	695	398
121	Steel and Concrete LLC	SHG	0.25 MW	Cyclone	Baganuur	*b	31	115	5,987	515

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No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
122	Sukhbaatar Devshil LLC	SHG	0.25 MW	None	Baganuur	*b	132	450	4,317	874
123	No. 217 Kinder Garden	Eco	0.3 MW	None	Baganuur	*b	12	114	5,839	674
124	MJL Aqua	Eco	0.3 MW	Cyclone	Baganuur	*b	80	224	668	496
125	Good Kaulm LLC	Eco	0.3 MW	Cyclone	Baganuur	*b	31	164	655	597
126	Anu Service LLC No. 49 Boiler	Kiturami KCR250	0.25 MW	Cyclone	Sharin Gol	*b	30	216	1,419	530
127	Eh Hugjil LLC	DZL	0.7 MW	Cyclone	Nalaikh	*b	36	378	3,695	671
128	Agro LLC	Kiturami KCR250	0.25 MW	None	Baganuur	*b	785	287	4,812	722
129	Chdmo LLC	Banasaik	0.4 MW	Cyclone	Tavan Tolgoi	*b	241	34	4,345	511
130	Chsmo LLC	Kizaczek	1.25 MW	Cyclone	Tavan Tolgoi	*b	195	23	4,987	584
131	Anu Service LLC No. Boiler	Carborobot3 00	0.3 MW	Cyclone	Sharin Gol	*b	408	52	1,278	612
132	Anu Service LLC No. 105 Boiler	Kiturami KCR250	0.25 MW	Cyclone	Sharin Gol	*b	191	52	12,089	599
133	Mongol Alt (MAK) LLC No	GV	0.75 MW	Cyclone	Khuut middling	*b	104	321	497	321
134	Nalaikh Heat Supply Center	KMTC		Cyclone	Nalaikh	*a	374	509	240	1,580
135	My Car LLC	HP	0.25 MW	None	Baganuur	*b	247	160	939	985
136	Tsushig Dayan	LST	2 t/h	Cyclone	Alag Tolgoi	*d	1,379	197	784	1,714
137	Agi Tsagaan LLC	DZH	2 t/h	Cyclone	Alag Tolgoi	*d	1,263	285	3,142	650
138	Urnukh Constr	DZH	4 t/h	Cyclone	Alag Tolgoi	*d	1,589	197	5,288	1,475
139	Bayan Nuudle LLC	LST	2 t/h	Cyclone	Alag Tolgoi	*d	741	212	876	1,378
140	Molor Trade LLC	DZL	2.8 MW	Cyclone	Baganuur	*d	885	234	7,671	3,285
141	Element LLC	A6000			Diesel	*b	266	150	2,806	666
142	Temuulan LLC	DZL	0.2MW	Wet Scrubber	Baganuur	*d	671	191	4,988	1,089
143	MOLOR OD LLC	DZL	2MW	Wet Scrubber	Baganuur	*d	712	191	4,180	1,205
144	BAYASAKH FOOD LLC	DZHH	2t/h	Wet Scrubber	Baganuur	*d	1,142	934	997	1,013
145	BIO ERGEL KHAIKHAN LLC	DZH	1t/h	Wet Scrubber	CXT	*d	116	305	1,001	1,571
146	GREED YARD LLC	vulkan	0,3 MW		CXT	*b	1,300	397	10,475	574
147	GAN KHIITS LLC	DZH	4t/h	Wet Scrubber	CXT	*d	645	464	1,345	2,013
148	MCS COCA COLA LLC	DZH	1.4MW	Wet Scrubber	Baganuur	*d	801	812	1.321	612
149	JHJ MANDUUKHAI LLC	DZH	2t/h	Wet Scrubber	Tavan Tolgoi	*d	176	181	1,079	148
150	ANUN SERVICE LLC No.107 Boiler	Carborobot	0,3 MW	Wet Scrubber	Tavan Tolgoi	*b	870	281	2,613	464
151	ANUN SERVICE LLC No.7 Boiler	Promertoi	0,3 MW	Wet Scrubber	Tavan Tolgoi	*b	876	170	4,812	783
152	SHAR DOCTOR LLC No. 7 boiler	DZH	1.4MW	Wet Scrubber	Tavan Tolgoi	*d	4,806	203	1,125	1,254
153	IKHER SHARANGAD LLC	CDZD	1.4MW	Wet Scrubber	Baganuur	*d	64	667	954	1,542
154	TUGS BUTEEMJ LLC	DZH	2t/h	Cyclone	Tavan Tolgoi	*d	2,584	294	2.023	1,545
155	TSETS MANKHAN LLC	DZH	2t/h	Cyclone	Tavan Tolgoi	*d	1,510	370	987	1,008
156	MDCCP LLC	DZH	1t/h	Wet Scrubber	Baganuur	*d	1,420	310	356	1,025
157	VANKHUU LLC	KCRM	0.6MW	Wet Scrubber	TTT	*b	870	294	2,023	979
158	SILE FOOD LLC	DZH	1t/h		TTT	*d	278	117	1,289	1,191
159	AMIN FOOD LLC	Sukoplam	0.3MW	Wet Scrubber	TTT	*b	300	297	5,739	376

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No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
160	MONGOL NEW RESOURCE TECH LLC	SZL	4t/h	Wet Scrubber	Tavan Tolgoi	*d	1,941	377	974	1,978
161	MONGOL INOVATION GREES LLC	YGL	2t/h	Wet Scrubber	Tavan Tolgoi	*d	1,741	397	390	1,594
162	GENERAL ETALON LLC	DZH	2t/h	Wet Scrubber	Tavan Tolgoi	*d	2,151	455	1,124	2,451
163	Engineering Facility Management Department	DZH	2.8t/h	Multi Cyclone	Baganuur	*d	1,921	541	8,752	2,410
164	Engineering Facility Management Department	DZH	2.8t/h	Multi Cyclone	Baganuur/ Middling	*d	1,784	349	7,150	1,828
165	Engineering Facility Management Department	DZH	2.8t/h	Multi Cyclone	Sharin Gol	*d	1,158	328	2,550	932
166	Anu Service" LLC No. Boiler	Carborobot300	0.3 MW	Cyclone	Improved fuel (TTT)	*b	408	52	1,278	612
167	Engineering Facility Management Department	DZL	1.4MW	Multi Cyclone	Baganuur	*a	990	383	9,617	2,740
168	Engineering Facility Management Department	DZL	1.4MW	Multi Cyclone	Baganuur/ Middling	*a	912	214	12,931	1,354
169	Engineering Facility Management Department	DZL	1.4MW	Multi Cyclone	Baganuur/ Middling	*a	762	150	18,641	1,110
170	Engineering Facility Management Department	DZL	1.4MW	Multi Cyclone	Baganuur/ Middling	*a	904	167	3,053	622
171	Blaze Tech LLC		1.5MW	None	Sharingol	*a	1,214	207	6,625	3,988
172	Blaze Tech LLC		1.5MW	Bag filter	Sharingol	*a	1,437	235	6,287	72
173	Blaze Tech LLC		1.5MW	None	Sharingol	*a	312	222	9,854	1,224
174	Blaze Tech LLC		1.5MW	Bag filter	Sharingol	*a	145	195	6,457	101
175	Blaze Tech LLC		1.5MW	None	Sharingol	*a	408	212	12,547	18,451
176	Blaze Tech LLC		1.5MW	Bag filter	Sharingol	*a	874	410	4,516	9,845
177	Ikher Sharangad LLC	CDZG	1.4MW	Wet Scrubber	Improved fuel (TTT)	*a	1,255	841	458	2,542
178	MBC ASIA PACIFIC LLC	DZL	4t/h	Wet Scrubber	Improved fuel (TTT)	*d	37	283	62	4,512
179	BIOCOMBINAT	SZL	1.4MW	Wet Scrubber	Improved fuel (TTT)	*a	1,540	478	1,120	1,760
180	VANHUU LLC	KCR	0.6MW	Multi Cyclone	Middling	*b	5,190	260	999	594
181	Khutul Energy Dulaan LLC	KBTC-20		Wet Scrubber	Shivee-Ovoo	*a	711	333	1,971	8,154
182	Bio Combinat	KE	6.5	Multi Cyclone	Baganuur	*a	904	935	4,321	1,486
183	INNOVA LLC	DZH	4t/h	Cyclone	Middling	*d	2,145	349	321	1,034
184	INNOVA LLC	DZH	4t/h	Cyclone	Middling	*d	3,124	372	552	4,514
185	JTSS LLC	DZH	2t/h	Wet Scrubber	Improved fuel (TTT)	*d	1,520	388	988	3,125
186	NEW SEVER LLC	YNT56	25t/h	Cyclone	Baganuur/ Middling	*e	1,490	733	291	1,791
187	JS DORNIIN KHUGJIL LLC	SZL	8t/h	Cyclone	Middling	*d	1,504	1,504	1,504	544
188	JHJ MANDUKHAI LLC	DZH	2t/h	Cyclone	Middling	*d	1,407	589	1,407	1,004
189	JAMBALD		0.07MW	None	Improved fuel (TTT)	*d	505	346	505	1,804
190	OPTIMALL LLC	DZH	4t/h	Cyclone	Improved fuel (TTT)	*d	981	314	981	987
191	NCD PRECON LLC	YJDZL	2.8MW	Cyclone	Middling	*a	714	423	714	2,136
192	PARK KHOSIT KHOLBOO		0.07MW	None	Baganuur	*c	712	345	4,854	712
193	Anu Service LLC KHIIMORI Boiler	Prometei	0.6MW	Wet Scrubber	Baganuur/ Middling	*b	766	175	4,518	332

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194	Anu Service LLC KHIIMORI Boiler	Carborobot	0.3MW	Cyclone	Baganuur/ Middling	*b	605	342	4,985	498
195	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	670	191	4,925	518
196	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	685	260	6,386	512
197	PARK KHOSIT KHOLBOO		0.07MW	Cyclone	Baganuur/ Middling	*c	610	311	3,254	512
198	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	605	342	4,985	498
199	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	670	191	4,988	518
200	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	450	381	4,781	414
201	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	781	342	4,924	517
202	Anu Service LLC KHIIMORI Boiler	Carborobot	0.3MW	Cyclone	Baganuur/ Middling	*b	645	392	4,723	502
203	Anu Service LLC KHIIMORI Boiler	Carborobot	0.3MW	Cyclone	Baganuur/ Middling	*b	703	352	4,127	534
204	Anu Service LLC KHIIMORI Boiler	Carborobot	0.6MW	Cyclone	Baganuur/ Middling	*b	685	427	4,002	592
205	Anu Service LLC KHIIMORI Boiler	Carborobot	0.3Mw	Cyclone	Baganuur/ Middling	*b	769	423	4,926	587
206	Anu Service LLC KHIIMORI Boiler	Carborobot	0.3MW	Cyclone	Baganuur/ Middling	*b	687	389	4,821	509
207	Dashvaanjil Gas LLC	DZC	2.8t/h	Multi Cyclone		*a	75	126	69	0
208	Dashvaanjil Gas LLC	DZC	2.8t/h	Multi Cyclone		*a	0	124	45	0
209	Ulaanbaatar Cons LLC	DZC	2.8t/h	Multi Cyclone	Sharingol	*a	439	267	8,765	125
210	Ulaanbaatar Cons LLC	Carborobot	0.3MW	Multi Cyclone	Improved fuel (TTT)	*b	1,377	544	565	1,837
211	Gas Kom LLC	YGL 2T	2t/h	Multi Cyclone	Baganuur/ Middling	*d		142	55	
212	Temuulen Od LLC	DZH	4t/h	Wet Scrubber	Improved fuel (TTT)	*d	1,254	542	944	5,421
213	Tumen Shuvuut LLC	KE-6.5	0.3MW	Multi Cyclone	Baganuur	*b	645	89	2,584	511
214	Tumen Shuvuut LLC	DZH	4t/h	Cyclone	Middling	*d	529	69	4,215	541
215	Tumen Shuvuut LLC	SZH	4t/h	Cyclone	Middling	*d	458	345	4,521	542
216	Tumen Shuvuut LLC	DZH	2t/h	Cyclone	Middling	*d	644	441	4,548	245
217	Davaadorj		0.6MW		Improved fuel (TTT)	*b	655	175	4,254	544
218	Elbeg Dulaan LLC	E-1.8	1.8MW	Cyclone	Middling	*a	1,029	223	1,080	866
219	Khatan Cashmere LLC	DZH	4t/h	None	Improved fuel (TTT)	*d	1,420	954	854	3,564
220	Bio Ergel Khaikhan	DZH	1.25t/h	Multi Cyclone	Improved fuel (TTT)	*d	505	121	800	4,000
221	Khos Shines	Topoli-M-60κBt	0.6MW		Improved fuel (TTT)	*b	700	209	4,100	450
222	Yarmag Block	DZH	4t/h	Multi Cyclone	Improved fuel (TTT)	*d	176	178	1,025	643
223	JS Dorniin Khugjil LLC	DZH	4t/h	Multi Cyclone	Improved fuel (TTT)	*d	581	211	551	3,193
224	Ikher Sharangad LLC	DZH	4t/h	Multi Cyclone	Improved fuel (TTT)	*d	1,445	423	847	3,541

No.	Measured site	Type of boiler	Capacity	Dust collection	Type of Coal	Item	SO ₂	NOx	CO	Dust
225	EM Plastic LLC	DZL	1.4MW	Cyclone	Improved fuel (TTT)	*a	1,145	191	4,425	785
226	New Sver LLC		2t/h	Multi Cyclone	Improved fuel (TTT)	*d	1,530	913	988	9,584
227	Top Shine LLC	DZH	2t/h	Multi Cyclone	Improved fuel (TTT)	*d	1,120	245	620	6,541
228	Mongol Eco Meat LLC	DZH	2t/h	Multi Cyclone	Middling	*d	1,766	294	598	1,121
229	Dun Fan International LLC	DZG	2t/h	Multi Cyclone	Middling	*d	644	111	12,017	355
230	Luvsandorj	Mongol Stove		Cyclone	Middling	*b	842	265	1,967	634
231	New Sver LLC		2MW	Multi Cyclone	Improved fuel (TTT)	*a	1,530	918	988	9,584
232	Amin Khuns LLC	Eurozigi	0.6MW	Cyclone	Improved fuel (TTT)	*b	553	75	877	816
233	Mongol New Resource Technology		2MW	Cyclone	Improved fuel (TTT)	*a	-	512	812	-
The number of boilers which meet emissions standard, separated by parameter							174	211	139	165
The ratio of boilers that achieved the emission standard, separated by parameter (%)							74.7	90.6	59.7	70.8

 : Exceeded emission standard

Item	Target	MNS Emission Standard (mg/m ³ N)			
		SO ₂	NOx	CO	Dust
*a	HOB : 0.8MW < Boiler Capacity ≤ 4.2MW (MNS 5043:2016)	600	400	4,000	400
*b	HOB: 0.1MW < Boiler Capacity ≤ 0.8MW (MNS 5043:2016)	800	450	5,000	600
*c	CFWH、Boiler Capacity ≤ 0.1MW (MNS 5043:2016)	1,000	500	9,700	225
*d	Steam Boiler : Steam Boiler Capacity ≤ 10t/h (MNS 5919:2008)	1,500	680	940	8,000
*e	Steam Boiler : Steam Boiler Capacity ≤ 25t/h (MNS 5919:2008)	1,560	680	865	7,300

At the request of TPP2, DAAEP performed flue gas measurement at 75t/h boiler on TPP2 in October 2020. In June, October, November 2022 and September 2023, DAAEP performed flue gas measurement for TPP2 through TPP4, and the measurement results met the emission standards. The flue gas measurement results are shown in Table 3-2-2.

Table 3-2-2 The Flue Gas Measurement Results at TPPs

(mg/m³N)

No.	Measured site	Capacity	Dust collection	Type of Coal	Item	SO ₂	NO _x	CO	Dust
1	TPP2 (October 2020)	75 t/h	Wet Scrubber	Baganuur	*f	443	448	1,120	1,200
2	TPP2 (June 2022)	75 t/h	Wet Scrubber	Middling	*f	455	218	40	139
3	TPP4 (June 2022)	420t/h	Wet Scrubber	Middling	*h	599	370	3	139
4	TPP2 (October 2022)	75 t/h	Wet Scrubber	Baganuur/Middling	*f	483	323	48	334
5	TPP3 (November 2022)	75 t/h	Wet Scrubber	Baganuur/Middling	*f	708	490	22	7,458
6	TPP4 (November 2022)	420 t/h	Wet Scrubber	Shivee-Ovoo	*h	1,117	369	2	139
7	TPP3 (September 2023)	220 t/h	Wet Scrubber	Baganuur	*g	454	414	37	1.847

 : Exceeded emission standard

Item	Target	MNS Emission Standard (mg/m ³ N)			
		SO ₂	NO _x	CO	Dust
*f	Thermal Power Plant • Thermal Boiler 51 t/h < Boiler Capacity ≤ 75 t/h (MNS 5919:2008)	1,932	1,270	3,547	21,000
*g	Thermal Power Plant • Thermal Boiler 75 t/h < Boiler Capacity ≤ 221 t/h (MNS 5919:2008)	1,485	1,100	300	10,800
*h	Thermal Power Plant • Thermal Boiler 221 t/h < Boiler Capacity ≤ 420 t/h (MNS 5919:2008)	1,200	715	180	200

With public recognition of the flue gas measurements of DAAEP, there have been requested from other provinces and cities than UB City to perform flue gas measurements for boilers, and DAAEP performed it in Serenge province, Dundgovi provinces and Erdene and Darkhan cities. In addition, 66 combustion tests of improved fuels and igniters were performed in 2023 at DAAEP's fuel combustion laboratory at the request of ME, NCEPR, TTT, and other companies.

DAAEP prepares an annual report on its activities, including the name of the facility and results of emission measurements. DAAEP has been reported in January 2019, January 2020, January 2021, January 2022, January 2023 and January 2024. The report is also available on the DAAEP website.

4) Activity 1-1-4: Flue Gas Measurement by IACC

Activity 1-1-4 was to introduce simplified measurement method by using IACC's portable gas measurement equipment including parallel measurement with JIS method, elaboration of manuals and manufacturer's calibration.

In 2019, JET diagnosed a portable flue gas measurement device to check for the usability. As a result, it was found that sensors for measurement needed to be replaced. Therefore, JET purchased the sensors for measurement and the lithium ion battery. NO_x, SO₂, O₂ and CO were able to be measured. In addition, JET made draft Standard Operational Procedure (SOP) of operation method of TESTO340 and educational materials as concentration conversion calculation used in boiler inspection.

In January 2020, IACC and JET discussed activities of an inspection using IACC's portable gas measurement equipment. As a result, IACC decided to conduct the inspection after 15th February 2020 because IACC is very busy with 24-hour monitoring operations at the east and west tollgates into UB City to prevent illegal raw coal entering UB City. The National Emergency Special Committee has decided to cancel all seminars and workshops on 13 February 2020 due to impacts of COVID-19 pandemic. Therefore, JET was planning to gather IACC and district inspectors to give guidance on how to use the device on 14 February 2020, this time JET granted flue gas measurement device and trained how to operate the device.

From November 2021, JET has resumed the travel of experts who are at low risk of serious disease from COVID-19 pandemic. The sensor for measurement devices, TESTO340 owned by IACC were necessary to be replaced due to deterioration. JET procured manufacturer calibrated sensors for TESTO 340 device in November 2022 and replaced the sensors in November 2022. Then, manufacturer's calibration of the device was completed. JET began activities of transferring technology of IACC's portable gas measurement equipment from October 2022. Then, JET and IACC accompanied DAAEP on the flue gas measurement, and JET began On-the-Job-Training on parallel measurement using Horiba gas analyzer owned by DAAEP and TESTO340 owned by IACC. Based on this training, JET and IACC developed a simplified measurement manual including parallel measurements with the JIS method, and the manual was completed.

According to Mayoral Order A/1649 "Partial Measures Related to the Abolition of Inspection Agency of the Capital City" dated 30 December 2022, IACC was abolished and inspection division was added to DAAEP. Therefore, air quality measurement and operations division of DAAEP performed the flue gas measurement and inspection division elaborated inspection report.

Since inspection division and air quality measurement and operation division of DAAEP were performing measurement only by the JIS method without performing simplified measurement for screening, the Mongolian side offered JET to terminate Activity 1-1-4 as it has been conducted so far, and it was decided that Activity 1-1-4 was terminated.

3-2-2 Activity 1-2: Enhancement of Emission Gas Control by TPP3 and TPP4 by Utilizing CEMS
Order of Minister of Natural Environment and Tourism, Mongolia No. A/222 (4 July 2018) was issued according to Article 12.5 of Law of Mongolia on Air, "The regulations on preparing air quality information shall be enacted by the central state administrative organization". The order defines monitoring responsibility of air pollutant emitting companies and organizations (Article 1.2), measurement and data submission to NAMEM twice or more in each month (Article 2.7), administration organizations' right to access and control any data directly sent to agaar.mn (Article 2.9), and data sharing service responsibility by NAMEM (Article 5.1).

Table 3-2-3 shows key specifications of TPP3 and TPP4, the targets of Activities 1-2. As they are the most important power plants in electricity supply in Mongolia, and in heat supply to UB City, they

are also the main air pollutant sources that use 16.5% and 45.8% of the total coal use in Mongolia in 2022, respectively. However, as shown in the results of Activities 2-2, the main source of air quality in UB city is air pollutant sources inside the Ger districts, and the contribution of TPP3 and TPP4 is relatively smaller. Therefore, in recent years, TPP3 and TPP4 have been modified to increase the supply capacity of heat and electricity by which air pollutant emission from the Ger districts was planned to be reduced, and air quality of UB City was expected to be improved.

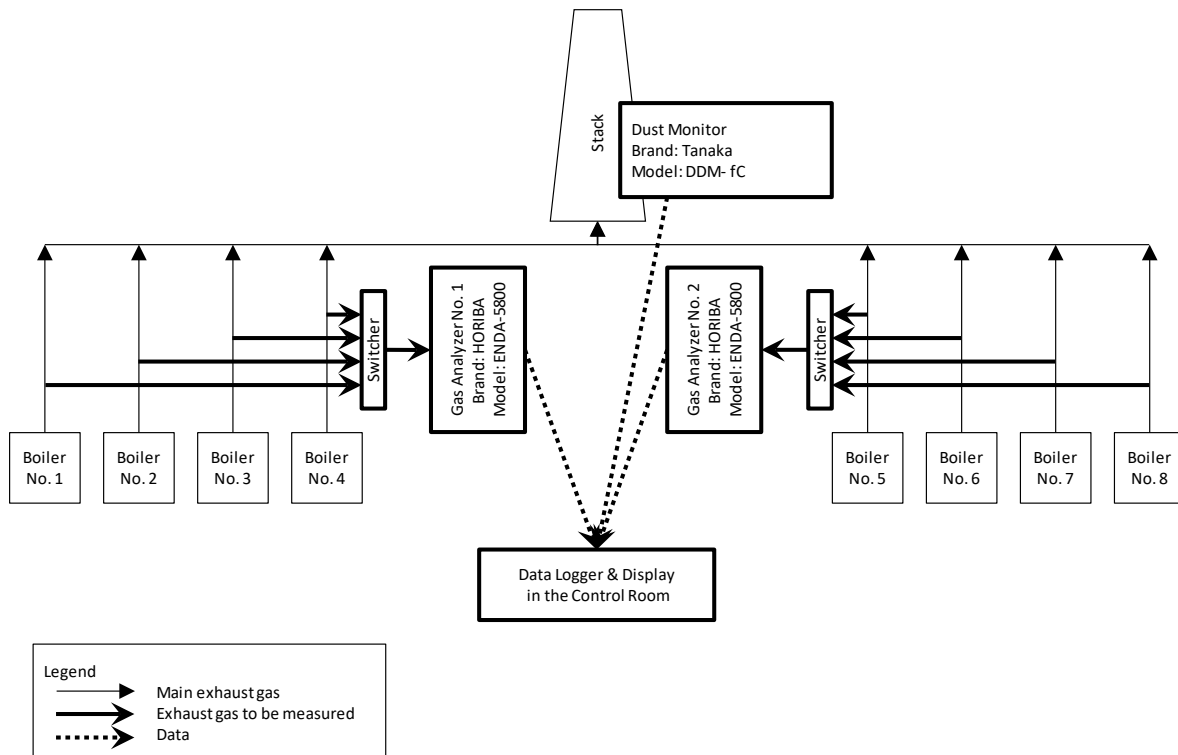
Table 3-2-3 Key Specifications of TPP3 and TPP4

Specifications	TPP3	TPP4
Annual Power Generation (of 2022)	1,085.8 million kWh (14.6%)	4,637.6 million kWh (62.4%)
Maximum Power Generation Record	171 MW (11.6%)	681 MW (46.4%)
Annual Heat Supply (of 2022)	2,642.1 thousand Gcal (22.1%)	4,551.4 thousand Gcal (38.2%)
Fuel Consumption Capacity	6 boilers of 75 ton/hour 7 boilers of 220 ton/hour Total 1,990 ton/hour	8 boilers of 420 ton/hour Total 3,360 ton/hour
Fuel	Coal of Baganuur Coal Mine	Coal of Baganuur Coal Mine
Equipment for cleaning exhaust gas	Bag filter (90-92% dust reduction)	Electrostatic Precipitator (99.98% dust reduction)
Start of Operation	1968	1983

Note: Percent values of power generation and heat supply are the shares in Mongolia total.

Source: NAMEM, and Statistics on energy performance 2022, Energy Regulatory Commission, Mongolia,
<https://erc.gov.mn/web/en/news/878>

In the Period of the Project Phase 2, JICA provided a set of CEMS to TPP4. JICA and TPP4 installed the CEMS to TPP4. TPP4 started exhaust monitoring by the CEMS. TPP4 developed a system to store and display CEMS data, and then installed it to the central control room of TPP4. TPP3 independently procured a set of CEMS and started exhaust monitoring by the CEMS (Figure 3-2-1 and Photo 3-2-1). The Project Phase 2 discussed and developed a system for transferring CEMS data to agaar.mn and sharing it among related ministries and agencies (Figure 3-2-2). However, since the password for the TPP3's CEMS database could not be found, data transfer system from TPP3 could not be developed, and CEMS data of TPP3 could not be transferred to agaar.mn.



Notes: CEMS and related equipment provided by JICA are indicated by bold frames. The gas and data flow paths newly created for the CEMS are indicated by bold lines.

Figure 3-2-1 Schematic Figure Related to the CEMS of TPP4

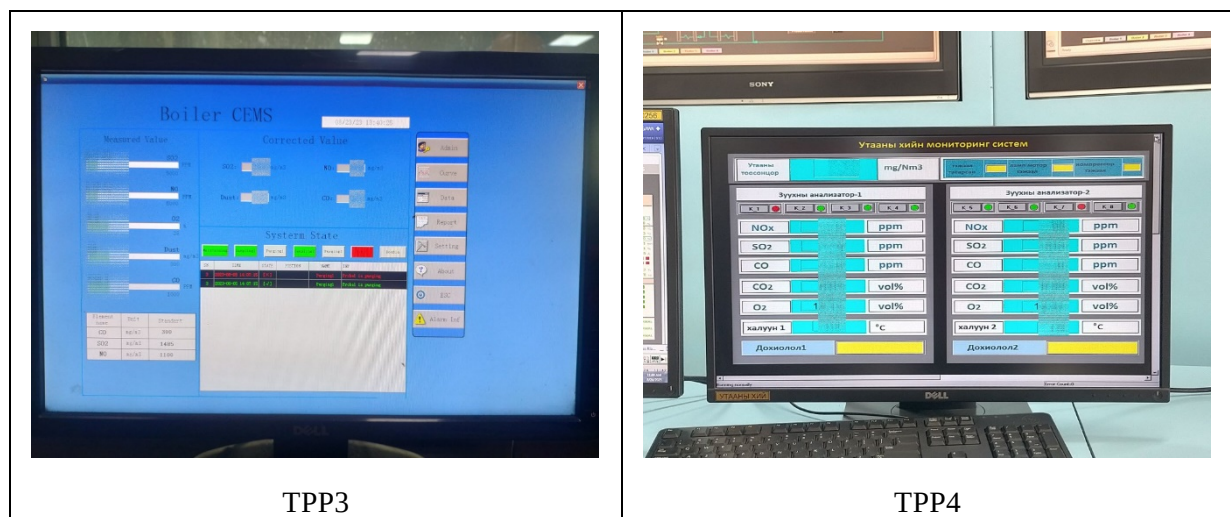
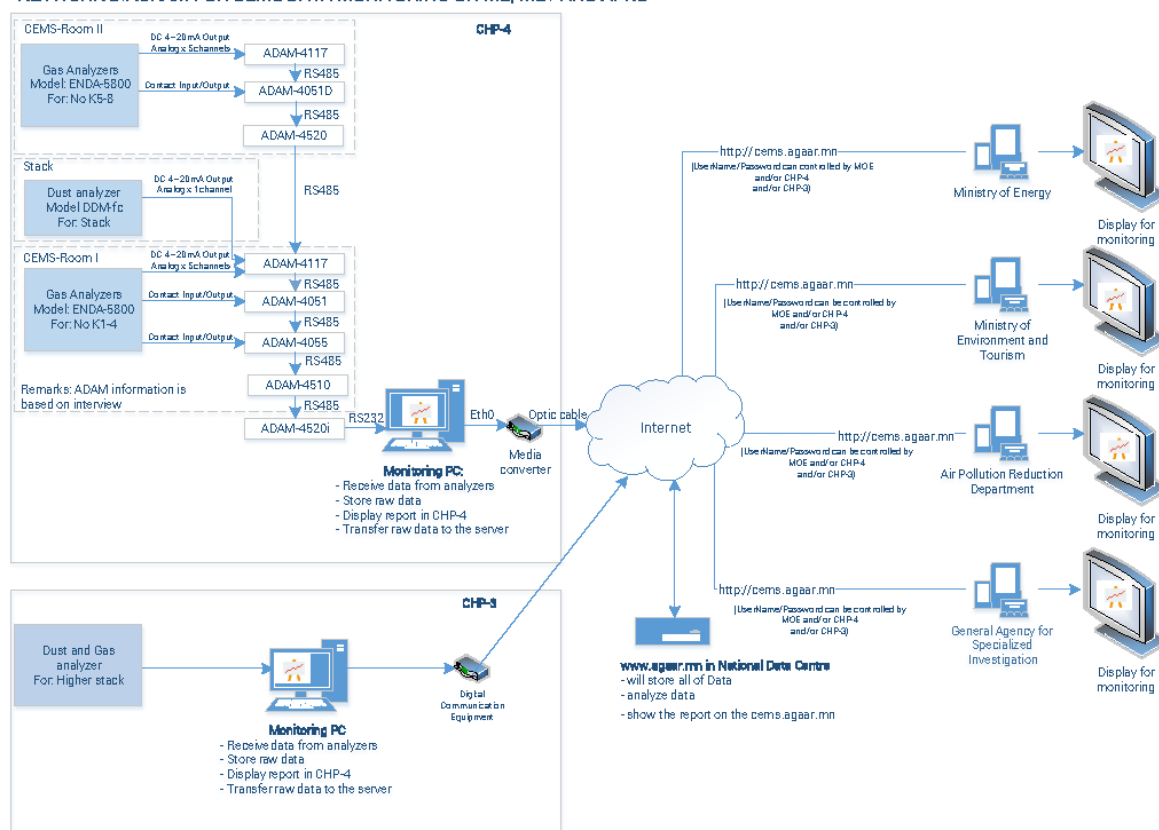


Photo 3-2-1 Screen Examples of CEMS Data Display Used in TPP3 & TPP4

NETWORK DIAGRAM FOR CEMS DATA MONITORING ON ME, MET AND APRD



Note: Data transmission from TPP3 was started in this Project Phase 3, while all the other functions have been operated from the period of the Project Phase 2.

Figure 3-2-2 CEMS Data Sharing System

For this Project Phase 3, following activities were agreed and implemented to strengthen emission control using CEMS:

- Follow up on the maintenance and management of CEMS by TPP3 and TPP4 (Activity 1-2-1~2)
- To display and continue TPP3 CEMS data in the data sharing system (Activity 1-2-3)
- To compile and share monitoring data of emissions from power plants (Activity 1-2-4~5), not only TPP3 and TPP4, but also TPP2 and Amgalan Heat Station.

TPP3 and TPP4 have been allocating managers and engineers necessary for CEMS, and educating necessary skills for any new persons for CEMS, and procuring necessary consumables. NAMEM and IACC checked the CEMS data for TPP4 periodically. Therefore, data transfer and sharing system from TPP3 CEMS was developed first in 2019 as Activity 1-2-3, and other activities were scheduled to start in the spring of 2020, when some amount of CEMS data of 2019 winter would have been ready to use. However, because of international flight cancels caused by the COVID-19 pandemic,

activities from the spring of 2020 were necessary to be postponed. Activities in UB was started from 2023.

Although some issues were found in TPP3 and TPP4 in budget allocation to solve some damages and to renew equipment, and in finding any trading company that ensures procuring traceable standard gases and passing them through the Mongolian custom, it is sure that TPP3 and TPP4 would be able to continue CEMS operation and maintenance.

MET has been allocating one position for air pollution control, which was often vacant, and previous person sometimes could not guide the new person well. IACC was dissolved. NAMEM considers that regulations regarding air pollutants emission from combined heat and power plants are necessary to be revised by MET (i.e. clarifying the "specialized institutions" and the responsibilities of related institutions regarding the transmission and sharing of CEMS data, etc. by amending Order No. A/222 (4 July 2018) of Minister of Nature and Environment and Tourism of Mongolia). However, the responsible person of MET is too busy to understand the issues well. If Mongolia Government considers that the air pollution by power plants are serious and emergent, it is important to increase the positions to enable amendment of the regulations related.

3-2-2-1 Operation and Maintenance of CEMS including QC of CEMS Data by TPP3 and TPP4

1-2-1 TPP3 and TPP4 with JICA Experts elaborate and implement CEMS operation and maintenance plan.

1-2-2 TPP3 and TPP4 with JICA Experts perform quality control of emission gas data of CEMS.

Activities 1-2-1 to 1-2-2 are follow-up activities on operation and maintenance of CEMS that were stated in the Project Phase 2 by TPP3 and TPP4. Table 3-2-4 shows the status at the beginning of this Project, and the activities summary throughout this Project.

Table 3-2-4 Activities Summary on CEMS Operation and Maintenance (1-2-1~1-2-2)

Act.	At the Beginning of this Project	Summary throughout this Project
1-2-1	TPP3 procured and installed the CEMS on its own budget and management. It developed and implemented an operation and maintenance plan based on the information provided by the supplier. TPP4 developed and implemented an operation and maintenance plan for the CEMS based on the information provided in and after the Project Phase 2 by JET and the suppliers.	TPP3 and TPP4 update and implement CEMS operation and maintenance plan. JET confirmed that regular inspections and periodic part replacements were generally carried out in a timely manner. TPP3's CEMS was installed in 2016. Its problem has been increased recently. Therefore, TPP3 considers that it is necessary to be renewed, and looking forward renewal budget possibility by Mongolia Government or any donor. In 2023, one of the LED displays of TPP4's CEMS system was broken. TPP4 checked it, and requested some technical support through the distributor, and JET supported the communication between TPP4 and the supplier. It is to show the status and to control of one of the switching devices for gas inlets, and was found that it is not problem in measurement and switching device itself. Since the display is relatively expensive because the switching devices were custom made portion of the CEMS system, it could not be procured by the initial budget for 2024. Although exhaust gas monitoring by CEMS is continued without the broken display, TPP4 plans to try to obtain the necessary budget to solve the display issue.
1-2-2	TPP3 and TPP4 have been calibrated the CEMS with calibration gases, etc. appropriately.	TPP3 and TPP4 continued calibration using calibration gases, etc. Standard gases for calibration are necessary to be renewed regularly. However, TPP4 could not find any way to procure suitable calibration gases because the procedure of Mongolia custom for hazardous materials became strict. NAMEM investigated the contact information of companies in Mongolia that could procure reliable standard gases, and shared the information with TPP4. To review CEMS data, NAMEM requested DAAEP to measure stack gas of TPP3 and TPP4 using isokinetic suction. The air pollutant concentration data of the stack gas of TPP3 and TPP4 were measured by DAAEP, and the compared with CEMS data.

Based on the information provided by the suppliers of CEMSs installed in 2016, TPP3 and TPP4 had prepared operation and maintenance plans of CEMS, and have been procuring and replacing consumables, calibrating, etc. JET reviewed the operation and maintenance of CEMS by TPP3 and TPP4. Some issues were found in requesting technical support from the distributors/suppliers, procurement of traceable calibration gases, and enhancement/renewal of CEMS. Technical issues were generally solved. Comparison of CEMS data and DAAEP's measurement is shown in Annex 3-2-1.

Remaining issues are listed below. Each of them requires additional budget and time for procurement process. Although the persons in charge started necessary coordination with the relevant organizations, it is taking time.

- 1) Renewing calibration gases (gases with international traceability guarantee is recommended)
- 2) Procurement and replacement of the LED display of one of the two gas analyzers of TPP4 (not included in the initial 2024 budget because the damage was inspected in the last quarter of 2023)
- 3) According to "Responsibility of private companies and organizations that emit air pollutants to monitor their own activities (paragraph 1.2)" of "Order of Minister of Natural Environment and Tourism, No. A/222 (4 July 2018)", private companies and organizations that emit air pollutants will be required to conclude if their exhaust gas comply the emission standards.
- 4) It was not possible to compare the measurements data of CEMS and DAAEP precisely because the measurement locations of DAAEP and CEMS were different. Measurement holes are necessary next to CEMS sampling points. In addition, the CEMS data could not be selected exactly because the start and end time of DAAEP's measurement were lost. It is necessary for DAAEP to record and keep the measurement conditions including sampling location information, and start/end time of sampling.
- 5) Operation and maintenance costs of <http://cems.agaar.mn/> system is necessary to be defined by any regulations of Mongolia government. Cost payment has been difficult to be authorized by any organization, by which CEMS data transfers from TPP3 and TPP4 to this CEMS data sharing system were suspended. In April 2024, data transfer from TPP4 is recovered, and that from TPP3 is still suspended.

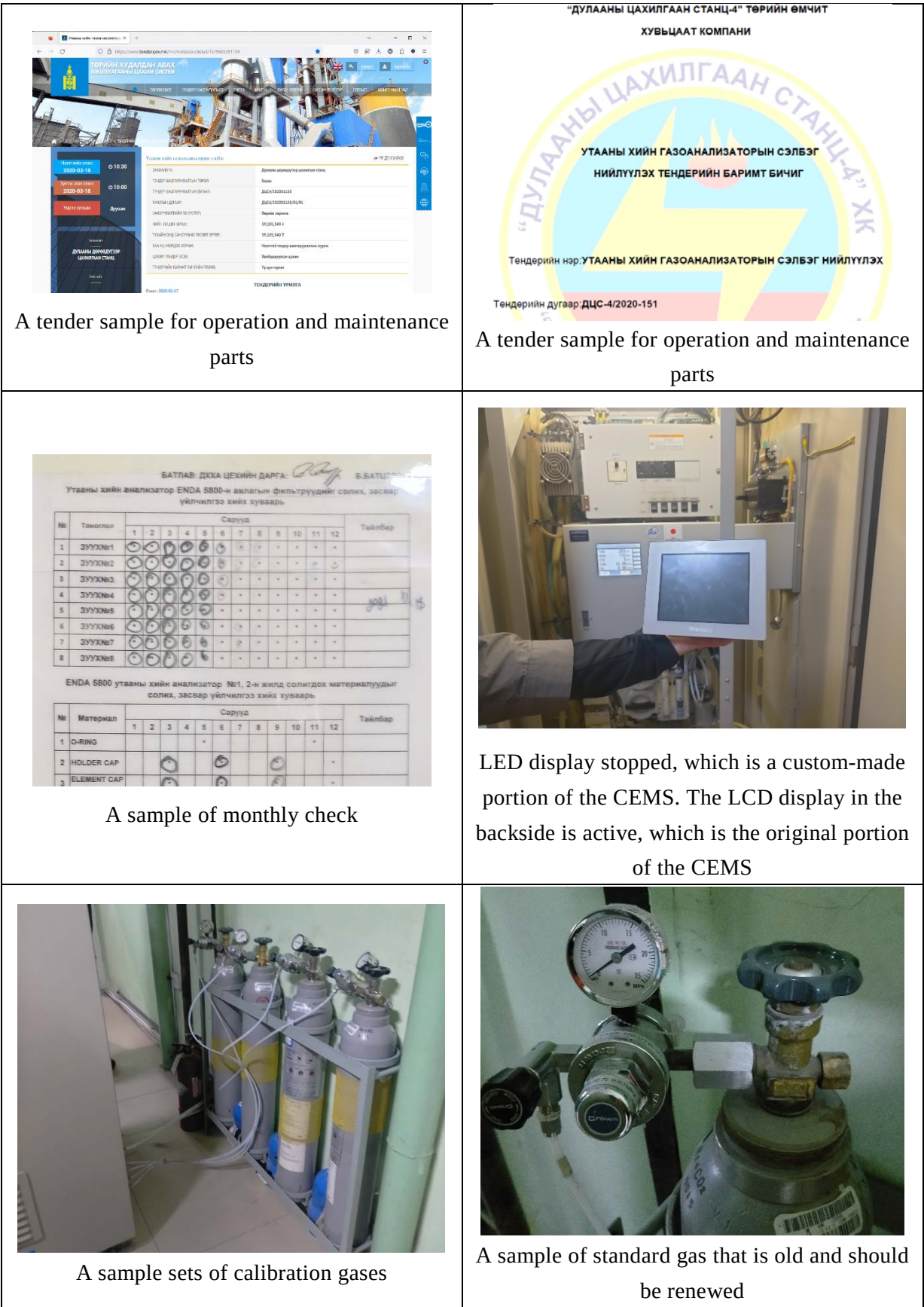


Figure 3-2-3 Operation and Maintenance of CEMS

3-2-2-2 Elaboration of Online Emission Data Reporting System for the CEMS.

- 1-2-3 TPP3 with MET and the relevant agencies elaborates online emission data reporting system for the CEMS.
- 1-2-4 NAMEM and the relevant agencies share and evaluate CEMS emission data.

Activities 1-2-3 to 1-2-4 are to develop a system to send CEMS data from TPP3, and to share and evaluate the CEMS emission data by government agencies. Table 3-2-5 shows the status at the beginning of this Project, and the activities summary throughout this Project.

Table 3-2-5 Activities Summary on CEMS Data Sharing (1-2-3~1-2-4)

Act.	At the Beginning of this Project	Summary throughout this Project
1-2-3	In the Project Phase 2, a system was developed for related governmental agencies to check TPP4 CEMS data http://cems.agaar.mn/ . TPP4 CEMS data was transferred continuously. CEMS data transfer from TPP3 was remained as an issue.	Based on the discussions between TPP3 and JET in 2019, JET supported to develop additional components to transfer and display TPP3's CEMS data, with the cooperation of AstVision LLC that developed and maintained the system http://cems.agaar.mn/ .
1-2-4	Exhaust gas information measured by CEMS was continuously shared with ME, MET, DAAEP and the Inspection Agency at http://cems.agaar.mn/ .	Shared continuously, although some of the old computer systems are considered as security risk and should be renewed.

In 2017 as an activity of the Project Phase 2, a system to transfer and share CEMS data of TPP3 and TPP4 was discussed, and then developed. However, the system developer that developed CEMS data management system of TPP3 forgot the password to access the CEMS database, so the system to transfer the data from TPP3 could not be developed. During this Project Phase 3, a method to access TPP3's CEMS database was found, so as Activity 1-2-3, additional component was developed to transfer and display TPP3's CEMS data on <http://cems.agaar.mn/>.

CEMS emission data has been shared continuously with the relevant agencies by MET through providing user name and password for <http://cems.agaar.mn/>.

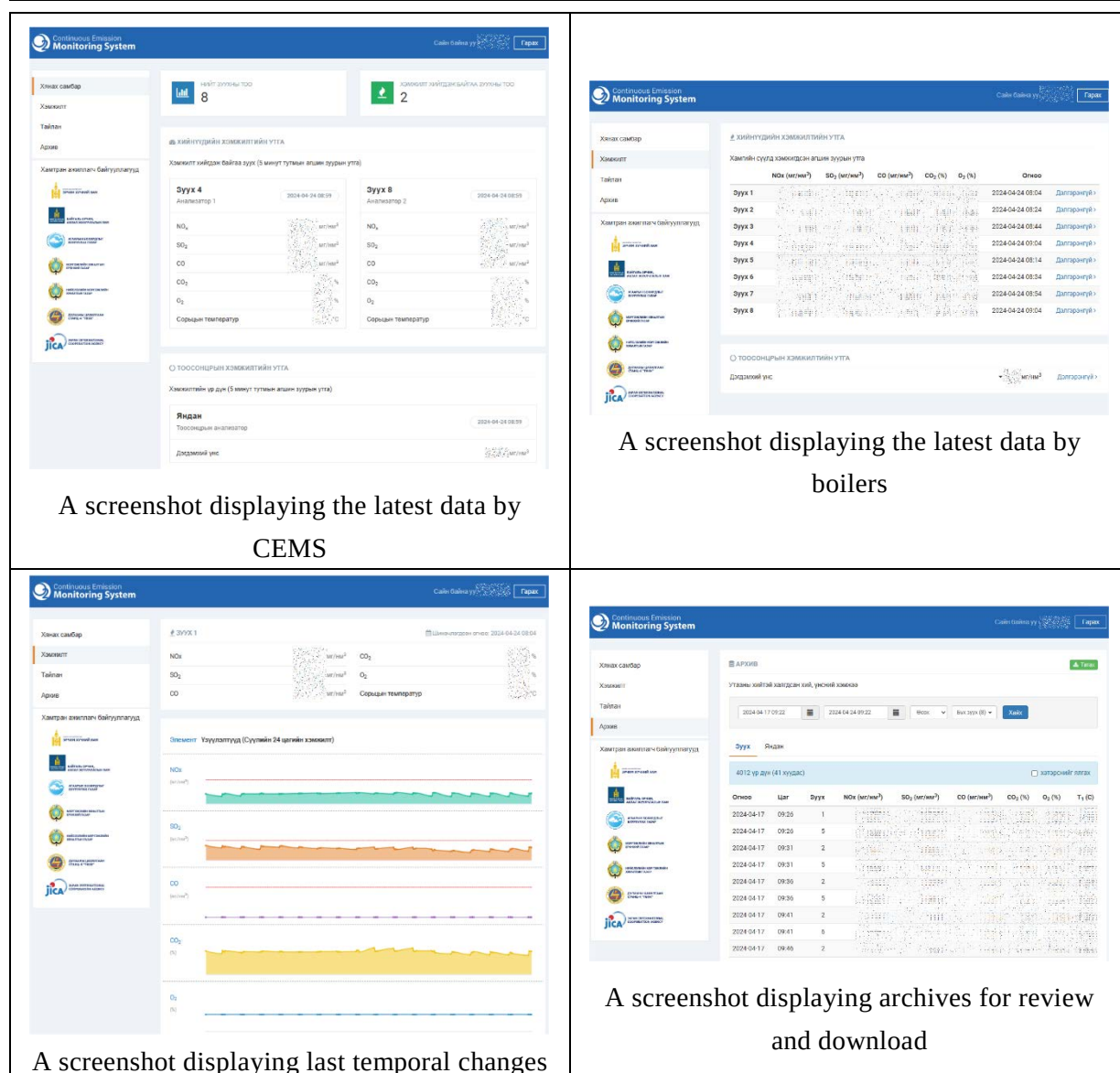


Figure 3-2-4 Sample Screenshots of <http://cems.agaar.mn/>

In August 2023, NAMEM allocated new person for CEMS of the power plants. Last issues were identified as follows through the discussion with her, and were tried to be solved with relevant organizations.

1. Any relevant organization is difficult to allocate budget for maintaining online emission data reporting system for the CEMS. It is because any Mongolian governmental official document does not specify clearly the responsibility of the data transfer system from TPP3 and TPP4 to <http://cems.agaar.mn/>, and the system <http://cems.agaar.mn/> itself. It would be preferable to revise the Mongolian MET Minister's Order No. A/222 (4 July 2018), etc.
2. There is no organization that can make recommendations based on the evaluation results after IACC was abolished in December 2020. It would be preferable to be discussed to identify which

organization should inspect and announce, for example by revising Mongolian MET Ministerial Order No. A/222 (4 July 2018).

3-2-2-3 Compilation and Sharing of CEMS Data and Emission Monitoring Data from TPPs by NAMEM

1-2-5 NAMEM compiles monitoring data of emissions from TPP2, TPP3, TPP4 and new large heat supply facilities and share them with relevant agencies.

Activity 1-2-5 is an activity by NAMEM to compile and share the results of stack gas monitoring. Table 3-2-6 shows the status at the beginning of this Project, and the activities summary throughout this Project.

Table 3-2-6 Activities Summary on Compilation and Sharing of Stack Gas Monitoring Results on Power Plants and New Large Heat Supply Facilities (1-2-5)

Act.	At the Beginning of this Project	Summary throughout this Project
1-2-5	Stack gas monitoring results were delivered to NAMEM. However, they were not compared with emission standards.	Stack gas monitoring results were compared with emission standards after identifying and solving related issues.

Stack gas monitoring results were compiled as Annex 3-2-2. Its overview is shown in the table below.

Table 3-2-7 Overview of Stack Gas Monitoring Results on Power Plants and New Large Heat Supply Facilities Compared with Emission Standards

Pollutant	TPP2	TPP3	TPP4	Amgalan Heat Station
NO _x	OK	OK continuously	OK generally	Over
SO ₂	OK	OK continuously	Over sometimes	Over
CO	OK	OK generally	OK generally	OK
Dust	OK	OK continuously for the stack for 220 ton/hour boilers, and necessary to be measured for the stack for 75 ton/hour boilers	OK generally	OK

Major conclusions are as follows;

1. It took time to check whether the exhaust gas concentration data were oxygen concentration converted results. It was because most of the related experts did not know about oxygen

concentration conversion, including its purpose and method. All the experts directly related to this Project understood it. It is necessary to be educated widely, not only the concurrent experts but also potential experts who would be graduate from universities.

2. Emission standard for boilers (MNS 5919:2008) was defined for classes defined by furnace types and boiler capacities. After capacities or furnace types of some boilers were enhanced or modified, there is no emission standards for some of the boilers. Emission standards for similar capacity boilers or furnace type boilers were applied in this Project, as conventionally implemented in Mongolia. Pollutant concentration from the power plants that were constructed before 2011 and covered by MNS 5919:2008 generally comply with the emission standards, which is due to the very high values of emission standards for certain furnace types and capacity boilers. Compared to the emission standards applied to new power plants (MNS 6298:2011), the emission standards applied to old power plants, MNS 5919:2008, are easy to comply. Some boilers in multiple emission standard classes are connected into one stack, and their pollutants emission are measured by CEMS at stack. In this case, single value of CEMS data cannot be compared with multiple emission standards for multiple boilers. In order to solve these issues, the emission standard MNS 5919:2008 is recommended to be revised. Note: Emission standards of other countries were set to achieve air quality standard for each country, depending on the condition of each country. It is preferable that the emission standards of Mongolia should be defined according to the condition of air quality, and air pollutant emission sources in UB City and Mongolia, considering the density of the power plants.
3. SO₂ concentration in the stack gas of Amgalan Heat Supply Station significantly exceeds the emission standard. Emission standard can be achieved by switching fuel to low-sulfur coal and/or installing desulfurization equipment. However, currently, Amgalan Heat Supply Station must use coals allocated by the Government. There is not enough budget by Amgalan Heat Supply Station alone to install desulfurization equipment because the heat tariff is decided by the Government. There is almost no space to start countermeasures without governmental decision. Some commitment for example by the relevant minister is considered necessary.

3-2-3 Activity 1-3: Introduction of Regulations Related to Automobiles based on Emission Measurement

3-2-3-1 Emission gas measurement of automobile by RSD

1-3-1 MRTD and PTD with JICA Experts implement automobile emission measurements by RSD, assess distribution of automobiles emission intensity and define target automobiles to be regulated.

Automobile exhaust gas measurements by RSD were conducted for 22 days from 29 May to 30 June 2023 at three locations: West Toll Gate, South Toll Gate, and Yarmag Bridge. Based on valid data from 28,431 automobiles, the number of automobiles by substance concentration rank was organized, and used measurement data from 423 opacimeters to set RSD emission standards and narrow down the automobiles subject to regulation. Details are described in 3-6-4-7.

3-2-3-2 Automobile fuel survey

1-3-2 MRPA and IACC with JICA Experts implement automobile fuel surveys.

For automobile fuel research, JICA provided a fluorescent X-ray sulfur analyzer to MRPA in November 2021. MRPA and IACC with JET analyzed components of fuel samples bought at petrol stations from December 2021.

Fuel analysis results (Table 3-2-8) was presented at the 7th JCC. There was one sample that contained 2,000 ppm or more sulfur, and another sample that contained 1,000 ppm or more sulfur. As fuel with extremely high sulfur content was confirmed, it was proposed to MMHI to import and sell low-sulfur fuel. In response to this proposal, Air Law was amended by inserting a new article regarding use of Euro 5 fuel and elimination of price differences, and import and sales volume of Euro 5 fuel has been increasing.

Table 3-2-8 Fuel Analysis Results (June 2022)

Gas Station	Type of Fuel	Grade	Sulfur(ppm)
A	Gasoline	92	381
		95	51
	Diesel	Diesel	1601
		Diesel Euro 5	29
B	Gasoline	92	365
		95	63
		98	44
	Diesel	Diesel Euro 5	31
C	Gasoline	92	336
		95	97
	Diesel	Diesel	428
D	Gasoline	92	375
		95	9
	Diesel	Diesel	901
E	Gasoline	92	128
		92 Euro 5	2
		95	49
	Diesel	Diesel	2373

3-2-3-3 Emission gas measurement of automobile by on-board emission measurement system

1-3-3 In addition to DAAEP, JICA experts will educate NRTC on exhaust gas measurement using an in-automobile meter, and DAAEP and NRTC will measure exhaust gas using an in-automobile meter.

In the Project Phase 2, JICA provided on-board emission measurement system to NAMEM and DAAEP, and JET trained their experts to measure real driving emission using the system provided.

In 2019, during the implementation of this Project, the on-board emission measurement system of NAMEM was transferred to NRTC. Additionally, DAAEP allocated a new person for data analysis technology for exhaust gas measurements using an on-board emission measurement system without capacity development by the previous person. Capacity level on measurement and data analysis using the on-board emission measurement system was not maintained well. Therefore, MRTD requested support from JET at the 3rd JCC, and Activity 1-3-3 was added at the 4th JCC.

From November 2021, 2 DAAEP experts and 4 NRTC experts were trained 3 times to evaluate eco-driving pilot project, and 2 times to confirm the effect of fuel additives and supplied the staffs with technical on measurement know-how.

In the eco-driving survey, as shown in 3-6-4-5, the on-board emission measurement system was used to confirm the effects of eco-driving.

In 2022, National Environmental Pollution Reduction Commission Secretariat was planning to introduce a fuel additive liquid to reduce air pollutants from automobiles by combustion improvement. This Project tested effect of the additive in August 2022 using an on-board emission measurement system for passenger cars and light-duty trucks by travelling in about 70 to 90 km on Peace Avenue, loop road, and airport-oriented streets in UB city with and without additives. It should be noted that for the break-in period with the additive, over 500 km was driven according to the instructions of the additive manufacturer. Comparisons were made by NO_x emission and fuel consumption for passenger car, and NO_x emission, PM emission, and fuel consumption for light-duty truck. No significant reduction in air pollutants emission or fuel consumption was observed with fuel additives for both passenger car and light-duty truck. The results were compiled into a report on the effectiveness of additives in reducing air pollutants and submitted to Secretariat of NCEPR. NCEPR initially planned to promote to use this additive as a measure against air pollution, however, based on the results of this study, it was decided not to promote this additive.

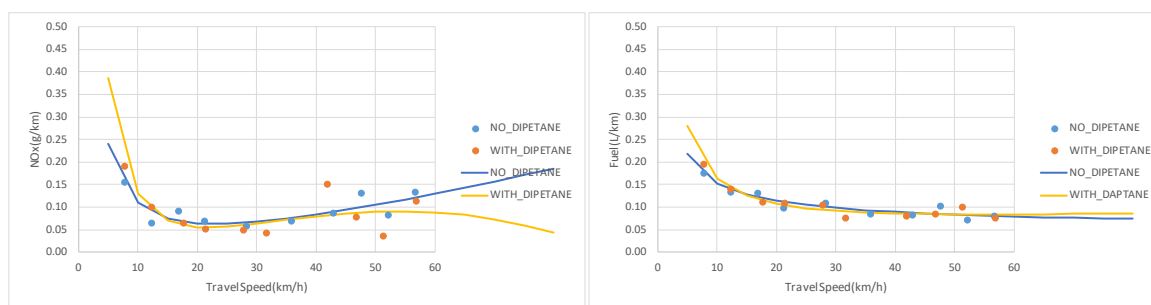


Figure 3-2-5 Measurement Results with and without Additives (Passenger Car)

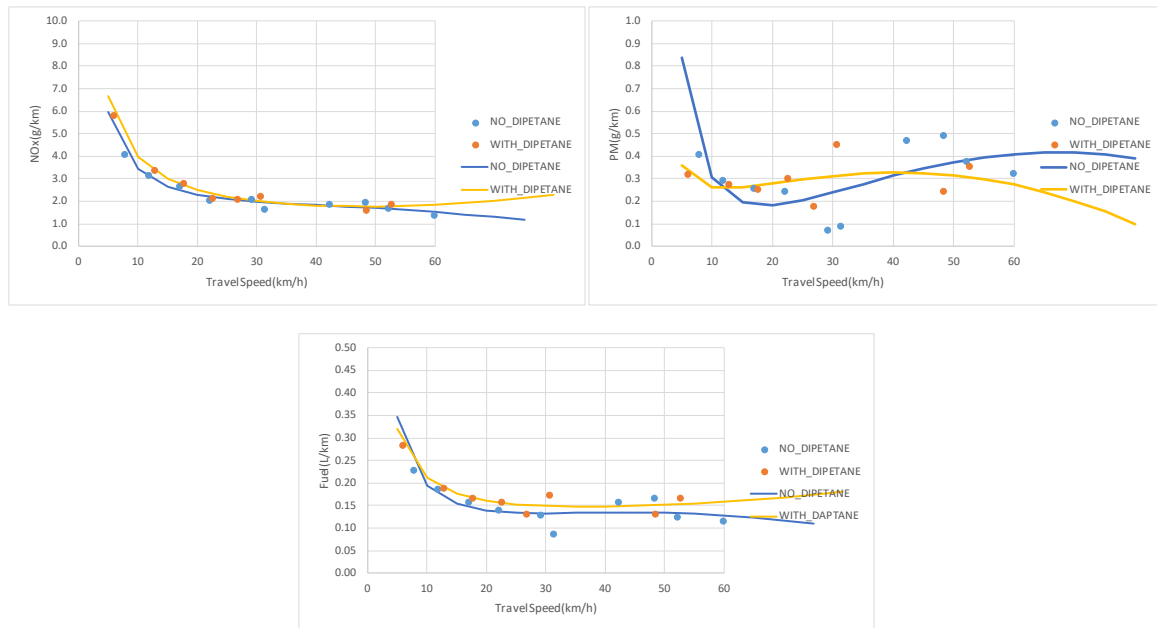


Figure 3-2-6 Measurement Results with and without Additives (Light-Duty Truck)

3-2-3-4 Transfer of DPF

1-3-4 Public Transportation Service Department of the Capital City (hereinafter referred to as “PTD”) with JICA Expert transfer the DPF which were installed on 24 large buses by the project “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of PM from Diesel Buses by DPF” to other buses.

In 2018, DPFs were installed on 24 large buses of Mongolia by another JICA project, “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of PM from Diesel Buses by DPF”, and the DPF devices were handed over to the related city organization. Since use of the original 24 buses were planned to be stopped in December 2021, PTD planned to transfer the DPFs to other buses. This Activity was added in the 6th JCC, as a result of request from PTD Bureau for technical support from the Japanese side regarding the relocation of the DPF.

At first, possibility of DPF relocation was considered inside 3 municipal bus companies of this Project in 2018. However, there is no suitable buses remained because buses of National Municipal Bus Companies No. 1 to No. 3 were renewed with electric buses and Euro V buses. For private bus company, 8 buses exceeded 12 years of use, which is the limit year of driving public buses in UB city. For this reason, the relocation of DPF was considered for the bus, however, none of bus were appropriate.

Therefore, PTD, the owner of the DPFs, and JET discussed other buses for DPF installation, and then started negotiation with private bus companies. As one company accepted to install the DPF to two buses, DPFs were installed to the buses of the company, and DPF recovery device was installed in the workshop of the bus company. Details are described in 3-6-4-6.

3-2-4 Activity 1-4: Strengthening of AQMS Utilization

3-2-4-1 Reference Laboratory of CLEM

1-4-1 CLEM and JICA Experts assess the current status of equipment in reference laboratory of CLEM and identify necessary actions if necessary.

JET checked the operational status of the quality control equipment in the reference laboratory at CLEM. The checked results are as follows;

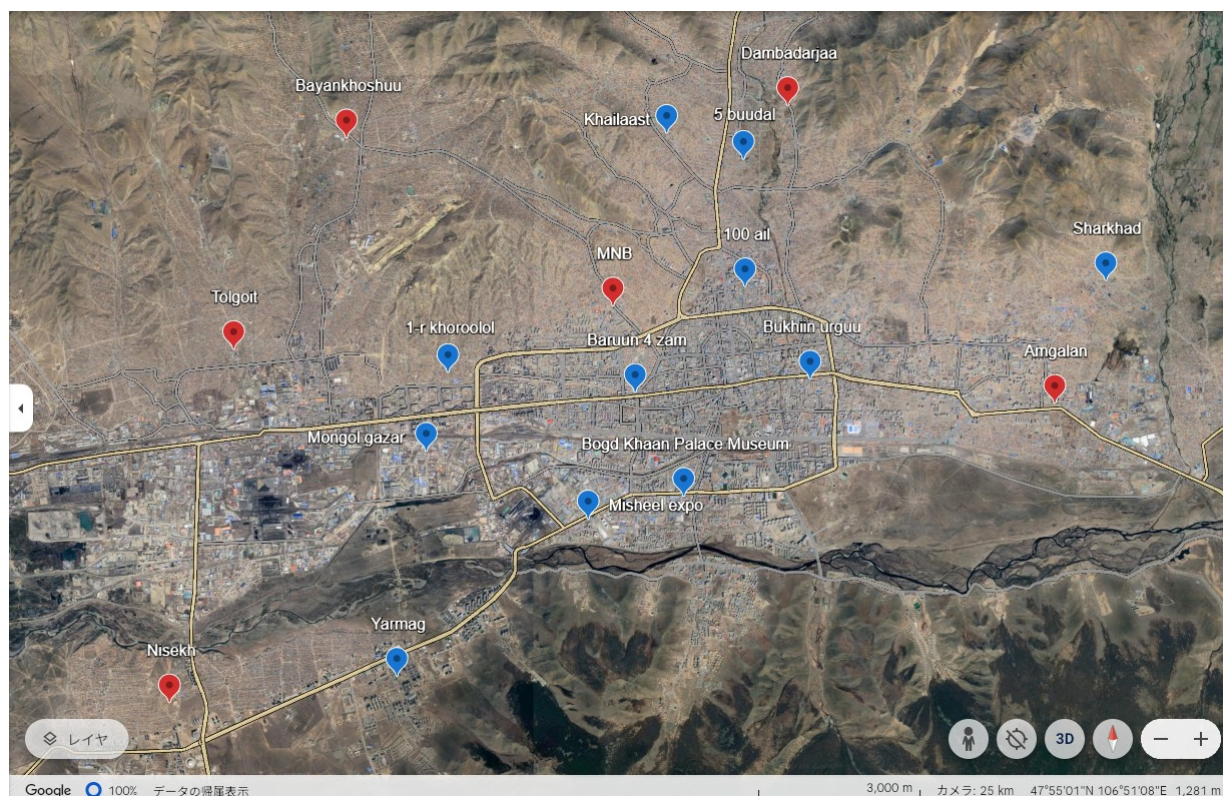
- The reference laboratory equipment was not used frequently because it is used only for equipment calibration and equipment operation check. In the future, the equipment will continue to be used for equipment accuracy check and equipment calibration.
- The equipment was operating normally without any problems.

More than one and a half years have passed since the end of the Project Phase 2, it was confirmed that CLEM was able to maintain the equipment self-sufficiently.

3-2-4-2 Operation and Maintenance of DAAEP's AQMS

1-4-2 DAAEP reinforces AQMS operation and maintenance based on the plan by the Project Phase 2
1-4-4 DAAEP with JICA Experts reinforces the AQMS at Bayankhoshuu station.

Figure 3-2-7 shows AQMS managed by DAAEP and NAMEM/CLEM. 6 red symbols are of DAAEP, the target AQMSs of Activities 1-4-2 and 1-4-4.



Note: Red symbols are DAAEP's AQMS. Blue symbols are NAMEM/CLEM's AQMS. Google Earth is used as base map.

Figure 3-2-7 Distribution of AQMS Manages by DAAEP and NAMEM/CLEM (as of April 2024)

1) Activity 1-4-2: Management of AQMS

According to the DAAEP's internal rules and operational structure, the maximum number of staff members, and the number of staff in charge are limited to one person in each category by Governor. When past person in charge of AQMS reinstated in April 2022, DAAEP decided to have the reinstated person take charge of AQMS and current person in charge changed his job to support the AQMS and develop inventory simulation. Therefore, JET requested DAAEP to assign person in charge until April 2022 to be in charge of AQMS because he is the most suitable and promising candidate in the progress made in training the person in charge. As a result, person in charge until April 2022 continued to be in charge of AQMS.

It is important that DAAEP becomes able to operate and maintain the system after this Project is completed without JET. Therefore, JET encouraged DAAEP to cooperate with CLEM and to obtain support from manufacturers and distributors. DAAEP studied more contact addresses regarding suppliers and distributors, and became more frequently to contact them directly. DAAEP's capability has been enhanced as DAAEP can solve issues without JET's support.

In the Project Phase 2, JET summarized remained issues of AQMSs, and then discussed it with DAAEP as a portion of maintenance plan. Data loggers, CO analyzers, and zero gas generators of the older four AQMS stations (Tolgoit, Amgalan, MNB, and Nisekh) provided by GIZ in 2009 had not

been overhauled or renewed by 2017. They have some problems such as corrosion of electronic boards. JET recommended overhauls or renewal. In response to this recommendation, in the Summary Seminar of the Project Phase 2 held on 25 April 2017, DAAEP reported that the data loggers (Horiba I/O Expander), CO analyzers (Horiba APMA-360), and zero gas generators (Horiba ZNV-7) of the four old stations are necessary to be renewed, and that there is an issue in making technical inquiries by DAAEP exerts to foreign suppliers by foreign languages.

Tender for renewing data logger was announced as WPLT-03 on 27 February 2018, with the financial resources of WB's Project "UBCAP". DAAEP requested any model compatible with the data logger in use, and it was clearly written in the tender documents. However, the tender management office selected an application with a model "eSAM" of ENVEA brand, which was not compatible in sending data to <http://agaar.mn/> or data usage workflow of DAAEP. Although DAAEP pointed out that the model does not meet with the tender specification, it was contracted on 18 April 2018. Although they were delivered in the summer 2018, and the supplier engineer tried to establish a data connection to <http://agaar.mn/>, the new data loggers were left without use, and old data loggers were continued to be used. Two years after the delivery, in August 2020, some additional equipment was supplied, and additional service "CloudMQTT" was contracted by DAAEP, by which two years old data loggers finally configured to send data to <http://agaar.mn/> etc., and started to be used.

DAAEP obtained budget for 4 sets of CO analyzers and zero gas generators renewal. After Ulaanbaatar Governor Order A/1302 was signed on 12 December 2019, UB City Office started procurement procedures. They were installed and in operation from August 2020.

DAAEP requested and received some other budget in 2021, and then sent some analyzers to the country of the origin for repairment as shown in the table below.

Table 3-2-9 AQMS Analyzers Repaired in 2021

No	Brand	Model	Category	Location	Count	Country of Repairment
1	Horiba	APSA-370	SO ₂ Analyzer	Tolgoit	1	Japan
2		APDA-371	PM Analyzer	Bayankhoshuu	1	Germany
3	GRIMM Aerosol Technik	EDM-180	PM Analyzer	Tolgoit & Amgalan	2	Germany

Source: DAAEP's Activity Report of the First Half of 2021

In 2023, the DAAEP expert requested support from JET as NO_x Analyzer of Tolgoit AQMS cannot be calibrated. He had already consulted with CLEM C/P. The CLEM C/P confirmed that there were no problems with the standard gas and dilution equipment, and then estimated that there was a problem in the NO_x detector inside the NO_x analyzer. In February 2023, after JET's coordination, an online diagnosis session was done by experts of the manufacture Horiba. It was found that small dust was accumulated in the detector, by which the detector could not measure NO_x correctly. In addition,

it was found that some parts had been replaced to wrong position which was done by somebody out of the manufacture's control. The NO_x analyzer became calibratable. However, the detector had deteriorated seriously, and other parts may have been installed incorrectly. Therefore, it was strongly recommended to be overhauled (or renewed).

DAAEP and JET reviewed all the records available, and estimated that the dust was accumulated between 27 January 2018 and 27 November 2020. There were no enough records to specify the date and reasons further in details. According to the available records of other analyzers, most of the other SO₂ analyzers and NO_x analyzers of DAAEP are estimated to have similar problems. A serious problem, measurement without dust filter, was pointed out in the report of the Project Phase 2, which may be started again.

Regarding operation and maintenance of AQMS in and after this Project Phase 3, JET recommended followings to DAAEP;

- 1) It is recommended to overhaul or renew all the SO₂ and NO_x analyzers of DAAEP's AQMS except Dambadarjaa AQMS. DAAEP has understood this importance and started to follow this recommendation. However, since 2024 budget is not enough, some can be done in 2024, and some will be left for the consequent years.
- 2) It is recommended to take following actions in order to prevent recurrence.
 - (1) DAAEP experts always check if the dust filter is installed at the correct position.
 - (2) DAAEP renew the dust filter regularly. The manufacturer recommends renewing it every two weeks. However, in UB, PM concentrations are very high especially in winter, so it is recommended to replace it more frequently, such as once a week.
 - (3) DAAEP will consult with external experts such as of CLEM, distributor or supplier whenever some slight change is found in the calibration coefficients. In order to realize it, calibration, or sensitivity check of the analyzers, with reliable zero gas, standard gases and calibrators should be done at least once a month for all the analyzers. The AQMS maintenance plan created in the Project Phase 2 confirmed weekly patrols and monthly calibration/check. However, as of February 2022, DAAEP experts were educated to check/calibrate once every three months in advance by DAAEP, by which frequency it will be too late to repair the analyzers once an issue is recognized.
 - (4) DAAEP should procure the dust filters etc. in order to have sufficient stocks enough for delays or unsuccessful bids in the next procurement.
 - (5) DAAEP needs to have standard gases with traceability guarantee, maintenance of the zero-gas generators (including regular part replacement), enough work hours for the experts to check and maintenance, and get supports from the CLEM C/P.
 - (6) An inappropriate operation and maintenance action may be selected whenever a single expert tries his best without any external support. It is important to simply consult with any other experts, such as CLEM's C/Ps, distributors and/or supplier experts. It is

important to improve technical communication by foreign language through emails and messenger applications.

Seoul Municipality provided and set-up the analyzers of Dambadarjaa AQMS in 2016, and then gave necessary trainings on DAAEP's experts until 2018. Therefore, this AQMS was not included in the AQMS operation and maintenance plan developed in 2016, and was not considered as the target of Activity 1-4-2 in this Project started in 2017. In 2021, DAAEP believed that all the analyzers of Dambadarjaa AQMS are well operated and maintained, and then requested JICA to establish data transfer system of air quality monitoring data from Dambadarjaa AQMS to the online information system of AQMS, which was agreed as new activity "Activity 1-4-10". However, through the Activity 1-4-10, PM analyzers of Dambadarjaa always raise errors in high concentration hours, and <http://agaar.mn/> shows no data from Dambadarjaa AQMS. Once, mass medias suspected that U. S. Embassy Mongolia hid high air pollution episodes intentionally since U. S. Embassy PM_{2.5} analyzer shows no data whenever high air pollution episodes were expected. In order to prevent mass medias to suspect DAAEP and UB City, JET provided advice and capacity development on the operation and maintenance of Dambadarjaa AQMS, as follows;

- 1) The analyzers of PM₁₀ and PM_{2.5} of Dambadarjaa AQMS always raised measurement error in the winter months whenever high pollution episode was estimated. JET consulted an expert of the analyzer manufacture. According to his requests, DAAEP provided internal data of the PM analyzers via JET. Air sampling flow speed of the PM analyzers should be kept as specified speed in order to separate PM₁₀ or PM_{2.5} from TSP correctly. Whenever the air pollution is extra-ordinary higher, PM samples on the filter tape disturbed the air sampling flow, PM analyzers could not maintain the necessary speed for separating PM₁₀/PM_{2.5} from TSP, and then PM analyzers raised errors. The expert of the supplier proposed two suggestions. 1st suggestion was to order and try filter tapes of "low pressure-loss" model instead of "normal" model, which will not increase operation costs because their prices are same. 2nd suggestion was to buy stronger air suction pump and replace it with existing one.

DAAEP tested low pressure-loss filter tapes by 2022 budget, by which errors were decreased but remained. DAAEP tested stronger air suction pump by 2023 budget, by which flow error has not yet raised, and continuous monitoring was realized.

The expert of the manufacturer estimated that the error was raised continuously every winter from 2016 until 2022. He did not have any chance to give any advice beforehand because there was no monitoring error report or support request.

DAAEP understood that support by higher level experts of analyzers' supplier is important.

- 2) The NO_x analyzer of Dambadarjaa AQMS can be turned ON even though no maintenance has been done for years. It is suggested to test the analyzers after procurement and replacement of all the consumable parts, analyzer health check, and calibration, or renew the analyzer.

- 3) The SO₂ analyzer cannot be turned ON because of electrical parts damage, and no maintenance work for years. It is recommended to be renewed, but there is a possibility to be reactivated by procurement and replacement of major parts, analyzer health check and calibration.
- 4) The CO analyzer is too old model to get support by the supplier. It is recommended to be renewed.
- 5) For any analyzer renewal, it is strongly recommended to procure any analyzer model which is compatible with the data transfer system developed through Activity 1-4-10. Otherwise, it is necessary for DAAEP to procure or develop a new data transfer system that is compatible with existing PM₁₀ and PM_{2.5} analyzers, new analyzers and <http://agaar.mn/>.



Photo 3-2-2 Operation and Maintenance of AQMS by DAAEP

In 2023, DAAEP has performed an average of 60 times maintenance and repairs at AQMS. Bayankhoshuu AQMS was maintained 59 times, Tolgoit AQMS was maintained 60 times, Nisekh AQMS was maintained 58 times, Amgalan AQMS was maintained 61 times, MNB AQMS was maintained 63 times, and Dambadarjaa AQMS was maintained 57 times. Specially, in order to ensure the normality of the measuring equipment at the AQMS, person in charge of DAAEP changed the filters on each piece of equipment, cleaned the tubing, and restarted the equipment if the measurements had stopped.

The effective hourly data in 2018 to 2023 at five AQMS of DAAEP are shown in Table 3-2-10 to Table 3-2-15. The average hours of effective data rate on six years are 84.3%.

Table 3-2-10 Hours of Effective Data in 2018 at AQMS of DAAEP

Parameter	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	8,372	98%	8,383	98%	6,339	74%	8,413	99%		
CO	5,933	69%	4,776	57%	7,497	88%	5,790	68%		
SO ₂	2,590	30%	8,413	99%	4,978	58%	8,195	96%		
PM ₁₀	1,862	21%	6,776	79%	2,970	34%	8,115	95%	8,199	96%
PM _{2.5}	8,127	95%	8,416	99%	7,444	87%	8,416	99%	8,011	94%
Average	83.4%									

Source: DAAEP's Annual Activity Report of 2018

Table 3-2-11 Hours of Effective Data in 2019 at AQMS of DAAEP

Parameter	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	8,208	100%	7,939	96%	8,188	99%	5829	71%		
CO			3,810	24%						
SO ₂	7,804	95%	7,234	88%	8,099	98%	7,379	89%	7,709	93%
PM ₁₀	8,208	100%	7,939	96%	8,187	99%	7,475	91%	8,097	98%
PM _{2.5}	8,208	100%	7,939	96%	8,187	99%	7,475	91%	8,097	98%
Average	91.7%									

Source: DAAEP's Annual Activity Report of 2019

Note: CO analyzer at MNB, Tolgoit and Amgalan AQMS was provided by German grant aid in 2009, and it is time to replace the equipment. Therefore, it was suspended in 2019, 2020 budget was approved, and CO analyzers were replaced in August 2020.

Table 3-2-12 Hours of Effective Data in 2020 at AQMS of DAAEP

Parameter	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	7,968	100%	7,732	97%	7,950	100%	7,922	99%		
CO	3,984	50%	3,984	50%	3,984	50%	3,984	50%		
SO ₂	7,224	91%	7,794	98%	6,445	81%	7,858	99%	7,945	100%
PM ₁₀	7,968	100%	7,794	98%	7,950	100%	7,968	100%	3,996	50%
PM _{2.5}	7,968	100%	7,784	98%	7,950	100%	7,968	100%	7,968	100%
O ₃	7,968	100%	7,732	97%	7,950	100%	7,922	99%		
Average	86.1%									

Source: DAAEP's Annual Activity Report of 2020

Note: CO analyzer at MNB, Tolgoit and Amgalan AQMS was provided by German grant aid in 2009, and it is time to replace the equipment. Therefore, it was suspended in 2019, 2020 budget was approved, and CO analyzers were replaced in August 2020. SO₂ analyzer at Tolgoit, MNB, and Amgalan AQMS and PM₁₀ and PM_{2.5} analyzers at Bayankhoshuu had been out of service for a long time, the equipment has been repaired and those parameters measurements have restarted.

Table 3-2-13 Hours of Effective Data in 2021 at AQMS of DAAEP

Parameter	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	7,718	96.0%	5,917	73.6%	5,821	72.4%	7,715	96.0%		
CO	7,300	90.8%	5,818	72.4%	7,458	92.8%	7,470	92.9%		
SO ₂	7,717	96.0%	6,288	78.2%			7,716	96.0%	2,165	26.9%
PM ₁₀	7,721	96.0%	5,626	70.0%	7,518	93.5%	4,531	56.4%	6,716	83.5%
PM _{2.5}	7,722	96.0%	5,654	70.3%	7,521	93.5%	4,531	56.4%		
O ₃	6,046	78.3%	6,286	78.2%	5,616	69.9%	5,769	71.8%		
Average	76.7%									

Source: DAAEP's Annual Activity Report of 2021

Note: So SO₂ analyzer at Tolgoit was being repaired that hours of effective data was 0%. SO₂ analyzer Bayankhoshuu had been out of service for a long time, the equipment has been repaired and this parameter measurement has restarted. PM₁₀ and PM_{2.5} analyzers at Bayankhoshuu had been out of service for a long time and was being repaired.

Table 3-2-14 Hours of Effective Data in 2022 at AQMS of DAAEP

	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
Parameter	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	6,954	87.7%	6,633	82.7%	4,467	55.7%	6,680	83.3%		
CO	6,828	85.0%	6,386	80.0%	3,532	44.0%	6,915	86.2%		
SO ₂	6,954	87.7%	5,390	67.2%	3,055	38.0%	7,055	88.0%	5,385	67.1%
PM ₁₀	6,835	85.0%	6,853	85.4%	6,664	83.1%	7,510	94.0%	7,510	94.0%
PM _{2.5}	6,835	85.0%	6,853	85.4%	6,664	83.1%	7,510	94.0%	7,510	94.0%
O ₃	6,810	85.0%	6,606	82.4%	6,417	80.0%	7,527	94.0%		
Average	81.0%									

Source: DAAEP's Annual Activity Report of 2022

Table 3-2-15 Hours of Effective Data in 2023 at AQMS of DAAEP

	MNB		Nisekh		Tolgoit		Amgalan		Bayankhoshuu	
Parameter	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data	Hours of effective data	Ratio of effective hourly data
NO _x	7,230	90.2%	7,535	94.0%	6,298	78.6%	7,673	95.7%		
CO	7,555	94.2%	7,438	92.8%	7,279	90.8%	7,616	95.0%		
SO ₂	7,032	87.7%	5,227	65.2%	7,542	94.1%	5,284	65.9%	4,524	56.4%
PM ₁₀	7,556	94.3%	7,471	93.2%	7,544	94.1%	7,664	95.6%	7,311	91.2%
PM _{2.5}	7,556	94.4%	7,471	93.2%	7,544	94.1%	7,664	95.6%	6,428	80.2%
O ₃	7,030	87.7%	7,313	91.2%	7,333	91.5%	7,466	93.1%		
Average	87.0%									

Source: DAAEP's Annual Activity Report of 2023

Note: Lack of measurements at AQMS is due to equipment life, power outages, power overloads, planned power outages, etc.

DAAEP has significantly increased budget compared to the Project Phase 2, DAAEP has purchased the consumables and standard gases based on air quality monitoring station maintenance manual prepared by the Project Phase 2. DAAEP has secured a budget for the transportation and repair of the equipment and the following equipment is being repaired at manufacturing companies in Japan and Germany. The maintenance and management of air quality measurement stations is being strengthened through the autonomous efforts of the Mongolian side.

The capabilities required of C/P is based on strengthening resources with a view to after the project is completed (in addition to project products, reading equipment instruction manuals and expanding relationships with manufacturers and distributors), and early detection of abnormalities.

Furthermore, a challenge for DAAEP is to secure a budget to deal with defects caused by improper management and operation of the previous person in charge, and to manage the schedule backward

from the time is needed, and to regularly order consumables and replacement parts, as well as to communicate and contract with foreign companies.

2) Activity 1-4-4: Reinforcement of Bayankhoshuu AQMS

Bayankhoshuu AQMS had a short circuit in the power distribution panel due to some external factor in late December 2019. This caused the power distribution panel, cooler, UPS, and SO₂ and PM analyzers failed. DAAEP repaired the power distribution board and ordered a cooler, and on 6th February 2020, C/P and JET checked current situation as the distributor was going to repair the equipment at the Bayankhoshuu AQMS. The distributor diagnosed the equipment. Then, DAAEP replaced a board and resumed measurement of the SO₂ analyzer; of the two PM analyzers, the PM_{2.5} analyzer resumed measurement after replacing fuses, etc. The PM₁₀ analyzer needed repair and was repaired in the 2020 DAAEP budget.

The data logger in Bayankhoshuu AQMS, which was originally installed in 2016 with PM₁₀, PM_{2.5} and SO₂ analyzers only, was configured by JET to handle potential analyzers for CO, NO_x, and O₃, assuming that DAAEP will install old but maintained analyzers that were used in any other AQMS of DAAEP, or new analyzers compatible with them. It is designed to use the current data validation worksheets, and the data publication system <http://agaar.mn/>, without updating the workflows.

In 2022, SO₂ data from Bayankhoshuu AQMS was not shown on <http://agaar.mn/> whenever PM concentrations was very high. The data logger was configured to "mark as error data whenever SO₂ analyzer output exceeds 210 ppb" because DAAEP's maintenance capacity were not well enough in 2016. Extraordinary high concentration error data was often informed to public. It was stopped by data logger configuration in 2016. As DAAEP's maintenance and management capacity has been improved and SO₂ analyzer is properly calibrated, concentration data over 210 ppb became reliable. JET explained the history here, and proposed DAAEP in January 2023 to change the settings of the data logger. On 30 January 2023, JET trained DAAEP's counterparts by demonstrating, and then, gave a chance to practice how to configure the data logger for valid value range. As a result, even when the instantaneous measurement value exceeded 210 ppb, it was all treated as a valid value, and shown on <http://agaar.mn/>

Detector output voltage of SO₂ analyzer does not recovered well even when UV lamp is renewed. After an investigation, it was found that the optical path was damaged by disassembling or deformation without required skill. The manufacture recommended to renew the measurement unit or overhaul the analyzer, and for the meanwhile before it, higher frequency of lamp renewal. DAAEP compared costs of measurement unit renewal, analyzer overhaul and analyzer renewal.

Repair and maintenance parts for AQMS manufactured by HORIBA, which were publicly announced in May 2023 and contracted in June 2023 under budget of DAAEP, were delivered to DAAEP in early August. For the SO₂ analyzer at Bayankhoshuu AQMS, the distributor engineer replaced the photodiode on 14 August 2023, and DAAEP personnel performed the calibration. Although this was an alternative to the overhaul that should have been performed, the span calibration coefficient was

within the manufacturer's allowable range (0.5 to 2.0). Possibly, due to this, negative values were no longer output after 15 August 2023.

Table 3-2-16 Main Parameters of SO₂ Analyzer before and after Replacement of Photodiode at Bayankhoshuu

	SO ₂ Value (mV)	Luminous intensity voltage of lamp (mV)	Zero point	Span coefficient
Before replace	9.8	144.5	-1347	0.50010
After replace	14.0	330.5	-805	0.61831

3-2-4-3 Air Quality Monitoring by mobile AQMS

1-4-3 DAAEP with JICA Experts starts air quality monitoring at pilot project area for improved household fuels by utilizing mobile AQMS.

In order to conduct air quality monitoring during the validation study of improved fuel, on 30th August 2022, DAAEP personnel under the cooperation of CLEM expert checked the equipment condition and maintained the equipment of mobile AQMS. Also SO₂, NO_x, and CO analyzers were calibrated using standard gases of CLEM. On the other hand, for PM, a GRIM EDM-180 had been used in the past, but it broke down, so a Dust Track made by TSI was used for the past few years.

JET suggested to DAAEP that they use PM analyzer, GRIM model EDM-180, as before, since Dust Track is a simple measuring device. On 22 September 2022, DAAEP personnel and JET searched for PM measurement equipment and installed a set of GRIM model EDM-180, which had been stored as a spare in the Amgalan AQMS, on the mobile AQMS. This made it possible to measure PM.

As per the final report of the Project Phase 2, the data logger in mobile AQMS was out of order. DAAEP in charge written down the displayed values of the measuring analyzers in a notebook. In the office, the data was manually entered into Excel to calculate averages, create graphs, and perform other processes. Therefore, mistakes occurred in the data recording process during long measurements, and in reading handwritten text and inputting data into the Excel. The use of data recording software developed by JET not only reduced the burden on counterpart institutions, but also eliminated errors caused by manual work.

Mobile air quality monitoring automobile owned by DAAEP was set in a Ger campsite which has begun pilot area from September to October 2022 and November 2022 to January 2023, and Air quality monitoring of PM_{2.5}, CO and SO₂ were measured.



Photo 3-2-3 Air Quality Monitoring at Ger Campsite by Mobile AQMS

3-2-4-4 Online Information System of AQMS

1-4-6 DAAEP and NAMEM with JICA Experts maintain the online information system of AQMS.
1-4-7 DAAEP and NAMEM share real-time monitoring data with the relevant agencies through the online information system.
1-4-10 DAAEP with JICA Experts establishes the data transfer system of air quality monitoring data of Dambadarjaa station to the online information system of AQMS.

Figure 3-2-8 shows an overall view of the online information system of AQMS in UB City. Blocks with red, blue, and white background colors mean managed by DAAEP, NAMEM/CLEM and any other organizations respectively. Frames lines and arrows of black, blue, red, and green mean active during the whole this Project Period, active at the start of this Project time but suspended during this Project Period, started during this Project Period and continued as active until the end of this Project, and started and suspended during this Project Period.

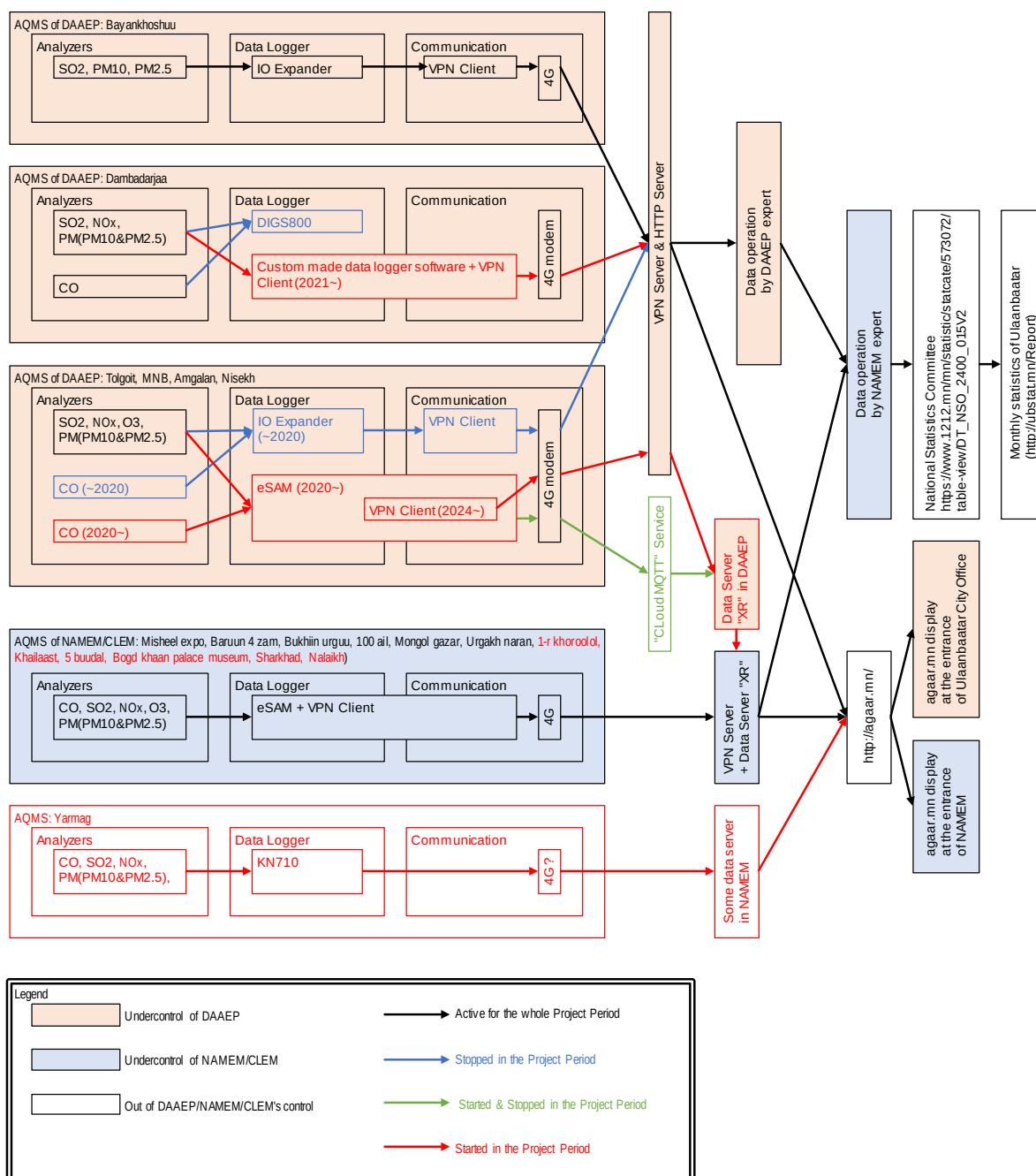


Figure 3-2-8 Overall View of the Online Information System of AQMS

Online Information System of AQMS has been continued and maintained by DAAEP, NAMEM, and CLEM as Activity 1-4-6. Real-time sharing of monitoring data with the relevant agencies was continued as Activity 1-4-7 by the operation and maintenance of <http://agaar.mn/>, and its display units at the entrances of NAMEM and UB City Hall. Samples are shown in Photo 3-2-4. Whenever DAAEP, NAMEM and/or CLEM faced any issue that cannot be solved alone, they solved it with some supports by the equipment supplier, the developer of <http://agaar.mn/> system, and/or JET. As Activity 1-4-10,

DAAEP establishes the data transfer system of air quality monitoring data of Dambadarjaa AQMS to the online information system of AQMS with some support by JET.

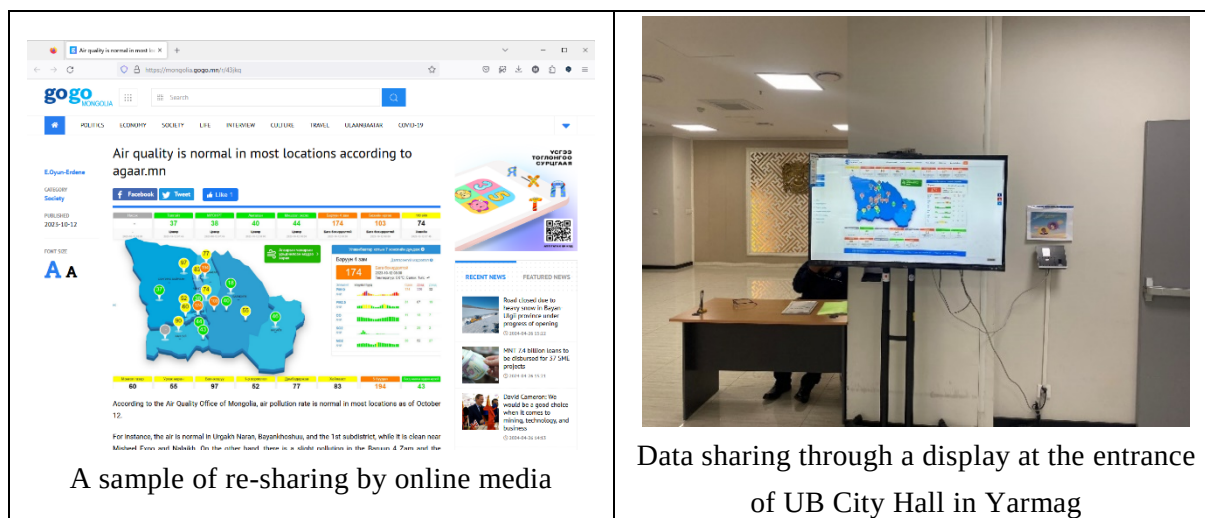


Photo 3-2-4 Samples of Sharing Real-Time Monitoring Data with Relevant Agencies

- 1) NAMEM/CLEM is capable to maintain the online information system of AQMS. Key episodes are described below.
 - (1) Tenders notifications (e.g., БОАЖЯ/201902040) for adding new AQMSs or renewing analyzers by CLEM/NAMEM always includes some specification parameters to connect to the existing online information system of AQMS, and then contracted as specified. Installation and configuration always could be done by CLEM's experts alone, or under some supports by the suppliers.
 - (2) Because of the installation and configuration experiences, CLEM's experts are ready to reinstall the system or to update the configurations. Whenever any portion of the online information system of CLEM/NAMEM AQMS is malfunctioned, it could be recovered by CLEM's experts. For example, a CLEM's expert recovered the online information system of CLEM/NAMEM AQMS by finding an old PC, installing necessary optional hardware, installing Windows and necessary software, and then reconfiguring the software.
 - (3) Data transfer from Urgakh Naran AQMS was often failed originally by 2014. In the Project Phase 2, JET made it continuous by installing an alternative modem of new technology, and configuring the data logger and server. CLEM's expert studied it and became ready to recover it. When "Ulusnet" WiMAX service stopped in 2017, the CLEM's expert could change the data line service from "Ulusnet" WiMAX to 4G "Manai Internet Service" by applying Urgakh Naran AQMS method to all the other AQMSs.

- (4) In a discussion with KOICA for additional AQMS supply, CLEM experts requested to connect the new AQMSs to the existing online information system of CLEM/NAMEM AQMS. After a series of discussions between NAMEM/CLEM and KOICA, KOICA promised to develop online information system of AQMS in addition to the original agreement “supplying AQMSs”.
 - (5) <http://agaar.mn/> became offline on 20 January 2023. This was because the domain registered by MET was expired. After NAMEM’s arrangement and coordination, agaar.mn was newly registered by Bold LLC, and then the system <http://agaar.mn/> became online as it was. In January 2024, domain registration was renewed successfully 9 days in advance.
- 2) DAAEP also made its best effort to maintain the online information system of AQMS. However, DAAEP could not solve some of the problems alone, and needed some supports by CLEM’s experts and/or JET. Key episodes are described below.
- (1) Monitoring by Dambadarjaa AQMS was started in 2016. However, online information system of AQMS was not yet planned by 2018 when the cooperation by Seoul Municipality was finished. In 2021, DAAEP requested support from JICA. JICA and DAAEP agreed to add a new Activity 1-4-10, and then realized it. Note: Data output protocols of the analyzers of Dambadarjaa AQMS are different protocols from the analyzers of other AQMS. Therefore, whenever anybody plans to renew some analyzers of Dambadarjaa AQMS, it is necessary to consider compatibility of analyzer data output protocol and the system developed by Activity 1-4-10. It is better to procure any analyzer of which data output protocol is compatible with the existing analyzers.
 - (2) Based on the issues identified in the Project Phase 2, DAAEP proposed to renew data loggers. DAAEP requested data protocol compatibility from AQMS to <http://agaar.mn/> etc. It was clearly mentioned in the specifications of the tender “WPLT-03” of WB's UBCAP (DA 5039-MN), published on 18 February 2018. However, the contracted and delivered data loggers did not satisfied the specifications announced in the tender, although DAAEP pointed out that the model did not satisfy the specification, and it will be a problem for online information system of AQMS. Even the new data loggers were delivered in 2018, nobody could configure it for the existing online information system of AQMS or develop an additional program. Therefore, the new data loggers were not used, and old data loggers were continued to be used.

Later, the new data loggers were configured and started to be used in 2020 finally, after contracting CloudMQTT service (shown as green part in Figure 3-2-8), and by new version of the data logger that is compatible with CloudMQTT service, and by new additional server.

It was announced that CloudMQTT service will be stopped in January 2025. The DAAEP’s expert requested any advice from JET. JET suggested few options with their

advantages/disadvantages to DAAEP, CLEM and NAMEM. After their study and selection, in May 2024, JET configured the data logger and the data server, and DAAEP's expert studied it.

- (3) DAAEP moved from the city center to Yarmag region. The owner of the building in the city center requested to remove air quality displays at the elevator hall on the ground floor. DAAEP started to display it after getting a permission from the building owner of Yarmag, and technical support by JET.
- (4) If any equipment is malfunctioned, data transfer from the corresponding AQMS will stop. It needs some time to allocate some budget and to recover the equipment. In order to continue the data transfer, or to recover the data transfer quickly, it is recommended to be prepared. eSAM and XR applications on Windows PCs would be able to be recovered soon if DAAEP keep some old PC as a spare, and then install and configure necessary software under some support by the CLEM's expert. The VPN & HTTP Server is located inside a server area where DAAEP's experts are not permitted to be entered. Therefore, in 2017 when a server was started to be used, DAAEP requested from IT Department of UB City to make image backups periodically, and to recover the server quickly in emergency case. Since this request is not remembered by the new experts of IT Department in 2024, DAAEP started to remind it. Regarding all the other programmable equipment, JET prepared image backups, gave trainings for recovery, and provided screen captures of recovery steps.

In the Final Seminar in April 2024, DAAEP presented the issues on air quality monitoring as follows. It stated that it is necessary to utilize the results of the activities and capacities developed through this Project for continuation and improvement after this Project Phase 3.

- 1) Wind direction and speed sensors were installed at all the AQMSs except Dambadarjaa AQMS. However, data from 4 AQMSs except Bayankhoshuu AQMS are not suitable for air quality modelling. Some measures are necessary to be taken.
- 2) Air quality analyzers for CO, NO_x and O₃ are necessary to be installed in Bayankhoshuu AQMS. It is recommended to install any analyzers of which data output is compatible with the data logger because the data logger and <http://agaar.mn/> were configured and are ready for data transfer.
- 3) At Dambadarjaa AQMS, it is necessary to restart CO, SO₂ and NO_x monitoring, by overhaul or renewal of the analyzers. Online information system is ready by Activity 1-4-10 for the existing model. If analyzers will be renewed with any model that is not compatible with the existing analyzers, additional costs and capacity will be necessary to develop a data logger software or to buy a data logger that is compatible with all the analyzers and online information system.
- 4) Whenever new analyzers or data logger will be procured, it is necessary to procure any models

that are compatible with existing analyzers, data logger and/or online information system. 8 years was necessary to show Dambadarjaa AQMS in <http://agaar.mn/> , and 2 years were necessary to use new data logger procured by WB project, since both were not compatible with the existing online information system.

- 5) Some analyzers and equipment have been damaged by working/storage environment, for examples by condensation. In order to prevent condensation in AQMSs, it is necessary to pay attention on temperature and humidity data, and to set air conditioners well. It is also necessary to pay attention on storing used equipment in order to keep them as spare equipment.
- 6) For analyzer calibration, it is necessary to procure standard gases periodically, of which pollutant concentration must be certified with traceability system. Whenever any of traceable standard gas was run-out, it was impossible to check (and calibrate if necessary) any analyzers. Whenever pollutant concentration of any of gas cylinder was wrong, it was impossible to check (and calibrate if necessary) any analyzers. Also, without standard gas, or with gas cylinder of which pollutant concentration is wrong, it may be impossible to find preliminary damage, and to prevent serious damage of analyzers.
- 7) It is necessary to procure consumables and replacement parts regularly. One of the estimated reasons of serious damage of analyzer detectors is air quality monitoring without dust filters because there were no enough stocks of dust filters.
- 8) It is necessary to have enough capability to communicate with foreign suppliers on technical issues. PM analyzers of Dambadarjaa AQMS became ready in 2024. However, it would have been ready in 2017 or 2018 if DAAEP started technical communication appropriately from 2016 with the supplier.
- 9) Currently, there is only one technical expert for AQMS operation and maintenance, which is not enough for the holiday season and oversea training weeks. It is necessary to assign some additional technical experts, and to train them.

3-2-4-5 Air quality monitoring data

1-4-8 DAAEP and CLEM with JICA Experts analyze air quality monitoring data and elaborate air quality monitoring reports.

1-4-9 The relevant agencies utilize air quality monitoring data.

These activities are continuing from the Project Phase 2. Major improvements during the Project Phase 2 and their current status are shown in Table 3-2-17.

Table 3-2-17 Summary for Air Quality Monitoring Data (Activity 1-4-8~1-4-9)

Improvements during the Project Phase 2	Current status in this Project
The publishing process of the annual report has been improved by adding the air quality monitoring data from AQMS owned by DAAEP, where only monitoring data from AQMS owned by NAMEM had been used.	The annual report has been continuously published including data of DAAEP-owned stations, until the latest annual report 2023.
Some analyses to be added to the annual report has been identified, including charts of annual changes of 24-hour values by each AQMS, monthly changes in AQI, and their preparation method was trained for the Mongolian side.	NAMEM has continued to prepare and publish the analyses shown at left by their own, until the latest annual report 2023.
Since NAMEM had been publishing the annual report as late as every October, it was difficult to use the report for considering the policy for the next winter. Therefore, schedule to prepare the annual report was revised so that they can prepare by every spring.	In April 2024, it was confirmed that the analysis for the winter period has been completed using data through last March, and the report is being prepared in a timely manner. Weekly reports of air quality status have been continuously published at the following website. http://agaar.mn/article/activity/airquality

It was confirmed that DAAEP sends weekly and monthly summary to NAMEM. Then, NAMEM prepares 5 types of reports; weekly report, 2 types of monthly reports (for MET and National Statistics Office of Mongolia), winter season report (from October to April), and an annual report. NAMEM is posting the weekly report on the web-site “<http://www.agaar.mn>” every Monday, as well as sending the report to MET. Annual report of 2022 is attached as Annex 2-2-1-6, and an example of weekly reports as Annex 3-2-3.

3-3 Output 2: Capacity Development to Analyze and Evaluate Pollution Structure

3-3-1 Activity 2-1: Source Apportionment Study Based on PM Composition Analysis

3-3-1-1 PM sampling and source apportionment study based on composition analysis

- 2-1-1 CLEM and JICA Experts elaborate PM sampling plan throughout the year, and implement PM samplings.
- 2-1-2 JICA Experts perform PM speciation analysis in Japan.
- 2-1-3 NAMEM and CLEM with JICA Experts learn PM speciation technologies (ion analysis, element analysis and carbon analysis).
- 2-1-5 DAAEP and NAMEM with JICA Experts perform PM apportionment study based on receptor modeling.

The objectives of the PM source contribution analysis in this project were focused on the following two points.

1. The source apportionment study in non-winter season by accumulating samples in the non-heating season
2. Understanding seasonal changes by sampling throughout the year at fixed point

Based on above points, CLEM, NAMEM, and JET considered the candidate sampling sites and sampling intervals, and then developed a plan of PM sampling at the three sites shown in Table 3-3-1 and Figure 3-3-1.

CLEM and JET installed PM samplers for component analysis at each sampling site in November 2021, and JET with CLEM implemented test operation of the sampling, as well as providing guidance on taking field note, sample condition during storing and transportation. The sampling was carried out from December 2021 to December 2022, and CLEM experts were able to carry out most of the sampling work on their own management. JET accompanied them during their stay in Mongolia to check the sampling process, and CLEM sent JET the field note shown in Figure 3-3-2 accordingly to check the progress of the sampling.

Table 3-3-1 PM Sampling Sites

	Location	Characteristics	Frequency	Sample number	Note
1	NAMEM (building rooftop)	Representing Ulaanbaatar, locating center of the city	For 1 year, every 10 day	37 sets of Fine/Coarse pair sample	Sampling site used in the Project Phase 2
2	Takhilt Met. Station (AQMS UB-3)	Sand dust in Spring Effect of the Ger district in Winter	For 1 year, every 10 day	37 sets of Fine/Coarse pair sample	New site
3	West Crossing (AQMS UB-2)	Effect of automobiles	For 1 year, every 15 day	24 sets of Fine/Coarse pair sample	Sampling site used in the Project Phase 2
	Total			98 sets of Fine/Coarse pair sample	

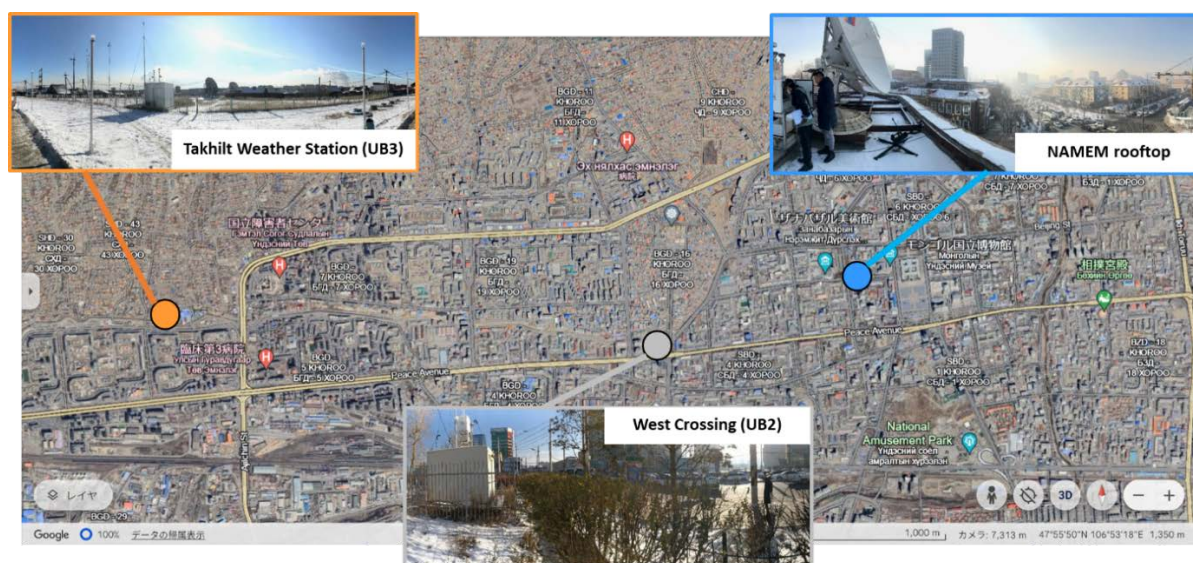


Figure 3-3-1 PM Sampling Sites

Завгар : 1	
№: 44	
PM сорьц авах ажлын тэмдэглэл	
Сорьц авах нэг (☐ -а ☒ тэмдэглэгээ хийнэ үү)	☒ R1 : ЦУОШГ ☐ R2 : УБ ЦУОШГ (UB-3) ☐ R3 : Баруун 4 зам (UB-2)
Огноо: YYYY / MM / DD (☐ -а ☒ тэмдэглэгээ хийнэ үү)	(2022 15 11) ☐ Даваа ☐ Мянмар ☐ Лхагва ☐ Пүрэв ☐ Баасан ☐ Бямба ☒ Аям
Сорьцын хугацаа (☐ -а ☒ тэмдэглэгээ хийнэ үү)	Эхэлх : ☐ 12:00 ☒ Бусад (16 : 00), Дууссан : ☒ 12:00 ☐ Бусад (16 : 00)
Фильтр ID (фильтрийн хайрцаг хэсэг ID)	Quartz Filter Coarse : MN- 044 Coarse Q Fine : MN- 044 Fine Q PTFE Filter Coarse : MN- 044 Coarse TF Fine : MN- 044 Fine TF
Ажлынханы мэргэжлтийн нэр	Фильтр суурилуулагч : <i>Д. Пунцагтүвшин</i> Фильтр хураасан : <i>Д. Пунцагтүвшин</i>
Тухайн өдрийн цаг агнаар (☐ -а ☒ тэмдэглэгээ хийнэ үү)	Суурь/үе : ☒ Цэцэрлэг ☐ Үүлтэй ☐ Бороотой ☐ Цастай ☐ Хүчтэй салхитай ☐ Шуургатай ☐ Шороон Хурь/үе : ☒ Цэцэрлэг ☐ Үүлтэй ☐ Бороотой ☐ Цастай ☐ Хүчтэй салхитай ☐ Шуургатай ☐ Шороон
Сорьц авах үеийн орчны нөхцөл (Дууссан дараа Line A, Line B-д шаардлагатай тэмдэглэл хийнэ)	Setting Time : (15 : 03) Collection time : (16 : 18) [Ambient] Pressure Суурь/үе : 86.5 kPa Хурь/үе : 86.1 kPa Temperature Суурь/үе : 21.5 °C Хурь/үе : 21.7 °C Humidity Суурь/үе : 20 % Хурь/үе : 19 % [Line A (Quartz)] Flow Vol : 88.736 m³ Flow Min: 9.8 L/min, Max: 30.1 L/min Hum. Min: 11 % Max: 51.5 % Prs. Min: 86.2 kPa, Max: 86.8 kPa Samp. T Min: 3.5 °C, Max: 22 °C Amb. T Min: 4.0 °C, Max: 22.9 °C [Line B (PTFE)] Flow Vol : 88.735 m³ Flow Min: 9.8 L/min, Max: 30.1 L/min Hum. Min: 11 % Max: 51.5 % Prs. Min: 86.2 kPa, Max: 86.8 kPa Samp. T Min: 3.5 °C, Max: 22.3 °C Amb. T Min: 4.0 °C, Max: 22.9 °C
24 цагийн дундаж утга (Зөвхөн суурин харуулдаг суурилуулагч сорьцлогч)	PM2.5 : мкг/м³ PM 10 : мкг/м³
Тайлбар: (Сорьцны нөхцөлөөс мэглэлтэй бүх үрлийн зураг авч, тэмдэглэл бичнэ үү. Жишээ: Үзлэх хайр шороон шуургатай байсан, өөрчлөх баримта, дээвэр, хавирын ажил хийгдэж байсан, сорьцлогч багтаж ласалдаж.)	<i>The roof of the building (NAMEM) was painted.</i>

Figure 3-3-2 Example of Field Note for PM Sampling

(1). Component analysis (Including Training in Japan)

JET has shipped the PM samples to Japan for composition analysis. The training course in Japan was conducted from 9 to 23 November 2022, and relevant eight experts from NAMEM and CLEM visited the sub-contractor in Japan to observe and practice the actual process of chemical composition analysis. Main contents of the training in Japan are as follows.

Period	9 to 23 November 2022
Participant	• CLEM: 6 members (Director, Technicians for chemical analysis) • NAMEM: 2 members (Senior expert in charge of equipment management plan of CLEM, and Specialist for emission inventory, air pollution sources)
Training Contents	Site visit to laboratory related to PM composition analysis and practice of analysis (Osaka Metropolitan University) Site visit to laboratory related to PM composition analysis / Introduction of examples of PM composition analysis / Quality Control (Research Institute of Environment, Agriculture and Fisheries, Osaka Prefecture) Preparation of Equipment Management Plan of CLEM (Suuri-Keikaku Co., Ltd.) PM Source Apportionment Study using Receptor Model (Suuri-Keikaku Co., Ltd.)



Photo 3-3-1 Training in Japan

Composition analysis of all samples was completed in March 2023, and practical training of data error checking and PM source apportionment study using receptor models were started in April 2023. CLEM and NAMEM staffs have been learned the necessary steps as listed below using their own PC.

- Error checking for composition analysis results
- Preparing input data for PMF analysis
- Setting up uncertainty
- Executing the program for PMF analysis

As an example of chemical composition analysis of all samples, Figure 3-3-3 shows the trends of mass concentration and major components of fine particles, and Figure 3-3-4 shows the concentrations of mass and major constituents averaged by site and winter/non-winter. Re-Constructed Fine Mass (RCFM), which are summation of the masses of major compound calculated from the results of chemical composition analysis, generally equals to the mass concentration (Mass) obtained by filter weighing, convincing that the sample collection, transportation, and analysis processes were conducted properly. The result shows that Particulate Organic Matter (POM) and sulfate ion (SO_4^{2-}), which are estimated to be mainly emitted from coal combustion, are higher in winter, while soil-related particles (“Soil”), estimated from elements related to earth crust, are higher in non-winter season.

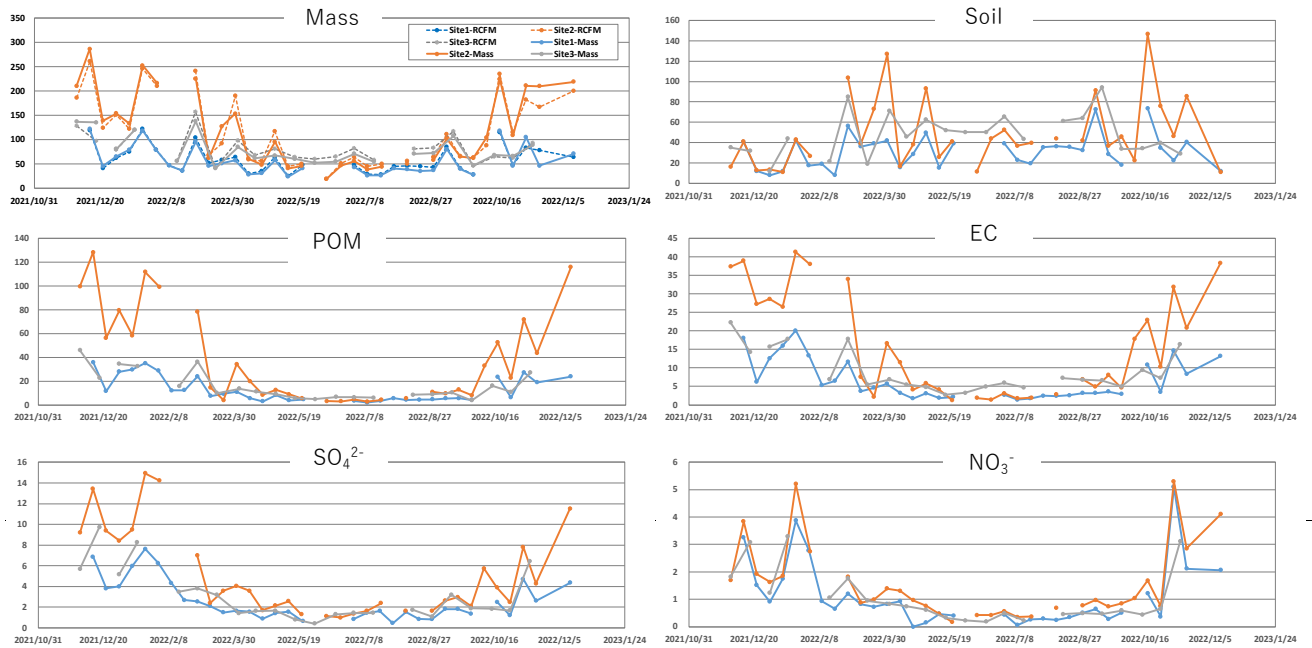


Figure 3-3-3 Trends of Mass Concentration and Major Component of Fine Particles

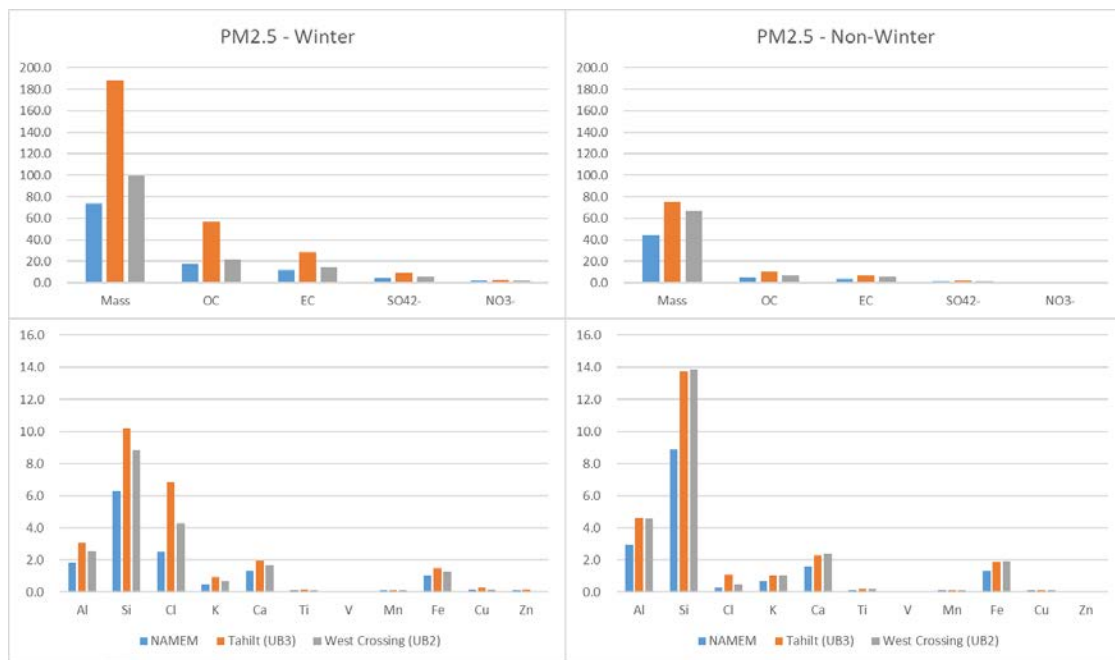


Figure 3-3-4 Concentration of Mass and Major Components of Fine Particles Averaged by Sites and Winter/non-Winter

(2). Source Apportionment Study using the result of component analysis

1) PMF analysis

Source apportionment study was implemented using all the samples for one year taken at the three sampling sites. The free software “PMF ver. 5.0¹¹¹” provided by U.S. EPA was used as receptor model program.

After repeating the PMF trial changing the number of factors to find appropriate results by comparing the results with the known characteristics of emission source types, it was decided to adopt the results with five factors. Source profiles and their trends in one year in calculation with five factors are shown in Figure 3-3-5.

As for seasonal changes, the main factors at high concentrations in winter were mainly Nitrate (Factor 1) and Coal combustion, OC, and Sulfate (Factor 3), while soil particles (Factor 5) tended to be higher in non-winter seasons. In addition, the ratio of the factors mainly composed of coal combustion, OC, and sulfate was very high, especially in winter, suggesting that measures to control these factors are important.

On the other hand, it was difficult to clearly distinguish mining and automobile sources as factors. This is presumably because the contribution of coal combustion in PM is so large that indicator elements from other sources have been incorporated into its error. For elements such as Zn and Cu, peaks sometimes appeared in a short period of time (a few days) rather than seasonal changes, which may be due to some industrial source in the vicinity of the sampling site, but this has not been identified.

¹¹¹ <https://www.epa.gov/air-research/positive-matrix-factorization-model-environmental-data-analyses>

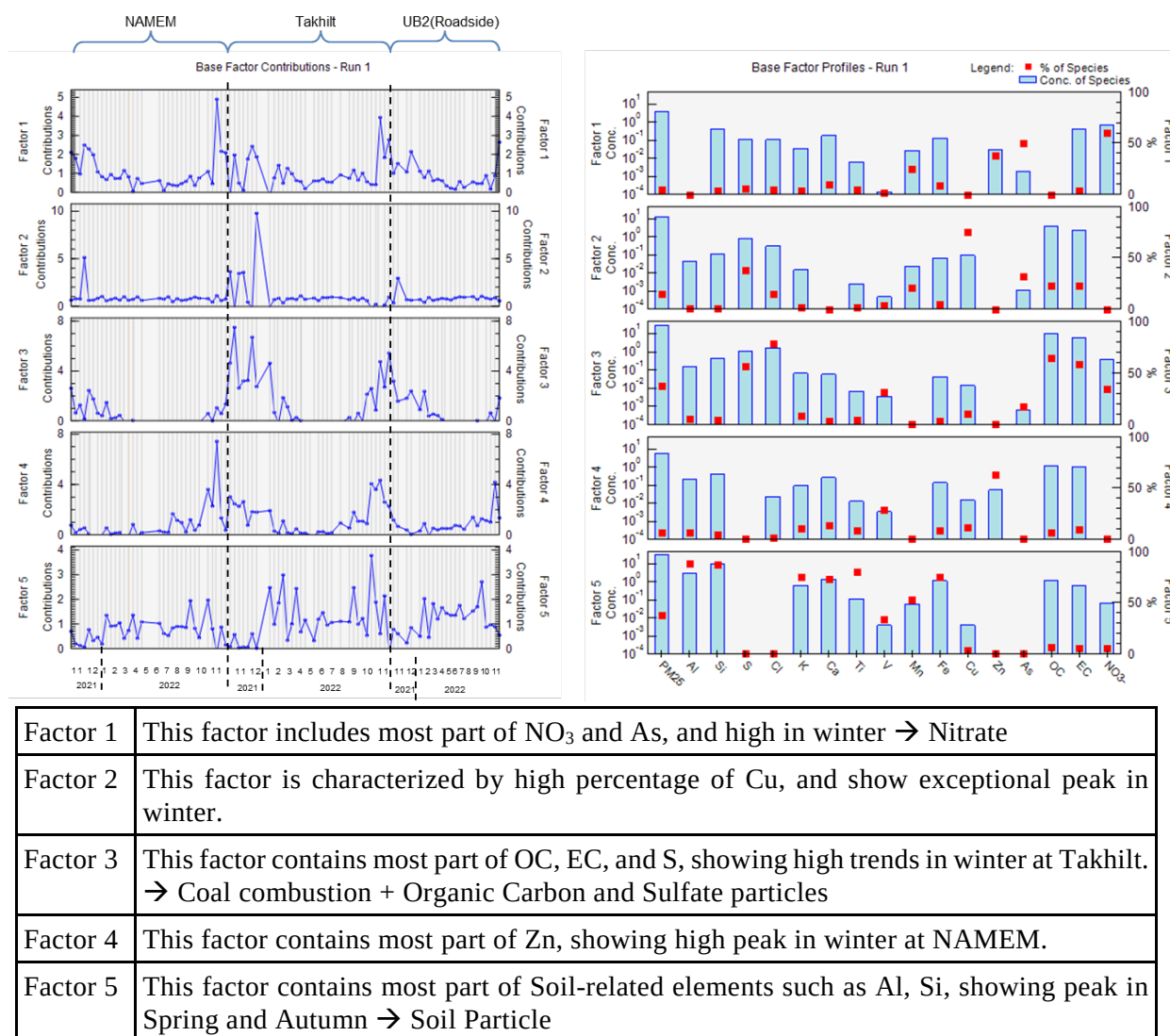


Figure 3-3-5 Source Profile of Each Factor (Right) and Their Trends in One Year (Left)
Result of PMF Analysis in Case of Five Factors in PM_{2.5}

2) Change before/after Prohibition of Raw Coal

As a representative point in UB city, the PM samples has been collected and analyzed at the NAMEM rooftop (Site 1), where samples were collected also in the Project Phase 2, albeit for a shorter period of time. Since the data was collected and analyzed in the same method before the ban on raw coal combustion in the city (2016), evaluation of the impact of the ban on raw coal use was attempted by comparing the data of each period, as part of the analysis exercise of capacity development.

Figure 3-3-6 shows the results of the component analysis of OC and EC. The blue, orange, and gray dots indicate the data from all samples collected in this project for one year at sites 1-3, respectively. The figure shows that OC and EC are correlated regardless of season, with a slope of 1.5 to 2, although the OC/EC ratio is slightly higher in areas with higher concentrations. In comparison, the data from NAMEM during the winter of 2016, indicated by the green dots, clearly shows a different OC/EC

ratio, suggesting that the decrease in OC generation due to the fuel shift contributed to the decrease in PM concentration.

Furthermore, carbon was classified into subcategories of OC1 ~ OC4 and EC1 ~ EC3 by combustion temperature, and were compared before and after the ban on raw coal use. The results are shown in Figure 3-3-7. It is clear that EC has not changed much, while the concentrations of OC1 and OC4 have decreased widely. OC1, in particular, is a volatile organic compound that affects fuel ignitability. If the volatile components in the improved fuel will be increased too much in order to improve ignitability, PM emissions would increase again. These findings are useful for further consideration of the improved fuel in the future, and were shared with the Mongolian side, including DAAEP and NAMEM, through seminars and other means.

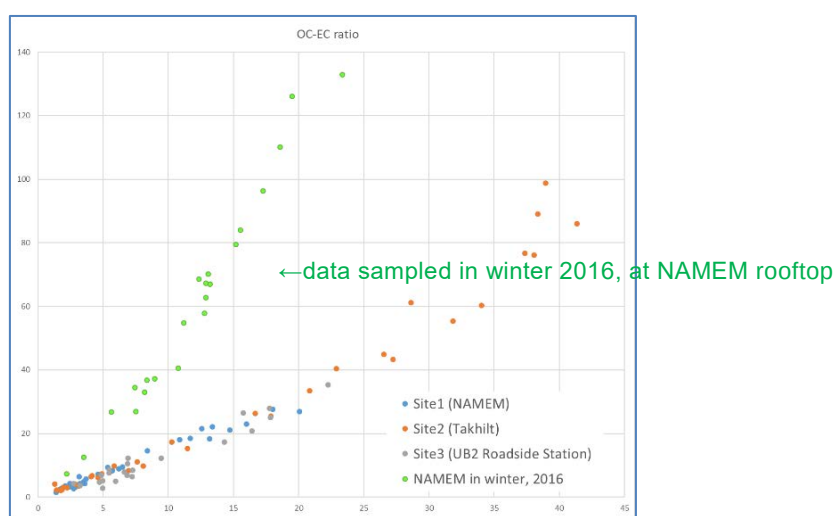
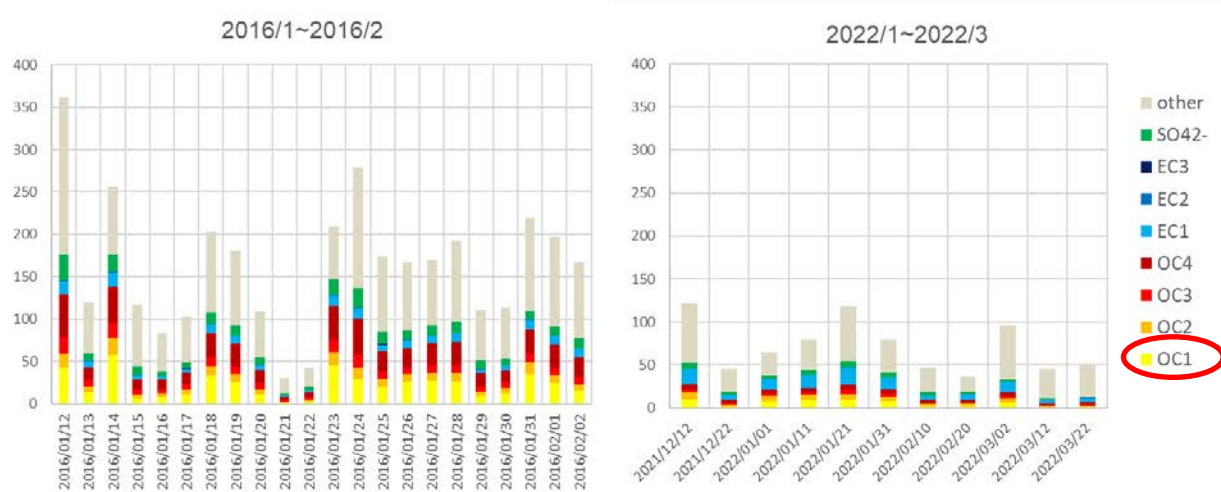


Figure 3-3-6 Comparison of OC/EC Ratio between Data in This Project and Data Sampled in the Project Phase 2 (winter 2016, NAMEM rooftop)



Left: 2016, Right: 2022

Figure 3-3-7 Comparison of Carbon Fraction Sampled in Inter at NAMEM

3) Seasonal and Spatial Variation of Carbon fraction

Figure 3-3-8 shows the seasonal and spatial variations for each carbon fraction. Almost all components tend to be higher at the Takhilt site (near the Ger district, orange line) in winter, suggesting that the contribution of coal combustion for heating in winter has dominant contribution. On the other hand, only EC2 tends to be higher at West Crossing (adjacent to the road, gray line) in summer and fall, indicating the influence of automobile emission. This feature may be useful for future source contribution based on the composition in UB City.

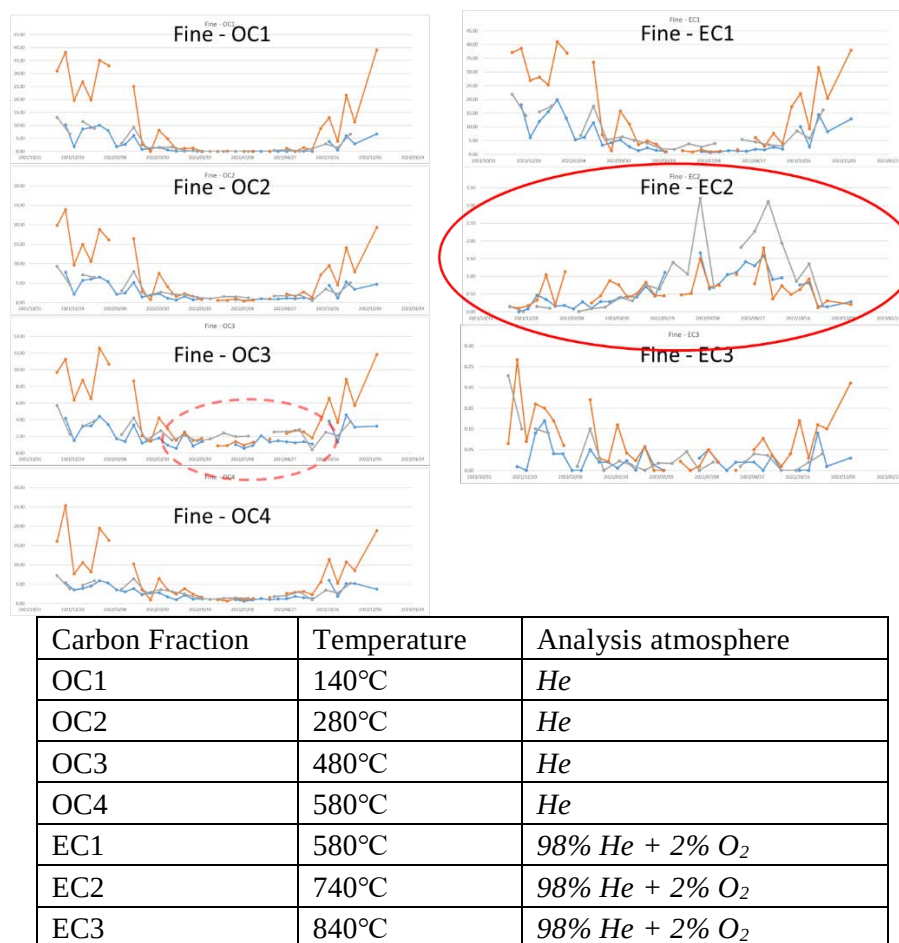


Figure 3-3-8 Seasonal and Spatial Variation of Carbon Fraction

(3). Utilization of the Results

The results of the above analysis were shared with CLEM and NAMEM through the seminars and practical training conducted in 2022 and 2023, and were also shared with the C/P members of other fields such as Activity 2-2 (Air Pollution Structure Analysis by Simulation Modeling) at the seminar held in December 2023. In the seminar, JET and CLEM were both took charge of half of the presentation for each, and in the final seminar held in the April 2024, CLEM presented the results of their activities, by which CLEM experts might understand deeper through the process of preparing the presentations.

The results of these analyses were used to improve the simulation model in the following ways.

- The calculated concentrations of PM in the simulation model are underestimated compared to the observed values. This was estimated to be due to the fact that the model calculation process didn't include the formation process of condensable particles. In the Project Phase 2, the contribution of condensable particles was estimated based on the results of component analysis by correcting emissions. This time, annual component analysis data was used in order to update the correction values to estimate the contribution of condensable particles by winter/non-winter.
- The contribution of each emission source type in the averaged PM₁₀ concentrations in winter were estimated at the AQMSs, using the contribution estimated by the source apportionment study using PMF. And then, the PM₁₀ emissions taking condensable particles into account were estimated by making correction ratio from the concentration calculated by CALPUFF program.

3-3-1-2 Equipment and laboratory plan for PM speciation analysis

2-1-4 NAMEM and CLEM with JICA Experts formulate equipment and laboratory plan for PM speciation.

During the above-mentioned training in Japan in November 2022, NAMEM and CLEM discussed and prepared an equipment and laboratory plan of CLEM, after visited laboratory in Japan to learn the analytical equipment necessary for PM composition analysis. Through the discussion, it was confirmed that the biggest problem in conducting analysis in Mongolia in the future is not only the equipment itself, but also to secure the budget, availability and quality for consumables. It was reaffirmed that it is necessary to request certain number of consumables and supporting instruments when the equipment is introduced through the ongoing 14 million USD soft loan from Korea. The presentation materials including the equipment plan prepared during the training in Japan are attached as Annex 3-3-1.

3-3-2 Activity 2-2: Evaluation of Air Pollution Structure and Health Impact

3-3-2-1 Emission Inventory

2-2-1 DAAEP and NAMEM elaborate plans for updating emission inventory.
 2-2-2 DAAEP, TCC and PTSD implement studies for mobile sources including update of emission inventory, examination of traffic signal control, traffic volume and automobile traveling speed.
 2-2-3 DAAEP and JICA Experts select the pilot areas and assess Ger stoves usage pattern (type and model of stoves, seasonal pattern of usage, insulation of Ger housing and coal consumption).
 2-2-4 DAAEP and NAMEM with JICA Experts implement studies for other emission sources as necessary.
 2-2-5 DAAEP and NAMEM with JICA Experts elaborates BAU (Business as usual) scenario for the future year based on TPPs future development plans, projection of number of automobile, population, economic growth, emission regulation, fuel quality regulation and so on.
 2-2-6 DAAEP and NAMEM update emission inventory for the present year and the future year for the BAU scenario

(1). Capacity Development and Seminar on Emission Inventory

At the beginning of this Project, a person in charge of emission inventory in DAAEP was planned to update emission inventory, however the inventory was not updated due to the retirement of the person in charge at the end of May 2019. In September 2019, DAAEP assigned a new person in charge and JET explained the objective of developing emission inventory, the procedure of updating emission inventory, and the necessary data for updating. According to the explanation, the person in charge of DAAEP began to collect the data and JET implemented the capacity development using email after returning to Japan. However, the capacity development in Mongolia could not be implemented due to the travel ban to Mongolia due to COVID-19 pandemic.

In order to train during the travel ban to Mongolia under COVID-19 pandemic it was conducted online, with participation of DAAEP, as well as NAMEM and IRIMHE. The online training record is shown in Table 3-3-2.

Table 3-3-2 Online Training Record to Update Emission Inventory

No	Date	Contents of Technical Transfer
1	2020-09-10	Objective of developing emission inventory Check of collected data (Annex 3-3-2)
2	2020-10-23	Training of emission calculation for 2018 (Power plant, Small stove for household)
3	2021-03-26	Training of emission calculation for 2018 (CFWH)
4	2021-04-02, 09, 16, 21, 28, 05-12, 19, 27	Training of emission calculation for 2018 (Automobile)
5	2021-05-27, 06-10	Training of emission calculation for 2018 (HOB, Fugitive ash from power plant)
6	2021-06-28, 09-22	Discussion on the point to modify in emission inventory report elaborated by DAAEP
7	2021-09-27, 10-01	Lecture on how to use GIS tools to draw emission distribution maps
8	2021-12-17	Checking the data for calculating emission of 2020 (Stationary sources)
9	2022-01-20	Checking the data for calculating emission of 2020 (Small stove for household)
10	2022-01-27	Checking the data for calculating emission of 2020 (Small stove for household and automobile)

Source: JET

For technical transfer after March 2022, when the person in charge of JET resumed traveling to Mongolia, data on emission inventory was transferred in DAAEP due to a change of the person in charge, but the technical details were not transferred. JET instructed the new person in charge of DAAEP to collect data and calculate emissions based on the updating emission inventory manual prepared in the Project Phase 2, and conducted the technical transfer in-person or online as needed.

The seminar for reporting the finalized emission calculation result by the above activity was held on 17 March 2022. The presentation document is shown in Annex 3-3-3. Dispersion simulation for 2020 was implemented using the emission data, and the concentration reduction effect and air pollution structure using improved fuel were understood.

Regarding Activity 2-2-4, technical transfer of the calculation method of emissions was carried out for waste disposal sites, fugitive ash from power plant ash pond, and brick factories in the Project Phase 2. However, the person in charge at that time was transferred and the Mongolian side was not able to calculate the emissions, thus the technical transfer was carried out again on 7 March 2024. Explanatory materials are shown in Annex 3-3-4. The Mongolian side opinioned there are no sources other than power plants, small household stoves, and automobiles that may have a significant impact on air pollution currently. Therefore, it was agreed that future emission inventory updates to be conducted in recognition of the following issues.

1. find emissions from sources other than those indicated using statistical data and foreign emission factors, in accordance with the emission inventory guideline in Mongolia
2. if the emissions indicate that any sources are likely to impact air pollution in UB City, detailed surveys and data collection will be conducted as necessary to improve the accuracy of the emissions

In Mongolia, National Source Registration Database System was developed and information on individual sources have been entered in the same format from smartphones and stored in the database. However, problems such as the inability to access to the system have reduced the accuracy of the collected data. DAAEP and NAMEM requested the system developer, thorough NCEPR, for improvement. Some request was reflected and DAAEP and NAMEM are able to access to the system. However, the system does not reflect the specification that was originally envisioned to be able to calculate emissions using the database. Therefore, it is expected that this system will be further improved by DAAEP and NAMEM's continuous requests to the system developer, even after this Project.

(2). Output of the Activities

1) Activity 2-2-1: Elaborating Plans for Updating Emission Inventory

Activity 2-2-1, under the support by JET, DAAEP elaborated the plans for updating emission inventory for 2018 and 2020-2022 and developed emission inventory of each year according to the plans. Furthermore, DAAEP elaborated the emission inventory annual report of each year and published on the DAAEP's website. DAAEP elaborated the annual plan for regularly updating emission inventory even after this Project Phase 3 is completed (Table 3-3-3).

Since Dr. Batbayar, the director of environmental monitoring division in NAMEM, requested this Project to identify the cause of the SO₂ high concentration in 2020, JET approached Ms. Purevsuren,

the acting director of DAAEP, changing the updating plan after finalizing the emission inventory report for 2018 at the DAAEP regular meeting in August 2021. The acting director of DAAEP agreed to prioritize the preparation of the emission inventory for 2020 and to execute the simulation model.

Furthermore, JET explained the updating plan of emission inventory to Dr. Batbayar on 8 September 2021. JET and NAMEM agreed to prepare the emission inventory for 2020 instead of 2019.

Table 3-3-3 Annual Plan for Updating Emission Inventory

Contents	Aug				Sep				Oct				Nov				Dec				Jan			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1 Developing emission inventory																								
1-1 Developing emission inventory of Power plant																								
1-2 Developing emission inventory of HOB																								
1-3 Developing emission inventory of CFWH																								
1-4 Developing emission inventory of small stove for household																								
1-5 Developing emission inventory of automobile exhaust gas																								
1-6 Developing emission inventory of fugitive dust from road																								
1-7 Developing emission inventory of fugitive ash from ash pond of power plant																								
2 Elaboration of annual report																								
2-1 Organization of fuel consumption by source																								
2-2 Organization of emission factor by source																								
2-3 Organization of emission amount by source																								
2-4 Description of comments on the result																								
2-5 Adjustment of document style, checking and correction of the report																								
2-6 Confirmation by total coordinator																								
2-7 Correction based on the comment																								
2-8 Perfection of annual report																								

Source: JET

2) Activity 2-2-2: Surveys for Mobile Sources

In Activity 2-2-2, the following surveys for mobile sources were commissioned to Mongolian survey companies. The surveys are summarized in Table 3-3-4.

Table 3-3-4 Summary of Surveys for Mobile Sources

	Traffic Count and Traffic Speed Survey	Traffic Condition Survey
Date	1. October and December 2019 2. October and December 2022	1. September 2019 2. September 2022 3. February 2023
Points	Maximum 45 points	17 intersections
Contents	1. Count by automobile types 2. Measurement of travel speed	1. Traffic jam length 2. Count of “Dead green” ¹² and “Excessive green” ¹³ 3. Traffic intensity of intersections 4. Number of automobiles accessed by green lights 5. Record of interruption for the light’s length mode by TCC 6. Measurement of travel speed
Times	24 hours or 16 hours (start from 6:00)	16 hours (start from 6:00)
Methods	1. Recording by camera 2. Manual measurement	1. Recording by camera 2. Manual measurement
Purpose	Updating air pollutant emission from automobile	Improving signal control system

To improve the accuracy of emission inventory, traffic count and travel speed survey were conducted in 2019 and 2022 by local research firm.

For the 2019 survey, more survey points were increased since significant change in traffic patterns are assumed after the traffic count and travel speed survey in the Project Phase 1, caused by opening of new roads and widening of existing roads. Figure 3-3-9 shows the traffic count survey points. The 2022 survey was conducted due to further development in Yarmag area, assuming that traffic conditions have changed significantly since 2019. Traffic counts in 2019 by link are shown in Table 3-3-6.

¹² A situation where a car cannot pass through an intersection due to a blockage ahead despite of the green light

¹³ Situation where no cars pass at all despite the green



Source: JET

Balloon: the measuring points by researchers

Pin: the measuring points by shooting video camera

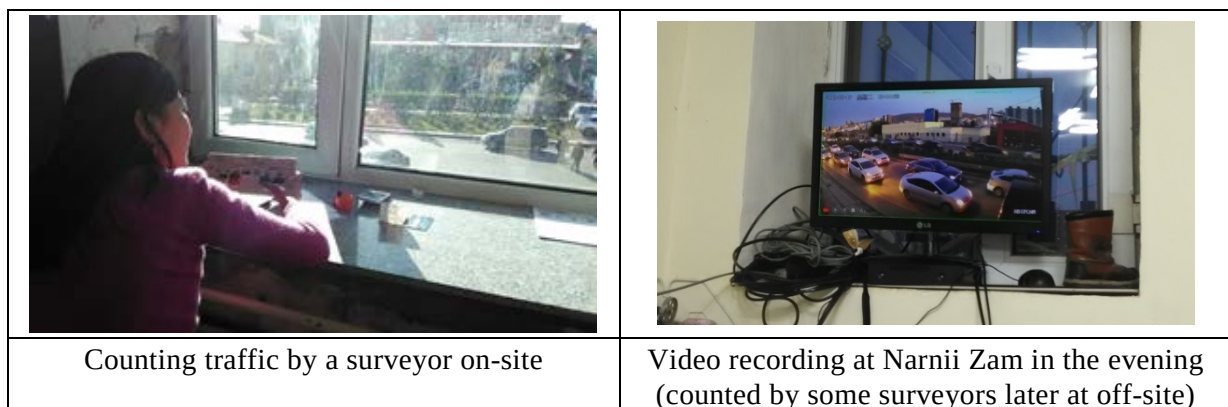
Colors of balloon or pin show the survey term (Table 3-3-5).

Figure 3-3-9 Traffic Count Survey Points

Table 3-3-5 Survey Term by Points in Traffic Survey

Colors	Non-winter		Winter	
	Weekday	Weekend	Weekday	Weekend
Red	24 hours	24 hours	24 hours	16 hours (2019) 24 hours (2022)
Pink	24 hours	24 hours	24 hours	No survey
Blue	16 hours	No survey	16 hours	No survey
White	24 hours	No survey	No survey	No survey
Light blue	16 hours	No survey	No survey	No survey

Source: JET



Counting traffic by a surveyor on-site

Video recording at Narnii Zam in the evening
(counted by some surveyors later at off-site)

Photo 3-3-2 Traffic Count Survey in Non-winter Season

Table 3-3-6 Traffic Count by Link (2019)

Link No.	Location	Lane	Autumn-Weekday		Autumn-Weekend		Winter-Weekday		Winter-Weekend	
			Hour	Count	Hour	Count	Hour	Count	Hour	Count
1	Rural	4	16	36,151			16	31,863		
2	Sub-urban	4	24	55,261						
3	Sub-urban	4	24	33,730	24	32,063	24	32,914	16	25,533
4	Sub-urban	4	16	27,928						
5	Rural	4	16	18,448						
6	Rural	6	16	37,327			16	38,774		
7	Sub-urban	6	24	50,280	24	46,833	24	56,674	16	42,571
8	Sub-urban	4	16	32,819			16	31,204		
9	Sub-urban	4	24	36,220	24	37,951	24	36,949	16	28,826
10	Rural	4	16	32,902			16	29,831		
11	Rural	4	16	28,110						
12	Rural	4	16	27,634						
13	Rural	8	24	76,274	24	80,646	24	96,300	16	68,119
14	Rural	6	24	67,486						
15	Sub-urban	4	24	34,324	24	32,323	24	49,189		
16	Sub-urban	6	16	49,056			16	50,432		
17	Sub-urban	4	24	77,848						
18	Central	6	24	80,551						
19	Sub-urban	6	24	47,115	24	46,806	24	44,436	16	52,753
20	Central	4	24	33,202						
21	Central	4	24	26,287						
22	Central	4	24	15,874	24	17,015	24	24,147	16	15,096
23	Central	4	24	35,915	24	29,570	24	32,868		
24	Sub-urban	4	24	48,605						
25	Sub-urban	6	24	77,092						
26	Central	6	24	53,335	24	52,244	24	46,092	16	50,345
27	Central	6	24	50,067						
28	Sub-urban	6	24	56,491						
29	Central	4	24	40,550	24	39,510	24	40,652		
30	Central	4	16	36,301			16	36,798		
31	Central	4	24	63,270	24	71,309	24	100,167		
32	Sub-urban	4	16	17,083			16	17,408		
33	Central	6	24	36,778						
34	Central	4	16	50,118						
35	Sub-urban	6	16	30,352			16	31,402		
36	Central	6	24	65,984	24	57,362	24	70,510	16	50,421
37	Sub-urban	4	24	48,951						
38	Central	4	24	60,052	24	59,791	24	69,600	16	52,496
39	Central	6	24	41,898	24	43,586	24	47,460	16	45,241
40	Rural	4	24	35,464						
41	Rural	2	24	27,487	24	25,619	24	29,437		
42	Sub-urban	4	16	36,333						
43	Sub-urban	4	24	37,624						
44	Central	4	24	26,257						
45	Sub-urban	4	16	39,748						

Source: JET

In order to estimate traffic counts for unmeasured hours, survey points were classified to region and number of lanes as shown in Table 3-3-7. For each classification, 24-hour traffic pattern and day-night ratio were calculated. Then, nighttime traffic volume and 24-hour traffic volume were estimated.

Table 3-3-7 Classification for Estimation of Traffic Count

No	Region	Number of Lanes
1	Urban	Less than 4 lanes
2		More than 6 lanes
3	Sub-Urban	Less than 4 lanes
4		More than 6 lanes
5	Rural	All

Source: JET

Nighttime traffic volume and 24-hour traffic volume at 16-hour traffic count survey points (6:00~22:00) were estimated by the following procedure.

- 1) Sum up hourly traffic counts for 24-hour survey points for each classification.
- 2) Calculate Day and night ratio = $\frac{24 \text{ hour traffic count}}{16 \text{ hour traffic count}}$.
- 3) Calculate traffic pattern in nighttime (22:00~6:00) using hourly traffic counts for each classification calculated in 1).
- 4) Estimate 24 hour traffic count = Surveyed 16 hour traffic count × Day and night ratio

Furthermore, for the not-surveyed points, 24-hour traffic count was estimated for each classification using the following formula, and hourly traffic count was estimated using the time change pattern at the points where 24-hour traffic count was surveyed.

$$TC_{(nmp, sea, we)} = TC_{(nmp, sea, wd)} \times \frac{\sum TC_{(mp, sea, we)}}{\sum TC_{(mp, sea, wd)}}$$

TC (nmp, sea, we): Weekend traffic count by season at not-surveyed point

TC (nmp, sea, wd): Weekday traffic count by season at not-surveyed point

TC (mp, sea, we): Weekend traffic count by season at surveyed point

TC (mp, sea, wd): Weekday traffic count by season at surveyed point

Estimated 24-hour traffic count by survey points by the above procedure is shown in Table 3-3-8 for 2019, and Table 3-3-9 for 2022.

Table 3-3-8 Estimated Traffic Count by Link (2019)

Link No.	Location	Lane	Autumn-Weekday		Autumn-Weekend		Winter-Weekday		Winter-Weekend	
			Hour	Count	Hour	Count	Hour	Count	Hour	Count
1	Rural	4	16	42,090		<i>44,162</i>	16	38,153		<i>34,056</i>
2	Sub-urban	4	24	55,261		<i>54,527</i>		<i>59,904</i>		<i>57,219</i>
3	Sub-urban	4	24	33,730	24	32,063	24	32,914	16	29,854
4	Sub-urban	4	16	32,081		<i>31,874</i>		<i>33,931</i>		<i>32,491</i>
5	Rural	4	16	21,472		<i>22,576</i>		<i>24,029</i>		<i>20,781</i>
6	Rural	6	16	43,428		<i>44,543</i>	16	46,155		<i>46,035</i>
7	Sub-urban	6	24	50,280	24	46,833	24	56,674	16	49,952
8	Sub-urban	4	16	37,964		<i>37,373</i>	16	36,478		<i>35,694</i>
9	Sub-urban	4	24	36,220	24	37,951	24	36,949	16	33,840
10	Rural	4	16	38,401		<i>40,208</i>	16	35,682		<i>36,287</i>
11	Rural	4	16	32,975		<i>34,358</i>		<i>35,542</i>		<i>39,071</i>
12	Rural	4	16	32,604		<i>33,547</i>		<i>33,199</i>		<i>43,772</i>
13	Rural	8	24	76,274	24	80,646	24	96,300	16	81,503
14	Rural	6	24	67,486		<i>70,598</i>		<i>73,230</i>		<i>71,322</i>
15	Sub-urban	4	24	34,324	24	32,323	24	49,189		<i>45,859</i>
16	Sub-urban	6	16	57,811		<i>55,787</i>	16	58,935		<i>58,915</i>
17	Sub-urban	4	24	77,848		<i>77,420</i>		<i>84,085</i>		<i>82,137</i>
18	Central	6	24	80,551		<i>76,046</i>		<i>79,160</i>		<i>88,053</i>
19	Sub-urban	6	24	47,115	24	46,806	24	44,436	16	61,760
20	Central	4	24	33,202		<i>33,352</i>		<i>40,184</i>		<i>35,678</i>
21	Central	4	24	26,287		<i>26,436</i>		<i>31,843</i>		<i>28,367</i>
22	Central	4	24	15,874	24	17,015	24	24,147	16	18,877
23	Central	4	24	35,915	24	29,570	24	32,868		<i>29,692</i>
24	Sub-urban	4	24	48,605		<i>47,986</i>		<i>52,886</i>		<i>50,449</i>
25	Sub-urban	6	24	77,092		<i>74,756</i>		<i>79,384</i>		<i>79,378</i>
26	Central	6	24	53,335	24	52,244	24	46,092	16	61,519
27	Central	6	24	50,067		<i>47,324</i>		<i>51,014</i>		<i>54,971</i>
28	Sub-urban	6	24	56,491		<i>55,046</i>		<i>58,151</i>		<i>58,085</i>
29	Central	4	24	40,550	24	39,510	24	40,652		<i>36,808</i>
30	Central	4	16	42,500		<i>42,641</i>	16	45,173		<i>41,023</i>
31	Central	4	24	63,270	24	71,309	24	100,167		<i>90,114</i>
32	Sub-urban	4	16	19,687		<i>20,197</i>	16	20,218		<i>22,598</i>
33	Central	6	24	36,778		<i>34,786</i>		<i>37,469</i>		<i>40,593</i>
34	Central	4	16	58,776		<i>59,072</i>		<i>70,812</i>		<i>63,462</i>
35	Sub-urban	6	16	35,679		<i>35,045</i>	16	36,638		<i>36,630</i>
36	Central	6	24	65,984	24	57,362	24	70,510	16	61,574
37	Sub-urban	4	24	48,951		<i>48,745</i>		<i>52,779</i>		<i>52,288</i>
38	Central	4	24	60,052	24	59,791	24	69,600	16	64,979
39	Central	6	24	41,898	24	43,586	24	47,460	16	55,371
40	Rural	4	24	35,464		<i>35,507</i>		<i>36,911</i>		<i>35,351</i>
41	Rural	2	24	27,487	24	25,619	24	29,437		<i>33,633</i>
42	Sub-urban	4	16	41,655		<i>43,006</i>		<i>43,239</i>		<i>48,732</i>
43	Sub-urban	4	24	37,624		<i>37,511</i>		<i>40,031</i>		<i>39,127</i>
44	Central	4	24	26,257		<i>26,538</i>		<i>31,960</i>		<i>28,847</i>
45	Sub-urban	4	16	46,098		<i>46,198</i>		<i>49,928</i>		<i>50,178</i>

Source: JET

Note 1: Black italics are estimated 24-hour traffic count, which is the sum of 16-hour traffic count and estimated nighttime traffic count.

Note 2: Blue italics are estimated 24-hour traffic count.

Table 3-3-9 Estimated Traffic Count by Link (2022)

Link No.	Location	Lane	Autumn-Weekday		Autumn-Weekend		Winter-Weekday		Winter-Weekend	
			Hour	Count	Hour	Count	Hour	Count	Hour	Count
1	Rural	4	16	37,631		<i>36,812</i>	16	35,844		<i>33,127</i>
2	Sub-urban	4	24	47,232		<i>51,885</i>		<i>46,451</i>		<i>45,947</i>
3	Sub-urban	4	24	33,207	24	41,954	24	36,330	24	29,171
4	Sub-urban	4	16	27,663		<i>30,988</i>		<i>27,106</i>		<i>26,093</i>
5	Rural	4	24	22,716		<i>21,706</i>		<i>21,792</i>		<i>20,177</i>
6	Rural	6	16	49,680		<i>47,025</i>	16	50,097		<i>46,275</i>
7	Sub-urban	6	24	63,948	24	45,856	24	50,036	24	46,883
8	Sub-urban	4	16	34,486		<i>37,947</i>	16	34,034		<i>33,827</i>
9	Sub-urban	4	24	33,594	24	35,906	24	35,222	24	37,280
10	Rural	4	16	45,838		<i>44,152</i>	16	45,841		<i>42,272</i>
11	Rural	4	16	27,961		<i>26,783</i>		<i>25,808</i>		<i>23,604</i>
12	Rural	4	16	41,322		<i>40,304</i>		<i>37,285</i>		<i>33,582</i>
13	Rural	8	24	88,572	24	78,062	24	79,393	24	72,933
14	Rural	6	24	91,839		<i>88,463</i>		<i>88,250</i>		<i>82,083</i>
15	Sub-urban	4	24	32,634	24	29,874	24	34,669		<i>34,212</i>
16	Sub-urban	6	16	59,487		<i>42,477</i>	16	54,805		<i>51,124</i>
17	Sub-urban	4	24	74,600		<i>53,131</i>		<i>66,090</i>		<i>60,210</i>
18	Central	6	24	86,808		<i>89,277</i>		<i>87,130</i>		<i>91,965</i>
19	Sub-urban	6	24	49,494	24	55,872	24	39,610	24	41,110
20	Central	4	24	35,674		<i>32,818</i>		<i>33,017</i>		<i>32,419</i>
21	Central	4	24	23,353		<i>21,409</i>		<i>21,394</i>		<i>21,168</i>
22	Central	4	24	18,466	24	16,587	24	19,892	24	12,281
23	Central	4	24	28,258	24	28,773	24	26,610		<i>26,322</i>
24	Sub-urban	4	24	47,190		<i>33,250</i>		<i>41,601</i>		<i>38,604</i>
25	Sub-urban	6	24	74,308		<i>52,912</i>		<i>65,844</i>		<i>59,997</i>
26	Central	6	24	49,445	24	43,714	24	47,608	24	54,240
27	Central	6	24	46,520		<i>47,234</i>		<i>47,388</i>		<i>49,342</i>
28	Sub-urban	6	24	61,482		<i>46,204</i>		<i>52,744</i>		<i>52,350</i>
29	Central	4	24	38,892	24	34,147	24	40,606		<i>40,449</i>
30	Central	4	16	53,070		<i>46,084</i>	16	47,013		<i>48,180</i>
31	Central	4	24	65,283	24	63,888	24	57,909		<i>57,957</i>
32	Sub-urban	4	16	22,490		<i>24,718</i>	16	21,825		<i>20,978</i>
33	Central	6	24	44,215		<i>44,974</i>		<i>44,775</i>		<i>46,615</i>
34	Central	4	24	47,244		<i>42,305</i>		<i>42,135</i>		<i>42,176</i>
35	Sub-urban	6	16	31,749		<i>23,153</i>	16	30,537		<i>28,901</i>
36	Central	6	24	75,398	24	63,232	24	62,618	24	70,874
37	Sub-urban	4	24	40,464		<i>44,670</i>		<i>39,448</i>		<i>38,214</i>
38	Central	4	24	70,333	24	59,638	24	56,741	24	56,936
39	Central	6	24	43,574	24	49,451	24	45,659	24	40,341
40	Rural	4	24	35,604		<i>36,510</i>		<i>35,802</i>		<i>33,027</i>
41	Rural	2	24	24,878	24	28,219	24	20,663		<i>18,973</i>
42	Sub-urban	4	16	41,529		<i>47,347</i>		<i>40,979</i>		<i>36,653</i>
43	Sub-urban	4	24	38,133		<i>42,393</i>		<i>37,364</i>		<i>36,321</i>
44	Central	4	24	26,065		<i>23,747</i>		<i>10,625</i>		<i>10,622</i>
45	Sub-urban	4	16	46,098		<i>49,587</i>		<i>44,093</i>		<i>43,280</i>

Source: JET

Note 1: Black italics are estimated 24-hour traffic count, which is the sum of 16-hour traffic count and estimated nighttime traffic count.

Note 2: Blue italics are estimated 24-hour traffic count.

Furthermore, these traffic survey results in 2019 and 2022 were compared with the one in 2010. Comparison of the traffic count at survey points by seasons on weekday is shown in Figure 3-3-10 to

Figure 3-3-13. Traffic counts on non-winter weekday in 2019 averaged about 1.4 times that of 2010 and maximum 3.8 times that of 2010. Traffic count on non-winter weekday in 2022 averaged about 1.5 times that of 2010 and maximum 5.2 times that of 2010. The traffic count on non-winter weekday in 2022 averaged about 1.0 times that of 2019 and maximum 1.4 times that of 2019.

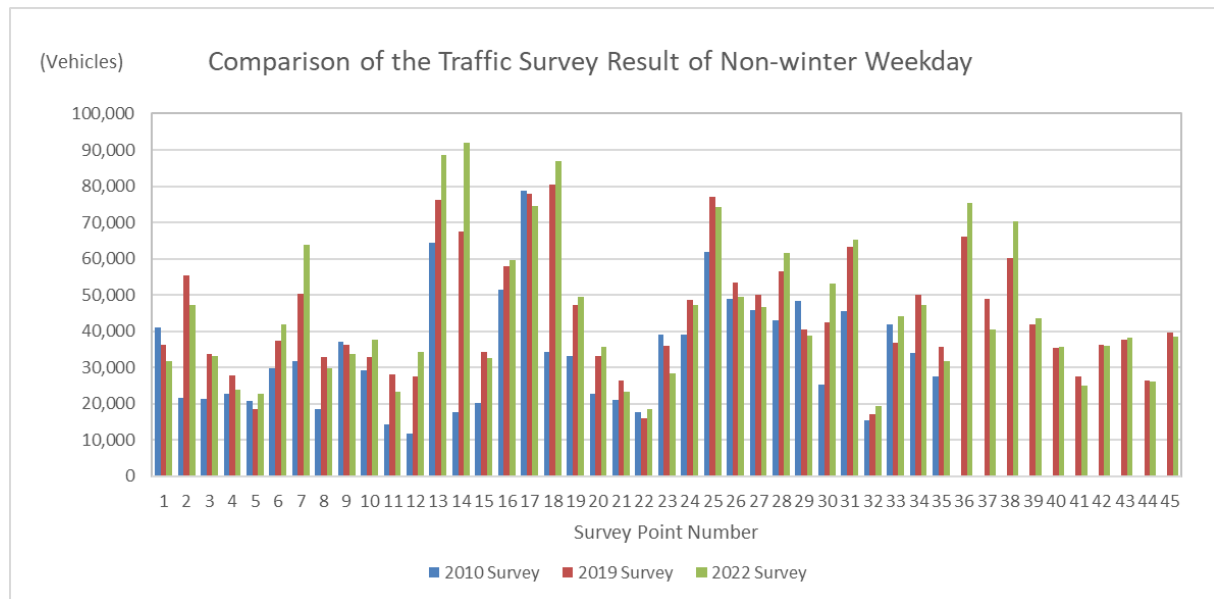
The traffic count on non-winter weekend in 2019 averaged about 1.5 times that of 2010 and maximum 1.9 times that of 2010. The traffic count on non-winter weekend in 2022 averaged about 1.5 times that of 2010 and was up to 2.2 times that of 2010. The traffic count on non-winter weekend in 2022 averaged about 1.0 times that of 2019 and maximum 1.3 times that of 2019.

On the other hand, the traffic count on winter weekday in 2019 averaged about 1.4 times that of 2010 and maximum 2.4 times that of 2010. The traffic count on winter weekday in 2022 averaged about 1.3 times that of 2010 and maximum 2.0 times that of 2010. The traffic count on winter weekday in 2022 averaged about 0.9 times that of 2019 and maximum 1.3 times that of 2019.

The traffic count on winter weekend in 2022 averaged about 0.9 times that of 2019 and maximum 1.2 times that of 2019.

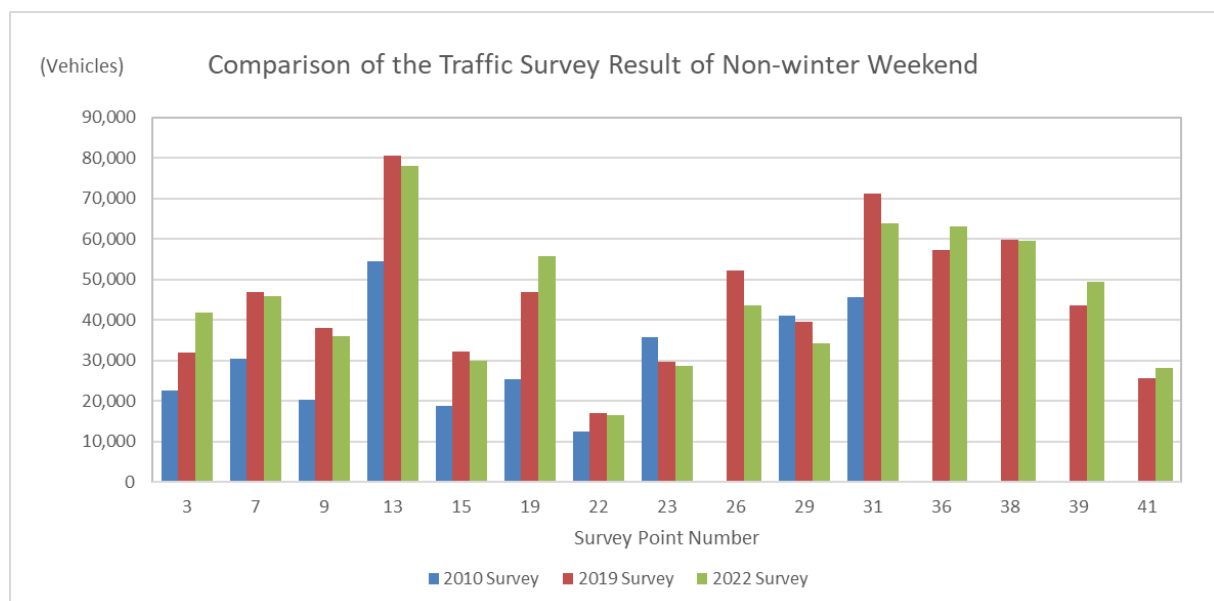
Compared to 2010, traffic counts increased at many points in 2019, particularly Yarmag area in the southwestern of UB City. The increase of the traffic count for commuting office or school is caused by the construction of apartments, shopping malls, and schools around this area after 2010. On the other hand, traffic count in 2022 was flat or slightly decreasing compared to 2019. The possible cause is thought to be the people avoided the use of cars to escape from severe traffic congestion.

In the trend of automobiles passed the technical inspection (Figure 3-3-14), automobiles passed the technical inspection increased 2.26 times from 2010 to 2019 and 2.68 times from 2010 to 2022. Although the traffic count in 2010 and 2019 cannot be simply compared due to no license plate driving regulation in 2010, it was found that the increase in traffic volume do not correspond to the increase in the number of automobiles which passed the technical inspection. Weekday daytime driving restriction by the number of license plates, which began in August 2012 as a measure to reduce traffic congestion in the central area of UB, is one of the factors that led to owning multiple cars to secure transportation. The material summarizing the survey results is shown in Annex 3-3-5.



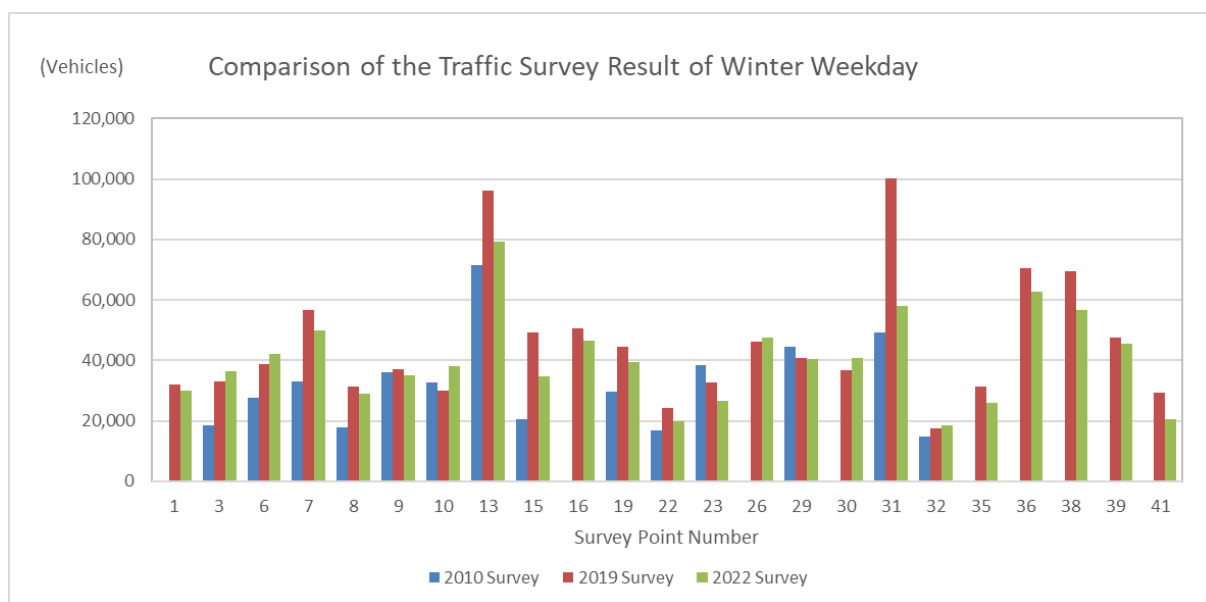
Source: JET

Figure 3-3-10 Comparison of the Traffic Survey Result on Non-Winter Weekday in 2010, 2019, and 2022



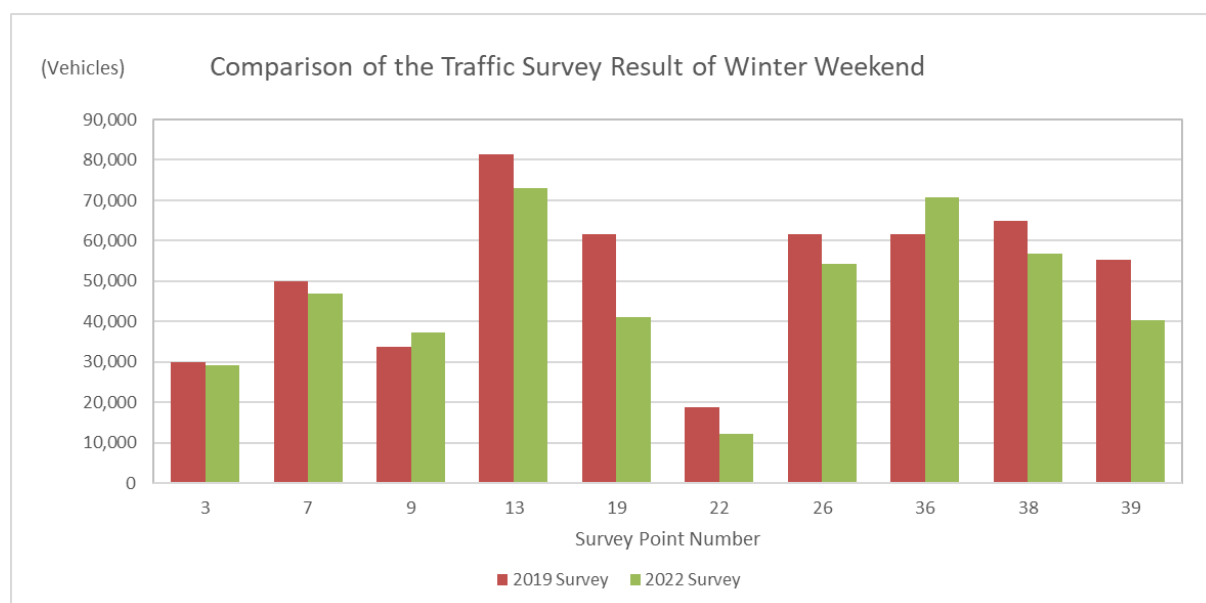
Source: JET

Figure 3-3-11 Comparison of the Traffic Survey Result on Non-Winter Weekend in 2010, 2019, and 2022



Source: JET

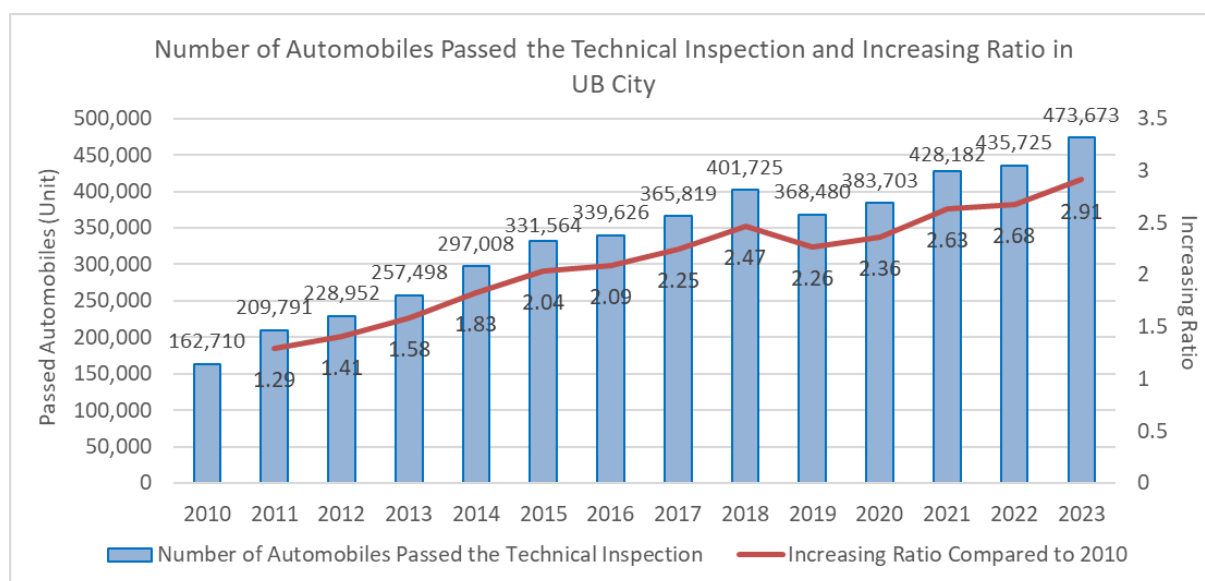
Figure 3-3-12 Comparison of the Traffic Survey Result on Winter Weekday in 2010, 2019, and 2022



Source: JET

Remarks: Traffic count was not surveyed in winter weekend in 2010.

Figure 3-3-13 Comparison of the Traffic Survey Result on Winter Weekend in 2019 and 2022



Source: Created by JET using “NUMBER OF AUTOMOBILES PASSED THE TECHNICAL INSPECTION, by type, by region, bag, soum, aimags and the Capital, by year” in “Mongolian Statistical Information Service” (www.1212.mn).

Figure 3-3-14 Number of Automobiles Passed the Technical Inspection in UB City

3) Activity 2-2-3: Actual Usage Survey of Small Stove

In order to calculate emissions from small stoves used by household, which is the main pollution source in UB City, and to improve the accuracy of reproducing the air pollution structure using the calculated emissions for simulation model, the actual usage survey for small stove was conducted to 84 households. Since fuel usage status varies by season, the survey was conducted in three seasons, winter (January 2023), spring (April 2023), and summer (June 2023). Photos of visiting target house before spring survey is shown in Photo 3-3-3. Regarding fuel input amount by time during daytime in winter, both improved fuel and wood were generally constant with exception of late night, although slightly higher in cooking hours such as morning, noon, and early evening (Figure 3-3-15). Although improved fuel input in spring morning was almost the same amount as winter, the input in spring daytime and evening was lower than that in winter. Input of wood in spring was much lower than in winter. In summer, both improved fuel and wood were rarely used. According to interviews on surveyed households, most households used induction cookers for summer cooking. Seasonal 24-hour emission patterns were set based on the results of each seasonal survey and reflected in simulation model.

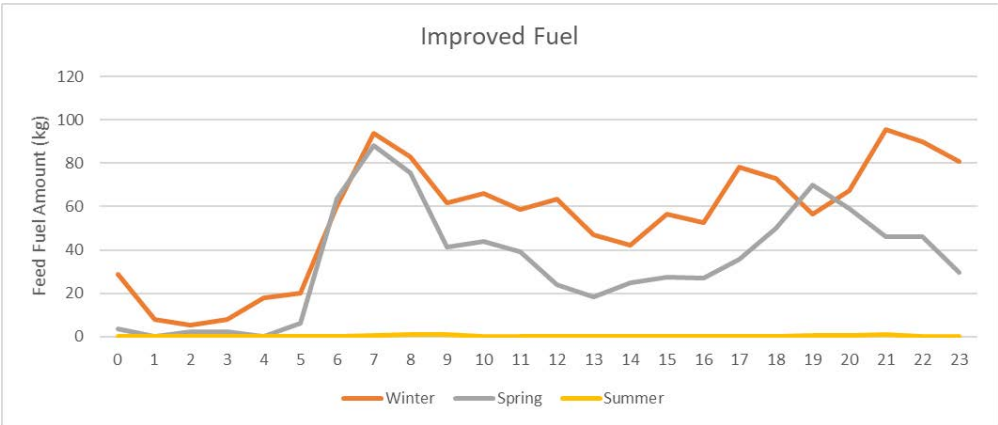


Figure 3-3-15 Seasonal Fuel Input by Time of Day Based on Actual Usage Survey of Small Stove (Improved Fuel)

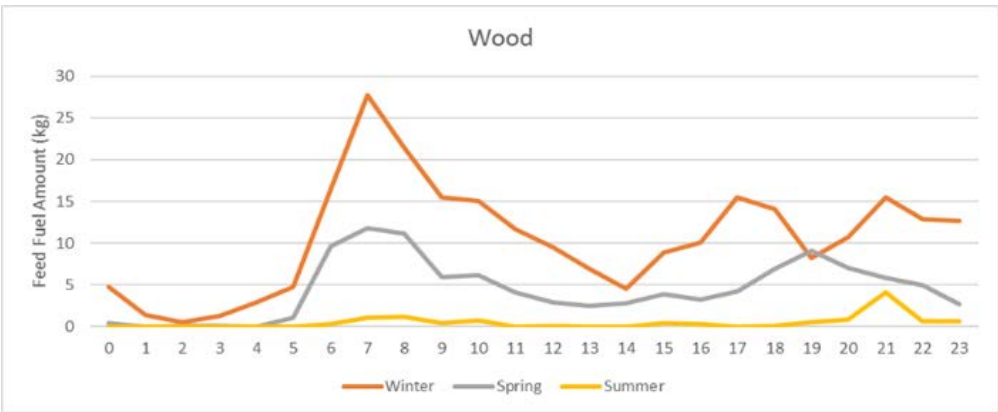


Figure 3-3-16 Seasonal Fuel Input by Time of Day Based on Actual Usage Survey of Small Stove (Wood)

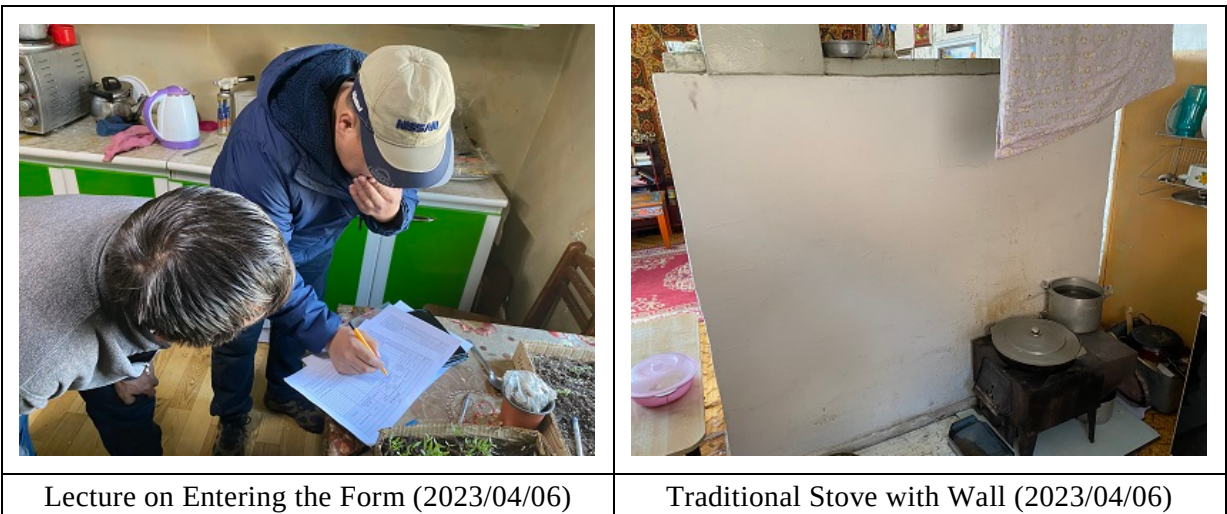


Photo 3-3-3 Visiting Target Household before Spring Survey

4) **Activity 2-2-4: Studies for Other Emission Sources**

In addition to the sources covered by this Project, air pollutant emissions at waste disposal sites were calculated. Waste disposal method in Mongolia is by landfill.

Activity data is the amount of municipal solid waste estimated using population. Population data by Khoroo in UB City was obtained from the statistical information release service of National Statistics Office of Mongolia (www.1212.mn). The annual municipal solid waste production per capita was set as 1.12 kg/person/day (408.82 kg/person/year)¹⁴, while the percentage of all municipal solid waste disposed to a landfill was assumed to be 65%¹⁵. The population in UB City and the calculated municipal solid waste amount are shown in Table 3-3-10.

Table 3-3-10 Population in UB City and Calculated Municipal Solid Waste Amount

	Unit	2018	2019	2020	2021
Population	person	1,444,669	1,466,125	1,499,140	1,539,252
Calculated municipal solid waste amount	ton	590,610	599,381	612,878	629,277

Source: Statistics Department of Ulaanbaatar City (<http://ubstat.mn/JobTables.aspx>)

Since there are no emission factors for air pollutants from landfill of waste disposal in Mongolia, Tier 1 values of EMEP/EEA Guidebook were used. These values are based on European emission studies. They depend on meteorological conditions and moisture content in waste. These emission factors are shown in Table 3-3-11.

Table 3-3-11 Emission Factor of Waste Disposal Site

Sub category	TSP	PM ₁₀	PM _{2.5}
Landfill	0.463	0.219	0.033

Unit: g/ton

Source: Table 3-1 in “5. A Biological treatment of waste - Solid waste disposal on land” of “EMEP/EEA air pollutant emission inventory guidebook 2016”

Annual emissions from waste disposal site in 2018 ~ 2021 are shown in Table 3-3-12.

¹⁴ Bolorchimeg Byamba and Mamoru Ishikawa (2017): Municipal Solid Waste Management in Ulaanbaatar, Mongolia: Systems Analysis, Sustainability 2017, 9, 896

¹⁵ Third National Communication of Mongolia, MET, 2018

Table 3-3-12 Annual Emission from Waste Disposal Site

Year	TSP	PM ₁₀	PM _{2.5}
2018	0.273	0.129	0.019
2019	0.278	0.131	0.020
2020	0.284	0.134	0.020
2021	0.291	0.138	0.021

Unit: ton/year

There are three waste disposal sites in UB City, each of which has a specific district for waste disposal. Therefore, emissions were distributed to the three disposal sites according to the population ratio of the target districts. Furthermore, these emissions were allocated with the area size of the disposal sites. The location of waste disposal sites is shown in Figure 3-3-17. Emissions for 2020 by the sites are shown in Table 3-3-13. PM emissions from disposal sites are very small compared to the coal combustion from power plants and other sources, and automobile emissions. In addition, these sites are located far from urban areas and are expected to have little impact on concentrations in residential areas.

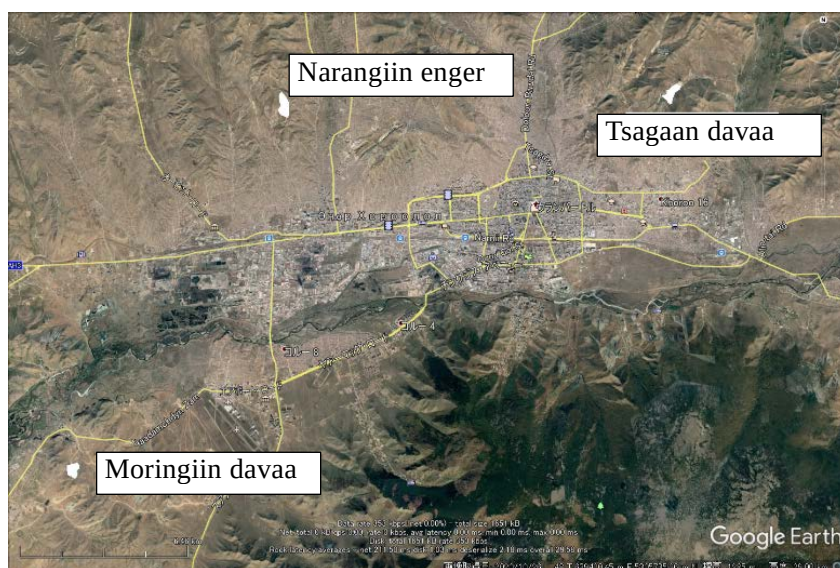


Figure 3-3-17 Location of Waste Disposal Sites

Table 3-3-13 Emission by Pollutants and Waste Disposal Sites in 2020

Disposal Site	Target Districts	TSP	PM ₁₀	PM _{2.5}
Narangiin enger	Songinokhairkhan, Chingeltei, Sukhbaatar, Nalaikh, Bayangol	0.171	0.081	0.012
Tsagaan davaa	Bayanzurkh	0.070	0.033	0.005
Moringiin davaa	Khan-Uul	0.037	0.018	0.003

Unit: ton/year

For fugitive ash from ash pond of power plants and brick factories, the technical transfer of the emission calculation method was conducted in the Project Phase 2. However, the person in charge at that time has been transferred and the Mongolian side could not calculate emission on oneself, the technical transfer was conducted again to the Mongolian side thus oneself could calculate the emissions on oneself. In addition to the sources covered by this Project, air pollutant emissions from brick manufacturing process were estimated for brick factories clustered in the northwestern part of the city. The emissions were estimated using the emissions calculation methodology used in the Project Phase 2. The calculation methodology is as follows.

$$\text{Emissions} = \sum \text{AD} \times \text{EF}$$

Where,

Emissions: Air pollutant emission (g)

AD: Production of bricks (ton/year)

EF: Emission Factors for Brick Manufacturing Operation (g/ton)

For estimating emission from brick manufacturing operation, production weight of bricks is necessary as activity data. The production of weight was calculated by multiplying the annual piece of bricks in statistic information website¹⁶ of UB City with the weight per a brick (3.2 kg/piece¹⁷). Number of produced pieces and weights of brick in UB City is shown in Table 3-3-14.

Table 3-3-14 Production of Bricks in UB City

	Unit	2018	2019	2020	2021
Brick	Million unit	14	15.6	5.6	6.7
	ton/year	44,800	49,920	17,920	21,440

Since emission factor for brick manufacturing operation in Mongolia do not exist, the values of AP-42 by USEPA were used as the emission factors. These emission factors are shown in Table 3-3-15.

¹⁶ <http://ubstat.mn/StatTable=362>

¹⁷ It is the average weight of some bricks in the survey of the Project Phase 2

Table 3-3-15 Emission Factors for Brick Manufacturing Operation

	PM	PM ₁₀	PM _{2.5}	SO ₂	NO _x	CO
Grinding and screening operations						
processing wet material	0.025	0.0023	ND			
Coal-fired kiln				1.2	0.51	0.8
uncontrolled	1.8	1.4	0.87			

ND: No Data

Unit: "lb. /ton". To convert from "lb. /ton" to "kg/Mg", multiply by 0.5.

Emissions for brick manufacturing operation in UB City in 2018~2021 are shown in Table 3-3-16.

Table 3-3-16 Emissions for Brick Manufacturing Operation

Year	TSP	PM ₁₀	PM _{2.5}	SO ₂	NO _x	CO
2018	40.88	31.41	19.49	26.88	11.42	17.92
2019	45.55	35.00	21.72	29.95	12.73	19.97
2020	16.35	12.56	7.80	10.75	4.57	7.17
2021	19.56	15.03	9.33	12.86	5.47	8.58

Unit: ton/year

PM emissions for brick manufacturing operation are about 16 tons/year in 2020, which is very low compared to emissions from stoves (about 1,500 tons/year). The factories are also located away from building and Ger district and is expected to have little impact on winter concentrations in residential areas.

5) Activity 2-2-5: Elaborating BAU Scenario

JET elaborated a draft BAU scenario using statistics of fuel use and the number of households for the last years as indicators (Table 3-3-17). JET discussed this draft with the Mongolian side and agreed to use the increase rate under the BAU scenario to calculate emissions for the case where the increase rate continues until target years. The target year was set to 2027, as it was considered possible to set overall goal by assuming three years after the end of this Project, which is assumed in the PDM's overall goal. In addition, the reference year was set to 2020, when the improved fuel was introduced and in full use.

Table 3-3-17 Setting of BAU Scenario

Source	Indicator for Calculating Increase Rate	Reference Year	Average Increase Rate (%/year)
Power plant	Increase rate of fuel consumption by power plants from 2015 to 2020	2020	0.6~5.8
HOB	Increase rate of fuel consumption of HOB from 2016 to 2020		-5.8
CFWH	Increase rate of fuel consumption of CFWH from 2015 to 2020		8.5
Small stove for household	Increase rate of population of district by house type from 2015 to 2020		Ger: -2.7 House: 0.4
Automobile	Increase rate of automobiles passed inspection by automobile type from 2019 to 2022		Passenger car: 6.4 Bus: 8.8 Truck: 3.7

Source: JET

6) Activity 2-2-6: Updating Emission Inventory

DAAEP under the support of JET elaborated emission inventory and the annual report for 2018 and 2020~2022. The reports are published in the DAAEP's website. The latest emission inventory report is shown in Annex 2-2-1-16.

2020 emissions by sources is shown in Table 3-3-18. Emission from automobile exhaust gas in UB City was calculated using emission factors for emission standard categories in Japan. It is because more than 80% of the automobiles in UB City is made in Japan. Considering deterioration based on the fuel quality and automobile maintenance condition in Mongolia, coefficients were set and multiplied with emission factors. Since gasoline automobiles, which emit less PM, account for nearly 80% of UB City, PM emission from automobiles is lower than other sources. Further measurements using the granted on-board emission measurement system will make it possible to calculate emissions closer to the actual situation in Mongolia.

Table 3-3-18 2020 Emissions by Sources

	SO _x	NO _x	TSP	PM ₁₀	CO
Power plant	13,544	18,114	24,514	22,447	10,415
HOB	1,429	356	1,687	1,603	4,612
CFWH	498	126	73	63	4,414
Small stove for household	5,612	2,073	1,813	1,667	65,289
Automobile exhaust gas	298	3,546	244	244	20,287
Road dust			3,417	3,417	
Fugitive ash from ash pond in power plant			4,951	1,521	
Total	21,382	24,214	36,698	30,962	105,017

Unit: ton/year

Emissions for 2017 to 2022 is shown in Table 3-3-19.

SOx emissions are on the rise, with a particularly large increase in 2020. This is thought to be due to the high sulfur content in the improved fuel introduced, although fuel used in small stove for household has been converted from raw coal to improved fuel. Another possible factor is that the fuel amount used in power plants is also on the rise.

NOx emissions from automobile exhaust gas and from small stove for household have increased. The emission increasing is thought to be due to lower travel speeds caused by worse traffic congestion.

TSP emission from small stove for household is decreasing due to the reduction of dust concentration in flue gas in small stove for household along with the introduction of improved fuel in 2019. On the other hand, emission from ash ponds at power plants fluctuate widely from year to year since the emission depends on the dry conditions of the ponds.

PM₁₀ emissions have been decreasing since 2017. Similar to the case with TSP, this may be due to the reduction of dust concentration in flue gas in small stove for household along with the introduction of improved fuels in 2019. From calculated PM₁₀ emissions for 2022 from power plants, one of the reasons for the decrease of the PM₁₀ emissions may be due to the revision of PM₁₀ emission factors of power plants.

CO emissions have increased since 2018. Especially, CO emissions from small stove for household and automobile have increased significantly. This is likely due to wood combustion, as the use of wood has increased along with the introduction of improved fuels.

Table 3-3-19 Emissions by Pollutant

	2017	2018	2020	2021	2022
SOx	17,174	16,973	21,382	21,939	24,014
NOx	22,663	23,458	24,214	27,416	29,930
TSP	35,718	35,951	36,698	38,526	42,447
PM ₁₀	32,043	32,343	30,962	30,007	27,035
CO	73,632	62,769	105,017	115,199	133,280

Unit: ton/year

For evaluating control measures based on the results of pilot projects, 2027 emissions under the BAU scenario were calculated using the settings elaborated in Activity 2-5-5. A comparison of the calculated 2027 emissions with 2020 is shown in Figure 3-3-18. These results were used to evaluate control measures set based on the results of pilot projects.

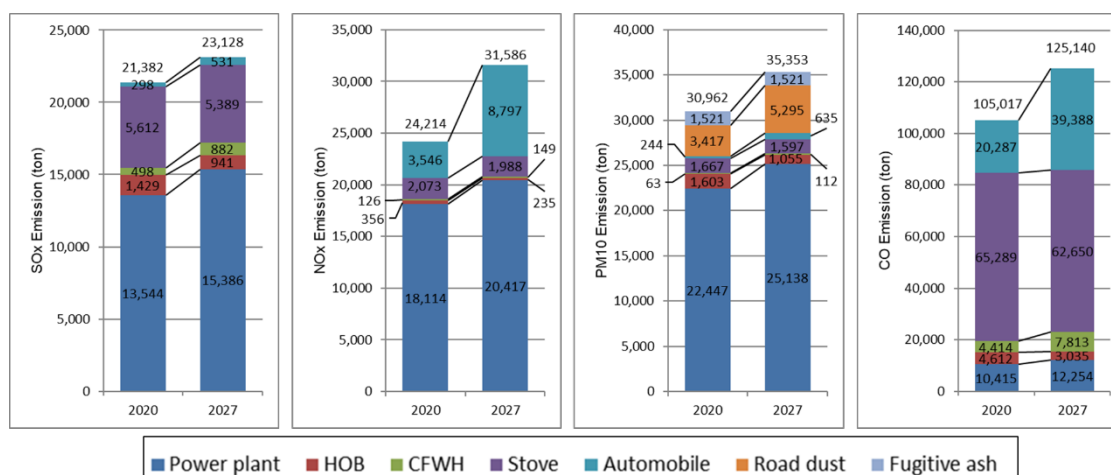


Figure 3-3-18 2020 and 2027 under BAU Scenario Emissions by Pollutant

3-3-2-2 Activity 2-2-7 ~ 2-2-9: Updating Air Quality Simulation Model

2-2-7 DAAEP and NAMEM update the air quality simulation model for PM₁₀, SO₂ and NO_x.
2-2-8 DAAEP and NAMEM evaluate the air pollution structure of UB City.
2-2-9 DAAEP and NAMEM evaluate indicative population exposure of PM₁₀ based on population-weighted concentration and so on.

(1). Capacity Development and Seminar on Simulation

The training for executing dispersion simulation model was conducted in March 2022 and April 2023. Related to Activity 6-3, National University of Mongolia (NUM), which implements the dispersion simulation with NAMEM, also participated the training of April 2023. The summary is shown in Table 3-3-20.

Table 3-3-20 Training and Seminar on Activity 2-2-7 ~ 2-2-9

No	Date	Contents
1	2022-03-11, 14, 15, 16, 18	Training for executing dispersion simulation model using 2018 emission
2	2022-10-05	Seminar on the result of air quality simulation before and after the introduction of improved fuel (Annex 3-3-6)
3	2023-04-04, 7, 11	Training for executing dispersion simulation model including the confirmation of NUM's ability to execute the simulation model
4	2024-01-24	Seminar on the result of developing PM ₁₀ simulation model considering condensable particle matter (Annex 3-3-7)
5	2024-03-13	Seminar on Population-Weighted Exposure (PWE) and the evaluation of pilot projects (Annex 3-3-8)

(2). Output of the Activities

1) Summary of Simulation Model in UB City

Based on CALPUFF model developed using 2018 emission data and 3D meteorological data by WRF, a dispersion simulation model was executed with emission data updated to 2020. The summary of meteorological model (WRF) and the dispersion simulation model (CALPUFF) are shown in Table 3-3-21 and Table 3-3-22.

Table 3-3-21 Summary of Meteorological Model (WRF)

Contents	D1 (Whole Mongolia)	D2 (Central Mongolia)	D3 (Whole UB City)
Version	WRF-ARW version 4.1.5		
Horizontal Coordinate System	Lambert conformal conic projection Standard Latitude: 30 N, 60 N Standard Longitude: 105.9 E		
Vertical Coordinate System	σ -P Coordinate system, top layer is 50 hPa (about 19,000 m)		
Grid Number	160 × 94 × 32	121 × 121 × 32	91 × 91 × 32
Resolution	20 km	5 km	1 km
Height at the Bottom Layer	About 27 m		

Table 3-3-22 Summary of Dispersion Model

Item	Contents
Model Used	CALPUFF version 7.2.1
Topography data	SRTM30/GTOPO30 Global Data (0 to 900 m, 30 arc-sec)
Land use data	USGS Land Use/Land Cover Scheme Eurasia (optimized for Asia)
Meteorology data	WRF-ARW version 4.1.5
Target area	34 km × 28 km including the central area
Resolution	1 km × 1 km
Target Pollutants	SO ₂ , NO _x , TSP, PM ₁₀ , SO ₄ , NO ₃ , HNO ₃ , CO
Emission Sources	2020 Emission inventory; TPP, HOB, CFWH, small stove for household, major road, minor road, fugitive dust from road, and fugitive ash from ash pond of TPP
Period	2020-03-01 ~ 2021-02-28
Concentration calculation points	Center points of 1 km × 1 km grid Air Quality Monitoring Station points

Source: JET

2) Developing Dispersion Simulation Model

Based on Table 3-3-22, in order to investigate the cause of high SO₂ concentration in 2020, JET developed the dispersion simulation model of 2018 as the current year that is before the improved fuel was introduced. Then, the air pollution structure in 2018 was evaluated. The target period for the evaluation was the winter season (November 2018 ~ February 2019) when air pollution was severe.

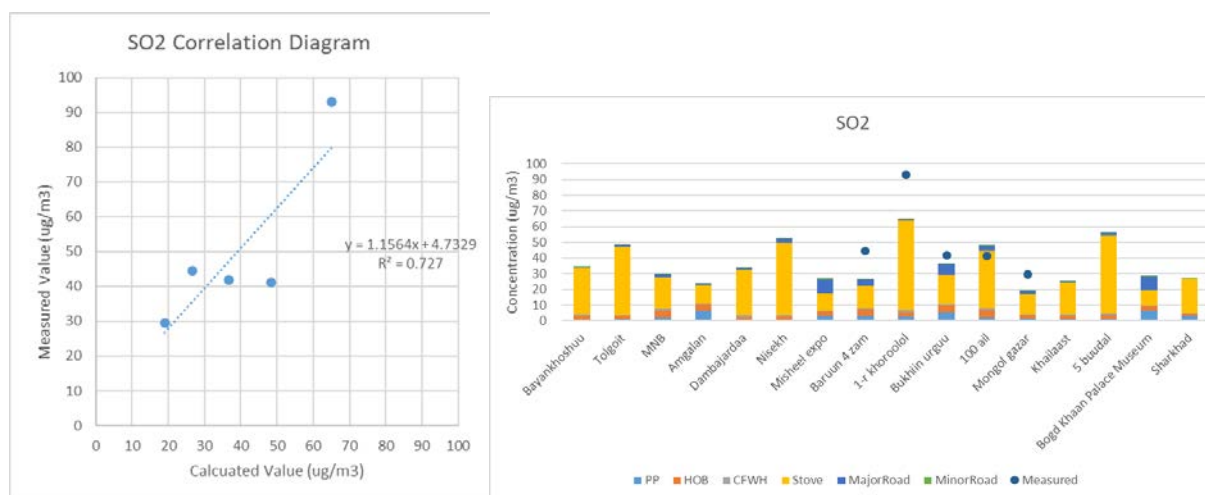
In order to evaluate the accuracy of the simulation model for the target calculation period, the average concentration by pollutant measured by AQMSs was compared with the sum of calculated concentration for each source using CALPUFF model, and the correlation coefficient and the slope of the approximate straight line were checked and evaluated. As the correlation coefficient and the slope of the line are closer to 1, it is considered that the model is reproducing the measured concentration well.

From 2018 to 2019, DAAP generally did not calibrate its AQMS analyzers, and the other maintenance works of the AQMSs were not sufficient also. Therefore, since there was no sufficient guarantee of the measurement results, JET decided to use the data from CLEM's AQMSs for comparison with the calculation results of the simulation model developed in this Project. In addition, among the measurement data from CLEM's AQMSs, measurement items whose effective measurement hours were less than 68.5%¹⁸ of the calculation period were excluded from the evaluation.

Regarding SO₂, the correlation between measured and calculated values, and the cumulated concentration at the point of AQMS are shown in Figure 3-3-19. The correlation coefficient was 0.8526, which was highly correlated, and the slope of the approximate straight line was 1.16, meaning that the calculated concentration was slightly underestimated, however, the reproducibility was generally high.

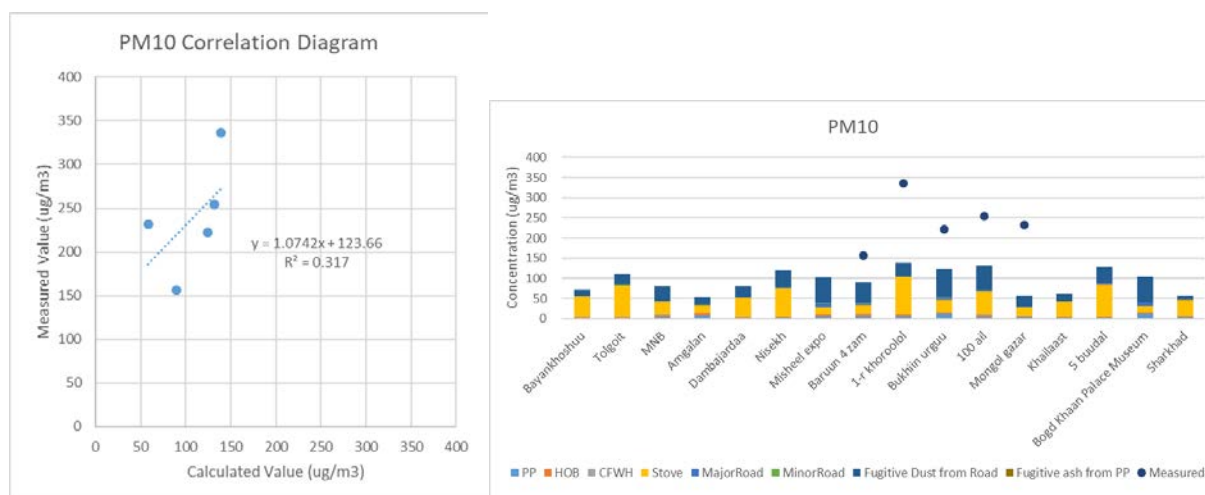
Regarding PM₁₀, the correlation between measured and calculated values, and the cumulated concentration at the point of AQMS are shown in Figure 3-3-20. The correlation coefficient was 0.5630, which was not high, and the calculated value was less than the measured value as a whole. Since the PM₁₀ concentration in CALPUFF is only for primary particles and some secondary particles are considered in pseudo-primary chemical reaction model, meaning that there was the room for improvements by considering secondary particles and condensable dust by PM component analysis and PMF analysis.

¹⁸ The effective measured time of 68.5% is obtained by dividing 6000 hours, which is the effective measurement hours for the annual average value in Japan, by total annual hours of 8760 hours.



Source: JET

Figure 3-3-19 Correlation and Cumulated Concentration at the Point of AQMS (SO₂)



Source: JET

Figure 3-3-20 Correlation and Cumulated Concentration at the Point of AQMS (PM₁₀)

3) Improving PM₁₀ Simulation Model Using the Result of Source Apportionment

The result of source apportionment from receptor model (PMF) in Activity 2-1 was used to improve PM₁₀ simulation model.

PM concentration estimated by the simulation model in the Project Phase 1 were under-estimated compared to the actual measured values. The reason for this was considered as the fact that the simulation model did not include the generation process for condensable particle matter. Therefore, in the Project Phase 2, the contribution of condensable particle matter was calculated based on the results of source apportionment, and PM₁₀ emission was adjusted. Similarly, the contribution of condensable particle matter was calculated and used to confirm and correct the correction values in this Project Phase 3.

PM₁₀ concentrations by sources were calculated from the average PM₁₀ concentrations in winter at AQMSs using the percentage contribution by source factor in winter from source apportionment by PMF. PM₁₀ emission considering condensable particle matter was calculated by using the ratio of the calculated PM₁₀ concentration to PM₁₀ concentration by sources with CALPUFF as the correction value.

Table 3-3-23 Concentration by Source Factor and Ratio of Generation Process for Condensable Particle Matter by PMF

	Coal Combustion	Wood Combustion	Automobile Exhaust Gas	Crustal	Sulfate	Nitrate	Others
Average of PM ₁₀ concentration measured at AQMSs (C _{AQ})	123.01						
PM ₁₀ distribution ratio of source estimated using PMF (A, %)	40.35	15.19	2.01	12.60	17.15	7.00	5.70
PM ₁₀ concentration of each source (C _S =C _{AQ} *A/100, µg/m ³)	49.63	18.69	2.47	15.50	21.10	8.61	7.01
Concentration by CALPUFF (C ₁ , µg/m ³)	20.03	12.23	1.61	4.64	8.51	1.40	
R=C _S /C ₁	2.479	1.528	1.528		2.479	6.132	

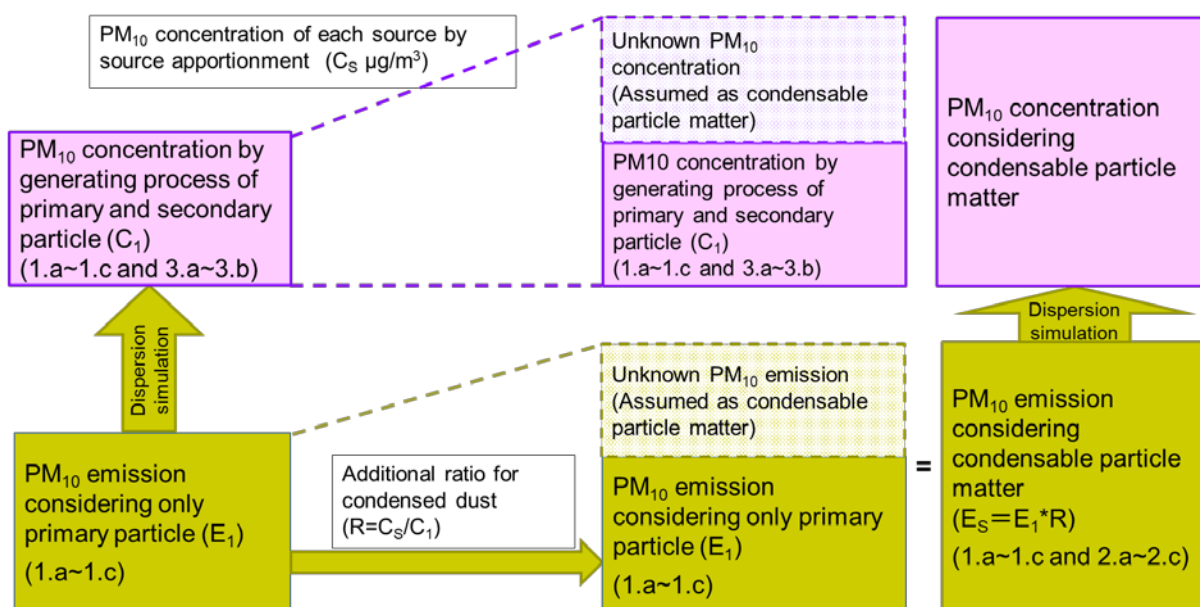
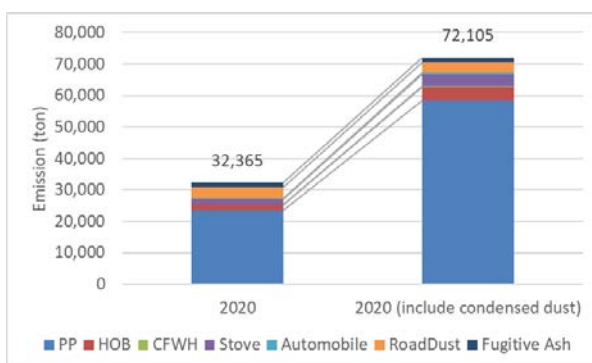


Figure 3-3-21 Generation Process for Condensable Particle Matter

Table 3-3-24 PM₁₀ Emission Considering Condensable Particle Matter (2020)

	Emission as primary particle	Condensable particle matter	Total
Power Plant	23,500	34,814	58,313
HOB	1,715	2,536	4,251
CFWH	101	150	252
Small stove for household	1,838	2,078	3,916
Automobile exhaust gas	266	162	429
Road dust	3,423	0	3,423
Fugitive ash from pond	1,521	0	1,521
Total	32,365	39,741	72,105



Unit: ton/year

CALPUFF model was executed again with PM₁₀ emissions with consideration of condensable particle matter. The calculation result became close to the winter average concentration measured by AQMSs.

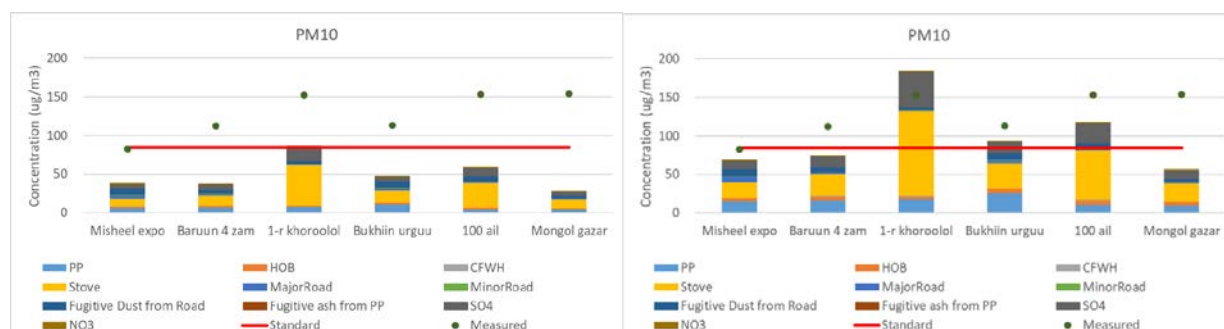


Figure 3-3-22 PM₁₀ Concentration at AQMSs before and after Considering Condensable Particle Matter

4) Result by Simulation Model

Using emission inventory for 2020 and the dispersion simulation model re-developed above, winter and annual concentrations were calculated for SO₂ and PM₁₀ by grid.

The results of the dispersion simulation are shown from Figure 3-3-23 to Figure 3-3-26.

(i) SO₂

Average concentration of SO₂ for four months in the winter season exceeded 100 µg/m³ in the north and east of the Ger district. Average annual concentrations of SO₂ in these areas exceed the air quality standard of 20 µg/m³ by four times. SO₂ concentrations in the Ger district exceeded 80 µg/m³, meaning these areas are highly polluted.

Regarding the SO₂ cross-section diagram, small stoves had the largest contributions in most areas. Therefore, to satisfy the air quality standard, air pollution control measures are necessary to reduce SO₂ concentration to less than one-third of the current concentration in the Ger district, which is located around the central area.

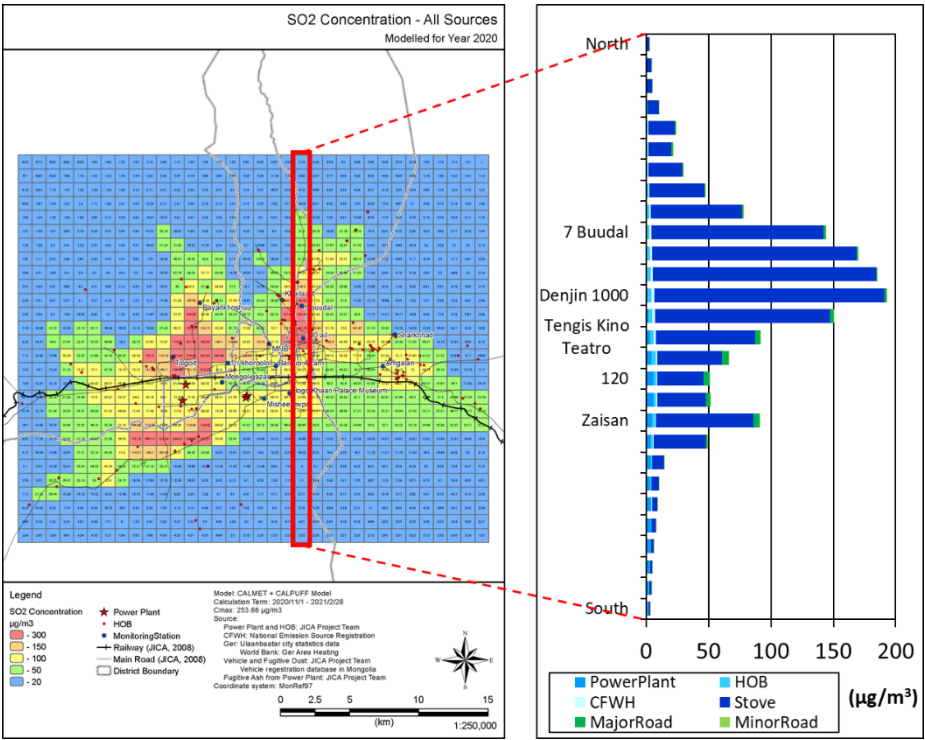


Figure 3-3-23 Concentration Distribution and Cross-Section Diagram by Source of SO₂ in Winter

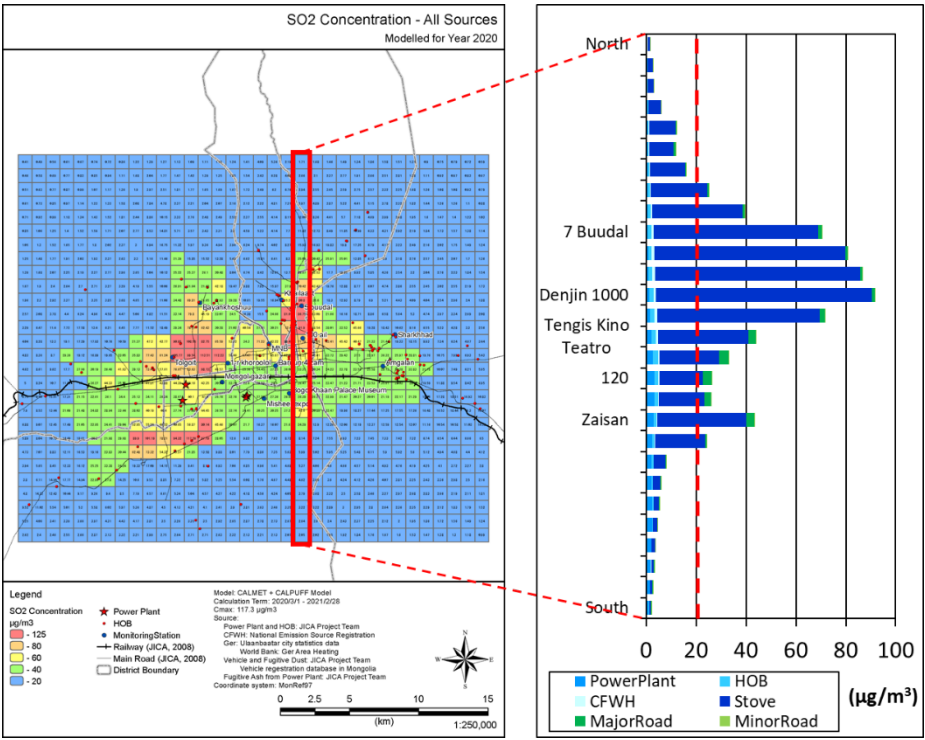


Figure 3-3-24 Concentration Distribution and Cross-Section Diagram by Source of SO₂ throughout the Year

(ii) PM₁₀

Average concentration of PM₁₀ for four months in the winter season exceeded 100 µg/m³ in the northwest, north, and southwest of Ger districts. Average annual concentration of PM₁₀ in these areas were simulated to be more than twice of 50 µg/m³, which is the air quality standard for PM₁₀. The concentration of PM₁₀ for four months in the winter season exceeded 150 µg/m³ in the Ger district.

Regarding PM₁₀ concentration distribution and cross-section diagram, small stoves contributed the most, followed by fugitive road dust and power plant (Figure 3-3-25 and Figure 3-3-26).

Therefore, for PM₁₀ concentration to satisfy the air quality standard, air pollution control measures are necessary to reduce PM₁₀ concentration to less than one-third of the current concentration in the Ger district, which is located around the central area.

PM₁₀ concentrations in southern area from Zaisan, which is Nature protected area of Bogdkhaan Mountain, are lower than in the central and northern Ger districts, and much less than the air quality standard. However, the contribution from power plant in this area is larger than other areas. This is caused by the high stack height of the power plant, leading pollutants to spread farther and land in the southern mountain region. Therefore, since some areas are highly influenced by power plants, it is necessary to consider installing dust removal equipment for power plants, in addition to reducing concentrations through control measures of stoves and automobiles.

Areas exceeding the annual average air quality standard for PM₁₀ of 50 µg/m³ had spread throughout UB City, with particularly high PM₁₀ concentration areas in the northwestern and southwestern of UB City.

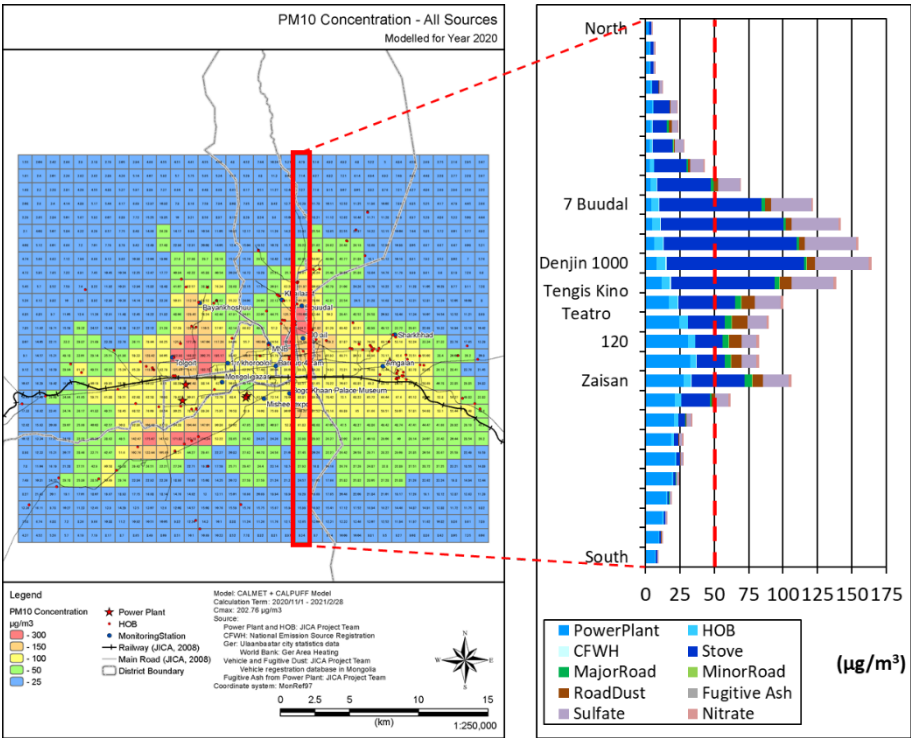


Figure 3-25 Concentration Distribution and Cross-Section Diagram by Source of PM₁₀
Considering Condensable Particle Matter in Winter

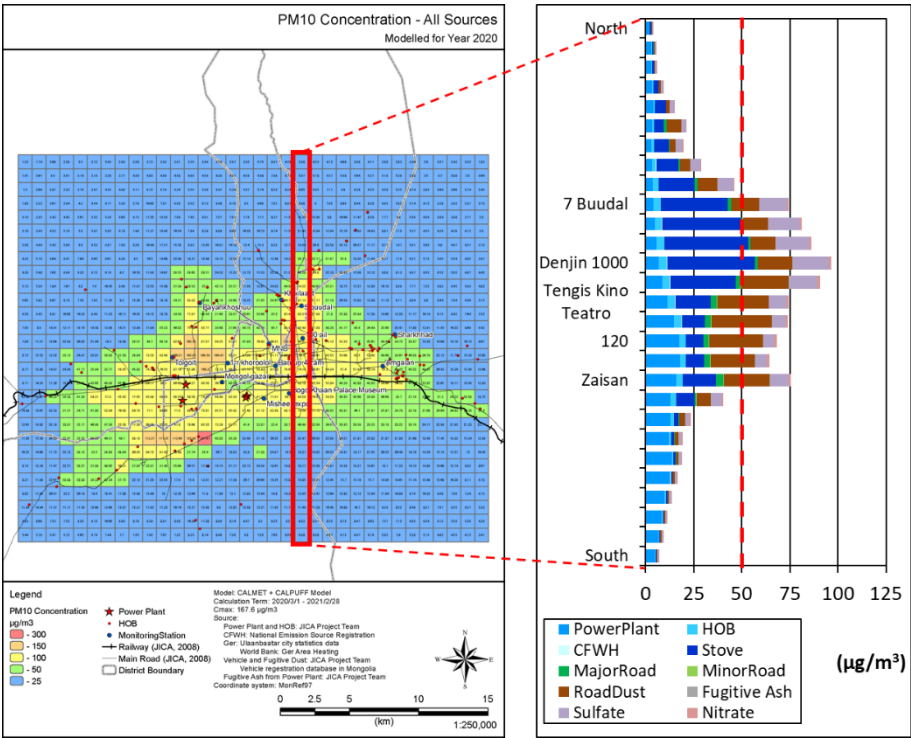


Figure 3-26 Concentration Distribution and Cross-Section Diagram by Source of PM₁₀
Considering Condensable Particle Matter throughout the Year

5) PWE and Exposure

To evaluate the impact of air pollution on citizens in UB, population-weighted exposure (PWE; Population-Weighted Exposure) was calculated from PM₁₀ concentration for 2020 and 2027 BAU scenario obtained through dispersion simulation. Regarding fuel combustion sources, PWE and averaged PM₁₀ concentration in the residential area for the 2020 and 2027 BAU scenario is shown in Figure 3-3-27. PWE was calculated using the WB (2011)¹⁹ method shown below. By using PWE, it is possible to calculate an average concentration that considers the size of population affected by pollutant, compared to average concentration. Figure 3-3-28 shows the percentage of total exposure ($\sum(C_i \times P_i)$) by source in the calculation domain for 2020 and 2027 BAU scenario. Exposure from small stoves for households is the largest, followed by thermal power plants and automobiles. These values were used to evaluate air pollution control measures based on Pilot Projects.

$$PWE = \frac{\sum(C_i \times P_i)}{P_{total}}$$

C_i : Concentration in grid i ($\mu\text{g}/\text{m}^3$)

P_i : Population in grid i

P_{total} : Total population in calculation area

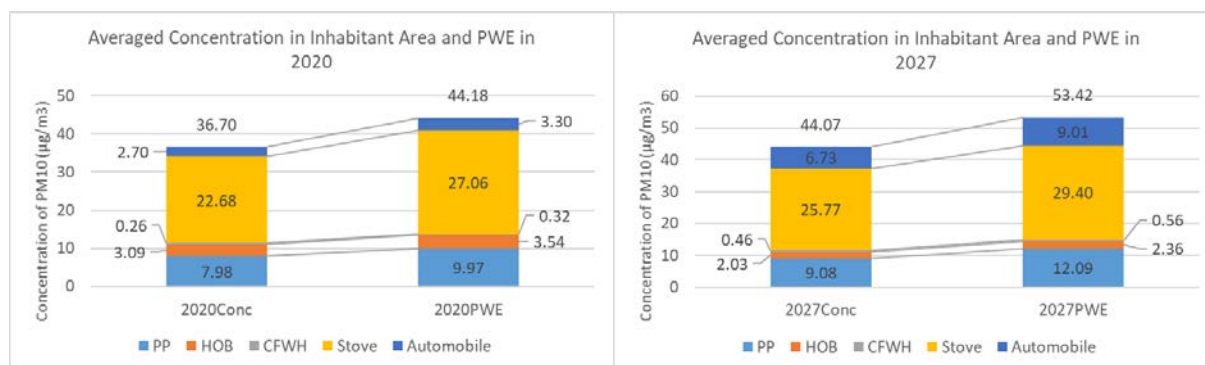


Figure 3-3-27 PWE and Average Concentration in Residential Area in 2020 and 2027

¹⁹ Air Quality Analysis of Ulaanbaatar Improving Air Quality to Reduce Health Impacts, WB 2011

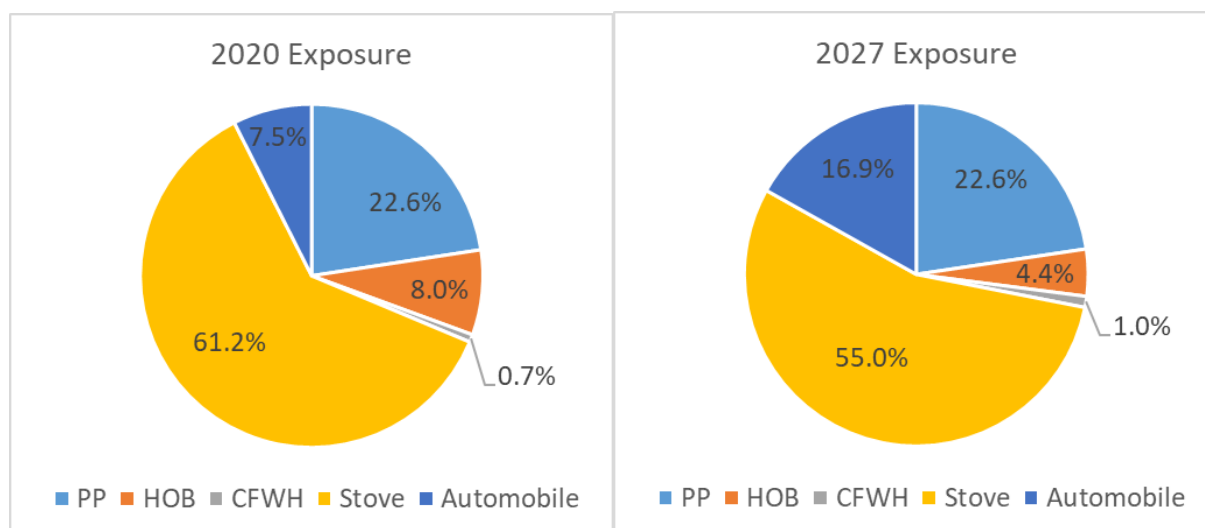


Figure 3-3-28 Percentage for Total PM₁₀ Exposure by Sources in 2020 and 2027

3-4 Output 3: Capacity Development for Technical Evaluation of Air Pollution Control Measures and Preparation for Implementation of the Measures

3-4-1 Activity 3-1: Preparation of MNS Proposal for Measurement Method and Quality Standard for Improved Fuel

3-1 DAAEP and the relevant agencies elaborate a draft MNS on an emission measurement method of improved fuel and fuel quality, and propose it to MASM.

The quality standard of solid fuel shall be specified by proximate analysis and concentration of emitted pollutants by combustion. In the beginning of the Project, generally, it was said and big issue in Mongolia that when the quality is good by proximate analysis, there was no problem in combustion. Though DAAEP asserted that a fuel combustion test was very important, the point that the fuel combustion test does not become common yet was a big problem. On the other hand, it was found people who are concerned an improved fuel has begun to recognize importance of a fuel combustion test when the government converted a policy into an improved fuel spread of 2019.

The quality standard shown in proximate analyses, MNS5679:2019, was already issued in May 2019, however, a rule for emitted gas emission standard was late. The emission standard of a Ger stove was shown in the “Table 3 Acceptable level of pollutants” in “General technical requirements of MNS 5216:2016 Household stoves”, this is used for only the evaluation of a stove. As problems of the regulation level, there was no description of a protocol for the fuel combustion test.

“Improved fuels working group” chaired by Minister of Energy, was established to revise the technical requirement for improved solid fuels MNS 5679:2019, and DAAEP joined the working group to examine volatile and sulfur content for industrial analysis. As a result, the working group decided that volatile and sulfur content for proximate analysis were not revised, a minimum calorific value expanded, and a maximum moisture content lowered. Then, MNS 5679:2019 was revised and MNS 5679:2022 was issued in October 2022.

On the other hand, TTT and ME requested DAAEP to measure various improved fuels, and DAAEP performed flue gas measurement at fuel combustion laboratory. Improved fuels were evaluated based on the MNS 5216:2016 emissions standards; there was no defined standard for the emissions measurement method.

The method carrying out in the fuel combustion laboratory of DAAEP is recommended as a representative example of combustion method for measurement of household improved fuel. The content of the combustion test with improved Ger stove is explained in a constant protocol shown in Figure 3-4-1 under constant measuring equipment shown in Figure 3-4-2. The measurement item for fuel evaluations is dust, O₂, CO, CO₂, SO_x, NO_x, flue gas temperature and the flue gas moisture.

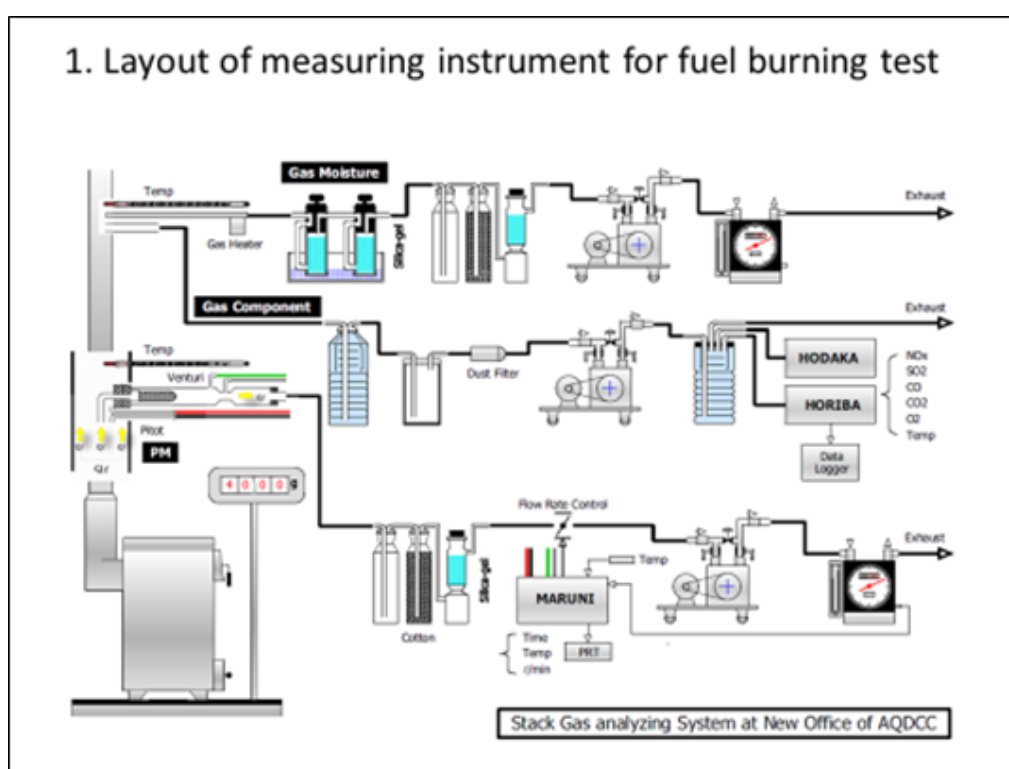


Figure 3-4-1 Layout of Measuring Instrument at DAAEP's Fuel Combustion Laboratory

- The timing of refuel is at less than 3% of CO₂ and the end of test is at less than 2% of CO₂
- The exchange time of the filter is decided by quality of outbreak of the dust

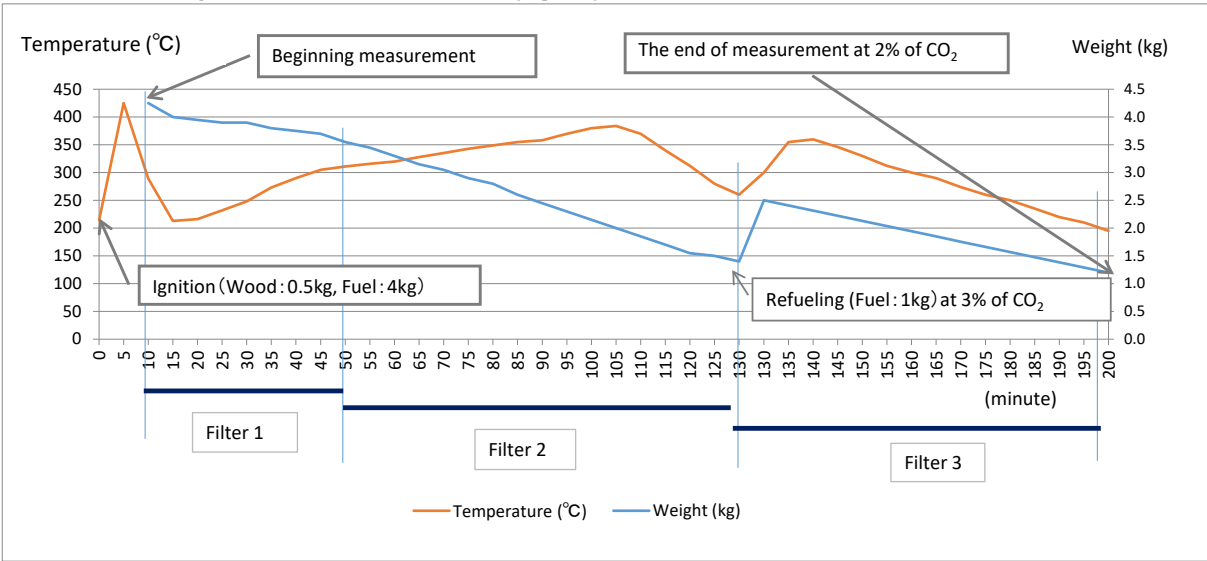


Figure 3-4-2 Protocol of a Fuel Combustion

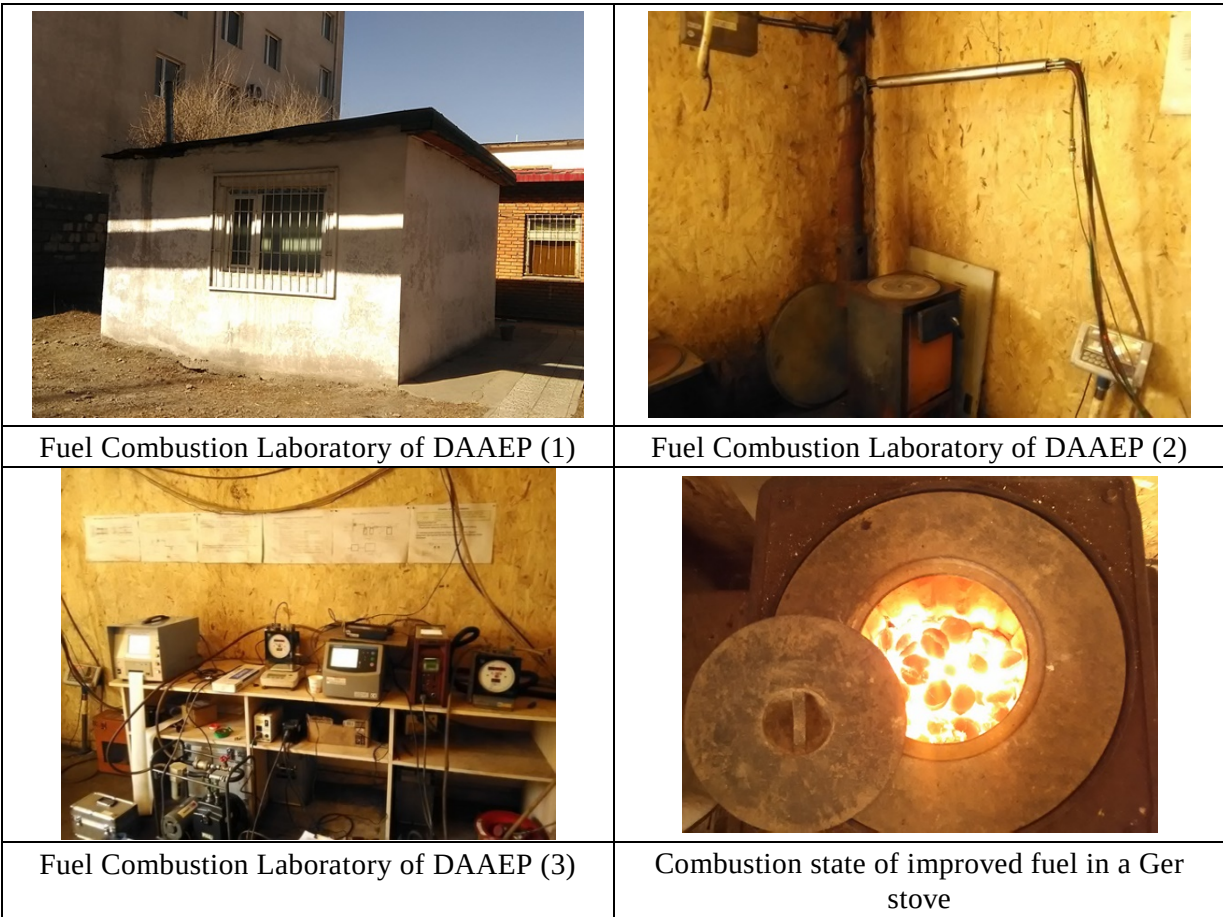


Photo 3-4-1 Fuel Combustion Laboratory of DAAEP

A working group to develop a methodology and emission standard for improved fuels was formed by Order No. 111 dated 30 August 2018 of ME, and DAAEP and JET participated in a working group meeting to develop a draft methodology and emission standard (MNS) for improved fuels in March 2019. The working group meeting has not been held since then.

Purpose of emission standard is to regulate fuels to reduce air pollutants generated by Ger stoves, and to bring to market fuels that pass standard values. On the other hand, the question is whether it is technically and economically feasible to manufacture fuels that is able to meet standard values. To this end, JET have proposed to Mr. Galymbek of DAAEP who is a member of the working group, a method of gradually tightening standard values and improving fuels to meet them.

From October 2019, an improved fuel manufactured by TTT was sold in the market as an alternative to raw coal. There was a method of performing fuel combustion tests using this fuel as the base fuel and discussing emission standards based on results. However, quality of the fuel was unstable, and no data were available for consideration. The fuel combustion test of improved fuel to be sold in the winter of 2020 was done.

Due to impacts of COVID-19 pandemic, JET had been unable to travel to Mongolia from March 2020 and had been unable to witness fuel combustion tests, JET remotely scrutinized fuel combustion test results of DAAEP, found several input errors in the Excel data and explained them to the responsible person in charge. In April 2022, after resumption of travel, JET advised DAAEP regarding emission measurements methods and provided Japanese Industrial Standards (JIS) for the measurements methods used in the measurements.

Since the Project started, JET had been advising DAAEP on the provisions of standards for flue gas measurement, however, no progress has been made on a standard of emission measurement method of improved fuel until recently. In September 2023, DAAEP and JET discussed the content of a standard for measurement method, and JET again proposed the following;

- It is assumed that a standard of measurement method for improved fuels will utilize the guidelines developed in the Project Phase 2. In addition, when evaluating fuels, the concentration of the measured substance should be used. Since measurement results without variation are required, improved stove will be used to evaluate results.
- The number of measurements will be performed at least three times, and additional measurements will be taken when the measurement results are more than $\pm 20\%$ of the average value.

On 21 September 2023, DAAEP issued a letter Urban Standards Oversight Department of the Capital City based on DAAEP's discussions with JET regarding a request to specify the measurement method for improved fuels in the Municipal Standards.

Urban Standards Oversight Department of the Capital City has decided to consider the matter.

As Urban Standards Oversight Department of the Capital City establishes a working group to elaborate the emission standards for improved fuel, DAAEP received a letter regarding the selection of members for the working group on 7 March 2024. DAAEP submitted two candidates for stationary

source emissions measurement as working group members for the week of 18 March 2024. The working group has not yet been established.

3-4-2 Activity 3-2: Safety Guideline for the Promotion of Gas Distribution for Households

3-2 ME with JICA Experts elaborates safety standards on the household gas distribution.

(1). Directions for Safe Use of Gas Fuel Promotion

Mongolia has banned the use of raw coal from May 2019. Although household gas distribution is one of the potential alternative fuels, gas fuel has the risk of gas leakage and explosion if mishandled. Therefore, it is necessary to develop safety guideline for the dissemination of gas fuel in order to ensure its safe use among Mongolian citizens and to promote its dissemination within UB City. Since there is no plan to construct a natural gas pipeline in Mongolia or to supply city gas to UB City at this time, it is appropriate to develop safety guideline for the use of liquefied petroleum gas (LP gas) because it is used already in UB City.

In Mongolia, the Law of Mongolia on Energy regulates the licensing of gas supply businesses, and MRPA has responsibility for the supply of LP gas. Currently, the main uses of LP gas in Mongolia are as fuel for automobiles and for use in restaurant kitchens, etc. The regulations for the use of LP gas have established requirements for gas service providers. However, the system for handling hazardous materials, including the handling of LP gas cylinders and management of LP gas filling facilities (gas stands, etc.), is based on the old framework of the former Soviet Union, and it is considered necessary to develop in parallel a legal system equivalent to the Fire Service Act, High Pressure Gas Safety Act, and Industrial Safety and Health Act, as applied in Japan in the future.

For general consumers, IACC has provided guidance on the safe use of gas fuel, but it only briefly outlines recommendations for the use of LP gas and considerations for the use of gas appliances. In order to create an environment in which gas fuel can be used safely, it is important not only to regulate gas suppliers, but also to promote voluntary efforts by gas suppliers and to encourage general consumers. In Mongolia, it is considered effective to establish safety guideline for gas suppliers, focusing on the advancement of voluntary safety systems and measures to inform and educate the general public. Therefore, we propose a draft safety guideline for the handling of gas fuel in UB City, based on the Japanese case.

(2). Gas Fuel Usage

1) Policies and Guideline

According to information from MMHI and the Mongolian Gas Fuel Association, the current demand for natural gas and LP gas in Mongolia is as follows:

1. There is a certain demand for LP gas (approximately 50,000 tons/year), and LP gas automobiles account for the largest portion of its use, followed by residential and commercial use. Natural

gas automobiles (compressed natural gas = CNG) also exist, but only about 80 public buses use them. Total domestic demand for natural gas is also limited to 600 tons/year.

2. As a government policy, the introduction of gas into Ger districts is also being considered for air pollution control, and from 2019, the government is promoting the use of gas for heating systems in schools and other public facilities through the national and municipal budgets. There are 168 facilities that fall under this scope, and the expansion of LP gas imports is being considered for further expansion in the future.
3. A subsidy program is also being considered. A proposal for subsidies (or discounts on gas prices, etc.) for the installation of household gas facilities was submitted to the Congress, but was withdrawn due to lack of support from the cabinet ministers. According to cost estimates, a budget of 10 billion MNT (approximately 400 million yen) would be required.

In addition, ME has confirmed the following future trends:

1. As a countermeasure to the shortage of hot water supply capacity during severe winters, the government is planning to construct a hot water supply facility using LP gas fuel. The FS has already been completed and a portion of the budget has been approved (60 billion MNT, approx. 2.5 billion yen). A total of four facilities with a total capacity of 228 MW is planned, and construction of one or two facilities is planned to start at first. The LP gas suppliers believe that it will be difficult for them to handle this LP gas project alone because of the sheer scale of the LP gas project, and the Gas Fuel Association is currently coordinating with the three major LP gas companies and construction companies to form a consortium to deal with the LP gas project.
2. Regional supply of gas and discounted gas prices only during peak hours are also under consideration. There are also plans for an 8 MW hot water supply facility for two locations in the Ger district (east and west respectively) funded by the UB Municipal budget.
3. Regarding the possibility of subsidizing the use of LP gas for Ger districts, there are estimates that the cost would be about four times higher, so it might not be feasible. In addition, all LP gas is imported, and it is not easy to meet increasing demand.

2) LP Gas Utilization and Promotion Technology

Based on interviews with private LP gas suppliers and the NUM, the following information was confirmed regarding the general situation of the LP gas business and recent trends:

1. The number of registered LP gas automobiles currently stands at 24,000, but has been declining in recent years. Meanwhile, commercial and residential use of LP gas is currently dominated by demand in restaurants, but due to the government's policy of promoting gas use, there has been an increase in gasification of heating equipment in schools and other public facilities.
2. In the case of residential use, the main heat source is currently electricity in addition to the improved coal, and gas fuel is generally used only as a cooking gas stove. Therefore, as a new

approach, gas suppliers started experimental studies on the development of LP gas-powered Ger stoves, floor heating with hot water circulation, or radiator-type heating systems. Currently, fuel costs are about 3 to 4 times higher than the improved coal, but is expected to be improved through combustion management and other measures.

3. As for other new technologies, NUM is studying the possibility of hybrid heating systems using solar or other heat sources and LP gas water heaters. Field tests have confirmed the effectiveness of a hot water heating system using solar thermal panels, and studies are underway to further improve its effective operation and thermal efficiency by including other heating equipment.

As case studies of the introduction of gas fuel to heating systems in Ger districts (non-hot water supply areas), we visited ordinary Ger dwellings and public schools to confirm the current application technology and to investigate the possibility of its future spread.

As an example of a Ger dwelling, we visited a private Ger dwelling with hot-water underfloor heating, where an LP gas supplier has converted an employee's dwelling into an experimental facility, which will be completed in autumn 2023. No traditional coal stove is used here. Although the system is capable of adequately warming the rooms even in severe winters, it appears that appropriate temperature settings and management of the water heater operation, as well as heat loss and insulation from the Ger wall surfaces, are issues to be addressed. The actual cost of LP gas fuel from October to December 2023 after the completion of the system is approximately 10,000-15,000 yen/month (consumption of six 14 kg cylinders), which is 3-5 times higher than the cost of a typical coal Ger stove, which is approximately 2,000-4,000 yen/month.

As examples of school installations, we visited two public schools in the Ger district of UB City. One school is equipped with a gas water heater for home use and a hot water heating system using commercially available LP gas cylinders, and the other has a full-scale gas boiler, with a large exclusive gas cylinder (tank) installed. Both schools replaced conventional coal HOBs under the initiative and budget of UB City. LP gas supply by exclusive gas tanks is a relatively new business operation in Japan, which started supplying LP gas to households and other small consumers in 1997 as "bulk gas supply."



LP gas Ger stove
Improved traditional coal Ger stove. Currently, gas consumption is high, and fuel efficiency needs to be improved.



LP gas use in restaurants
No metered management of the remaining gas, but one cylinder is alternatively replaced by the supplier on a regular schedule.



Ger with gas heating system (floor-heated)
A gas hot water supply facility is connected to the traditional Ger.



Gas hot water supply facility
Divided into water heater and gas cylinder chamber; 14 kg cylinder used.



Inside the Ger house
Hot water is circulated from the water heater. An electric heater is also installed as a backup.



Temperature inside the Ger (December)
The floor is very warm due to underfloor heating (red), while the wall is cooler (blue).

	
Ten smaller gas water heaters installed for heating a public school.	Cylinder room for ten gas water heaters. Equipped with two lines of 15 50 kg cylinders (switchable alternately).
	
Gas boiler for heating another public school An example of installing a full-scale boiler instead of a set of small water heaters.	Exclusive LP gas tank for full-scale boiler A large gas tank is installed. Regularly refilled by lorry. Equivalent to 'bulk supply' in the Japanese regime.
	
School heating equipment (public school 3) *Another school with LP gas heating installed.	Experimental equipment for hybrid heating NUM is currently studying a hybrid heating system with solar thermal, electric heaters and LP gas water heaters.

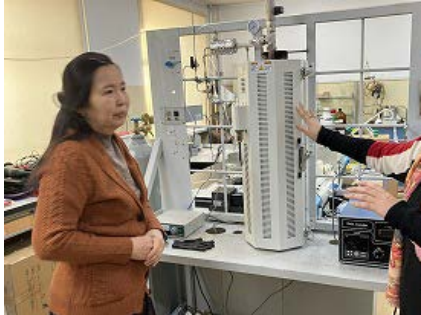
(3). Trends in Coal Gasification Technology

Research on coal gasification technology has been conducted in Mongolia for some time, and JICA is also cooperating in joint research as part of the “Higher Engineering Education Development Project”, an ODA loan, scheduled for 2014-2024.

The Clean Energy Development Laboratory of NUM, in cooperation with Kyushu University in Japan, is researching lignite gasification technology. The laboratory is studying the process of mixing H₂, CO, CO₂ (and a small amount of CH₄) obtained from the pyrolysis of lignite coal to obtain highly concentrated methane (CH₄) through a catalytic reaction (350 - 400 degree Celsius). Lignite from various coal mines in Mongolia is used as raw material for this process. Currently, the methane concentration produced by the system in this laboratory is 37%, and the production rate is 5 L/min, which is a very small-scale experiment.

Under ideal conditions (experiments using standard gas), the concentration of methane gas produced is almost 100%, but when lignite coal is used as source material, the production efficiency becomes poor due to contaminants in the resulting gas mixture. In addition, the pyrolysis of lignite coal and synthesis gas generation are currently separate processes, but for mass production, it is necessary to establish a continuous process. Furthermore, for practical use, CO₂ removal from the product gas is also necessary (currently, it cannot be used as fuel).

Regarding other trends in gasification technology, there is information that Mongol Alt (MAK), a coal mine development company, is conducting a feasibility study with a Japanese company using technology from East China University of Science and Technology (ECUST) in China. This one is specifically targeting the synthesis of dimethyl ether (DME).

	
Pyrolysis equipment Lignite is pyrolyzed with heated steam (800 degree Celsius) to produce H₂, CO, CO₂ and CH₄ (mixed gas).	Coal gas synthesis unit (mixed gas) Methane is synthesized from the mixed gas generated from lignite coal (pulverized coal). Efficiency is 37% due to contaminants, etc.
	
Coal gas synthesis unit (catalyst evaluation) Methane is synthesized from standard gases. The catalyst's synthesis ability is tested. Efficiency is nearly 100%.	Coal (lignite) sample Store lignite (pulverized coal) from each coal mine in Mongolia for use in gasification experiments.

(4). Safety guideline required in Mongolia

1) Background and Case Studies in Japan

The LP gas safety administration in Japan is based on the “Act on the Securing of Safety and the Optimization of Transaction of Liquefied Petroleum Gas” and is maintained as a system that ensures the safety of general consumers through the minimum necessary ex post facto regulations by the government, such as on-site inspections, while based on the voluntary safety of LP gas suppliers.

In December 2000, based on the status of past safety measures and recent accidents, a new “LP Gas Safety Enhancement Program” was proposed, and various individual measures were implemented until the end of March 2003 with the goal of enhancing voluntary safety and eliminating serious accidents among gas suppliers.

In 2003, a number of large-scale industrial accidents occurred, and approximately 80% of the accidents were caused by human factors such as non-compliance with manuals. As a countermeasure, it was considered important to isolate the security system under the responsibility of top management.

In addition, the 1997 amendment to the law regarding bulk supply systems made it possible to use these systems as a means of supplying small consumers, including ordinary households, which

necessitated the enhancement of security measures in terms of both hardware and software related to bulk storage tanks and containers.

Based on this background, it was decided to prepare a document entitled “Guideline for Safety Measures for LPG Suppliers, etc.” in 2004, which outlines priority issues and specific safety measures to be taken.

1. In order to improve the self-security system, LPG suppliers are requested to enhance safety education, conduct internal audits, and ensure compliance with laws and regulations, and LPG suppliers are requested to conduct re-inspections to prevent accidents in bulk supply systems and mass sales.
2. As measures to inform and educate general consumers about LPG safety, special attention will be given to fostering an awareness of safety responsibility among general consumers, and to public relations to prevent accidents involving CO poisoning. In addition, a new guidebook will be prepared and disseminated to consumers so that they can easily check the safety status of their supply and consumption facilities.
3. Following the results of the “Safety Upgrading Program” up to 2002, business operators are requested to continue to implement individual measures that require continuous implementation in order to further contribute to the advancement of self-security.

Since the following year, 2005, priority issues in safety management have been set every year based on the details and number of accidents in the previous year, and specific items have continued to be reviewed and revised.

In 2020, the “Liquefied Petroleum Gas Safety Enhancement Plan 2030” was established as a comprehensive gas safety measure for the next 10 years, and a major review of its contents is being conducted. However, due to the consistent decrease in the number of serious accidents such as fatalities and accidents resulting in injury, the national government, prefectures, third-party organizations, LP gas suppliers, general consumers, and related entities have each taken the lead in implementing comprehensive safety measures. The targets and contents of the measures have not changed significantly from those in the past, but rather, the new law stipulates items to be addressed through voluntary safety measures from the perspective of accident countermeasures, natural disaster countermeasures, and the development of safety infrastructure, aiming to eliminate serious accidents and further enhance safety.

2) Proposed guideline for Mongolia

With reference to the Japanese background and case studies described above, we decided to propose a draft guideline based on the following principles.

1. The contents presented in the Japanese security measures guideline (2004 version) shall be used as a basis for the draft guideline.

*Since the latest Japanese security measures (Safety Enhancement Plan 2030) are considered to

be out of step with the current situation in Mongolia, it would be appropriate to refer to the previous security guidelines.

2. The contents based on the Japanese legal system and examples should be consistent with the Mongolian legal system and current situation.

*In preparing the safety guideline, it may be necessary to develop related laws in parallel.

3. Items not covered by existing laws or cases in Mongolia will be considered as future plans.

*Since it takes time to develop laws, feasible contents by existing laws will be considered.

4. The guideline shall be reviewed and updated as appropriate.

*It is important to reflect the results of the number of accidents and the details of accidents as priority issues.

The outline of the safety guideline is as follows. See Annex 3-4-1 for safety guideline in detail.

1. Background of the Guideline

An overview of the situation in Mongolia regarding the use of gas fuels, and an introduction to Japanese legislation and regulations.

2. Proposed Safety Guideline

The guideline consists of the following headings.

(1) Measures to improve the level of self-safety by business operators

- ✓ Appropriate implementation of safety work based on applicable laws
- ✓ Appropriate installation and management of bulk supply systems
- ✓ Appropriate personnel assignment and management
- ✓ Ensuring safety education
- ✓ Establishment of an internal audit program
- ✓ Earthquake and other disaster countermeasures
- ✓ Steady and effective implementation of after-the-fact monitoring

(2) Awareness-raising and education of general consumers on the responsibility and knowledge of LPG safety

- ✓ Foster awareness of safety responsibilities among consumers
- ✓ Measures to prevent CO poisoning accidents

(3) Review of safety guideline

3-4-3 Activity 3-3: Implementation Plan of the Pilot Project and Related Work Instructions

3-3 DAAEP and the relevant agencies elaborate implementation plans and terms of reference for pilot projects such as improved fuel, HOB, traffic signal control, eco-driving, RSD, smoke belching program based on portable emission device, DPF, low sulfur fuel and low emission automobiles.

3-4-3-1 Pilot Project of Household Improved Fuel

The pilot project on improved fuel was implemented two times and they were called 1st pilot project and 2nd pilot project 9 in the Project. Regarding specification of improved fuel for household used in the pilot project, main improved points were dust, SO₂, and CO concentration. Since concentration of emission standard was not yet stipulated in MNS, this improved fuel presupposed to become more improved than a middling briquette manufactured by TTT.

(1). Purpose of the pilot project

Initially, the purpose of the pilot project was to use raw coal and improved fuel at Ger stoves to compare air pollution status and to propose introduction of improved fuel to the Mongolian side. However, raw coal use was banned from May 2019 by the No.62 Cabinet Decision of Mongolian Government dated 28 February 2018. According to the joint order of the Minister of Environment and Tourism and the Governor of UB city, No. A/433-A/820 "On the Renewal and Approval Air Quality Improvement Areas Enforcement Regulation" dated 14 August 2019, raw coal was replaced with an improved fuel, TTT's middling briquette, in the winter of 2019-2020 although not in all households. It was said that the use of the TTT's middling briquette have reduced PM air pollution by about 50% in the same period of the previous year.

The purpose of the pilot project under this situation was to develop and propose a household improved fuel, better environmental performance, and the content of the project was to compare the TTT's improved fuel with manufactured improved fuel. From around 2022, TTT was considering semi-cokes middling briquettes blended with semi-cokes as an improved fuel. On the other hand, a middling briquette blended with biomass was planned for the pilot project. A plan was to burn each of the improved fuels for combustion test in the laboratory, and results would be evaluated by comparing air pollution caused by the actual use of Ger stoves for a certain period of time in the pilot project.

In particular, improved fuels were expensive to manufacture, so improvement measures would be evaluated by their effectiveness. It was hoped that the superiority of biomass blended briquette would be a driving force for their widespread use.

(2). Verification Study of Pilot Project

1) Schedule

Original plan of the 1st pilot project is shown in Table 3-4-1. The schedule must avoid the lunar New Year in Mongolia to push forward business smoothly. Because the lunar New Year was 23rd February 2020, the schedule to carry out a 1-month trial examination before the lunar New Year was made. Original plan was considered as follows;

1. It was aimed for production, transportation, distribution of an improved fuel being finished by the end of December 2019. The briefing session to inhabitants would be held at the time of an improved fuel distribution for introduction of purpose of the pilot project and an improved fuel manufactured by the pilot Project.
2. It was asked that the inhabitants should use the improved fuel manufactured by the pilot Project for approximately one month and fill out a questionnaire about use comparison with the improved fuel manufactured by the pilot Project and TTT's improved fuel.
3. An air quality monitoring automobile of DAAEP would be located in an area and measured ambient air concentration of PM₁₀, PM_{2.5}, and SO₂ for at least three days, on the day when the measurement situation would be good, such as a windless day, no snow and so on. Around the time of the usage of JICA improved fuel, it would be also measured in situation using TTT's improved fuel for at least three days for one month. Based on this monitoring, the improved fuel manufactured by the pilot project would be compared with and the TTT's improved fuel, and the improved fuel manufactured by the pilot project would be considered for improvement of air quality. Additionally, emission reduction effect would be examined based on the flue gas measurement result in fuel combustion laboratory of DAAEP.

Table 3-4-1 Schedule for Verification Study of Pilot Project

		Oct. 2019				Dec.				Jan. 2020				Feb.				Mar.			
1	Production and distribution of JICA improved fuel																				
2	Trial use of JICA improved fuel																				
3	Atmospheric measurements																				
4	Door-to-door survey																				
4.1	1st survey																				
4.2	2nd survey																				
4.3	3rd survey																				

2) Implementation site of the Verification Study

The area among mountains or an independent area was expected for an implementation site not to be affected by the air pollution from the neighboring areas. The implementation site was finally decided in Moringiin davaa which DAAEP used for a prior pilot project. The choice reason is an independent area, easiness of improved fuel distribution and air pollution measurement and including the recommendation of DAAEP.



Figure 3-4-3 Candidate Site: Moringiin Davaa

1. Moringiin Davaa was located the west of former Chinggis Khan International Airport and became the place that was hard to be affected by an air pollution from other areas.
2. The number of stoves was same as the number of the households, and approximately 600 households were going to apply. The final distribution amount would be decided after enforcement in the visit investigation to each household planning it in November 2019, but it was thought by improved fuel distribution of around 300 ton.

(3). Change of Schedule for the Pilot Project

The pilot project of household improved fuel was scheduled to be implemented in the winter seasons of 2019-2020 and 2020-2021, however, the pilot project household improved fuel was rescheduled to be implemented two years later in 2022-2023 and 2023-2024.

1) Reason for delay in implementation

The Japanese side had planned to use middling briquettes blended with semi-cokes for the first pilot project, however due to the delay in the entry of middling and semi-cokes, it became impossible to manufacture the fuel for the pilot project, so it was decided to postpone the verification survey in the pilot project for one year, and the verification survey would be implemented from winter season of 2020.

After that, on 28 February 2020, JICA requested JET to restrain its overseas travels as a measure against COVID-19 pandemic, and it was not possible to travel to Mongolia during 1 year and eight month.

2) Change in the location of the project

Due to the incident of CO poisoning caused by TTT's improved fuel, the Advisor to the Prime Minister expressed his strong concern about distributing the improved fuel to the residents for verification test in the pilot project. Initially, the project was planned to be implemented in Moringiin davaa, where DAAEP had conducted the pilot project in advance, however at the 3rd JCC, the Japanese and the Mongolian sides agreed to implement the project as follows;

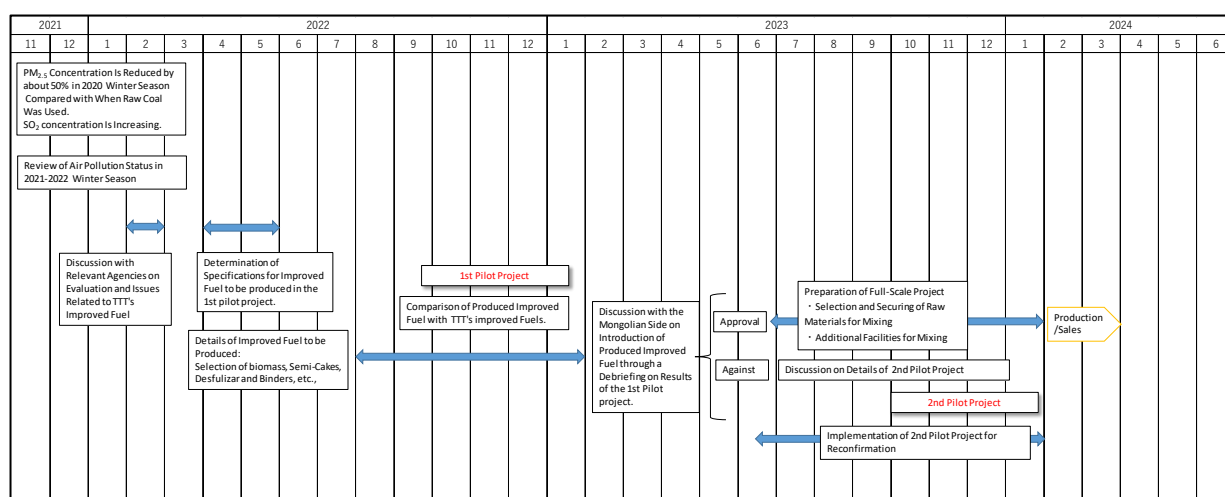
- Cancel the demonstration test in selected villages.
- The verification survey would be implemented at the camping site by the researcher on the project charter.

Due to the change in the location of the verification survey for improved fuel, a candidate site would be selected for a campsite near UB city.

3) Implementation schedule

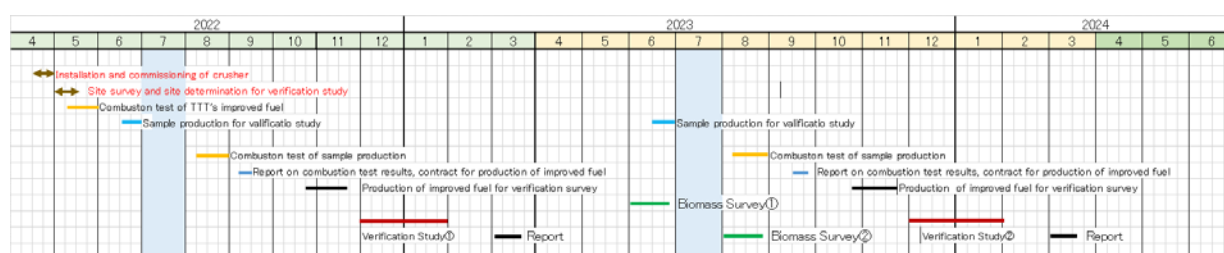
As COVID-19 pandemic subsided, JET and DAAEP scheduled an implementation plan for the pilot project that would begin a field studies in April 2022. Schedule of the pilot project for household improved fuel is shown in Table 3-4-2.

Table 3-4-2 Schedule of the Pilot Project for Household Improved Fuel



A detailed schedule of the pilot project for household improved fuel is shown in Table 3-4-3.

Table 3-4-3 A Detail Schedule of the Pilot Project for Household Improved Fuel



Based on the results of 2022 pilot project, an overall schedule for 2023 was developed. Table 3-4-4 shows the overall schedule for 2023 pilot project.

Table 3-4-4 Overall Schedule for 2023 Pilot Project of Household improved Fuel

Np.	Item	2023										2024				
		4	5	6	7	8	9	10	11	12	1	2	3	4	5	
1	2022 Pilot Project															
	1. Issue consolidation (including BCB combustion testing and evaluation of 2022 production)															
	2. Consideration and determination of manufacturing methods for marketable quality															
2	2023 Pilot Project 1															
	1. BCB production (Approximately 100kg to 150kg)2															
	2. Combustion test at fuel combustion laboratory of DAAEP															
	3. BCB strength test															
	4. Combustion test at fuel combustion laboratory of DAAEP in winter season															
	5. BCB strength test in winter season															
	6.Understanding the effects of air pollution control measures through simulation execution															
3	Survey of Biomass Supply															
	1. Preparation of specifications															
	2. Competitive quotation requestor review															
	3. Request for Quotation															
	4. Opening quotations, contracts and payments															
	5. Conduct biomass supply feasibility study															
	6. Preparation of biomass supply feasibility study report (deadline by the end of November)															
4	Final Report on Pilot Projects															
	1. Conduct a comprehensive evaluation of the air pollution improvement effects and production costs of BCB introduction															
	2. Preparation of feasibility report on BCB introduction including air pollution control effects (including winter combustion test)															

※1 Manufactured BCB will be performed 5 combustion tests at fuel combustion laboratory of DAAEP using new stoves with stability.

※2 The BCB will be stored in DAAEP's warehouse until winter season to ensure that the quality is acceptable, and then combustion test will be performed again

3-4-3-2 Pilot Projects Related to Automobiles

Implementation plan for Pilot Projects related to automobiles was prepared in consultation with the C/P members from May 2019. This implementation plan is shown in Annex 3-4-2. The seminar for Pilot Projects related to automobiles was held in January 2022 in order to re-check the implementation plan again and to check the progress. The handout of this seminar is shown in Annex 3-4-3.

These activities in Mongolia have been restricted due to COVID-19 for a year and eight months. Thus, the schedule of Pilot Projects related to automobiles is shown in Table 3-4-5.

Regarding signal control, since the resumption of training for the recipients in Japan had been delayed, the training in Japan was scheduled for November 2022 and it was planned to adjust and evaluate

signal control for the remaining 13 intersections from December 2022. The traffic condition survey, which is used for improvement of signal control, was conducted in September 2019 and the output may not be reflecting the current actual traffic. Thus, the traffic condition survey was scheduled again in September 2022, before training in Japan.

For eco-driving study, it was planned that automobile emission gas would be measured during normal driving before the introduction of eco-driving and during eco-driving practice after the implementation of eco-driving education, and evaluate the effects of eco-driving in reducing emissions and improving fuel efficiency. It was planned that the evaluated eco-driving effect would be used to organize the methods of eco-driving in Mongolia and prepare a brochure for dissemination and enlightenment. In addition, as a dissemination and enlightenment, it was planned to introduce operation management equipment and promote eco-driving.

For PM reduction devices (DPF, etc.), it was planned to evaluate the performance of PM reduction device with an on-board emission measurement system at the time of proposal, as well as encourage to establish automobile-related regulations that require the installation of PM reduction devices.

For introduction of low-sulfur fuel and low-emission automobiles, since the quality of low-sulfur fuel using a portable sulfur fuel analyzer has been checked since November 2021, it was scheduled to support the introduction of low-sulfur fuel and low-emission automobiles. In addition, it is planned to encourage the maintenance to develop the automobile-related regulations.

Table 3-4-5 Schedule of Pilot Project Related to Automobiles

Subject		Y 2022						Y 2023												Y 2024																	
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6												
Signal control	Understanding the traffic control system																																				
	Traffic condition survey (before review)																																				
	Signal control review (model case)																																				
	Signal control training in Japan																																				
	Signal control review (production)																																				
Eco-driving	Traffic condition survey (after review)																																				
	Evaluation of signal control review																																				
	Exhaust gas measurement during normal operation																																				
	Introduction of eco-driving support equipment																																				
	Eco-driving education																																				
DPF	Exhaust gas measurement during eco-driving																																				
	Evaluation of eco-driving effect																																				
	Promotion and enlightenment of eco-driving																																				
	DPF product performance evaluation method																																				
	Implementation of performance evaluation of DPF products																																				
Low-sulfur fuel	Support for the introduction of automobile-related regulations that require the installation of DPF																																				
	Evaluation of exhaust gas reduction effect by performance evaluation of DPF products																																				
	Measurement of sulfur content in fuel																																				
	Support for the introduction of automobile-related regulations to popularize low-sulfur fuel and low-emission vehicles																																				
	Evaluation of emission reduction effect by introducing low sulfur fuel and low emission vehicle																																				
RSD	Examination of emission standard values related to operation regulations																																				
	Support for the introduction of automobile-related regulations using RSD and opasimeters																																				
	RSD introduction support																																				
	Evaluation of exhaust gas reduction effect by exhaust gas regulation using RSD and opasimeter																																				
	Confirmation of exhaust gas measurement results																																				
On-board emission system	Reselection of in-vehicle meter holding organization																																				
	Establishing technology transfer for exhaust gas measurement																																				

3-5 Output 4: Support for the Suggestion of Air Pollution Control Measure through the Project Activities to Decision Making Agency

3-5-1 Activity 4-1: Suggestion on the Air Pollution Status, Air Pollution Control Strategies, and Evaluation of Air Pollution Control Measures

4-1 DAAEP and NAMEM submit to the decision makers the analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned).

The seminar on air pollution status in 2018 as a current year and 2020 as a year after improved fuel implementation was held in 5 October 2022. Based on the results of SO₂ concentration increase due to the introduction of the improved fuel, it was recommended to use low sulfur coal or to mix desulfurizer with the improved fuel when the improved fuel is further improved. MET requested JET for the cooperation at the time when he is asked to report and propose these results to decision makers. The comment by MET was expected to help decision makers to understand the necessity to grasp the air pollution structure as well as to evaluate air pollution control measures quantitatively using emission inventory and simulation model. NAMEM utilized the result for preparing the presentation of the discussion on the improved fuel in December 2022.

JET presented the impacts of the improved fuel before and after its introduction using the simulation results for 2018 and 2020 (Annex 3-5-1). Among C/P-WG, CLEM presented the result of PM component analysis and IRIMHE presented the simulation result by chemical transport model using emission data of this Project. Mongolian authorities such as ME, Ministry of Construction and Urban. Development (MCUD), MET, DAAEP, NAMEM, CLEM, and IRIMHE, donor agencies such as UNICEF, Swiss Agency for Development and Cooperation (SDC), ADB, and JICA, and research institutions such as NUM were participating in the seminar.

High-level Forum on Clean Air in Asia-Pacific Regional Action Program for Air Pollution was held on 2-3 March, 2023. The organizers were MET, UNESCAP, and UNEP. In each session, the panelists introduced the initiatives of their countries and organizations, and repeatedly mentioned the various monitoring method using satellite, AQMSs, and the low-cost air quality measurement equipment, the importance of regional and national cooperation, and the importance of sharing data and experience. From C/P, two experts in NAMEM presented the air pollution status and the air quality measurement network in Mongolia.

Since the head of Department of Environment and Natural Resources Management of MET was replaced, JET explained the impacts of the improved fuel to the new head on 10 April 2023.

JET presented the setting of BAU scenario and the evaluation of air pollution control measures based on the result of pilot projects (emissions, concentrations, and exposure) at the seminar on 13 March 2024 and the final seminar on 18 April 2024.

In November 2023, JET presented to Ms. Nominchimeg, the Deputy Governor of UB City, the evaluation result of air pollution control measure by converting raw coal to the improved fuel

implemented as a Mongolian national policy and recommended the effectiveness of air pollution control measures.

In April 2024, JET presented the results of a comparison of improved fuels for household to Ms. Nominchimeg, the Deputy Governor of UB City. Specifically, JET presented the result of the comparison between TTT's existing improved fuel and BCB improved fuel produced by this Project and the result of the comparison of the air pollution control measures between using BCB and changing stoves. Then, JET recommended the effectiveness of air pollution control measures.

3-5-2 Activity 4-2: Preparation and Utilization of the Technical Guidelines by the Organizations Involved in the Pilot Project

4-2 Relevant agencies with pilot projects elaborate technical guidelines and utilizes them.

3-5-2-1 Household Improved Fuel

Based on the results of the pilot project of household improved fuel, DAAEP and JET prepared a guideline for future reference (Annex 3-5-1) in 2024. The guideline summarizes types of coal in Mongolia, differences between two types of household stoves, differences between three types of improved fuels, and production methods for improved fuels. The main points of this guideline are as follows;

1. There are various coal producing regions in Mongolia. As raw coal from other mines may be used as raw material in the future, characterizations of coal are listed throughout the country for reference purposes.
2. Since differences between traditional and improved household stoves had not been clarified, so stove drawings, combustion characteristics, concentrations of emitted gases, etc., are described.
3. Since differences between three types of fuel, TTT, BCB, and semi-cokes blended briquettes, were not clearly defined, so results of proximate analysis, combustion characteristics, and exhaust gas concentrations are described.
4. It is noted that study is needed to conduct using prototypes to determine required amount of desulfurizer, optimal amount of binder, and molding pressure.

In April 2024, the Project explained to Deputy Governor the differences in combustion conditions between a traditional and an improved stove based on the results of the pilot project. The project also proposed to discontinue the manufacture and sale of traditional stoves because traditional stoves that do not meet the technical requirements for stoves in MNS 5216:2016 may result in carbon monoxide poisoning.

3-5-2-2 Signal Control

Technical guideline was compiled in April 2023 after organizing information for signal control improvement with TCC, such as operation procedures, adjustment methods, and method to create

operation mechanisms. TCC utilized this technical guideline to consider measures such as traffic control at Zaisan (intersection at the base of Zaisan hill) and traffic control on the south side of the Sun Bridge, and was able to put some of them into full-scale operation. Annex 3-5-2 shows the current technical guideline.

Based on the technical content learned in Japan, this technical guideline contains the necessary procedures for calculating optimal signal durations and implementing improvements to signal control using a science based calculation formula using traffic volume survey results. In particular, the procedure for calculating signal durations from traffic volume survey data is clear, and showing irrefutable results based on evidence will be important for future operation in Mongolia.

3-5-2-3 Low Sulfur Fuels for Automobiles

During the Project, a law on the promotion of low-sulfur fuel was developed, and publicity activities related to it were conducted in this Pilot Project. As a result, the awareness of both suppliers and users about the appropriate use of fuel for Euro IV and Euro V buses increased, so it was decided that the preparation of technical guideline for low-sulfur fuel was not necessary.

3-5-2-4 Eco-driving

Technical guideline was compiled in February 2024, including training method of drivers and operation managers, and daily operation cycle using operation management equipment (driving analysis/evaluation → guidance/training → practice eco-drive). The technical guideline is planned to be utilized in future as dissemination and awareness of eco-driving proceed. Annex 3-5-3 shows the current technical guideline.

This guideline describes the contents of eco-driving as well as shows the results of an evaluation of the effects of eco-driving on air pollutants and fuel consumption in Mongolia using on-board emission measurement systems, and summarizes daily operation cycle (analysis and evaluation of driving → guidance and education → practicing eco-driving) using operation management equipment that evaluates eco-driving and also summarized an eco-driving manual to be used in eco-driving education. In particular, the guideline includes a case study which evaluated the effects of eco-driving when actually driven in Mongolia using the provided on-board emission measurement system, and the results provided support for dissemination and awareness-raising. In addition, a support system for eco-driving is necessary for dissemination and awareness-raising, and introduces examples from Japan and provides concrete information of a certification system for businesses and the development of promotional tools for individuals that can be applied in Mongolia.

3-5-2-5 PM Reduction Device (DPF)

Regarding PM reduction devices (such as DPF), the work procedures and evaluation methods for performance evaluation methods for DPF products were organized, and then a DPF performance evaluation method was created in August 2019. Later, the technical guideline was compiled in 2024 with additional contents such as DPF types, etc. Annex 3-5-4 shows the current technical guideline.

This guideline explains DPFs, types of DPFs, and different regeneration methods, and also contains methods for evaluating the PM reduction (collecting) performance of DPFs thus to prevent ineffective DPFs to be introduced and become widespread. In particular, regeneration methods of manual and automatic have different characteristics, thus selecting the regeneration method is important when introducing DPFs. In addition, using the provided on-board emission measurement system to evaluate PM reduction (collecting) performance will lead to the implementation of effective measures using useful equipment.

3-5-2-6 RSD

Regarding RSD and simplified automobile exhaust gas measurement equipment (opacimeter), based on the road inspection using RSD in 2023, the work procedure, investigation system, and inspection operation method were organized for road side inspection, and issued technical guidelines in January 2024. Annex 3-5-5 shows the current technical guidelines.

In January 2024, JET discussed on the use of the developed technical guideline with MRTD. Since MRTD needs to procure RSD in addition to legal development, this technical guideline will be used after the procurement and etc.

This guideline explains the traffic regulations, the procedures for roadside inspections (selection of roadside inspection points, lane restrictions, installation of RSDs, implementation details), implementation structure, and operation methods (implementation details, implementation costs), and also compiles an operation manual for RSDs. In addition, the guideline contains the legal framework necessary to implement traffic restrictions, the traffic restrictions and the legal framework in Japan, and the proposed legal framework in Mongolia. In particular, traffic restrictions using RSDs prohibit the use of automobiles that exceed the emission standards based on the emission standards based on the MNS (RSD measurement value 25 corresponding to 40% opacity specified by the MNS). Since restricting the operation of high emitters leads to air pollution measures, the guideline shows the direction of legal framework applicable to Mongolia based on the Japanese example as well as concretely shows the method to implement traffic restrictions using RSDs.

3-5-3 Activity 4-3: Approval of the Pilot Projects

4-3 The relevant agencies discuss and endorse the selection of pilot projects.

3-5-3-1 Pilot Project of Household Improved Fuel

As shown in Table 3-5-1, JET explained to relevant agencies details of the pilot project of household improved fuel at the kick-off seminar, and JET and these project responsible members discussed for the project to obtain their opinions and approval. The materials used for explanation are shown in Annex 3-5-6.

Table 3-5-1 Interviewee

Date	Persons
10 December 2018	Relevant agencies at Kickoff Seminar
5 March 2019	Head of DAAEP, Dr. TSATSRAL Batmunkh
19 March 2019	Director of ME, Ms. Davaasuren
20 March 2019	Secretary General of NCEPR, Mr. GANTULGA
10 May 2019	Special Advisor to the Prime Minister, Mr. ALTANGEREL

The postponement of the pilot project due to impacts of COVID-19 pandemic and the details of implementation of pilot project were approved at the 6th JCC.

3-5-3-2 Pilot Project Related to Automobiles

Based on the implementation plans, terms of reference for pilot projects was prepared, and 16 C/P-WG members (MRTD、MMHI、IACC、NRTC、MRPA etc.) related to pilot project on automobile gathered and discussed, and the finalization was completed in 16 September 2019. The terms of reference for pilot project on automobile has been finalized. Annex 3-4-2 shows the implementation plan.

The postponement of the pilot project due to impacts of COVID-19 pandemic and the details of implementation of pilot project were approved at the 6th JCC.

3-5-4 Activity 4-4: Mongolia Approves Pilot Project as a Large-scale Project

4-4 NCEPR and the relevant agencies approve large scale investments based on pilot projects implementation and assessment.

The Mongolian Government has decided to add a new regulation to Article 16.1.6 of the Air Law on 22 April 2022, a ban sale of the highest-grade fuel (Euro 5) in MNS0216:2017 and retail and sale of lower grade fuel within air quality improvement areas in UB City. The introduction of Euro 5 standard fuels, which has been promoted through pilot projects, is expected to introduce the pilot projects into a full-scale as a result of the establishment of the Air Law. However, there are no refineries in Mongolia (currently under construction), and Mongolia imports all automobile fuels from Russia and

China, where it is still sold because Euro 2 standard fuel is cheaper than Euro 5 standard fuel. Therefore, it is necessary to publicize the use of Euro 5 fuel to Ulaanbaatar citizens and businesses, to eliminate difference of price between Euro 5 fuel and Euro 2 fuel, and to establish a policy that only Euro 5 fuel will be sold in the future.

It is expected that other pilot projects will be considered and approved as full-scale projects in the future.

3-5-5 Activity 4-5: Utilization of the Outputs of the Projects and the Pilot Projects

4-5 NCEPR, or the sections of the relevant agencies in charge of allocating funds for air pollution control in the Mongolian government such as the Environment and Climate Fund utilizes the Outputs of the Projects and pilot projects implementation and assessment.

In September 2022, the secretariat of NCEPR was considering the introduction of an additive as a measure against air pollution in automobiles. JET used an in-vehicle meter to investigate whether the additive had an effect on reducing air pollutants, and it became clear that it was not effective, so it submitted a report on the effect of the additive on reducing air pollutants to the secretariat of NCEPR. NCEPR has decided not to implement this as a measure against air pollution in automobiles.

The emission inventory in 2020 updated on the Mongolian side is being implemented, the simulation model was developed. The simulation was used to identify the main cause of the SO₂ concentration. Evaluation of the effectiveness of air pollution countermeasures will be implemented after June 2023. The automobile-related pilot project ended in October 2023, and the results of the improved fuel pilot project were achieved in April 2024. These results will be used by NCEPR or the Natural Environment and Climate Fund.

JET explained several times to the JCC, Deputy Governor, and the relevant agencies that it is necessary to use Euro 5 fuel for diesel vehicles with low sulfur content. As a result, it was used in the first to third buses of public buses.

NCEPR was dissolved at the end of December 2023. It is planned that the government will transfer the entity implementing air pollution countermeasures to UB City, but the division of duties between Ministries and UB City has not been decided, and as of May 2024, there is no department in charge of allocating funds to air pollution countermeasures.

3-6 Output 5: Enhancement of Air Pollution Control Measure for PM, SO₂ and NO_x emission reduction

3-6-1 Activity 5-1: Implementation of Public Awareness and Advisory Activities for Citizens

5-1 DAAEP with Health Department of Capital City and the relevant agencies implements public awareness and advisory activities for citizens including school students and parents.

To ensure safety when using home stoves and wall stoves, DAAEP produced videos and poster banners, and these were posted on DAAEP's website (<https://aprd.ub.gov.mn/>), partner websites, and

Capital News and television stations for regular public distribution. Also, public information videos were posted on DAAEP's Facebook (<https://www.facebook.com/aprd.ub.gov.mn/videos>).

From 1 November to 15 December 2018, DAAEP, child and family division of UB city, junior high schools, high schools and orphanages at Songinokhairkhan District cooperated to introduce air pollution control measure and held public awareness and advisory activities regarding self-health management and prevention for citizens.

To advice and warning information on prevention of CO poisoning for citizen, DAAEP signed a business alliance agreement with "Erchis Gyalbaa" and performed enlightenment and warning activities to provide advice and warning information on preventive measures against CO poisoning for citizens. Two videos, "Preventing Carbon Monoxide Poisoning" and "How to Burn Correctly Improved Fuel" were manufactured, and those videos were broadcasted on TVs such as ETV, EagleTV, StarHD, MassTV, TM, MNC, SBN, UBS from 15 March to 20 May 2020. DAAEP provided information on the prevention of CO poisoning through the websites of 44 city agencies. In addition, DAAEP posted 10,000 warning signs to prevent carbon monoxide poisoning on billboards in public places such as drinking water supply points, fuel sales points, shopping centers, and food markets in Ger area.

As part of the "Ensure Winter Preparedness" and "Stock Up on Fuel" campaigns, DAAEP produced a 5-minute video including the correct way to burn improved fuel, information on stove, wall stove, and chimney sealing conditions, and carbon monoxide poisoning prevention advice, which was aired on 28 August 2020 on TV-5's "Let's Educate!" program, which was broadcast 3 times. Within the framework of implementing the "Smokeless Ulaanbaatar" program selected by the Evaluation Committee established by DAAEP Director's Order A/11 dated 8 February 2021, DAAEP updated and developed DAAEP's website (<https://aprd.ub.gov.mn/>). On this website, citizen was able to view the current air pollution conditions in UB City, and a 3-minute video on reducing air pollution to the public as a part of its public awareness campaign.

On 8 October 2021, DAAEP and the department of health of the Capital City collaborated to hold an online training "Emergency Systems and Measures to Prepare for a Serious Social Health Outbreak" on the correct way to burn raw coal and improved fuels, and to prevent the risk of death from CO poisoning. Doctors and specialists from 21 provinces and health-related institutions in the capital city have participated. In this online training, DAAEP presented the theme of "The main causes of carbon monoxide poisoning, and how to prevent it" and provided relevant information and advice to the participants.

As part of the UB Mayor's Decree No. A/1025 "On some measures to prevent gas poisoning and safeguard against risks dated 4th August 2022" dated 4 August 2022, DAAEP implemented the 2022-2023 Winter training of information and guidance on 16 September 2022.

Most recently, DAAEP disseminated information on ensuring safety when using household stoves and wall stoves on the DAAEP's website (<https://aprd.ub.gov.mn/>) on 25 March and 19 April 2024,

and on DAAEP's Facebook (<https://www.facebook.com/aprd.ub.gov.mn/videos>) on 28 March and 25 April 2024.

3-6-2 Activity 5-2: Publication of the Project

5-2 MET and DAAEP publish progress of the Project by newsletter, newspaper articles, web-site and other medias.

In March 2019, a Mongolian media tour was organized by the JICA Mongolia Office, and the project was broadcasted on Mongolian National Broadcaster (MNB).

On 28 January 2022, an article was published on the internet media gogo (<https://gogo.mn/r/knxxmj>) in which head of the Air Quality Control Division at DAAEP explained the activities of the Project.

The Project received a request for interview related to SDGs from Japanese television station, Tokyo Broadcasting Television (TBS). TBS filming took place on 31 January 2024 in AQMS provided at the Project Phase 2 and the fuel combustion laboratory of DAAEP. In addition to JET, DAAEP staff in charge of flue gas measurement at stationary sources and AQMS were also interviewed during the filming.

The contents of the interview explained about BCB improved fuels and future air pollution measures were broadcast on TBS's evening news program on 13 February 2024, under the title "Japan helps improve air pollution in capital city of Mongolia ". The broadcast can be viewed on YouTube and the TBS news site^{20,21}.



Source: <https://newsdig.tbs.co.jp/articles/-/996276?display=1>

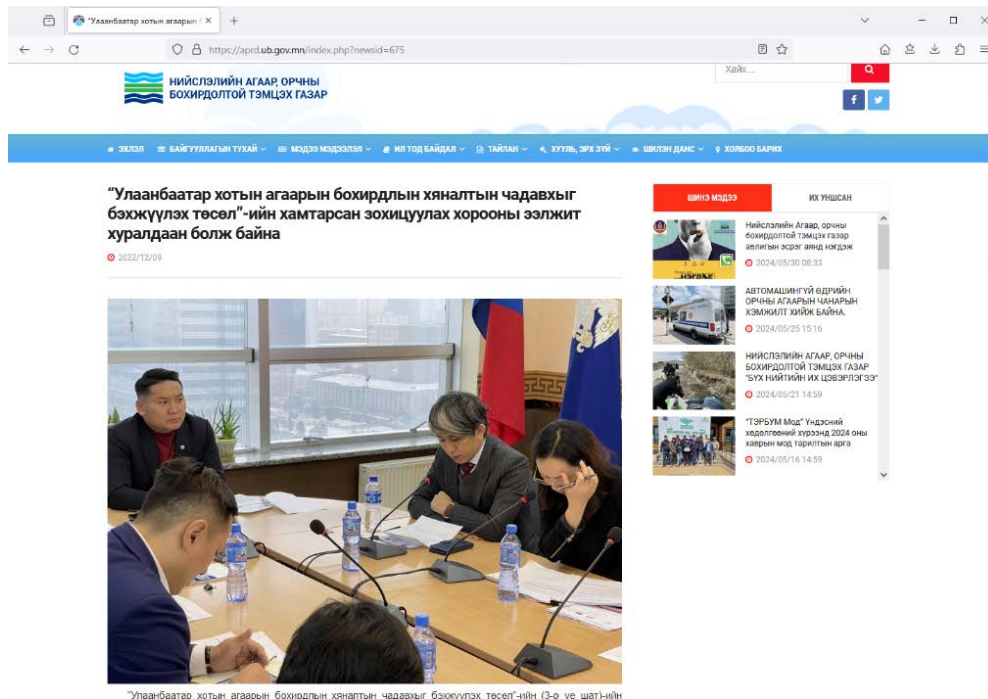
Photo 3-6-1 Screenshot of TBS broadcast

²⁰ <https://youtu.be/OsLChfcluYE?si=la8xGZAJtGNBUgWq>

²¹ <https://newsdig.tbs.co.jp/articles/-/996276?display=1>

DAAEP disseminated the following information about the Project on DAAEP's website;

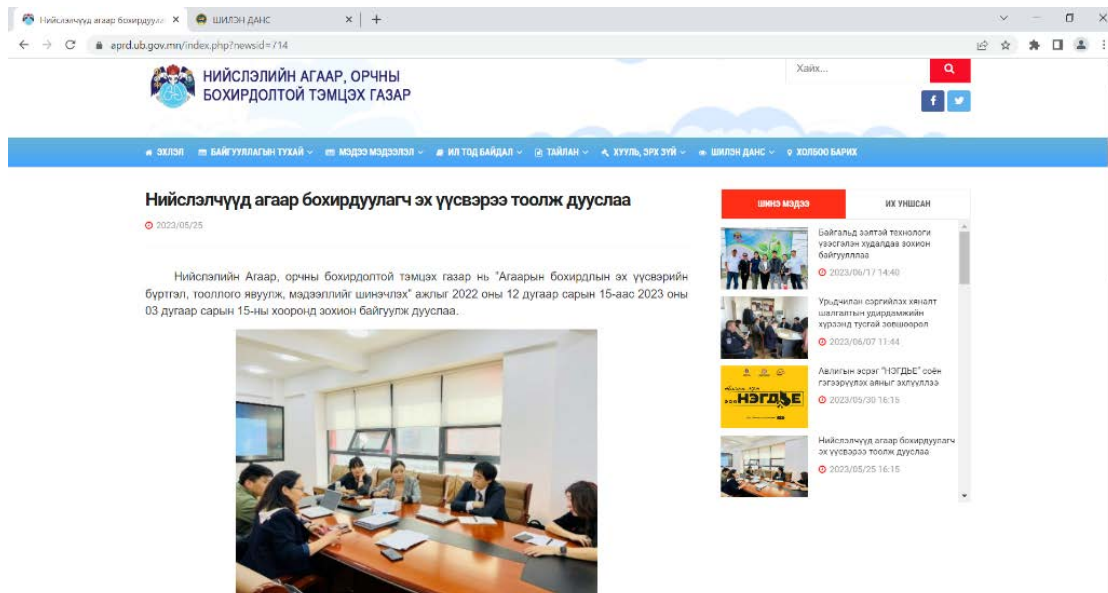
1. The 8th JCC



Source: <https://aprd.ub.gov.mn/>

Figure 3-6-1 The 8th JCC

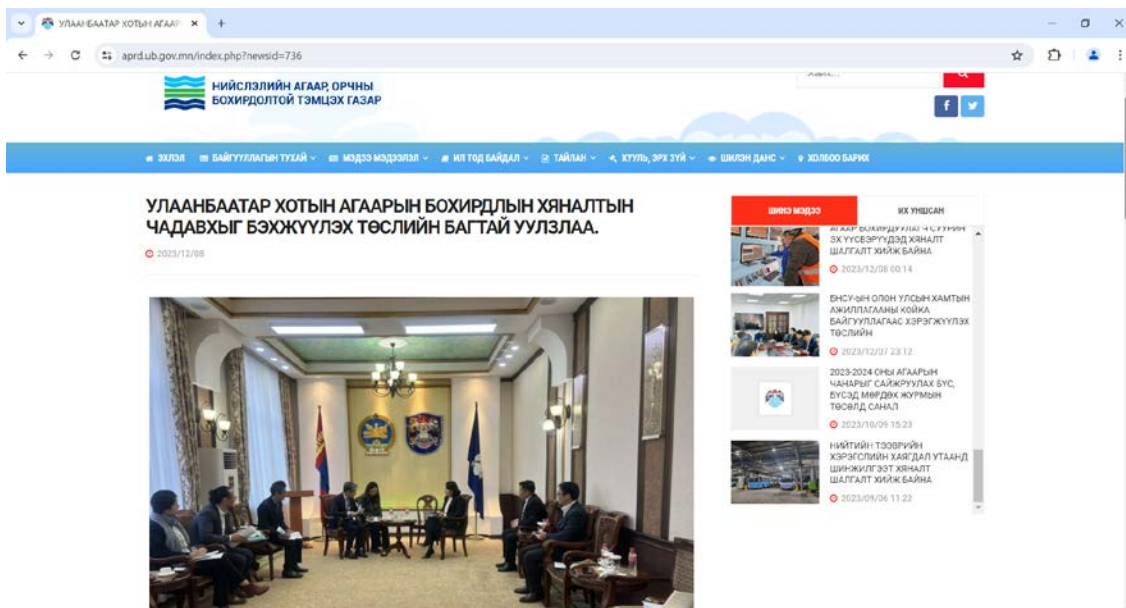
2. Discussion of emission inventory in May 2023



Source: <https://aprd.ub.gov.mn/>

Figure 3-6-2 Discussion of Emission Inventory in May 2023

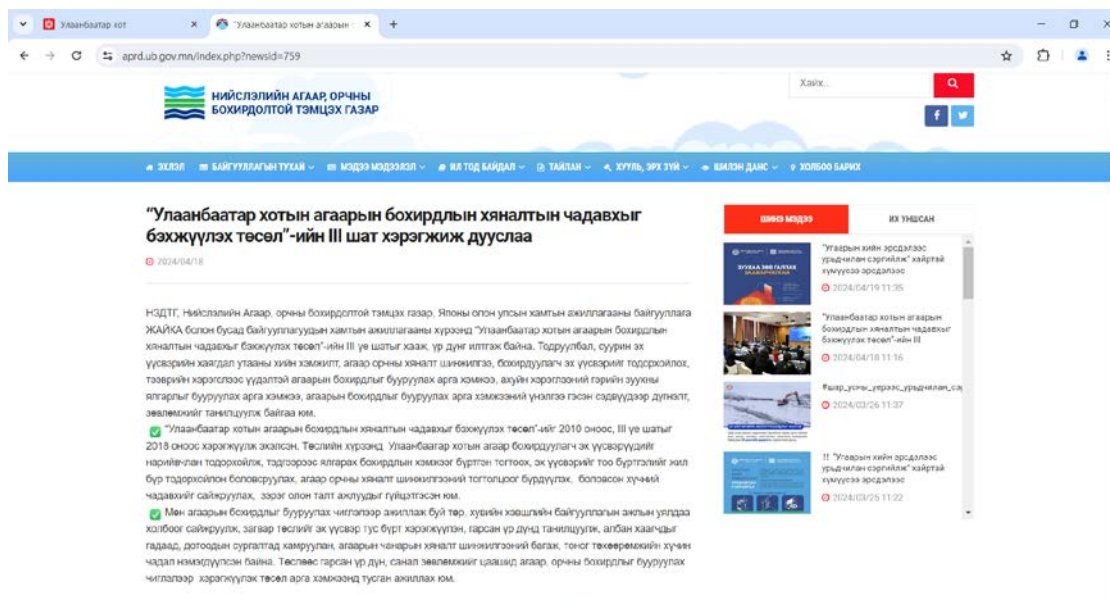
3. The Project discussion between Deputy Governor of UB city, JICA Mongolia office, JET and DAAEP in 2023



Source: <https://aprd.ub.gov.mn/>

Figure 3-6-3 The Project discussion between Deputy Governor of UB city, JICA Mongolia office, JET and DAAEP in 2023

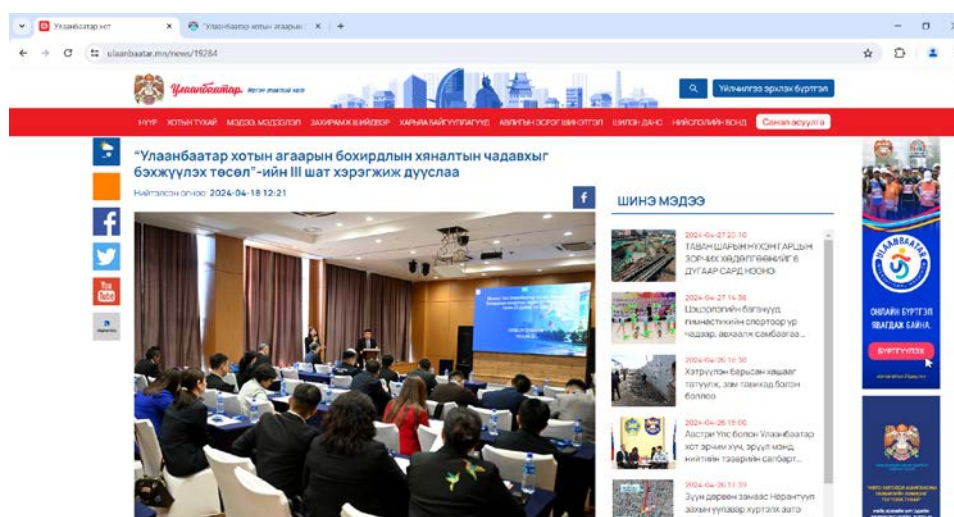
4. Final Seminar in April 2024



Source: <https://aprd.ub.gov.mn/>

Figure 3-6-4 Final Seminar in April 2024

UB city disseminated the information about the final Seminar in April 2024 on UB city website.



Source: <https://www.ulaanbaatar.mn/news/19284>

Figure 3-6-5 Final Seminar in 2024

DAAEP and JET published Newsletters “Project Outline (February, 2019)”, “The Initiatives for Improving Traffic Congestion by Signal Control Technology (September, 2023)”, “The Initiatives for Improving Various Problems in Automobile Society by Eco-Driving (October, 2023)”, and “Project Summary (June, 2024)”. The Newsletters are attached as Annex 2-2-3.

The JICA Mongolia office has published the Project activities on Facebook 13 times, between December 2018 and May 2024. The titles of publication are shown in the Table 3-6-1. The publications are attached as Annex 3-6-1.

Table 3-6-1 Publication on Facebook on JICA Mongolian Office

	Date	Title of publication
1	13 December 2018	【The JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
2	17 December 2018	【The Kick-off Seminar of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
3	10 June 2019	【The 2nd JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
4	30 September 2019	【The traffic count survey and traffic condition survey were conducted in ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ !】
5	8 December 2019	【The 2nd C/P-WG Meeting of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
6	12 December 2019	【The 3rd JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
7	3 February 2021	【The 4th JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】

8	30 June 2021	【The 5th JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
9	14 December 2021	【The 6th JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
10	24 June 2022	【The 7th JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
11	19 December 2022	【The 8th JCC of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】
12	6 October 2023	【The interview about dissemination of low-sulfur fuel (Euro5 fuel) in ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ was broadcast !】
13	23 April 2024	【Final Seminar of ‘Capacity Development Project for Air Pollution Control in UB City Phase 3’ held !】

3-6-3 Activity 5-3: Advice on Improved Fuels to Manufacturers to Improve Their Production Techniques

5-3 DAAEP and JICA Experts provide technical guidance to manufacturers for improved fuel production.

In December 2020, when JET was still unable to travel to Mongolia due to impact of COVID-19 pandemic, JET explained to DAAEP based on a comparative table of sulfur content between Baganuur coal and TTT's improved fuel that TTT's improved fuel had a higher sulfur content than Baganuur coal and that a desulfurizer should be added in an online meeting. Also JET advised TTT through DAAEP to add the desulfurizer.

In May 2022, DAAEP and JET explained to TTT on the results of combustion tests of semi-cokes blended briquettes and BCB. Comparison results are shown in Table 3-6-2. In addition, Annex 3-6-2 shows the explanatory materials.

Table 3-6-2 Comparison results of Semi-cokes Blended Briquette and BCB

Category	Semi-cokes blended briquette	BCB
Dust	• Less than TTT's improved fuel	• Less than TTT's improved fuel and
SO ₂	• The desulfurizer contained in the binder made in China is insufficient. • Desulfurizer such as CaO, CaCO₃ and Ca(OH)₂, etc. must be added.	
CO	• Higher than TTT's improved fuel	• Same level as improved fuel
Ignitability	• Worse than TTT's improved fuel	• Better than TTT's improved fuel, and the amount of ignition material can be reduced.
Burning temperature	• In some cases, lower than TTT's improved fuel	• Higher than TTT's improved fuel
Burning time	• Longer than TTT's improved fuel	• Shorter than TTT's improved fuel
Hardness	• Same as TTT's improved fuel	• Prototype was soft. • If the form is small and the biomass addition rate is reduced, it will be possible to make it as hard as TTT's improved fuel.

In June 2022, at request of a president of TTT, Minister of Energy who manages TTT, the president of TTT, DAAEP, and JET held discussions. Specifically, SO₂ concentration in winter season is higher than in the past, and Jet requested the Minister of Energy that a desulfurizer must be added to the improved fuel this winter season as a SO₂ reduction measure is a top priority.

In December 2022, TTT and DAAEP jointly hosted consultation "How to Improve Improved Fuel Quality"; DAAEP and JET prepared a presentation material, which were presented by DAAEP. The presentation materials are shown in Annex 3-6-3. It was explained that the dust concentration of the improved fuel blended with semi-cokes is less than existing TTT's improved fuel, but CO concentration was increased.

In March 2024, based on the results of the pilot project, the Project explained to TTT environmental performance of BCB and the feasibility of introducing BCB in Mongolia based on the fuel combustion test results and biomass supply feasibility study result.

In June 2024, JET provided advice on improving manufacturing technology for each component of the exhaust gas by clarifying the mechanism of its generation. An outline of each component is shown as follows.

(1). Dust

Dust is a particulate form of volatile organic compounds (VOCs) in fuels that condense in the atmosphere without burning, and a higher volatile content of coal, a dust is more emitted.

When coal is used only without biomass, there is not enough fire source to burn all of the VOCs, however, when biomass is included, the VOCs are burned by the biomass fire source, which is easier to ignite than coal, and dust emissions are reduced.

(2). SO₂

Figure 3-6-6 shows SO₂ emitting concentration on BCB, blended calcium carbonate (CaCO₃) as a desulfurizer, combustion test.

- Degradation of CaCO₃ → CaO + CO₂ and fixation of SO₂ to CaO hardly progresses at temperatures below 600°C.
- Therefore, although CaCO₃ exists, SO₂ concentration rises rapidly because the degradation temperature of CaCO₃ has not yet been reached (1).
- Thereafter, the temperature rises, CaCO₃ degrades, and SO₂ and CaO combine to form CaSO₄, which is fixed (desulfurized) in the ash (2).
- When additional fuel is fed, the temperature temporarily drops and CaCO₃ is insufficiently degraded. At this time, SO₂ concentration rises sharply due to ignition of volatile S (organic sulfur compounds) (3).
- Thereafter, the temperature rises again, CaCO₃ degrades, and SO₂ and CaO combine to form CaSO₄, which is fixed (desulfurized) in the ash (4).

Degradation of slaked lime Ca(OH)₂ begins at around 350°C, so desulfurization begins earlier than with CaCO₃. However, Ca(OH)₂ is highly alkaline and should be handled with care. If possible, low sulfur coal should be selected as raw material.

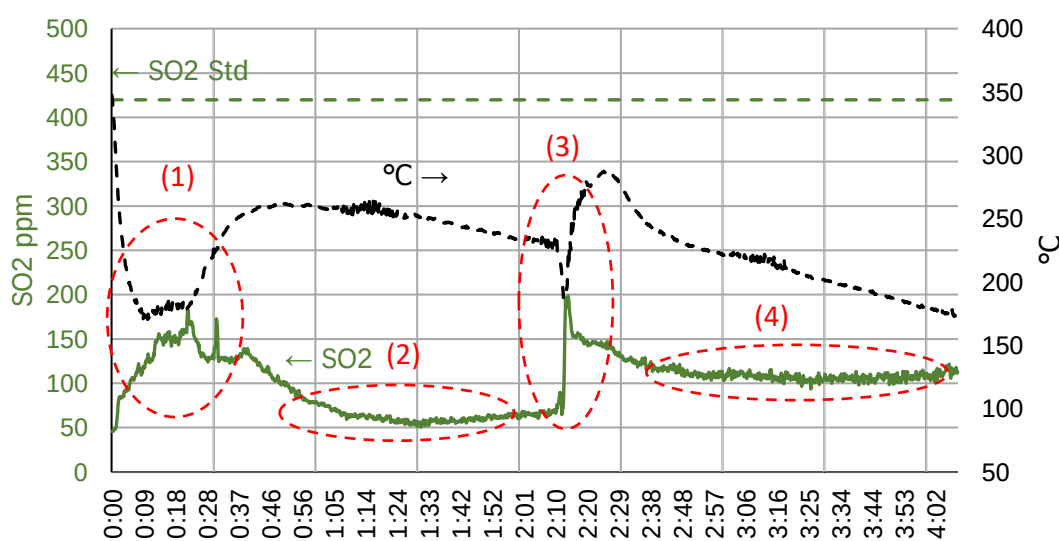


Figure 3-6-6 SO₂ Emitting Concentration (Desulfurizer, CaCO₃)

Desulfurization rate is determined by Ca/S molar ratio; experimental values showing Ca/S molar ratio versus desulfurization rate available (not attached).

(3). NO_x

Figure 3-6-7 shows NO_x emitting concentration on BCB combustion test. The starting temperature for nitrogen emissions is about 400-500°C, about 50-100°C higher than the main volatile components such as C and H. Generally, NO_x emissions increase with increasing temperature. All fuels met emission standards, so there is no problem.

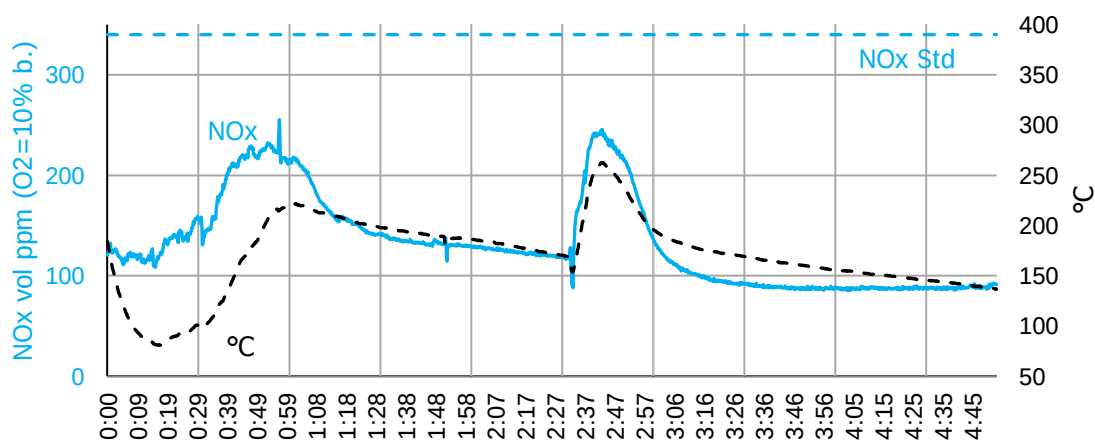


Figure 3-6-7 NO_x Emitting Concentration

(4). CO

Figure 3-6-8 shows a drawing of an improved stove. The combustion residue turned to ash, leaving briquette form. Therefore, the ash hardly fell down from grate and accumulated on the grate, preventing air entry from the bottom of the grate. In the case of 31 January 2024 BCB combustion residue, a briquette-form residue was deposited 120 mm thick on the grates and 85 mm thick when all of it was ground to powder.

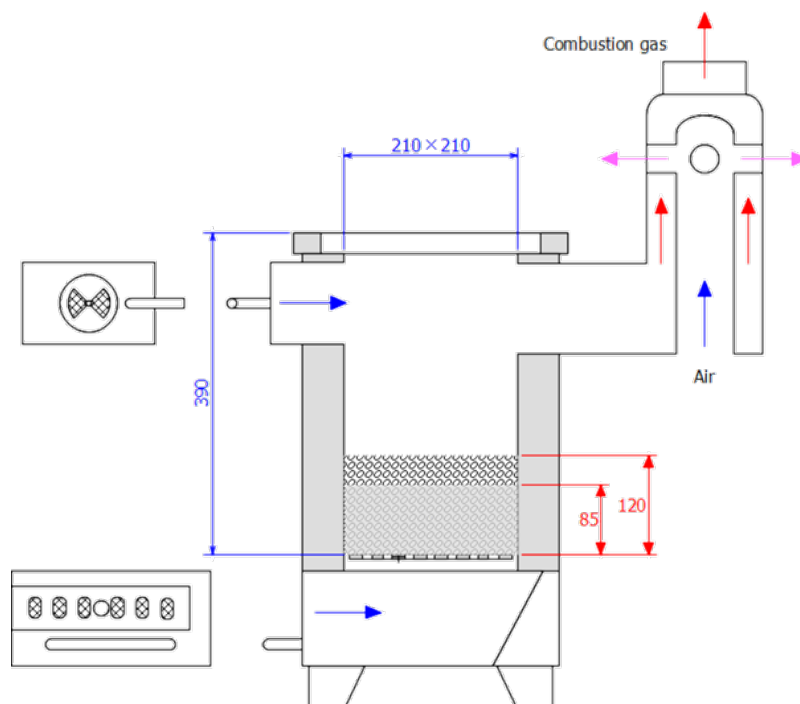


Figure 3-6-8 Deposition of Combustion Residues

Figure 3-6-9 shows the CO emitting concentration on BCB combustion test.

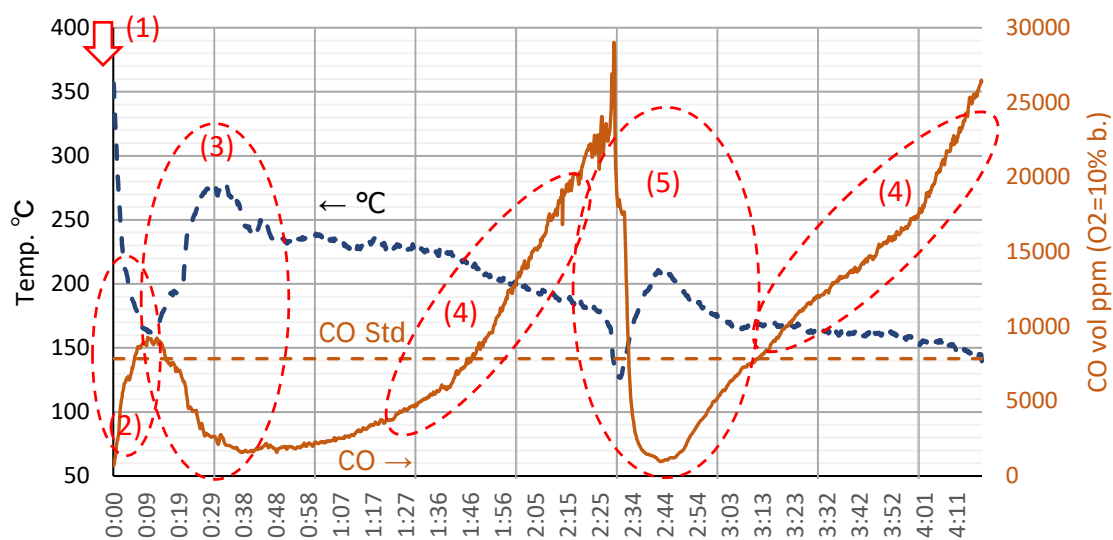


Figure 3-6-9 CO Emitting Concentration

- The high temperature and low CO concentration immediately after ignition may be due to wood for ignition (1).
- Then, coal ignites gradually, but due to still low temperature and low fire power, and attraction of air from the bottom of the grate is insufficient, which may have led to increase in CO concentration in a short period of time (2).

- Next, volatile components are ignited. The flame and temperature rise caused by the combustion of volatile components increases gas flow rate in a stack, which are drawn in inflow air from bottom of a grate and leads to reduction of CO concentration (3).
- It is also possible that CO in the flame was ignited by oxygen that entered through an upper inlet, leading to a decrease CO concentration (CO ignition temperature is 609°C) (3).
- Then, as the flame disappears and combustion becomes char combustion, gas flow rate in the stack decreases and drawn in inflow air from the bottom of the grate also weakens.
- Furthermore, as combustion proceeds, ash on the grate becomes thicker, which further inhibits inflow air from the bottom of the grate, and the CO concentration continues to increase (4).
- A new flame is generated by combustion of volatile components when additional fuel is fed, and same phenomenon occurs (5) as above (3).

As shown in Figure 3-6-9, CO concentrations are an average of portion that meets and exceeds emission standards. If a large portion is lower value of emission standard, the average concentration will meet the emission standard, and if a large portion is higher value of emission standard, the average value will exceed the emission standard.

Figure 3-6-10 shows a case where the average CO concentration exceeds the emission standard, and Figure 3-6-11 shows a case where the average CO concentration meets the emission standard. Area A in both figures is areas below the emission standard value; if the area of area A is small, the average value of CO concentration exceeds the emission standard value (Figure 3-6-10) and if the area of area A is large, the average value of CO concentration meets the emission standard value (Figure 3-6-11).

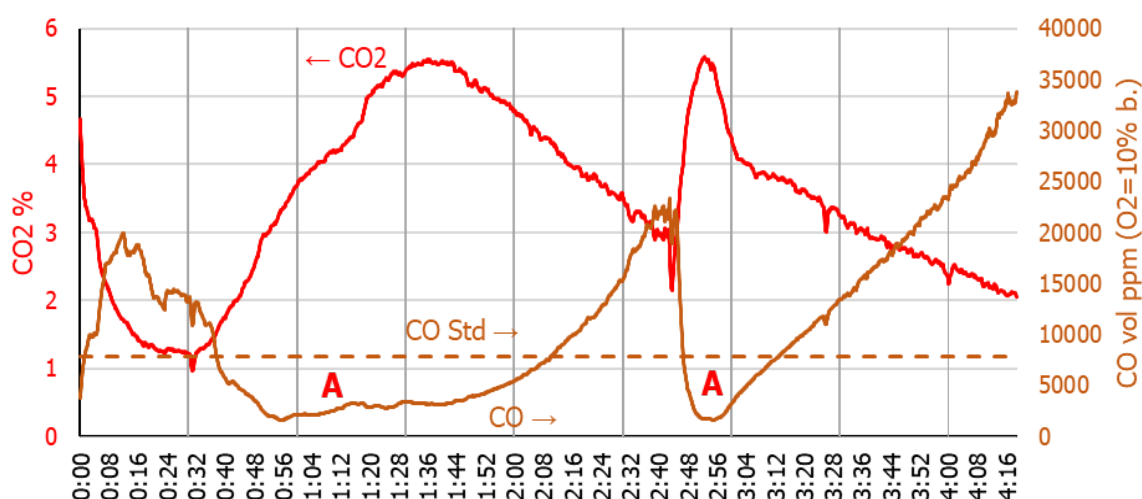


Figure 3-6-10 In Case the Average Value of CO Concentration Meets the Emission Standard

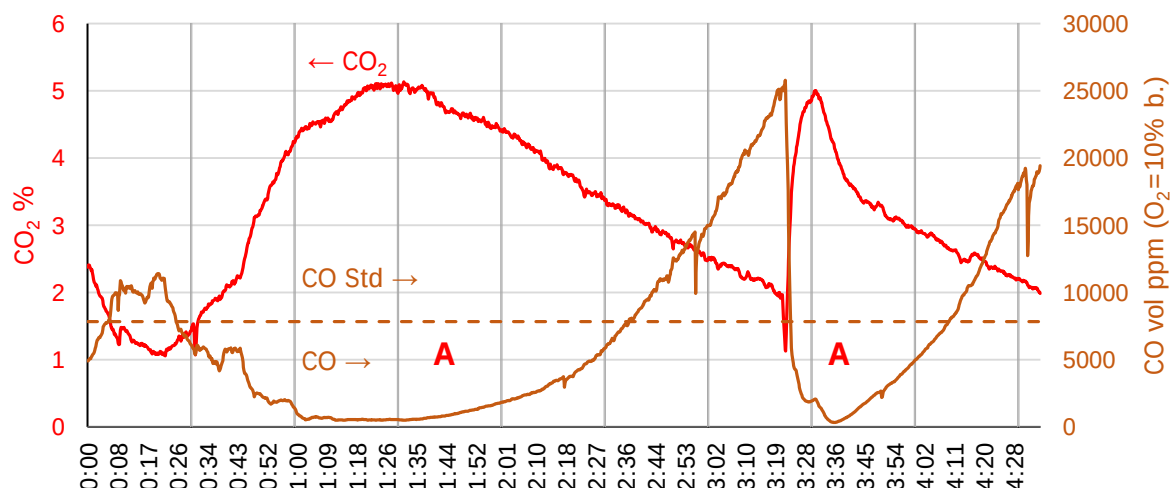


Figure 3-6-11 In Case the Average CO Concentration Exceeds the Emission Standard

The BCB manufactured in 2023 constantly met the emission standard, and as an example, the average CO concentration was 3,513mg/m³N which is below the emission standard, 9,800mg/m³N. Figure 3-6-12 shows the relationship between flue gas temperatures and CO concentrations. The characteristic feature is presence of condensed ash in the combustion residue (Figure 3-6-13). Since a raw material was coking coal, it is thought that the coal melted, softened, and condensed into ash. Combustion characteristics at this time were excellent and CO generation was low. It is thought that the condensed ash prevented airway blockage and did not prevent the oxygen supply from the grate.

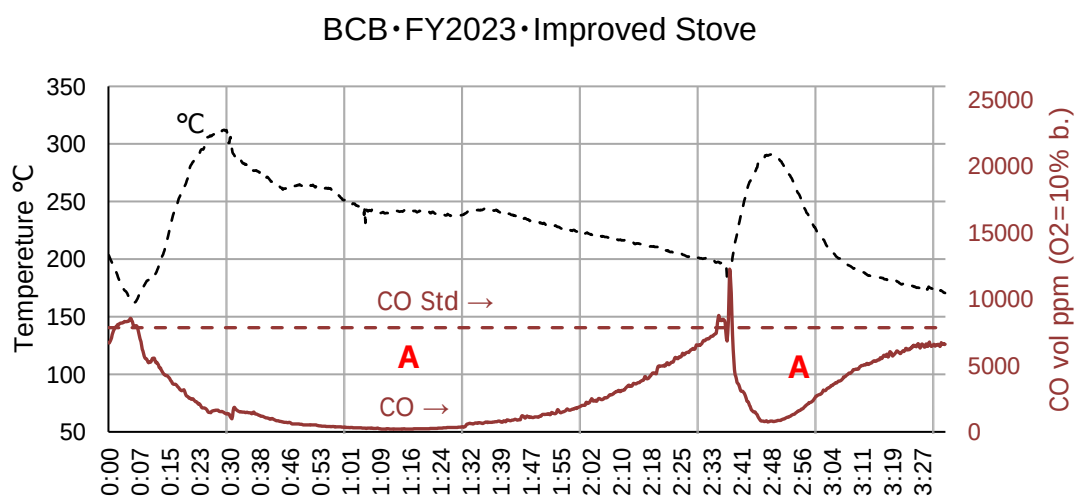


Figure 3-6-12 In Case Constantly Met the Emission Standards



Figure 3-6-13 Melt-softened and Condensed Ash

3-6-4 Activity 5-4: Implementation of the Pilot Project

5-4 The relevant agencies with JICA Experts implement pilot projects according to the implementation plan by Activity 3-3.

3-6-4-1 Relation between the National program and the Pilot projects

The Project selected pilot projects in conjunction with the Mongolian Government Cabinet Decision No.98 “National Program for Air and Environmental Pollution Reduction” dated 20th March 2017 and MET Ministerial Order No. A/107 “Implementation Plan of National Program for Air and Environmental Pollution Reduction” dated 27 April 2017. Table 3-6-3 shows the relevance of the pilot project to Cabinet Decision No.98 on 20 February 2018 and Ministerial Order No. A/107 on 27 April 2017.

Table 3-6-3 Relevance of the Pilot Project to the Mongolian Government Cabinet Decision No. 98 on 20 March 2017 and MET Ministerial Order No. A/107 on 27 April 2017

	Pilot Project	No.98 Cabinet Decision of the Mongolian Government “National Program”	MET Ministerial Order No. A/107 Implementation Plan of National Program for Air and Environmental Pollution Reduction based on approval of the National Program	
		Measures to be implemented	Object	Activity
1	Household Improved Fuel	4.2.3 Provide improved fuel that meets standards to Ger areas, support and promote improved fuel production and use it instead of raw coal	2 Reduction of pollution sources through introduction of environmentally friendly and efficient advanced technologies and innovations, and reduce pollutant emissions by phase-out of raw coal consumption.	2.3.1 Supply of improved fuel compliant with standards to households in Ger areas within UB City, support and promotion of activities of improved fuel production plants.
2	Signal Control	-	3. Implementation of comprehensive measures to reduce pollutant emissions from automobiles.	-
3	Introduction of low-sulfur fuel and low-emission automobiles	4.3.2 Support the import and use of fuels that meet Euro 5 standards and gradually ban import, sale and use of fuels that do not meet these standards, and strengthen the control system over fuel properties.		3.2.1 Increase the use of Euro 5 compliant fuels by requiring the quality of fuels used in UB cities and larger cities to comply with Euro 5 standards.
4	Eco-driving study	-		3.3.4 Installation of "eco-drive" monitoring devices on public transportation buses for promotional and introductory activities
5	Remote Sensing Device (RSD)	4.3.1 Implement measures to ban automobiles use in UB city that does not meet standards that have a negative impact on human health and the natural environment.		3.4.4 Installation of RSDs at toll gates in UB cities to measure emissions from transportation
6	PM reduction devices (DPF, etc.)	4.3.4 Reduction of pollutant emissions from transportation by expanding the road network, implementing traffic management smart systems, and improving the quality of service and maintenance of public transportation.		3.3.3 Installation of DPFs on diesel public transport buses and their regeneration equipment and provision of constant service

3-6-4-2 Household Improved Fuel

As described in 3-4-3 above, Moringiin Davaa area adjacent to former international airport in the western part of UB City was initially selected as a site for the verification study of the pilot project. The Mongolian and the Japanese sides held discussions at the 3rd JCC and decided to stop using private houses and to use Gers at a campsite in Terelj National Park, located eastern part of UB City and to implement verification study by hired staffs.

(1). April 2022 ~ April 2023

1) Decisions of improved fuels to be manufactured and production of improved fuels

Implementation of the verification study for the pilot project was delayed from the original plan due to travel restrictions caused by the global pandemic of COVID-19 and delayed installation and trial operation of a biomass crusher, and was implemented from the end of November 2022 to the end of January 2023.

In order to select an improved fuel for the verification study, JET requested TTT to manufacture trial products of four types of semi-coke blended improved fuel and two types of BCB, and combustion tests of trial products were conducted by DAAEP. The raw material ratio are shown in Table.

Table 3-6-4 The Raw Material Ratio of BCB and Semi-Cokes Blended Briquette

	UHG Middling	Biomass	Semi-Cokes	Binder	Desulfurizer
BCB	76.0%	Sawdust:15%		6.0%	3.0%
BCB	76.0%	Sawdust: 7.5% Cow dung: 7.5%		6.0%	3.0%
Semi-Cokes Blended 12.5%	80.5%		12.5%	4.0%	3.0%
Semi-Cokes Blended 25.0%	68.0%		25.0%	4.0%	3.0%
Semi-Cokes Blended 50.0%	43.0%		50.0%	4.0%	3.0%
Semi-Cokes Blended 93.0%	0%		93.0%	4.0%	3.0%

The results of combustion tests by improved stove in DAAEP's fuel combustion laboratory are shown in Table 3-6-5. When comparing BCBs and semi-coke blended fuels, concentration of dust was almost the same, and CO concentrations of BCBs was lower than semi-cokes blended briquettes. In addition, when comparing the TTT's improved fuel and the BCBs, the CO concentrations is high. It was decided to investigate other test results from TTT and to compare the results of combustion tests and consider good quality the BCBs to be manufactured in the future.

The CO readings indicate the CO concentrations in flue gas, and impact of the CO concentrations in a Ger was not particularly problematic, as there were no detector alarms in the Gers of either the

TTT's improved fuel or the BCBs during verification study period. On the other hand, less the CO concentrations were an issue for future study, as less the CO concentrations are able to lower the hazard risk. The evaluation results of combustion test are shown in Table 3-6-6.

Table 3-6-5 The Result of Flue Gas Measurement at Fuel Combustion Laboratory of DAAEP

MNS 5216:2016			TTT's improved fuel	Middling blended with Biomass		Middling blended with Semi-Cokes			
				Sawdust 15%	Sawdust+ Cow dung 15%	12.5%	25%	50%	100%
Dust	130	mg/Nm ³	130	44	59	87	50	48	33
SO ₂	1,200	mg/Nm ³	941	645	675	749	831	885	836
NO _x	700	mg/Nm ³	215	253	244	297	259	246	222
CO	9,800	mg/Nm ³	9,424	10,184	11,492	12,141	13,292	14,746	20,057

Note: Red values indicate exceedance of emission standards.

Table 3-6-6 The Evaluation Results of Combustion Test

Category	Semi-cokes blended briquette	BCB
Dust	• Less than TTT's improved fuel	• Less than TTT's improved fuel and
SO ₂	• The desulfurizer contained in the binder made in China is insufficient. • Desulfurizer such as CaO, CaCO ₃ and Ca(OH) ₂ , etc. must be added.	
CO	• Higher than TTT's improved fuel	• Same level as improved fuel
Ignitability	• Worse than TTT's improved fuel	• Better than TTT's improved fuel, and the amount of ignition material can be reduced.
Burning temperature	• In some cases, lower than TTT's improved fuel	• Higher than TTT's improved fuel
Burning time	• Longer than TTT's improved fuel	• Shorter than TTT's improved fuel
Hardness	• Same as TTT's improved fuel	• Prototype was soft. • If the form is small and the biomass addition rate is reduced, it will be possible to make it as hard as TTT's improved fuel.

Based on the combustion test results, DAAEP and JET selected improved fuel to be used for the verification study at the campsite. Since approximately 10 tons of improved fuel are required for the verification study, the Project decided to be used BCB in the first verification study at the campsite, because semi-coke, raw material, is difficult to obtain in UB City, and TTT is currently studying use of semi-coke blended improved fuel.

A BCB with a 15% biomass blending was difficult to manufacture due to low pressure of the molding machine used to manufacture BCB. Therefore, JET consulted with manufacturer and lowered the biomass blending ratio to 10%. In addition, a trial product used a desulfurizer contained in a binder made in China, however, combustion tests showed that the desulfurization effect was low, so 3% dolomite ($\text{CaMg}(\text{CO}_3)_2$) was newly added as a desulfurizing agent. JET set the moisture content during production at 15% for easy molding. Drying of the manufactured BCB was done by air-drying in building of a manufacturing plant, however, it was later founded that drying was insufficient. The BCB production method is shown in Annex 3-6-4.

Table 3-6-7 shows results of combustion tests of TTT's improved fuel and BCB used at the campsite in DAAEP's fuel combustion laboratory. Since the Gers used in the pilot project were traditional stoves, the combustion test was also conducted using the traditional stoves. The results of BCB combustion test conducted in 2022 (before freezing) were not able to be evaluated accurately due to the large variation in the results of 3 times measurements. Therefore, BCB combustion tests were conducted again in April 2023 (after freezing). Based on these results of the combustion test, BCB was expected to have better environmental performance than TTT's improved fuel. Since the Gers used in the pilot project were traditional stoves, the combustion test was also conducted using the traditional stoves.

Table 3-6-7 Results of Combustion Tests of TTT's Improved Fuel and BCB at the DAAEP Fuel Combustion Laboratory

				TTT				BCB (Before freezing)				BCB (After freezing)			
								Sawdust (10%)				Sawdust (10%)			
								CaCO ₃ (3%)				CaCO ₃ (3%)			
		MNS 5216:2016		1	2	3	AVG	1	2	3	AVG	1	2	3	AVG
Emission Concentration after O ₂ conversion at 10%	Dust	130	mg/Nm ³	179	163	163	168	174	78	29	94	127	127	118	124
	SO ₂	1,200	mg/Nm ³	645	739	917	767	267	207	212	228	269	289	205	254
	NOx	700	mg/Nm ³	220	289	338	282	314	221	165	233	198	228	208	211
	CO	9,800	mg/Nm ³	10,346	10,897	13,453	11,565	8,874	12,865	8,976	10,238	14,861	11,607	12,241	12,903

Note: Red values indicate exceedance of emission standards.

2) Verification Study

A road to the north of a campsite where the verification study of the pilot project was a valley, and further north is a large mountain. There was also a large mountain to the west of the campsite, however, the south side of the campsite was a lower hill than those mountains. The campsite was located on the north-facing slope of that hill.



Source : Google Earth

Figure 3-6-14 Verification Study Site of the Pilot Project (Inside of a Red Circle)



Photo 3-6-2 Verification Study Site of the Pilot Project

Table 3-6-8 shows a schedule for the verification study of the pilot project, which tested TTT’s improved fuel three times and BCB three times over a 40-day duration from 27 November 2022 to 20 January 2023.

Table 3-6-8 Implementation Schedule of the Verification Study

Nov-22				Dec-22																				Jan-23																			
27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	8	9	10	11	12	13	14	15	16	17	18	19	20				
Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri				
TTT-1														TTT-2													TTT-3																
								BCB-1													BCB-2																			BCB-3			

BCB: Biomass Coal Briquette

Figure 3-6-15 shows a layout of Gers used and an air quality monitoring automobile at the campsite. 15 Gers were used for combustion tests, and hired staffs were assigned to Gers.

Table 3-6-9 shows the details of main contents of combustion test in the Gers.

Table 3-6-9 Main Contents of Combustion Test in the Gers

Combustion Test Time	7:00 - 21:00
Atmospheric Concentration Measurement Time	8:00 - 21:00
Stove used	Traditional Stove
Burning Pattern	Morning ignition → several times of refueling → ash removal, fuel input, ignition → several times of refueling.
Fuel Consumption	TTT, BCB: each approx. 25 kg/day/Ger

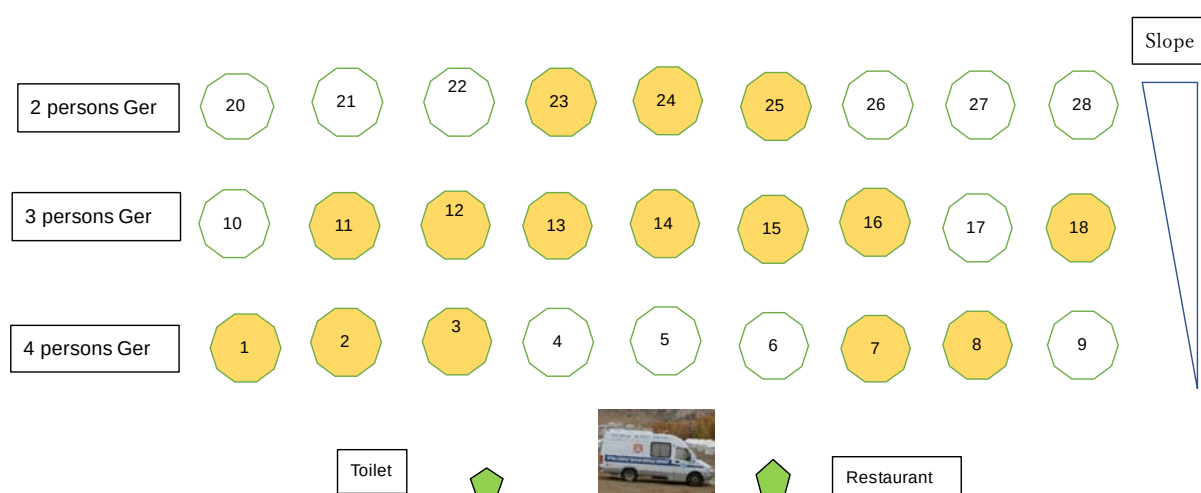


Figure 3-6-15 The Layout of the 15 Gers used and the Air Quality Monitoring Automobile at the campsite

	
Ger campsite and the air quality monitoring automobile	At the start of combustion in early morning

Photo 3-6-3 Verification Study

The BCB used for the verification study at the campsite was crumbled and only lumps were sorted through a sieve to implement the combustion test. The summary of the results showed that the BCB had better ignition and temperature rise than the TTT's improved fuel. After analyzing air quality measurement data obtained in this verification study at the Ger campsite, conclusion is that BCB is not able to evaluate its environmental performance advantages over TTT's improved fuel. The causes were considered to be follows;

1. Air quality monitoring by the air quality monitoring automobile were 866 (221 for the TTT's improved fuel and 645 for the BCB) in the 10-minute period during the 24 days of the study (14 hours from 7:00 to 21:00) when data was not able to be obtained under favorable conditions with light winds and/or stagnation. This was only 43% of data obtained during conducted verification study, and making conditions for air quality monitoring were difficult.
2. The BCB was not adequate strength strong due to effects of high moisture caused by insufficient drying of the BCB. The BCB did not achieve the expected combustion conditions due to high moisture content, which was repeatedly frozen and thawed resulting in increased expansion and powdering during storage in winter season.

In this pilot project using the Ger campsite and air quality monitoring automobile in this case, it was determined that it would be difficult to quantitatively evaluate the BCB and the TTT's improved fuel by air quality monitoring using the air quality measurement automobile due to various variable (influencing) factors. In the pilot project for the improved fuel starting in June 2023, it was decided not to implement a verification study at the Ger campsite, but only to perform flue gas measurements at the DAAEP fuel combustion laboratory.

(2). **June 2023 ~ April 2024**

1) Fuel Specification and Combustion test method

The Mongolian side is considering an improved fuel blended with semi- cokes from around 2022. The raw material ratio of BCB and TTT's improved fuel is shown in Table 3-6-10, and the appearance is shown in Figure 3-6-16.

Since the binder and desulfurizer were not able to be purchased separately from TTT, a binder for the BCB was the Chinese binder used by TTT in 2022, and a desulfurizer for the BCB was limestone (CaCO_3). Thus, a blended product of binder and desulfurizer was used for the TTT's improved fuel.

The BCB is an oval form with a diameter of 50 mm x 35 mm. TTT's product in 2023 is available in three forms, including this square with rounded corners and one with the same form as the BCB. Since TTT was unable to secure necessary quantities of dolomite ($\text{CaMg}(\text{CO}_3)_2$) procured domestically, it have blended two types of Chinese-made binders and desulfurizers in the following proportions to manufacture the improved fuel.

Table 3-6-10 The Raw Material Ratio of BCB and TTT's Improved Fuel

	UHG Middling	Biomass	Binder	Desulfurizer
BCB	81.0%	Sawdust:10%	6.0%	CaCO_3 :3%
TTT's improved fuel	95.0%		5.0%(Dolomite)	
TTT's improved fuel	95.0%		5.0%(Imported)	



Figure 3-6-16 BCB and TTT's improved fuel

Combustion tests by an improved stove were conducted three times with the BCB and two times with the TTT's improved fuel.

Since purpose of a measurement protocol is to evaluate environmental performance of fuels, measurement starts when 0.5 kg of igniter wood is burnout and 4.0 kg of fuel is ignited (Hot Start). The measurement protocol of combustion test is shown in Figure 3-6-17.

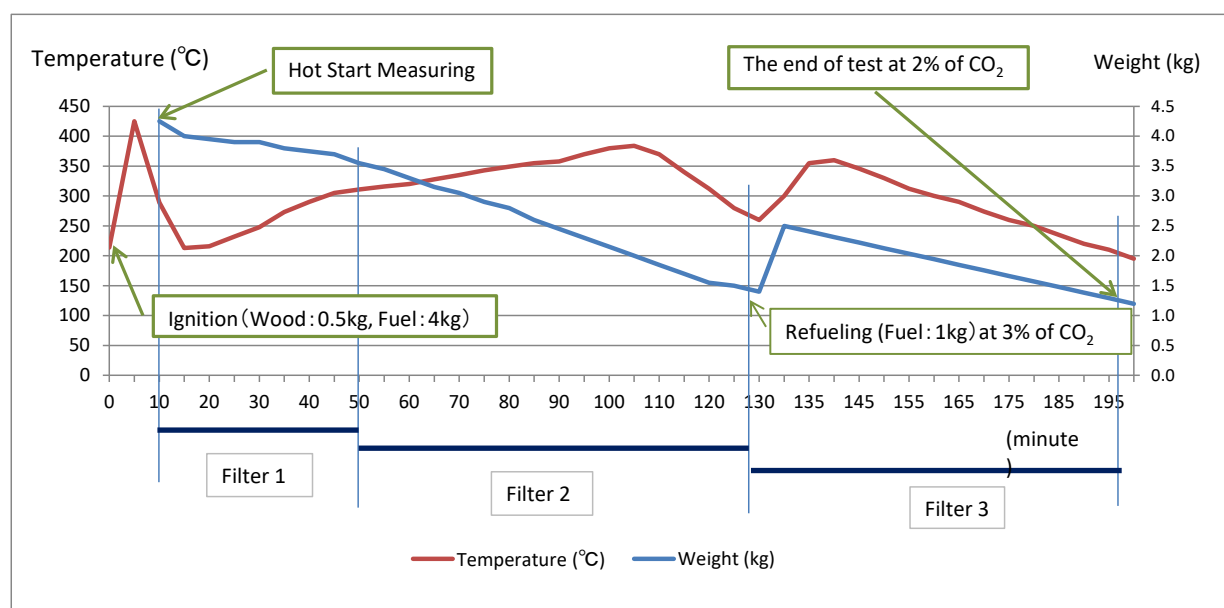


Figure 3-6-17 Measurement Protocol of Combustion Test

2) The Result of Combustion Test

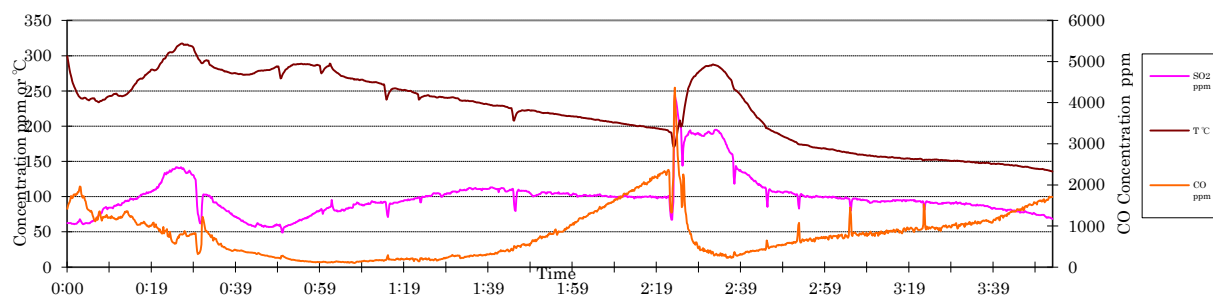
Combustion tests were performed in December 2023, January 2024, and February 2024; flue gas temperatures and flue gas concentrations during combustion test of the BCB and the TTT's improved fuel are shown in Figure 3-6-18. The results of the measurements, along with past results of TTT's improved fuel, are shown in Table 3-6-11, evaluation results of combustion test are shown in Table 3-6-12.

The BCB met emission standards in all parameters. Compared to the BCB and the TTT's improved fuel, the BCB had lower concentrations of Dust, SO₂, NO_x, and CO, and especially CO concentrations differed significantly.

On the other hand, the TTT's improved fuel was more likely to generate CO than the BCB, and both Dust and CO concentration exceeded the emission standard. In addition, the TTT's improved fuel did not add any desulfurizer in 2020, added 4% desulfurizer in 2021 and 4.3% desulfurizer (CaMg(CO₃)₂) in 2023. As a result, SO₂ concentrations are lower than in 2020.

The TTT's improved fuel has poorer ignitability than the BCB, and the temperature inside the stove rises more slowly, thus the combustion test laboratory tends to be less warm, and the CO concentration tends to be higher.

BCB, 31 January 2024



TTT's Improved Fuel, 1 February 2024

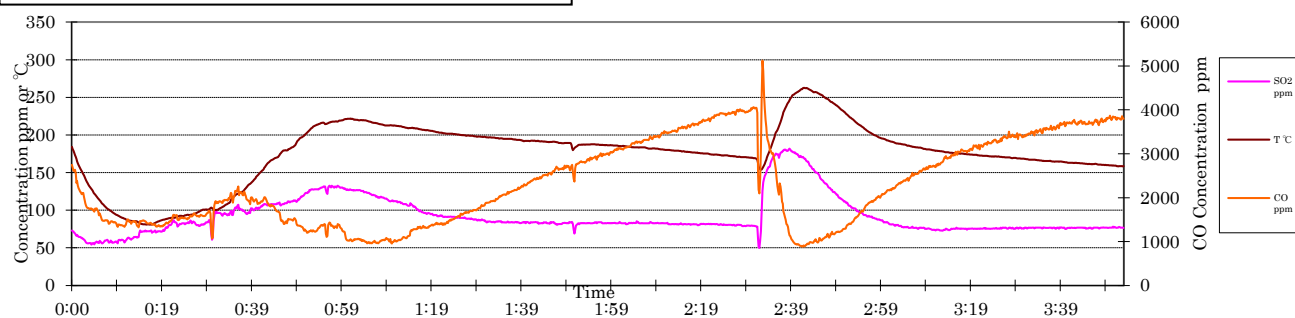


Figure 3-6-18 Flue Gas Temperature and Flue Gas Concentration of BCB and TTT's Improved Fuel during Combustion Test (Raw Data)

Table 3-6-11 The Combustion Test Results of BCB and TTT's Improved Fuel at Improved Stove

MNS 5216:2016	2020 year TTT					2021 year TTT				2023 year TTT			2023 year BCB (Saudust10%, CaCO ₃ 3%)			
	1	2	3	4	Average	1	2	3	Average	1	2	Average	1	2	3	Average
Dust 130 mg/Nm ³	137	124	120	139	130	204	149	105	153	151	125	138	98	86	47	77
SO ₂ 1,200 mg/Nm ³	919	776	1,042	1,027	941	637	748	464	616	747	778	762	518	371	724	538
NO _x 700 mg/Nm ³	187	178	277	220	215	231	225	269	241	177	178	178	152	163	140	152
CO 9,800 mg/Nm ³	7,570	10,694	11,119	8,313	9,424	9,064	9,286	8,116	8,822	10,698	11,581	11,139	3,513	1,492	2,988	2,664

Note: Red values indicate exceedance of emission standards.

Table 3-6-12 Evaluation Results of Combustion Test

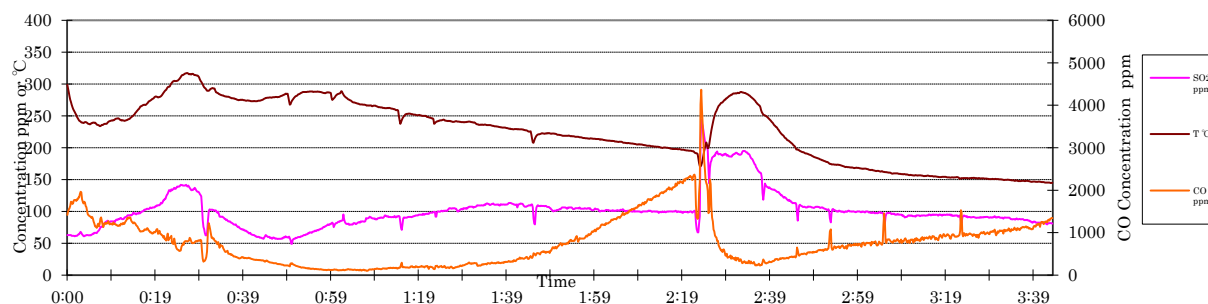
Category	TTT's Improved Fuel	BCB
Dust	Emission standard is exceeded.	- Emission standard is met. - Dust reduction is more effective than TTT's improved fuel.
SO ₂	Some desulfurization effect is expected.	BCB provides more effective desulfurization than TTT's improved fuel.
CO	Emission standard exceeded.	- Emission standard is met. - Significant reduction in CO concentration is possible compared with TTT's improved fuel.
Ignitability	Poor	BCB has better ignitability than TTT's improved fuel and reduces the amount of ignition material.
Burning temperature	Average 170°C	Average is 243°C, higher than TTT's improved fuel, which makes the room warmer.
Burning time	- Low temperatures continue for long periods of time. - More igniters and fuel are likely to be used to heat the room faster.	About 12% shorter than TTT's improved fuel
Hardness	Hard	Not as hard as TTT's improved fuel

(3). Differences between traditional and improved stove

Combustion tests of traditional and improved stove were conducted using BCB from December 2023 to March 2024. The flue gas temperatures and flue gas concentrations during combustion test for the different stoves are shown in Figure 3-6-19.

Also, results of measurements are shown in Table 3-6-13; When the BCB was used as fuel, the improved stove met the emission standard, however, Dust concentration of the traditional stove was higher than the improved stove, especially high concentrations of CO continued for a long time, and CO concentration exceeded the emission standard. Therefore, traditional stoves that do not meet the technical requirements for stoves in MNS 5216:2016 should be discontinued for production and sale because of the risk of carbon monoxide poisoning.

Improved Stove



Traditional Stove

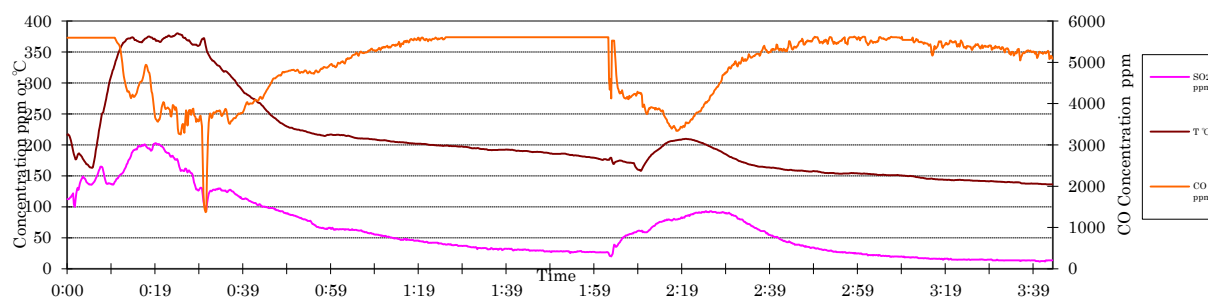


Figure 3-6-19 Flue Gas Temperature and Flue Gas Concentration during Combustion Test for the Different Stoves (Raw Data)

Table 3-6-13 The Result of BCB Combustion Test for Traditional and Improve Stove

MNS 5216:2016			Traditional Stove				Improved Stove			
			2023year BCB (Saudust10%.CaCO ₃ 3%)							
			1	2	3	Average	1	2	3	Average
Dust	130	mg/Nm3	125	107	99	110	98	86	47	77
SO2	1,200	mg/Nm3	287	363	392	347	518	371	724	538
NOx	700	mg/Nm3	161	164	152	159	152	163	140	152
CO	9,800	mg/Nm3	16,783	16,080	16,826	16,563	3,513	1,492	2,988	2,664

(4). Production of BCB

1) Biomass supply feasibility study

A biomass supply feasibility study was conducted from July 2023 to December 2023. A result showed that Mongolia was able to supply an average of 8.6 million tons of biomass per year of which 91.0% is animal dung and manure, 4.6% is crop residues, and remaining 4.4% is sawdust, deadwood, fallen trees, dried wood, and other wood.

The challenge is that although dung and manure biomass is abundant, there is no established system to enable the supply of biomass.

TTT manufactures 650,000 tons of improved fuel each year, and if the fuel were converted to BCB, the required biomass would be 71,500 tons (considering an average moisture content of about 10%). 7.15 million tons of biomass would cost 23.1 billion MNT (1 billion yen) to procure.

Table 3-6-14 Supply Quantity by Biomass Type and Price including Transportation to TTT's East Plant

(Unit: MNT)

No	Types of biomasses	Amount of supply, tons	Price per 1 ton	Biomass purchase cost	Total cost of labor and transportation	Total Amount
1	Wood	15,000	200,000	300,000,000	20,000,000	520,000,000 (22,600,000JPY)
2	Crop residues	50,000	300,000	1,500,000,000	350,000,000	1,850,000,000 (80,400,000JPY)
3	Dry dung and manure	50,000	200,000	1,000,000,000	350,000,000	1,350,000,000 (58,700,000JPY)
Total		115,000				3,720,000,000 (161,700,000JPY)

2) BCB production costs

Changing from existing low-pressure molding machines to a high-pressure molding machine may reduce addition rate of binder, thereby lowering production cost. Therefore, tablets (briquettes that look like larger round tablets of medicine with a circular diameter of 52 mm and a thickness of 24 mm) were manufactured at high pressure molding to reduce the binder addition rate, and strength tests of the tablets were conducted. As a result, it was found that even at high molding pressure, binder is essential in terms of strength and that 6% binder needs to be added to BCB.

The production cost of the BCB is about 22% higher than the 2023- planned cost of the TTT's improved fuel because of a cost of purchasing biomass and crusher, although a cost of transporting the middling is lower because the amount of middling used in the feedstock is reduced.

In addition to this, other capital investments include the construction of a production line for the BCB, including biomass storage, biomass dryers, etc., because the existing TTT's production line is not able to be diverted for the production of the BCB.

(5). Output

The BCB was manufactured under the constraints of using coal which are used the production of TTT's improved fuel, which is manufactured under the policy of the Mongolian Government. The BCB has better environmental performance than existing TTT's improved fuel, and the Project was

able to manufacture a product that meets all parameters of MNS5216:2016 emission standards for stoves in the improved stove.

In addition, it was found that 115,000 tons of biomass required for production were able to be supplied from Tuv Province, which is located near UB City. However, it was found that the production cost of 650,000 tons of the BCB is estimated to be 22% higher than 2023 planned production cost of the TTT's improved fuel, because of the increased cost of purchasing and transporting biomass, etc. In addition, new investment will be required because manufacturing equipment of the existing improved fuel isn't able to be used to manufacture BCB, and biomass supply chain is necessary to be established.

3-6-4-3 Signal Control

Regarding signal control, in order to implement appropriate operation (maintenance and management) of the traffic control system installed at TCC, training based on Japanese traffic engineering in Japan was held in December 2022.

Based on the results of the traffic phenomenon survey conducted in September 2022, and using the technology acquired through the training in Japan, JET and TCC carried out the following signal adjustments in April 2023 and evaluated the impact.

1. Among the 17 intersections surveyed (Figure 3-6-20), signal lighting duration adjustment was proposed for 13 intersections. Of the 13, 3 intersections were unable to reflect the proposed adjustment due to a problem with the signal controller, and signal lighting durations of the remaining 10 intersections were adjusted.

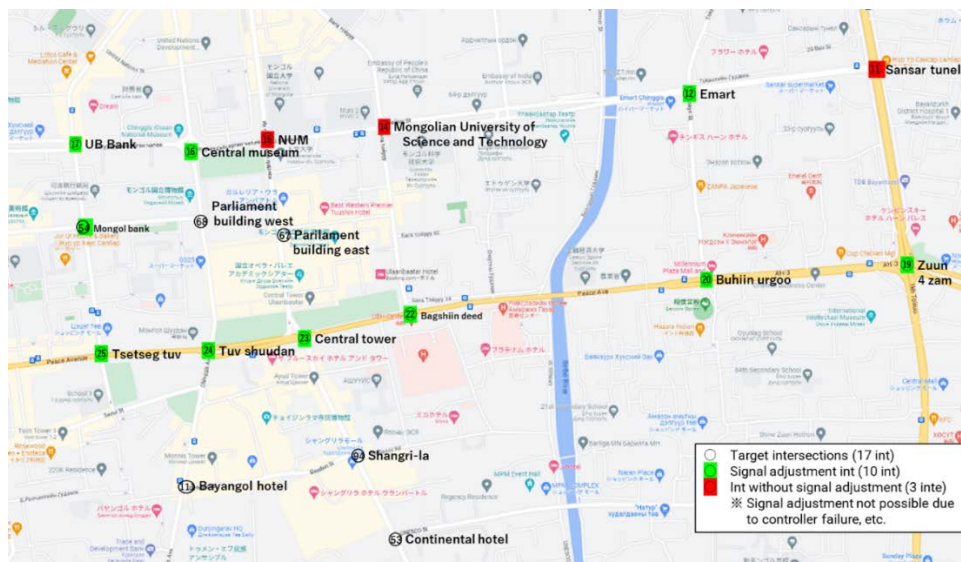


Figure 3-6-20 Target Intersections for Traffic Condition Survey

2. Traffic volume at 10 intersections was 574,270 automobiles before and 593,767 automobiles after the adjustment, increasing by 19,497 automobiles. This output indicated that more automobiles could pass through the intersection after signal lighting adjustment.

3. Congestion length at 10 intersections was 8,260 m before and 7,921 m after the adjustment, decreasing the congestion by 338 m.
4. Test driving was done for clockwise and anti-clockwise for 2 routes (4 routes in total), and 3 times (morning, afternoon and night) for each route. Travel time increased in 7 of the 12 routes traveled, and decreased in 5. Since travel time greatly depended on the traffic control by traffic police at the time of travel, the travel time increased or decreased depending on the number of travels. Travel time decreased especially one of the routes characterized by north-south directions during the night driving, from 47 minutes 36 seconds before (travel speed 9.5 km/h) to 40 minutes 19 seconds after signal adjustment (travel speed 11.2 km/h), decreasing by 7 minutes 17 seconds (improved travel speed 1.7 km / h).
5. TCC monitors traffic online, and often control programmed traffic signal manually. Manual controls at 14 intersections decreased from 340 to 315 after the adjustment. This means that due to congestion improvement, need for manual controls was decreased, and the number of interventions was decreased.
6. Length of each manual control by TCC was measured. Its average decreased from 3 minutes and 14 seconds to 2 minutes and 13 seconds after signal adjustment. This improvement is a result of the Traffic Control Center learning through training in Japan that traffic signal intervention has an adverse effect on traffic flow. The Traffic Control Center and the Traffic Police discussed in the end of January to decrease the signal intervention and to set a time limit of the signal intervention (unlimited → within 240 seconds).

In this project, changes in traffic conditions before and after the signal lighting adjustment were compared by traffic volume, congestion length, travel time, and signal intervention, and partial impact of signal adjustment were surveyed. The traffic condition data obtained before and after the adjustment were not only the impact by traffic signal adjustment in this project, but also the manual control in traffic signals implemented by (1) TCC by utilizing the technology transferred in the training in Japan, (2) traffic control by police ignoring traffic signals, and (3) improvement of traffic congestion in urban areas through traffic control in Zaisan area which was advised by JET.

In addition, through training in Japan to strengthen the capacity of the staffs in TCC (guidance on concept of signal adjustment), the approaching attitude of the staffs to improve the traffic congestion arose.

It should be noted that it is difficult to solve the traffic congestion only by adjusting traffic signals, and complex measures such as adjusting traffic signals, rearranging lanes, improving roads, improving public transportation systems, adjusting traffic demand, and improving traffic manners are required.

As a result of the signals adjusted in this project and the guidance on the concept of signal adjustment, including training in Japan, there was a change in the way TCC staff approached to improve traffic congestion and improve their technical skills. The traffic control center utilized this technical guideline (Annex 3-5-2) to consider measures such as traffic control on Zaisan area and the south side

of Narnii Bridge, and was able to put some of them into full-scale operation. In future, it is necessary to utilize the skills acquired through this project to select and implement effective measures to alleviate traffic congestion. Additionally, with support from the World Bank, the traffic control system is scheduled to be updated, but it is recommended to pay attention on ensuring that this system update includes system maintenance, etc.



Photo 3-6-4 Signal Adjustment

3-6-4-4 Low-sulfur Fuel

In Mongolia, automobile fuel in the market had high sulfur generally. For this reason, as part of our activities to introduce and disseminate low sulfur fuel (Euro 5 fuel), JET and the Mongolian side calculated SO₂ emissions reduction possibility if low sulfur fuel is introduced, and explained the history of why and how low sulfur fuel was introduced in Japan and the legal development. JET supported legal development and dissemination activities through MMHI, and tested the sulfur content of fuel sold at petrol stations in collaboration with MMHI.

The actual state of the sulfur content of fuel supplied to the market was determined by utilizing a fluorescent X-ray sulfur analyzer provided to MRPA in November 2021, and MRPA procured fuel samples from several petrol stations every month from December 2021, and analyzed the sulfur content. According in March 2023, out of 16 samples of diesel fuel that meet Euro 2 standards, 4 samples had sulfur concentrations exceeding 2000 ppm.

Based on the results of fuel analysis, reduction possibility of SO₂ emissions was calculated for the case when low-sulfur fuel disseminates, and found that SO_x emission from cars in UB city was 408.6 ton/year in 2018 because the sales ratio of low-sulfur fuel 12.8%, and decrease to 97.3 ton/year in 2025 assuming that the sales ratio of low-sulfur fuel is 80.0%. Through dissemination of low-sulfur fuel, it was calculated that SO_x emissions will be reduced by 76.2%.

As a result of the above activities, low-sulfur fuel was promoted by the amendment of Air Law on 22 April 2022 by inserting a new article, which prohibited the retail sale of fuel below the Euro 5 standard (K5 in Mongolia) within the air pollution improvement area of UB city.

However, although the sales volume of low-sulfur fuel is gradually increasing, it did not fully disseminate as everyday use due to a price difference between low-sulfur fuel and regular fuel (Euro 2 fuel).

Therefore, with the aim of disseminating low-sulfur fuels, JET prepared materials on the serious negative impact that high-sulfur fuels have on diesel automobiles that comply with Euro V regulations, and explained to MMHI, MRTD and PTD in April 2023.

During the explanation process, it was discovered that some public buses use regular fuel (high-sulfur fuel) for Euro V buses. In addition to requesting the issuance of a letter to use low-sulfur diesel oil, requested to prohibit the use of regular fuel. JET also issued a letter to the deputy Governor to raise awareness about the use of low-sulfur fuel. As a result, the bus company decided to use low-sulfur fuel.

Table 3-6-15 Sulfur Contents of “Euro 2 Diesel Fuel” sold in UB City

Sample No.	Sulfur (ppm) measured by ASTM D5453-09 method
GT065	3546.0
GT066	2217.0
GT067	1431.0
GT068	1921.0
GT069	1424.0
GT070	1431.0
GT071	1738.0
GT072	3150.0
GT073	1848.0
GT074	1405.0
GT075	1538.0
GT076	1480.0
GT077	2795.0
GT078	1929.0
GT079	1348.0
GT080	1808.0

Note: The standard for sulfur content in Euro 2 diesel fuel is 2,000 ppm or less.

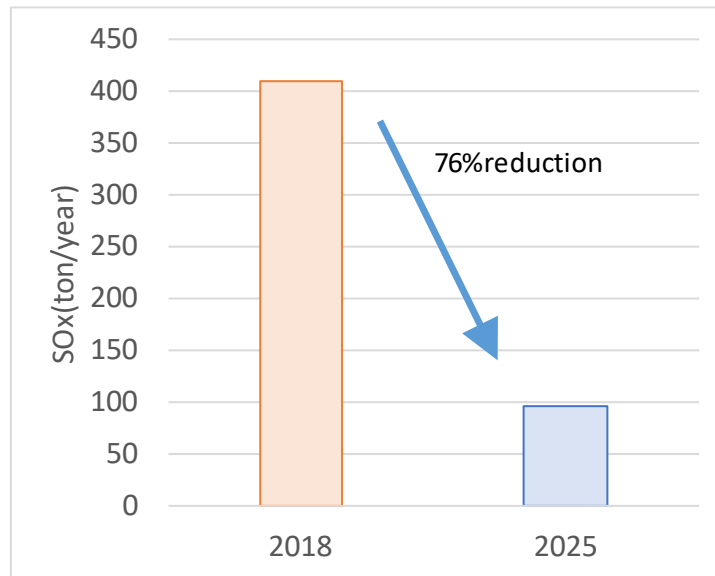


Figure 3-6-21 Estimated Results of SOx Emissions due to the Dissemination of Euro 5 Fuel

As part of our efforts to disseminate and raise awareness of low-sulfur fuel (Euro 5 fuel), JET, at the request of the MMHI, provided advice from a professional perspective, such as on the merits of Euro 5 fuel, to Shunkhlai LLC, which has been selling Euro 5 fuel since 2014. JET also appeared on Mongolian National Television Station (NTV) three times to disseminate low-sulfur fuel.

1) A JICA expert were interviewed by NTV on 3 October 2023, in style of answering the following questions. The interview was broadcasted on a news program from 7:00 pm on the same day. The news can be viewed at any time on NTV's official channel (<https://www.facebook.com/NTVNewsMN/videos/2018039411898251/>).



Photo 3-6-5 Interview on NTV

(Answer)

A. Information regarding improvement of fuel efficiency using to Euro 5 standards fuel as part of automobile measures

Fuel efficiency improvement by using Euro 5 fuel, compared to regular fuel, would be within the margin of error. However, large amount of sulfur contained in normal fuel deteriorates injectors, O₂ sensor, A/F sensor, and three-way catalyst of gasoline cars, and injectors, oxidation catalyst, DPF, urea SCR, and various sensors of diesel cars, which will be resulted in errors in volume of fuel injection. Therefore, using high-sulfur contained normal fuel will lower fuel efficiency.

B. Benefits and importance of Euro 5 fuel

Use of Euro 5 fuel is important because regular fuel not only increases fuel efficiency but also increases air pollutants such as SO₂, CO, HC, NO_x, and PM. In particular, the amount of SO₂ emissions is determined by the sulfur content in the fuel. In gasoline, when the sulfur content of normal fuel is about 150 ppm, whereas Euro 5 fuel is actually about 7 ppm, so by using Euro 5 fuel, SO₂ emission will be about 1/20th. With diesel, if the sulfur content of normal fuel is about 2,000 ppm, the Euro 5 fuel is actually about 7 ppm, so by using Euro 5 fuel, SO₂ emission will be about 1/280th. In UB city, high SO₂ concentration related to the use of coal fuel in the Ger district is an issue, however, since one of the causes is the use of regular fuel for cars, use of Euro 5 fuel is important countermeasure of air pollution that can be implemented immediately.

C. Other necessary information

(1) When the dissemination of Euro 5 fuel reaches 100%

If all automobiles in UB city used Euro 5 standard fuels, regardless of whether they are gasoline or diesel automobiles, deterioration of exhaust gas reduction devices would be minimized, which would contribute to improving air pollution. Additionally, since the sulfur content of Euro 5 fuel is lower than that of regular fuel, SO₂ emission per automobile are approximately 1/20 for gasoline automobiles and approximately 1/280 for diesel automobiles, compared to regular fuel.

(2) Japan's efforts and challenges in Mongolia

In Japan, the petroleum industry worked together to supply low-sulfur fuel by installing desulfurization facilities at refineries in response to requests from car manufacturers, that was necessary for the dissemination of low-sulfur emission automobiles. This cooperation achieved an improved level of desulfurization. However, Mongolia does not currently have a refinery, so it is difficult to disseminate Euro 5 fuel on its own, but countries from which it imports fuel (Russia and China) are making progress in introducing Euro 5 fuel. For this reason, I don't think there are any major issues with future procurement. On the other hand, even if the supply (import amount) of Euro 5 fuel increases steadily, if users do not understand the significance of using Euro 5 fuel, use of low-sulfur fuel will not disseminate. Therefore, continuation of educational activities to disseminate awareness of use of Euro 5 fuel is important.

2) As part of our efforts to disseminate Euro 5 fuel, public relations activities on NTV was conducted in cooperation with Shunkhlai LLC. NTV interview was conducted on Monday, 18 December 2023, and broadcasted on the evening of Wednesday, 20 December 2023. The news can be viewed at any time on NTV's official channel (<https://www.facebook.com/watch/?v=611376561080018>).

3) On 23 April 2024, NTV conducted an interview on Euro 5 fuel at gas stations, and broadcasted on the evening of the same day. The news can be viewed at any time on NTV's official channel (<https://www.facebook.com/watch/?v=1548909752338264>).



Source: <https://www.facebook.com/NTVNewsMN>

Photo 3-6-6 Broadcast on NTV

3-6-4-5 Eco-driving

For eco-driving, in order to understand the impact of reducing exhaust gas before and after introduction of eco-driving, the on-board emission measurement system was attached to three automobiles: a passenger gasoline automobile, a passenger gasoline hybrid automobile, and a diesel light duty truck from October 2021 to April 2022.

The experts in charge of DAAEP and NRTC were trained to measure the exhaust gas and to analyze the data recorded.

As a result of implementing eco-driving, the frequency rank of speed, acceleration, and engine speed have shifted to the lower rank compared to normal driving (i.e. before implementation of eco-driving). The effect of reducing air pollutants was 12-31% for NO_x, 33% for PM, and 2-13% for fuel consumption, excluding light duty truck. (The details are shown in Annex 3-6-5.)

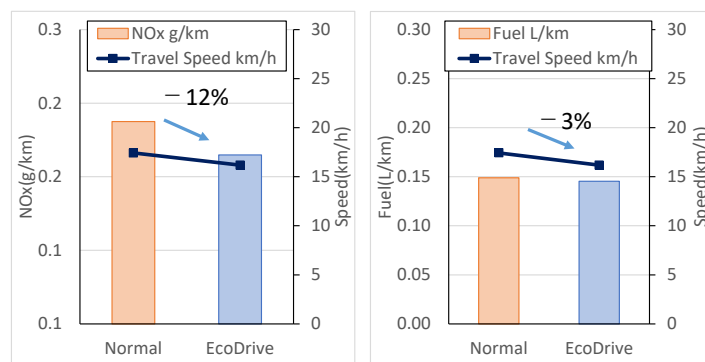


Figure 3-6-22 Effect of Reducing Air Pollutants through Eco-driving (Gasoline Automobiles)

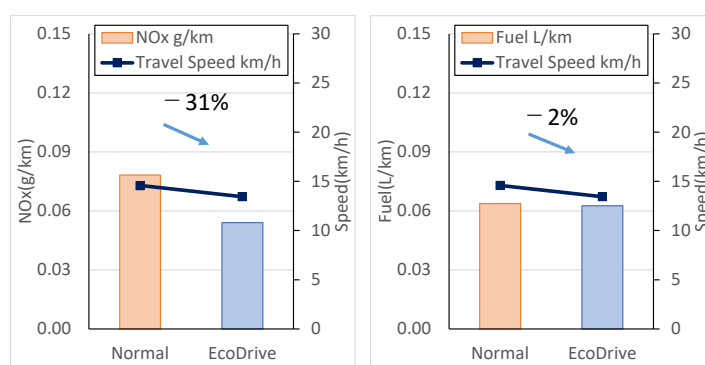


Figure 3-6-23 Effect of Reducing Air Pollutants through Eco-Driving (Gasoline Hybrid Automobile)

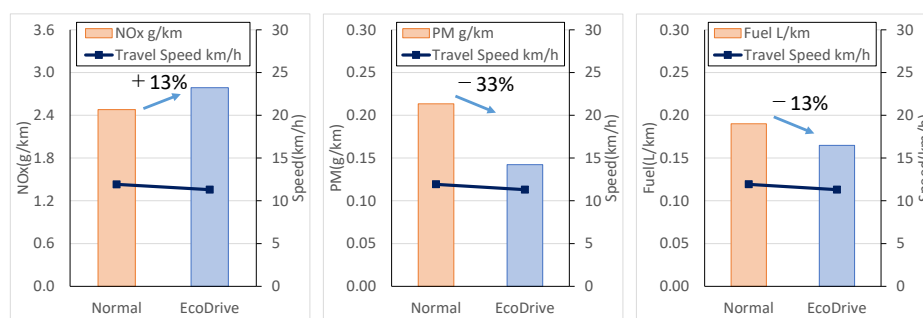


Figure 3-6-24 Effect of Reducing Air Pollutants through Eco-Driving (Light Diesel Truck)

Based on the above-mentioned effects of eco-driving, JET and the Mongolian side have created an eco-driving manual (Annex 3-6-5) to disseminate and raise awareness of eco-driving. In addition, operation management equipment was installed in total of eight automobiles of two companies, and after one month of normal operation, an eco-driving training was conducted using the created eco-driving manual. Using the achieved knowledge, eco-driving was carried out. Figure 3-6-25 compares the scores of normal driving and eco-driving.

For the drivers of Trust Trade Co., Ltd, which is a delivery company, the brake scores tended to be lower due to delivery within the city. The total score of only “car 4171” had improved by eco-driving, which was caused by improved brake score. The results were informed to the eight drivers from the two companies, and the driver with the highest score was awarded with a commemorative gift.

It is thought that it was difficult to implement eco-driving due to the traffic conditions in UB city, however, since driving habits of eco-driving does not consolidate immediately, it is important to continue implementing eco-driving based on the technical guideline for eco-driving (Annex 3-5-3). It is necessary to continue to evaluate driving performance and practice eco-driving until drivers become accustomed to eco-driving.

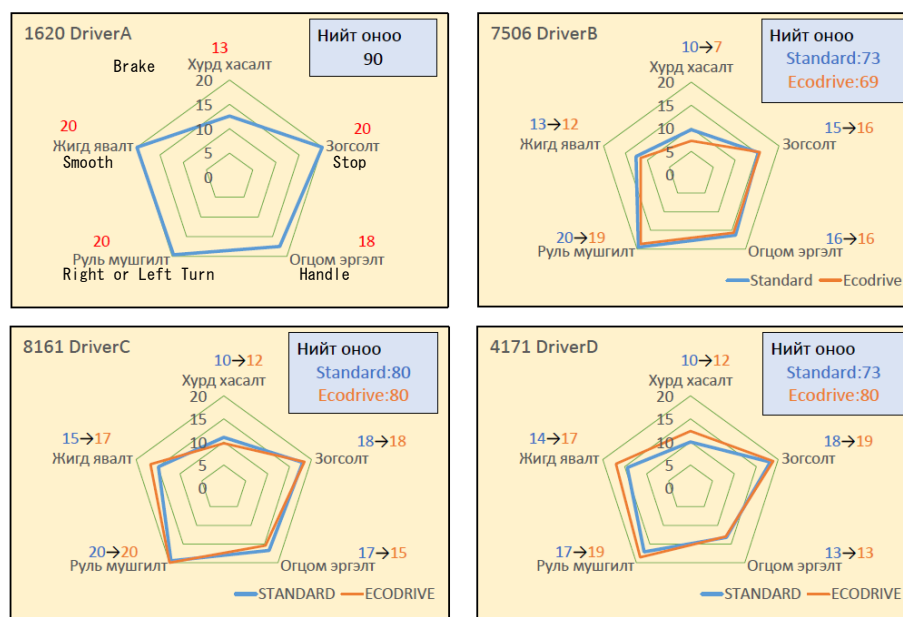


Figure 3-6-25 Driving Evaluation Sheet for Eco-Driving Education (Trust Trade)



Photo 3-6-7 Eco-driving Award Ceremony

3-6-4-6 PM Reduction Device (DPF)

For PM reduction devices (DPF, etc.), JET prepared instructions, and discussed on the future procedure with MRTD to promote the development of automobile-related regulations that oblige the installation of PM reduction devices (DPF, etc.) as a full-scale project.

However, MRTD has criticized the fact that the DPF itself is expensive, as well as the operation and the installation cost are too high.

MRTD has conducted a survey on the production potential of DPF in Mongolia. Currently, it is in a stage to consider necessity of introducing the DPF, meaning that the DPF will not be introduced at all. In addition, 24 Mongolian diesel route buses were equipped with the DPF through “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of Particulate Matter (PM) from Diesel Buses by DPF Suitable for Ulaanbaatar Condition” in order to make exhausts of in-use buses clean because procurement of new clean exhaust buses were not realistic within 12 years from 2009. Those 24 buses were over the expiration date of 12 years, and the buses retired in December 2022. In order to utilize the DPF installed in the retired bus, PTD requested the DPF to be replaced to other buses, thus, JET were preparing for the support.

However, as public route buses were being converted to electric buses and Euro V buses, there were almost no buses to which DPFs could be relocated. One of public bus operating companies accepted to install DPF. JET installed DPFs to two buses, installed a regeneration device to the workshop of the company, and proceeded with the operation and management of the DPF.

The DPFs were operated without any problems due to the deployment of specialized DPF filter regeneration workers.

In addition, the DPF's PM reduction effect was confirmed to have very high environmental performance by reducing black smoke during driving and gauze tests with and without passing through the DPF.

On the other hand, it has been reconfirmed that if regeneration workers cannot be assigned, it will be difficult for regular bus companies to operate the DPF on a daily basis with their existing maintenance personnel alone. For the future, it is necessary to consider the operation structure including its operation cost.

3-6-4-7 RSD

(1). RSD survey implementation status

The survey was conducted every day from 29 May to 30 June 2023, excluding Saturdays, Sundays, and 22-25 June. The survey status is shown in Table 3-6-16

Table 3-6-16 Survey Condition

Date	Point	Time of calculation	RSD measurement			Opacity measurement
			Number of detections	Number of valid cases	Valid rate (%)	
2023-05-29 Mon	West Gate	10:23 ~ 16:35	1,323	492	37	22
2023-05-30 Tue	West Gate	8:53 ~ 14:10	349	242	69	3
2023-05-31 Wed	West Gate	10:30 ~ 16:31	1,483	1,106	75	24
2023-06-01 Thu	West Gate	9:42 ~ 16:31	2,427	1,973	81	-
2023-06-02 Fri	West Gate	9:18 ~ 16:30	2,175	1,736	80	33
2023-06-05 Mon	West Gate	9:26 ~ 16:28	1,871	1,388	74	32
2023-06-06 Tue	West Gate	9:17 ~ 16:27	1,709	1,341	78	-
2023-06-07 Wed	West Gate	9:08 ~ 16:32	2,135	1,659	78	9
2023-06-08 Thu	West Gate	9:08 ~ 16:17	2,103	1,561	74	23
2023-06-09 Fri	West Gate	8:19 ~ 16:30	2,632	2,086	79	21
2023-06-13 Tue	South Gate	9:50 ~ 16:30	1,240	1,056	85	36
2023-06-14 Wed	South Gate	9:27 ~ 16:30	1,329	1,025	77	15
2023-06-15 Thu	South Gate	9:14 ~ 15:41	1,332	1,106	83	48
2023-06-16 Fri	South Gate	9:11 ~ 16:09	1,333	1,102	83	14
2023-06-19 Mon	South Gate	9:30 ~ 16:29	1,436	1,195	83	44
2023-06-20 Tue	South Gate	8:56 ~ 16:26	1,403	1,185	84	21
2023-06-21 Wed	South Gate	9:05 ~ 15:55	1,424	-	-	14
2023-06-26 Mon	South Gate	10:19 ~ 16:28	1,105	946	86	27
2023-06-27 Tue	South Gate	9:25 ~ 16:17	1,274	1,069	84	37
2023-06-28 Wed	South Gate	9:19 ~ 16:22	1,405	1,202	86	-
2023-06-29 Thu	Yarmag Bridge	9:46 ~ 14:59	3,406	2,455	72	-
2023-06-30 Fri	Yarmag Bridge	9:21 ~ 15:00	3,772	2,506	66	-
Sum			38,666	28,431	74	423

(2). RSD

An exhaust gas measuring device of RSD (Remote Sensing Device) manufactured by Opus RS Europe S.L (Spain) was used. The device consists of a Source Detector Module (SDM) that measures exhaust gas, a speed/acceleration bar that measures speed and acceleration, a camera that takes pictures of automobile license plates, and a computer that controls these devices and saves the data.

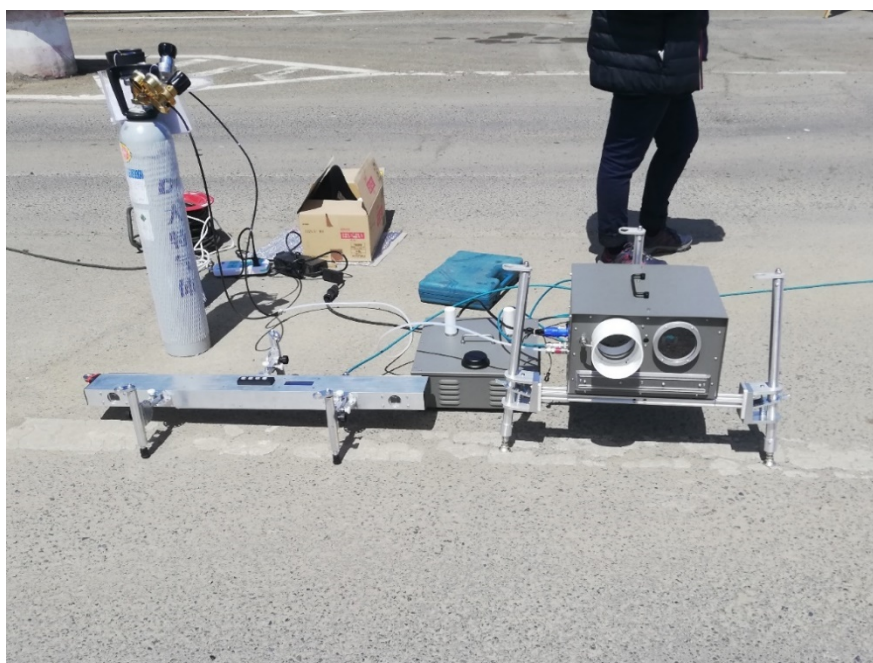


Photo 3-6-8 RSD

(3). Survey Points

RSD surveys were conducted at the west toll plaza from 29 May to 9 June 2023, at the south toll plaza from 13-28 June 2023, and at Yarmag Bridge from 29-30 June 2023. The implementation status of the survey is shown in Photo 3-6-9 to Photo 3-6-11.

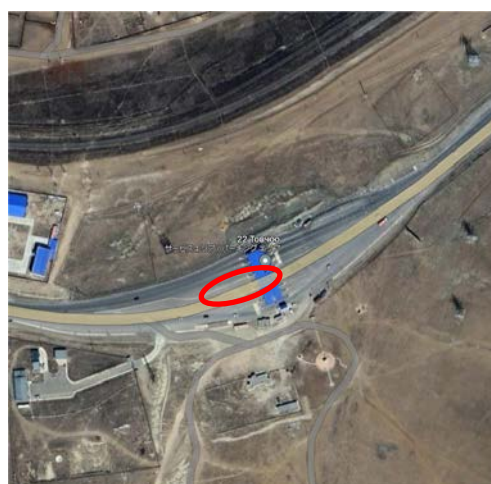


Photo 3-6-9 Survey Point (west tollgate)



Photo 3-6-10 Survey Point (South Tollgate)



Photo 3-6-11 Survey Point (Yarmag Bridge)

(4). Measurement Items

Measurement items included carbon monoxide concentration (hereinafter CO, unit %), carbon dioxide concentration (CO₂, %), hydrocarbons (HC, ppm), nitrogen oxides (NO, NO₂, NO_x, ppm), PM (g/100 g Fuel), speed, and acceleration. Photo of the front of automobile was also taken. Traffic polices stopped automobiles of which smoke was detected after passing the RSD, and the opacity was measured using an opacimeter.

(5). Measurement Results

Regarding PM concentration measured, the highest proportion was seen in the highest rank (0.075 or more), followed by the lowest rank (less than 0.005) at all three sites in Mongolia. The overall distribution trend is similar to that in Japan, but the ratio of 0.075 or higher was 40-56% for each

location in Mongolia, while it was 8% in Japan, meaning that Mongolia had a higher concentration than Japan. (Details are shown in Annex 3-6-7.)

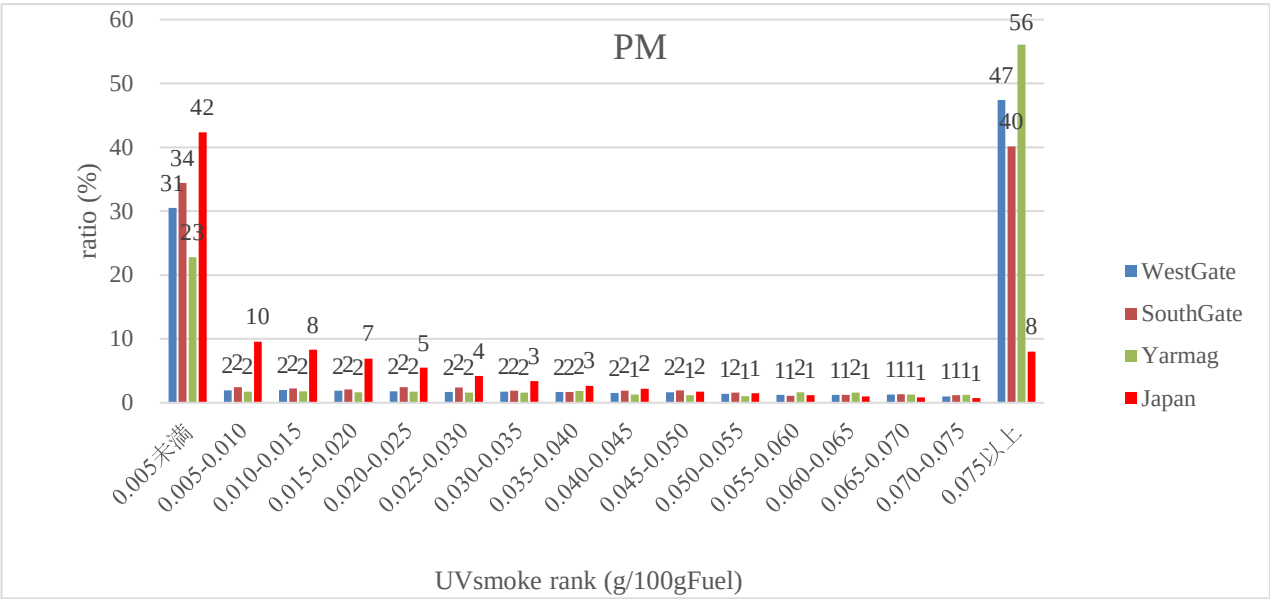


Figure 3-6-26 Appearance Rate by PM Concentration Rank at Three Sites in Mongolia and Japan

(6). RSD Reference Value

For the future introduction of operation regulations using the RSD emission standard value that corresponds to the emission standard (40% opacity) stipulated by the MNS 5014:2009, relationship of the opacity value (%) measured by the opacity meter and the RSD smoke value (g/100 g Fuel) was studied.

Calculating the proportion exceeding the emission standard (40% in opacity) stipulated by MNS 5014:2009 for each RSD Smoke value, the proportion exceeding the emission standard was 100% when the RSD Smoke was 40 or higher, and over 80% when the RSD Smoke was 25 or higher. When the RSD Smoke was less than 25, proportion was over 70%, and as the RSD Smoke increases, the proportion exceeding the emission standard tended to increase.

From this, if threshold value for RSD measurement will be set as 40, all 3 out of 3 automobiles (100%) exceeded the emission standard. If threshold will be set as 25, 9 out of 10 automobiles (90%) exceeded the emission standard. Assuming that 10% error rate of automobiles exceeding the emission standard could be acceptable, emission standard value for RSD is proposed to be set at 25 based on the current state of UB automobiles and their emission status. By the way, since PM emissions are generally high in UB City, it is necessary to review from time to time, considering the inspection and maintenance system, the proportion of automobiles that comply with exhaust gas regulations, etc.

Table 3-6-17 Appearance of Opacity in RSD Measurement

Opacity	RSD_Smoke(g/100gFuel)											
	-1	1-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-
40%under	126	69	21	11	8	4	1	1	1	0	0	0
40%over	297	212	84	42	27	12	9	6	5	3	3	1
Sum	423	281	105	53	35	16	10	7	6	3	3	1
40%over Ratio	70.2	75.4	80.0	79.2	77.1	75.0	90.0	85.7	83.3	100.0	100.0	100.0

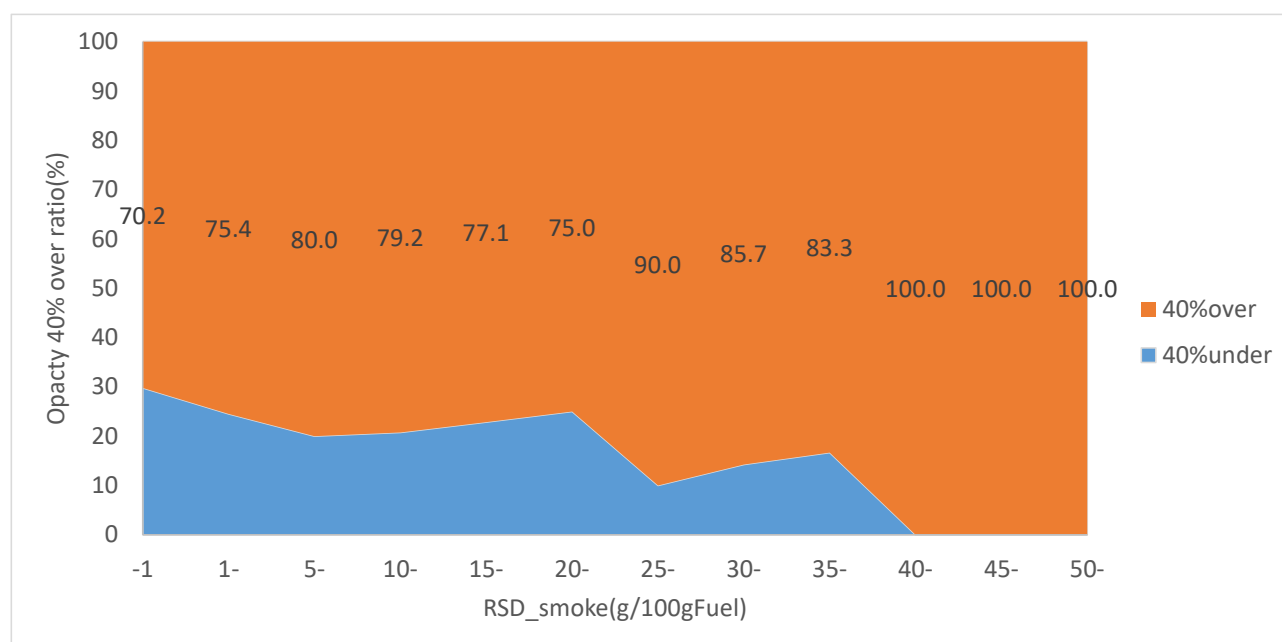


Figure 3-6-27 Ratio of Opacity 40% over in RSD Measurement

(7). Introduction of RSD

Since Mongolia does not have RSD equipment and the legislation system is not in place, JET and the Mongolian side have created a legislation proposal (Annex 3-6-8) and technical guidelines for RSD measurement (Annex 3-5-6).

After this Project, it will be necessary by MRTD to obtain RSD, and to prepare and start vehicle exhaust control by roadside inspections using RSD. It means that regulations should be prepared and authorized for examples as MRTD Ministerial Decree and/or UB Mayor's Decree to obtain RSD, to start roadside inspection, and to request the users or owners of vehicles of which exhaust exceed the standard to pay penalties, and/or to satisfy the standard by service maintenance, installation of PM reduction device if the vehicle is diesel vehicle without PM reduction device, or renewal with vehicle of which exhaust does not exceed the standard.

3-6-5 Activity 5-5, 5-6: Evaluation and Analysis of Result of Pilot Projects, and their report to NCEPR

- 5-5 The relevant agencies with JICA Experts evaluate pilot projects results in terms of emission reduction, air quality improvement and exposure to citizens, and extract lessons learned.
5-6 The relevant agencies with JICA Experts report the pilot projects results to NCEPR.

JET presented to the Mongolian side the setting of BAU scenario and the evaluation results of the effectiveness (emissions, concentrations, and exposure) of air pollution control measures based on Pilot Projects on 13 March 2024 (Annex 3-3-8). JET explained that the Mongolian side should be able to examine and evaluate air pollution control measure quantitatively by their own in future.

The target year for the evaluation of air pollution control measure based on the result of Pilot Projects was set to 2027, three years after the end of this Project, which was agreed as “Means of Verification” of “Overall Goal” in the PDM. Emissions in 2027 were calculated as BAU scenario, which is a case assuming that any further air pollution control measure will not be implemented. Pollutant concentrations were calculated by dispersion simulation model. Using the emissions in 2027 as BAU scenario and the settings for emission calculation based on the results of Pilot Projects, emissions in the cases of implementing Pilot Projects were calculated. The settings for emission calculation are shown in Table 3-6-18.

Table 3-6-18 Settings for Emission Calculation for the Implementation of Control Measures tested by Pilot Projects

	Pilot Project	Setting for Emission Calculation for the Implementation of Control Measure
1	Improved fuel (BCB)	All the current improved fuel are replaced by BCB developed in the Pilot Project as an emission measure from small stove for household. The average emission factors by stove type in the BCB combustion test are applied to all stove using improved fuel. SO ₂ emission factor depends on sulfur content of fuel, thus the SO ₂ emission factor of the lowest value in the combustion test is applied. Activity data of BCB is considered same as amount of improved fuel.
2	Signal control	Based on the analysis of the travel speed survey before and after signal control improvements, the average travel speed increases by 18% ²² on all time zones and major roads in UB City. However, the speed is set not to exceed the legal speed limit (60 km/h) for urban roads in Mongolia.
3-1	Low sulfur fuel and all automobiles with Euro V	All automobiles (including all buses) of Euro IV and earlier are replaced with Euro V, and Euro 5 fuel is used, thus that degradation due to high sulfur fuel is not considered. ● The emission factor of 2005 automobile emission standard in Japan (new long-term regulation) is applied to all automobiles. ● Sulfur content of fuel is 10 ppm.
3-2	Low sulfur fuel and all buses with Euro V	All buses of Euro IV and earlier are replaced with Euro V, and Euro 5 fuel is used, thus that degradation due to high sulfur fuel is not considered. ● The emission factor of 2005 automobile regulation in Japan (new long-term regulation) is applied to all buses. ● Sulfur content of fuel is 10 ppm.
4	Eco-driving	This emission calculation is trial calculation, since the survey is conducted on only one automobile of each automobile type and emissions vary by automobile and engine type. In addition, since gasoline and gasoline hybrid automobiles cannot be distinguished for calculating emission, the reduction effect for gasoline automobiles is calculated by average of the survey results for gasoline and gasoline hybrid automobiles. ● Gasoline: 21.5% reduction in NO_x, 2.5% reduction in fuel. ● Diesel: 13% increase in NO_x, 33% reduction in PM, 13% reduction in fuel.
5	DPF to buses	As in the Project Phase 2, PM emissions is reduced by 80% ²³ for buses with Euro IV (2003 automobile regulation in Japan (new short-term regulation)) and earlier.
6	RSD	RSD find emission non-compliant automobiles, and the non-compliant automobiles are no longer operated in UB City, and regular inspections and maintenance is conducted to reduce automobile deterioration. ● Automobiles with opacity of more than 40% (1998 regulations (long-term regulation) and earlier) are excluded from the automobile type composition ratio. ● The coefficient for poor maintenance is not multiplied in calculating emission.

3-6-5-1 The Improved Fuel Pilot Project

Table 3-6-19 and Figure 3-6-28 show the estimated emissions of small stove for household without and with control measure for improved fuel in the case of the above Pilot Project is implemented fully in UB City. SO_x and PM₁₀ emissions are expected to be reduced by more than 65% and nearly 30%, respectively.

Table 3-6-19 Emissions of Small Stove for Household without and with Control Measure for Improved Fuel

			SO _x	NO _x	PM ₁₀	CO
Emission of small stove for household without control measure (2027 as BAU scenario)		ton/year	5,388.5	1,988.2	1,597.3	62,649.7
Improved fuel (BCB)	Emission with control measure	ton/year	1,692.9	1,326.3	1,130.5	47,202.4
	Emission reduction	ton/year	3,695.6	661.9	466.8	15,447.4
	Emission reduction ratio	%	68.6	33.3	29.2	24.7

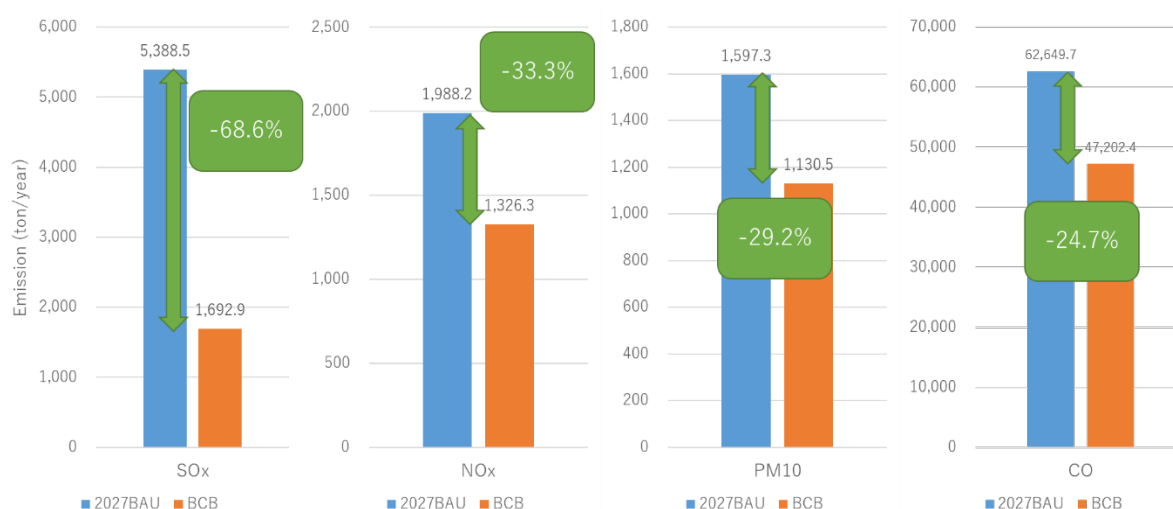


Figure 3-6-28 Emissions of Small Stove for Household without and with Control Measure for Improved Fuel

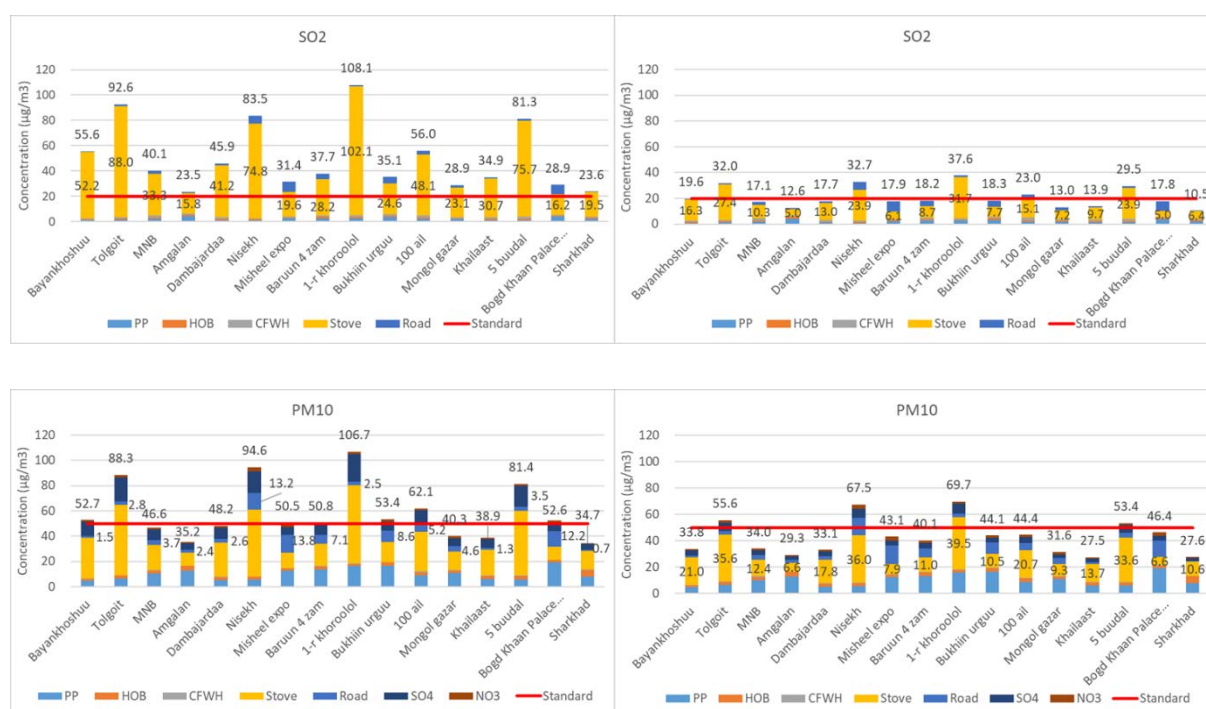
Based on these results, dispersion simulation was executed to verify the effect of reducing the annual average concentrations of SO₂ and PM₁₀ at AQMSs without and with conducting the control measures. Figure 3-6-29 shows the effect of reducing the annual average concentrations of SO₂ and PM₁₀ at all AQMSs of UB City. The concentrations of SO₂ and PM₁₀ were reduced by average of 59% and 27%,

²² Traffic congestion in the morning and evening is not eliminated by an 18% increase in travel speed.

²³ Reduction ratio in the Project Phase 2 and the result in “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of Particulate Matter (PM) from Diesel Buses by DPF Suitable for Ulaanbaatar Condition”

respectively. Nevertheless, concentration at some AQMSs still exceeded the air quality standard value of annual average (SO_2 : $20 \mu\text{g}/\text{m}^3$ and PM_{10} : $50 \mu\text{g}/\text{m}^3$).

Improved fuel can reduce ambient SO_2 concentration if it will be made of lower sulfur content coal or with a desulfurizing agent. If possible, using lower sulfur fuel is a better control measure for SO_2 reduction, since additional desulfurizer is not required. PM concentrations are reduced by using coal that emit less PM, by manufacturing fuels that emit less PM, or by converting fuels. Conversion of the traditional stoves to the improved stoves would also reduce fuel use and lower the concentrations of flue gas.



Left: BAU Scenario, Right: Improved fuel (BCB)

Figure 3-6-29 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measure (Full Implementation of further Improvement of Improved Fuel)

3-6-5-2 Pilot Project Related Automobiles

Table 3-6-20 and Figure 3-6-30 show the estimated emissions of automobiles without and with control measures. Improvement of signal control is expected to reduce emissions of all pollutants by 5-10%. If all automobiles are converted to automobiles with Euro V and post-Euro V, and Euro 5 fuels, emission reductions of more than 85% are expected for all pollutants, especially SO_x and PM emissions, which are both expected to be reduced by about 98%. If all buses were converted to Euro V and post-Euro V buses, and Euro 5 fuels, emission reductions of 20-44% are expected for SO_x , NO_x , and PM. Eco-driving and DPF are expected to reduce PM emissions. RSD is expected to reduce PM, NO_x , and CO emission by 70-80%.

Table 3-6-20 Emissions of Automobile Exhaust Gas without and with Counter Measures

		Unit	SOx	NOx	PM	CO
Automobile emission without control measure (2027 as BAU)		ton/year	531.1	8,797.4	634.9	39,387.7
Signal control	Emission with control measure	ton/year	492.8	8,260.8	599.4	34,825.1
	Emission reduction	ton/year	38.3	536.6	35.5	4,562.6
	Emission reduction ratio	%	7.2%	6.1%	5.6%	11.6%
Low sulfur fuel and low emission automobile (All automobiles)	Emission with control measure	ton/year	12.0	1,037.1	11.7	1,727.0
	Emission reduction	ton/year	519.1	7,760.3	623.2	37,660.7
	Emission reduction ratio	%	97.7%	88.2%	98.2%	95.6%
Low sulfur fuel and low emission automobile (Only buses)	Emission with control measure	ton/year	409.4	6,398.5	356.9	38,181.3
	Emission reduction	ton/year	121.7	2,398.9	278.1	1206.3
	Emission reduction ratio	%	22.9%	27.3%	43.8%	3.1%
Eco-driving	Emission with control measure	ton/year	484.7	9,032.7	432.4	39,387.7
	Emission reduction	ton/year	46.4	-235.3	202.5	0.0
	Emission reduction ratio	%	8.7%	-2.7%	31.9%	0.0%
DPF for only buses	Emission with control measure	ton/year	531.1	8,797.4	411.2	39,387.7
	Emission reduction	ton/year	0.0	0.0	223.7	0.0
	Emission reduction ratio	%	0.0%	0.0%	35.2%	0.0%
RSD	Emission with control measure	ton/year	418.2	2,129.1	192.8	7,944.6
	Emission reduction	ton/year	112.9	6,668.3	442.1	31,443.1
	Emission reduction ratio	%	21.3%	75.8%	69.6%	79.8%



Figure 3-6-30 Emissions of Automobile Exhaust Gas without and with Control Measures

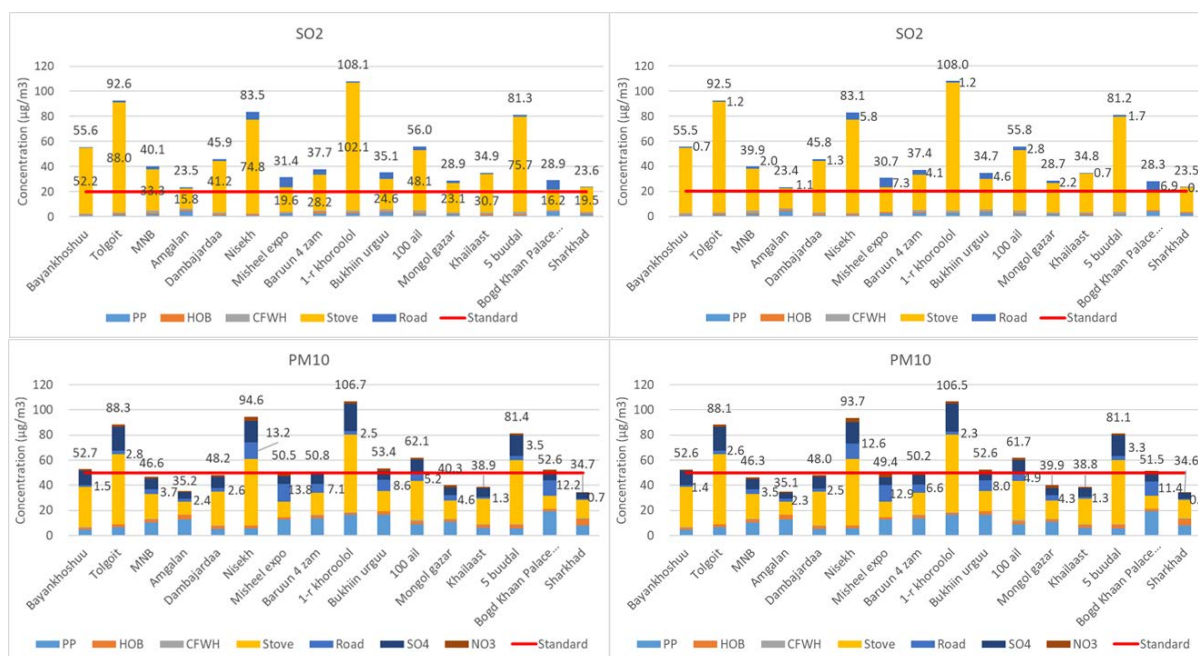
Based on these results, dispersion simulation was executed to verify the effect of reducing the annual average concentrations of SO₂ and PM₁₀ at AQMSs without and with the control measures. Table 3-6-21 and Figure 3-6-31 ~ Figure 3-6-36 show the effect of reducing the annual average concentrations of SO₂ and PM₁₀ at all AQMSs of UB City. In the annual average of AQMSs, all measures were effective in reducing SO₂ concentrations by a maximum of about 5% and PM₁₀ concentrations by a maximum of about 12%. This is caused by small stove for household being the major source of SO₂ and PM₁₀, which account for an average of more than 85% of the total concentration of SO₂ and about 50% of the total concentration of PM₁₀ in BAU scenario.

By Pilot Project, the measures of low sulfur fuel and low emissions automobile (all automobiles and only buses) as well as RSD were effective in reducing concentration.

Since the ratio of the automobile concentration to the total concentration is high during periods of low stove use, it is assumed that the combined implementation of these automobile measures will be effective in reducing concentration. On the other hand, conversion of automobiles and fuels, education on eco-driving, and introduction of DPF and RSD are costly and time-consuming. However, it is expected that the effects of these measures will be achieved through promotion of these measures little by little.

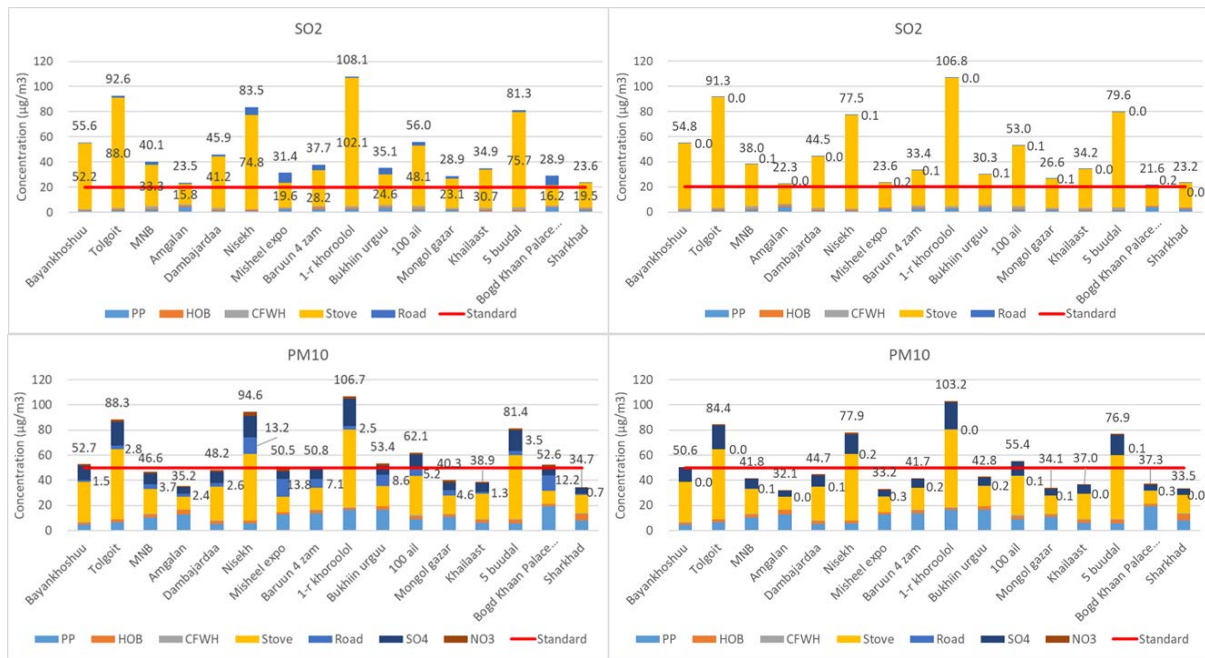
Table 3-6-21 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Counter Measures

		Unit	SO ₂	PM ₁₀
Without control measure (2027 as BAU)		µg/m ³	50.4	58.6
Signal control	With control measure	µg/m ³	50.2	58.1
	Concentration reduction	µg/m ³	0.2	0.4
	Concentration reduction ratio	%	0.4	0.7
Low sulfur fuel and low emission automobile (All automobiles)	With control measure	µg/m ³	47.5	51.7
	Concentration reduction	µg/m ³	2.9	6.9
	Concentration reduction ratio	%	5.7	11.8
Low sulfur fuel and low emission automobile (Only buses)	With control measure	µg/m ³	49.7	55.3
	Concentration reduction	µg/m ³	0.7	3.2
	Concentration reduction ratio	%	1.5	5.5
Eco-driving	With control measure	µg/m ³	50.2	56.8
	Concentration reduction	µg/m ³	0.2	1.7
	Concentration reduction ratio	%	0.5	2.9
DPF for only buses	With control measure	µg/m ³	50.4	56.3
	Concentration reduction	µg/m ³	0.0	2.2
	Concentration reduction ratio	%	0.0	3.8
RSD	With control measure	µg/m ³	49.8	53.7
	Concentration reduction	µg/m ³	0.7	4.9
	Concentration reduction ratio	%	1.3	8.3



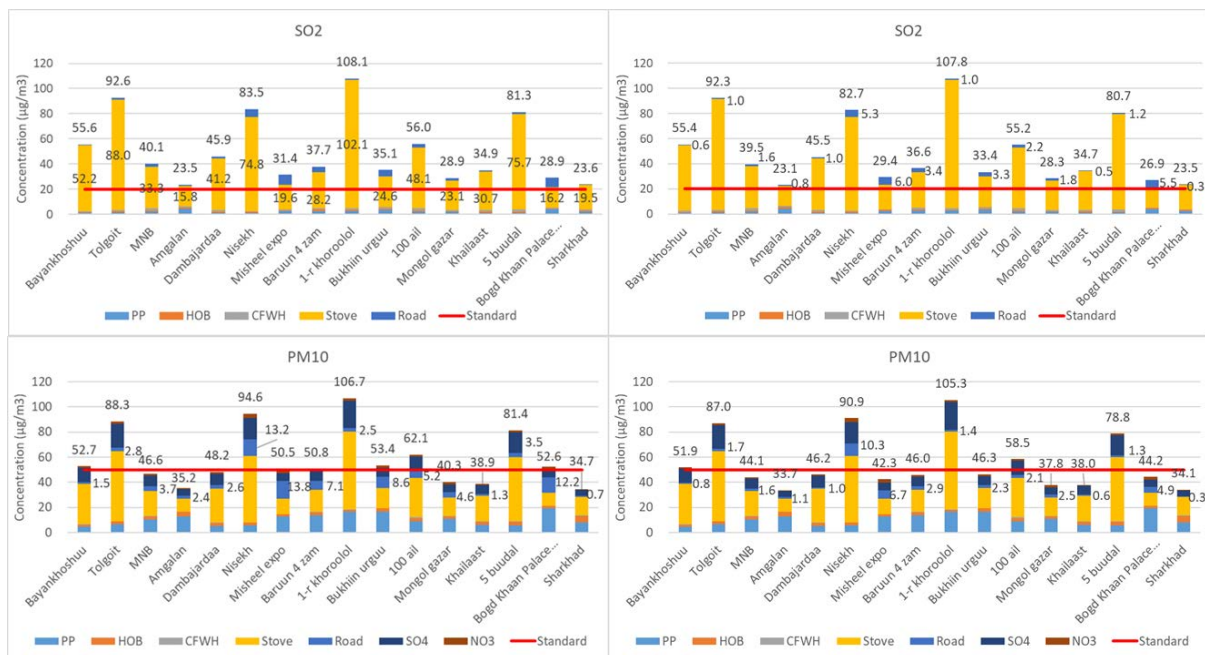
Left: BAU Scenario, Right: Signal control

Figure 3-6-31 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measures (Full Implementation of Signal Control Pilot Project)



Left: BAU Scenario, Right: Low sulfur fuel and low emission automobile (all automobiles)

Figure 3-6-32 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measure (Full Implementation of Low Sulfur Fuel and Low Emission Automobile for All Automobiles)



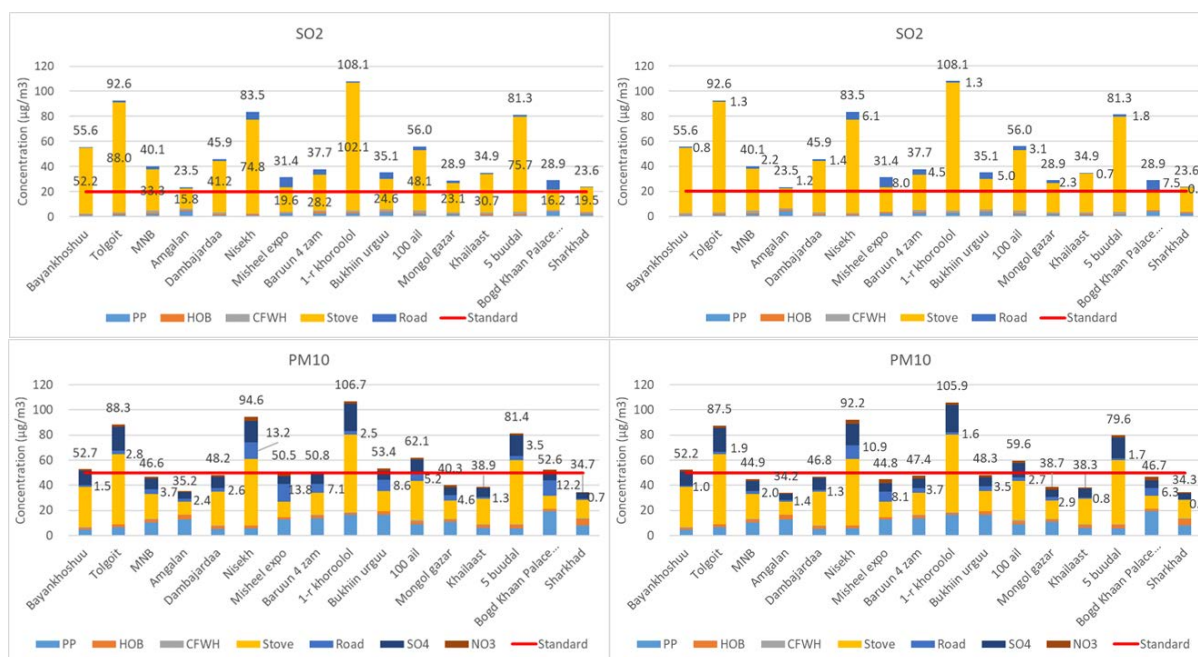
Left: BAU Scenario, Right: Low sulfur fuel and low emission automobile (only buses)

Figure 3-6-33 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measure (Full Implementation of Low Sulfur Fuel and Low Emission Automobile Only for Buses)



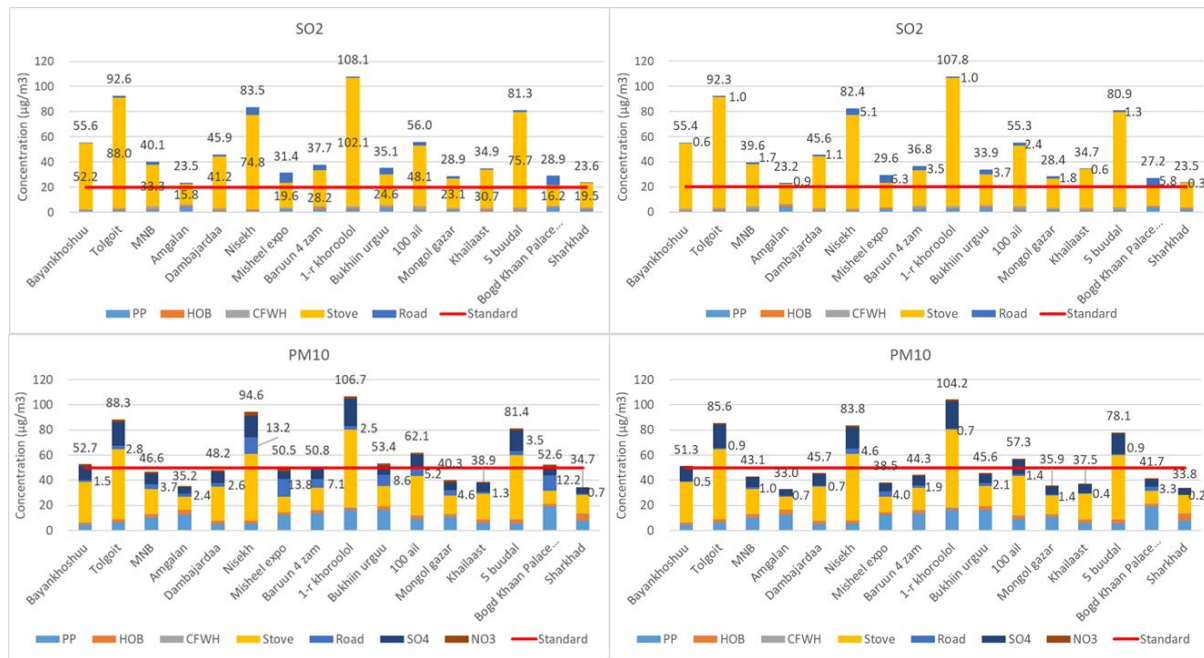
Left: BAU Scenario, Right: Eco-driving

Figure 3-6-34 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measure (Pilot Project of Eco-driving Pilot Project)



Left: BAU Scenario, Right: DPF for only buses

Figure 3-6-35 Reducing Effect of the Annual Average Concentrations at AQMSs without and with Control Measure (Full implementation of DPF Pilot Project for Buses)



3-6-5-3 Evaluation of Exposure

PWE and exposure were calculated for the above-mentioned full implementation of improved fuel and automobile Pilot Projects (Figure 3-6-37). Full implementation of improved fuel Pilot Project reduced PWE by about 24%, while full implementation of automobile Pilot Projects reduced PWE by 1.0~16.3%.

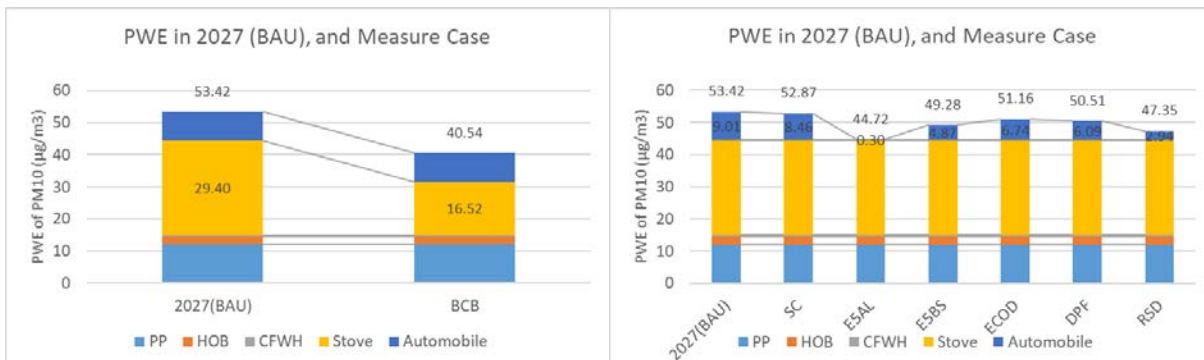


Table 3-6-22 Exposure without and with Control Measures

	BCB	Low sulfur fuel and low emission automobile (Only buses)	RSD
2027 as BAU scenario	85.33		
Exposure with control measure	64.75	78.72	75.63
Exposure reduction	20.58	6.61	9.70

Unit: Million $\mu\text{g}/\text{m}^3 \cdot \text{person}$

3-6-6 Activity 5-7 and 5-8: Examination of Air Pollution Control Measures and Elaboration of the Emission Reduction Plan through CEMS Data Analysis

5-7 TPP3 and TPP4 analyze CEMS data, and examine viable air pollution control measures.
5-8 TPP3 and TPP4 with JICA Experts elaborate emission reduction plans.

JET interviewed and discussed with TPP3 and TPP4 experts in August 2023, then examined data and potential control measures until March 2024. The summary is as follows;

- 1) JET suggested potential air pollution control measures as follows;
 - (1) Preventive maintenance of equipment and facilities related to air pollution control
 - (2) Optimization of fuel input, for example after identifying and/or procuring low-sulfur and/or low-nitrogen coal
 - (3) Optimization of voltage and current of electrostatic precipitator
 - (4) Optimization of excess air supply
 - (5) New installation of desulfurization and/or denitrification equipment
- 2) TPP3 and TPP4 have been examining variable air pollution control measures based on analysis of CEMS data, and implementing emission reductions as follows;
 - (1) Electrostatic precipitators are maintained frequently in order to comply with dust emission standard. In addition, whenever dust concentration becomes higher, conditions of electrostatic precipitators are tuned in response to dust conditions.
 - (2) SO_2 concentration slightly exceeds the emission standards when the boiler load is heavy in winter. However, under the heavy load condition, it is difficult to adjust operation conditions to lower SO_2 concentration.
 - (3) NO_x and CO concentrations are always less than their emission standards.
- 2) Further emission reductions have been discussed, for example, switching the fuel to lower-sulfur coals, and/or installing dust collector, desulfurization equipment, and/or denitrification equipment for the flue gas. However, since the power plants are not the main source of the air pollution of the city, and flue gas satisfies the emission standards, adoption in aid projects or budget allocation by the Government for further air pollution control equipment have been

postponed. (i.e. The preparatory survey on the Ulaanbaatar 4th thermal power plant rehabilitation project in Mongolia, JICA, Dec. 2012)

Since emission reduction methods are already being implemented through CEMS data analysis, plan to reduce air pollutants was not been elaborated newly, but it is confirmed that the emission reduction methods will be continued.

- Operation and maintenance of CEMS since CEMS data is necessary for flue gas control through operation and management.
- Maintenance of electrostatic precipitators, etc. to prevent malfunctioning
- Tuning of operational conditions of electrostatic precipitators based on CEMS data
- Tuning of O₂ supply based on CEMS data
- Coal supply adjustment based on coal analysis data such as sulfur content, calorific value

3-7 Output 6: Strengthening the Platform for Legal Framework, Resource Allocation and the Air Quality Management Cycle

3-7-1 Activity 6-1: Demarcation of Roles in Air Quality Management Related Activity of the Project

6-1 The relevant agencies discuss and elaborate written agreements on demarcation of roles in air quality management related with each Output and Activity of the Project.

In the project duration, following various demarcation of roles in air quality management were elaborated in relation to each of the outputs and activities.

In the kickoff seminar and first JCC meeting, relevant agencies discussed and elaborated demarcation of roles in air quality management related to each activity and output of the Project, and the result were summarized in the 1st JCC Minutes of Meeting.

Decision No. 19/03 of National Commission for Environmental Pollution Reduction on 24 January 2019 set out roles of relevant agencies for some measures to reduce pollutants emitted from automobiles. In addition, Decree No. 346 of the Ministry of Road Transport and Development on 13 November 2019 established a working group to carry out audit measurements on automobile emissions and to study and prepare and evaluate measures to reduce smoke (exhaust gas) emissions.

In the 6th JCC, JET suggested to elaborate “Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models” which summarize a series of flow from developing emission inventory to evaluating plans of control measure and division of roles utilizing the strengths of DAAEP, NAMEM, and IRIMHE. In response to this, Mr. Batbayar of NAMEM intended to prepare letter of agreement that stipulates the division of roles for developing emission inventory, executing simulation model, and evaluating control measures in order to implement future activities. As a result, the Mongolian side and JET discussed on the contents of the agreement. Regarding executing simulation model, NUM was asked to participate in the Project as a joint implementation with

NAMEM. In April 2023, DAAEP, NAMEM (IRIMHE) and NUM confirmed and signed the agreement of the division of roles among 3 agencies. From now, it is the responsibility of each agency to implement their activities and to secure budget in accordance with the agreement.

3-7-2 Activity 6-2: Providing Technical Data to the National Committee for Environment Pollution Reduction

6-2 DAAEP with JICA Experts submits technical documents to NCEPR for improved fuel standard, emission standard on stationary sources, mobile sources and other emission sources, and revision of ordinance.

JET submitted the technical document of the emission measurement results between the existing improved fuel of TTT Co. and the improved fuel used for the pilot project to DAAEP.

DAAEP conducted combustion tests of Chinese-made semi-coke briquettes and igniters to be introduced on a trial basis in the winter of 2023, and reported the measurement results to NCEPR.

With the dissolution of NCEPR at the end of December 2023, JET explained the combustion test results of the BCB to Deputy Governor in April 2024.

3-7-3 Activity 6-3: Elaboration of Fuel Quality and Emission Standards

6-3 NCEPR and the relevant agencies elaborate fuel standard and emission standard, and submit them to MASM.

With a ban on use of raw coal and replacing on use of improved fuel in UB city, the quality standard shown in proximate analyses, MNS5679:2019, was issued in May 2019. Also, improved Fuels Working Group, chaired by the Minister of Energy, was established to revise technical requirements for improved solid fuels, MNS 5679:2019, by the Mongolian government, and DAAEP joined the working group to examine volatile and sulfur content for proximate analysis. As a result, the working group decided that volatile and sulfur content for proximate analysis were not revised, a minimum calorific value expanded, and a maximum moisture content lowered. Then, MNS 5679:2019 was revised and MNS 5679:2022 was issued in October 2022.

3-7-4 Activity 6-4: Enactment Laws, Regulations and Ordinances Related to Air Pollution Control Measures

6-4 Relevant ministries / relevant agencies of UB City elaborate laws, regulations and ordinances on air pollution control measures, and submit them to national parliament / city council.

With reference to the evaluation of the proposed pollution control measures by the Project Phase 2 (introduction of improved fuels throughout UB City), DAAEP prepared its own draft revision of the Air Quality Improvement Area Regulations. The draft revision was discussed and approved by the UB Mayors' Council and delivered to Minister of Environment and Tourism by Letter No. 01/1810 dated 9 May 2019. Subsequently, Air Quality Improvement Area Enforcement Regulation for 2019

was approved as Joint Order No. A/433-A/820 of the MET and the Mayor of UB, dated 14 August 2019.

No. 62 Cabinet Decision of Mongolian Government on 28 February 2018 "Ban of Raw Coal Use" was amended on 27 May 2020 to invalidate the second paragraph of No.62 Cabinet Decision and approved No. 189 Cabinet Decision. Based on No. 62 Cabinet Decision of 2018 and No. 189 Cabinet Decision of 2020, updated Air Quality Improvement Areas Enforcement Regulation for 2020 was approved as Joint Order No. A/604-A/112 of the Minister of Environment and Tourism and the Mayor of UB dated 12 October 2020.

As a result of the above revision, No.20 Khoroo in Bayanzurkh District, No.21 Khoroo in Songinokhairkhan District, and No.12, 13 and 14 Khoroo in Khan-Uul District in UB City became the target areas of the air quality improvement areas. Therefore, utilization of raw coal has been banned in all 6 central Districts of UB.

The Air Quality Improvement Areas Enforcement Regulation for 2021 (Revised) was approved as Joint Order No. A/322-A/780 of MET and Tourism and the UB Mayor, dated 13 October 2021. With this revision, No. 9, 10, 21, 22, and 23 Khoroo in Bayangol District gradually changed from areas connected to electricity and other heating sources to areas with solid improved fuels. No. 24 and 25 Khoroo in Bayangol District changed to areas where all solid fuels are prohibited.

No. 62 Cabinet Decision of Government of Mongolia, "Ban of Raw Coal Use", dated in 2018 was introduced at the 5th meeting of the Mayors Competent Council dated 10 March 2022. Comments on the proposed revision of the 62nd Cabinet Decision 2018 will be collected and submitted to the Council of Ministers for their explanation and discussion.

No. A/346 UB Mayor's Decree of 2022 and UB Deputy Governor's Implementation Bylaws on Carbon Monoxide Poisoning Risk Prevention and Risk Measures dated 14 March 2022 were approved. UB Deputy Governor is in charge of Social Sector, Green Development and Air and Environmental Pollution. As part of the implementation bylaws, 5 videos and 20 posters on carbon monoxide poisoning risk prevention are provided to the public through DAAEP website (<http://aprd.ub.gov.mn/>), 11 Facebooks of cooperating agencies, and 4 TV stations. In addition, 180,000 copies of the Carbon Monoxide poisoning risk prevention advisory booklet were distributed in the Ger area.

Amendment of the Air Quality Improvement Areas Enforcement Regulation for 2022 was approved as Joint Order No. A/424-A/1353 of MET and UB Mayor, dated 17 October 2022. The main changes are addition of Nalaikh District to the Air Quality Improvement Area and All Solid Fuel Use Ban Area increased from 57 to 73 Khoroo.

Referring the proposal on low-sulfur fuel by JET, the provision on Euro 5 fuels proposed by the Ministry of MMHI to the Mongolian Government decided to amend the Air Law dated 22 April 2022 by adding a stipulation in Article 16.1.6 to provide retail and sale of the highest grade fuel of Mongolian National Standards (hereinafter referred to as "MNS") and to prohibit the retail and sale, etc. of lower grade fuel in Air Quality Improvement Area of UB City.

Draft Air Quality Improvement Areas Enforcement Regulation for 2023-2024 was prepared, and comments and opinions from each ward office and related organizations were solicited. The discussion at the mayor's council was prepared.

3-7-5 Activity 6-5: Training on Air Pollution Control Measures and Technical Appraisal Guidelines

6-5 JICA Experts provide training on air pollution control measures and technical appraisal guidelines for staff of the sections of the relevant agencies in charge of allocating funds for air pollution control.

At meetings of NCEPR (Ministers and deputy Ministers' departments of each ministry and heads of specialized agencies), the implementation plan (activity plan) based on the national air and environmental pollution reduction program and government decisions, etc. and the budget amount of each measure are discussed, and the budget, implementation period, implementation agency and fund management agency for each measure are approved as decisions of NCEPR within the countermeasure budget (ME work package decided by the government). The chairman of NCEPR (Minister of Environment and Tourism followed by the ME) will make a decision on the expenditure of the budget according to the implementation period of each measure. After that, the secretariat of NCEPR submitted a request to the Ministry of Finance for funding, and the Ministry of Finance used the requested funds to implement measures (for example, the Ministry of Roads and Transportation Development for automobile measures, ME for nighttime electricity bill discount measures, etc.).

Figure 3-7-1 shows the decision-making process for environmental pollution measures.

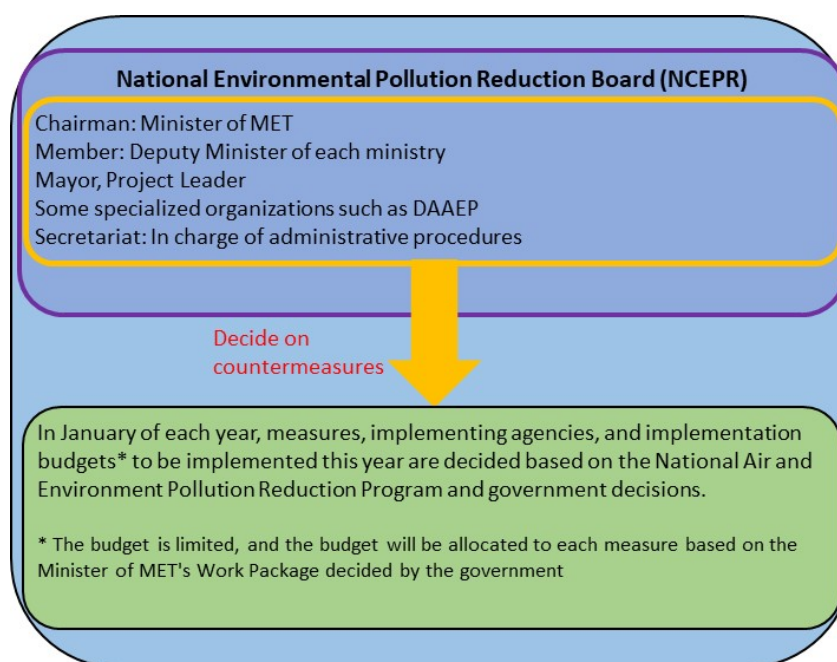


Figure 3-7-1 Decision Procedure by NCEPR

The flow of Countermeasure funds, management, and audit is shown in Figure 3-7-2.

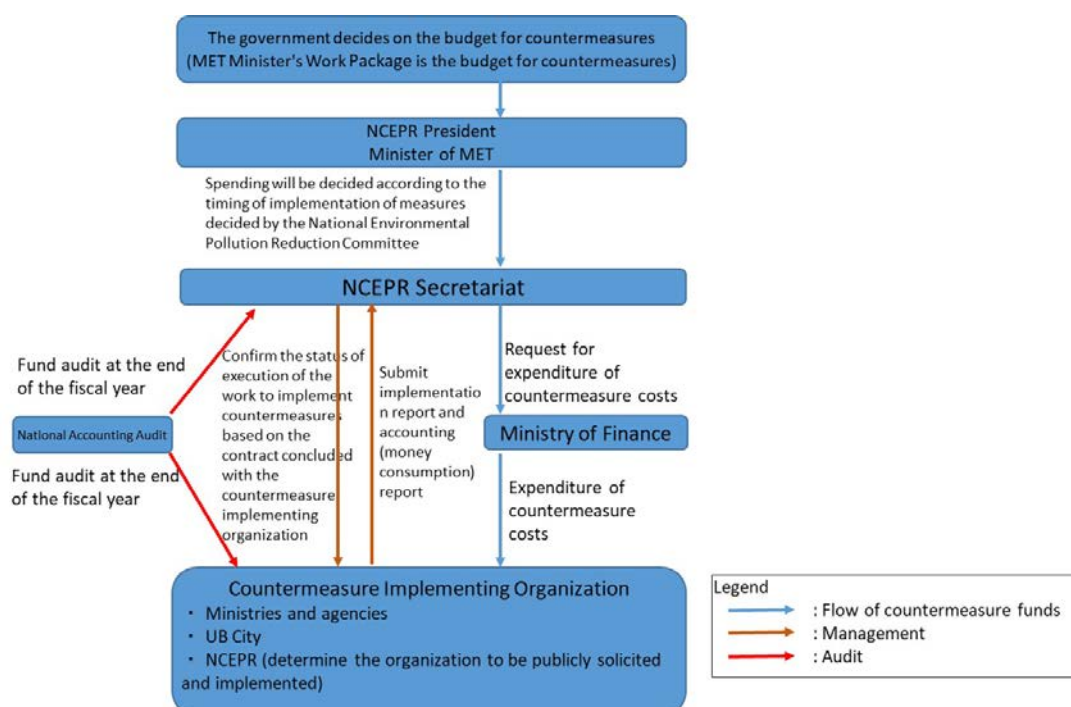


Figure 3-7-2 Flow of Countermeasure funds, Management, and Audit

With the dissolution of NCEPR at the end of December 2023, approval and authority for cost sharing of the National Program for Air and Environmental Pollution Reduction was transferred to UB City, NAMEM, etc. in the Order of the Minister of Environment and Tourism No. A/163 dated 7 March 2024. However, no department of responsibility for air pollution control has yet been determined, and no department responsible for allocating funds has yet been determined. Therefore, this department was assumed to be an (tentatively named) Air Pollution Control Board, a technical appraisal guideline was completed at the end of June 2024 (Annex 3-7-1). The (tentatively named) Air Pollution Control Board will use this guideline.

3-7-6 Activity 6-6: Improvement of Procedures for Allocating Funds for Air Pollution Control Measures

6-6 Staff of the sections of the relevant agencies in charge of allocating funds for air pollution control with JICA Experts improve relevant operations with allocating funds for air pollution control measures, if necessary.

At meetings of the NCEPR (ministers and deputy ministers' departments of each ministry and the directors of specialized agencies), the implementation plan (activity plan) based on the national air and environment pollution reduction program and government decisions, etc. and the budget amount of each measure are discussed, and the budget, implementation period, implementation agency and fund management agency for each measure are approved as NCEPR decisions within the

countermeasure budget (ME minister work package decided by the government). Discussions were held with the NCEPR Secretariat to see if there was any room for improvement in the allocation of funds. The Mongolian side concluded that there was no room to improve the procedures related to the allocation of funds, as a system has been established to allocate funds based on the matters discussed at the NCEPR.

With the dissolution of NCEPR at the end of December 2023, approval and authority for cost sharing of the National Program for Air and Environmental Pollution Reduction was transferred to UB City, MET, etc. in the Order of the Minister of Environment and Tourism No. A/163 dated 7 March 2024. However, it is expected to take until the fourth quarter of 2024 before the division of duties is confirmed at the transferee.

3-7-7 Activity 6-7: Enhancement of Donor Coordination in Air Pollution Control by the Mongolian side

6-7 Mongolian side enhances donor coordination in air pollution control.

The stakeholder meeting was organized by the JICA Mongolia Office in December 2018 to understand overview of each donor's activity plan.

“Air pollution, scientific evidences and solutions Science and technology conference” was organized by UNICEF in February 2023. The activities of each donor were presented in the conference. The Project made a presentation on emissions and simulation for 2018 and 2020 needed to assess the effectiveness of the introduction of improved fuels.

JET is advising NAMEM to strengthen the emphasis on collaboration between Korea International Cooperation Agency (hereinafter referred to as “KOICA”) and Mongolian donors. KOICA plans to grant AQMS equipment and monitoring systems to MET for the period 2023-2027. In April 2023, NAMEM, the host institution of AQMS, was asked to advise JET on the Korean-made AQMS to be installed. Based on the activities in the Project, JET sent written advice to have the Korean side establish a data transfer system so that the AQMS can be maintained and managed sustainably after the grant and until the data of the future installed measuring stations can be displayed on agaar.mn and the app as in the case of other measuring stations. Based on this document, NAMEM is conducting discussions with KOICA.

[Reference: Activities of other donors]

Deputy Governor of UB city, the Secretariat of NCEPR and Director of DAAEP are participating in the Donor Working Group organized by the German Embassy.

The Mongolian side will accept from USD 14 million Korean soft loan (paid) to CLEM, which has been approved by the Ministry of Finance. JET assisted CLEM in preparing a list of equipment needed for PM component analysis.

In March 2019, JET exchanged information with the German Federal Environment Agency, which had conducted project with NAMEM.

In December 2021, Mongolian parliament decided to implement Ulaanbaatar Sustainable Urban Transport Project (UBSUTP, <https://projects.worldbank.org/en/projects-operations/project-detail/P174007>) with 100 million USD World Bank loan, and update the traffic control system. Improvement of the traffic control system is contemplated to change traffic signals and servers. Currently, the GS survey (cost estimate) is being conducted by the World Bank.

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) as part of the Asia-Pacific Regional Action Programme for Air Pollution The High-Level Forum on Clean Air was held in Mongolia on March 2-3, 2023, with the MET as one of the organizers. To host the event, MET requested each donor in January 2023 to cooperate in donor collaboration coordination on air pollution control. In addition, since we would like to hold a "sub-meeting" before the High-Level Forum on Clean Air in March 2023, MET requested each donor to cooperate in the sub-meeting, and UNICEF will host the Air Pollution, Scientific Evidences and Solutions Science and Technology conference in February. Science and technology conference will be held in February 2023, hosted by UNICEF.

Since the second half of 2023, donors have not implemented any major activities related to air pollution control.

3-7-8 Activity 6-8: Operational Guideline for Elaboration, Implementation and Evaluation of Air Pollution Control Measures

6-8 Relevant agencies of pilot projects with JICA Experts develop an operational guideline for elaboration, implementation and evaluation of air pollution control measures based on pilot projects implementation.

Due to a delay in resuming the activities in Mongolia, Activity 6-8 began in November 2021, when plans for the Pilot Projects for automobiles began to emerge. The activity resumed in April 2022 for the Pilot Project on improved fuels.

The Pilot Projects for automobiles was completed in March 2024. The first Pilot Project on improved fuel was conducted in the Ger camp from November 2022 to January 2023 as the first demonstration test, however, the results were not clear on the air pollution control effects of improved fuel. As the second demonstration test, a prototype of BCB was developed and combustion tests were conducted from January to March 2024. The results showed that the BCB was expected to have a significant improvement effect compared to TTT's improved fuel.

Operational guideline was completed in June 2024 based on the experience of the Pilot Projects for BCB and automobiles (Annex 3-7-2). In the evaluation of the pilot project, the emission reduction effects were verified by comparing the emissions of target sources before and after the implementation of air pollution control measures. Therefore, the operational guideline describes the content of the comprehensive evaluation of air pollution control measures in terms of emission reduction

effectiveness, concentration reduction effectiveness, and cost-effectiveness for concentration reduction (million MNT/μg/m³).

3-8 Capacity Assessment (CA)

3-8-1 Policy for Capacity Assessment

Regarding CA of individual, JET assessed the capacity of C/P and C/P-WG members, main responsibilities persons, by interviewing and by assessing their technical competence in the field. The capacity of organizational and social level was assessed. Verifiable indicators must be the ones that are able to assess the capacity of organizational and social level systematically related to overall goal and project purpose through the implementation of the Project. In addition, the verifiable indicators are the ones that can grasp the conditions of enhancement of capacity development of the Mongolian side. The CA was implemented through the form of self-assessment test and judgement of JET.

3-8-2 The Capacity Assessment of Individual

The capacity of individual level increased as an individual, with presentations at summative seminars, donors and international forums, as shown in the below.

- UNICEF held “Air pollution, scientific evidences and solutions Science and technology conference” in February 2023. CLEM, IRIMHE, and other C/P-WG members made presentations in the conference.
- In the “The High-level Forum on Clean Air by the Asia-Pacific Regional Action Program for Air Pollution”, two members of NAMEM, one of the main C/P of the Projects, presented status on air pollution in Mongolia and the network of air quality monitoring.
- The Final seminar of this Project was held in April 2024, and DAAEP, TCC, MRTD, NAMEM, and other C/P-WG members prepared presentation materials and presented project activities at this seminar.

In addition, since individual capacity is essential for understanding the current status of air pollution, analyzing a structure of air pollution, and disclosing environmental information, which is basis of air quality management, CA of individual level was conducted in 5 sectors: 1) flue gas measurement at stationary source, 2) emission measurement of automobiles, 3) operation and maintenance of AQMS, 4) emission inventory and simulation, and 5) PM composition analysis. Since CA of individual objectively evaluates extent of improvement of individual capabilities, interviews and technical evaluations were conducted 7 times with C/P and C/P-WG members from the beginning of the Project to the end of the project.

The evaluation of capacity building as observed by JET is shown in Table 3-8-1.

The assessed result is summarized and shown in Figure 3-8-1 to Figure 3-8-5 as a chart where X-axis is a person and the assessment timing and Y-axis is capacity in percent.

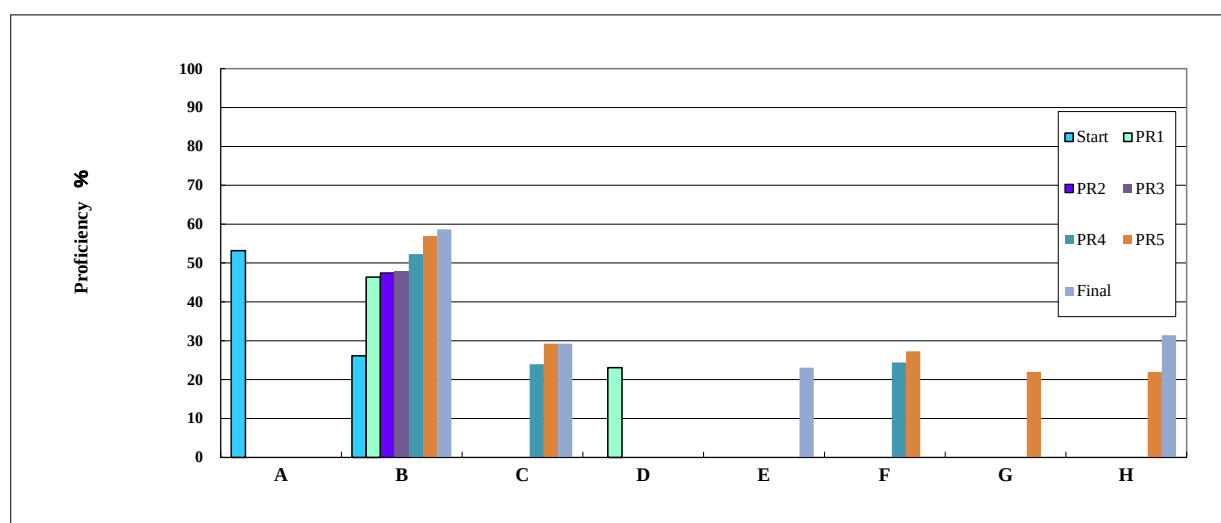
Table 3-8-1 The Result of the CA of Individual

Sector	At the beginning of the Project	At the end of the Project
Flue gas measurement at stationary source	More than one and a half years have passed since the end of the Project Phase 2, the capacity of the personnel to whom the technology had been transferred was retained, and DAAEP was becoming perform the flue gas measurement on their own.	Throughout the project duration, the capacity of the persons in charge who transferred the technology in the Project Phase 2 has been improved and were providing guidance to other personnel in charge of the project. The capacity of all personnel in charge has been improved.
Emission measurement of automobiles	The Mongolian side transferred CLEM's on-board emission systems to NRTC, which had no experience of emission measurement with the on-board emission measurement system. As for DAAEP, although the capacity development of the measurer was well established, there was no one in charge of data analysis of the measurement results.	The persons in charge had acquired sufficient capacity through practical experience in eco-driving pilot project and in emissions study on the effects for the additive using on-board emission systems had been conducted.
Operation and maintenance of AQMS	As for DAAEP, the transfer of technology of the measurers was well established; a two-person team had been maintaining the AQMS, but due to retirement and maternity leave, another person had been in charge of the AQMS since February 2019.	The person in charge was changed, and JET and CLEM conducted the capacity development again. The person in charge had acquired sufficient capacity through practical experience and is now more capable than at the end of the Project Phase 2.
Emission inventory and simulation,	A person in charge of DAAEP who transferred the technology in the Project Phase 2 retired in May 2019, and the new person in charge had never prepared an emissions inventory of air pollutants. A person in charge of NAMEM had involved since the Project Phase 1. Although the person in	DAAEP: DAAEP changed a person in charge of the inventory, and JET conducted the capacity development again. The person in charge acquired sufficient skills through practical experience. NAMEM: NAMEM changed a person in charge of simulation and JET again conducted the capacity

	charge had acquired basic knowledge, etc., and had not an opportunity to actually calculate emissions due to her position in the organization.	development; under JET's guidance, NAMEM was able to operate and run the program on its own. However, its understanding of its operation is still insufficient. IRIMHE: IRIMHE participated in the middle of the Project. Although IRIMHE has knowledge and experience in executing simulation model for weather forecasting and air pollution forecasting, it has not yet been able to use the simulations to evaluate air pollution control measures.
PM composition analysis	PM sampling was also conducted in the Project Phase 2, and some CLEM personnel had mastered the PM sampling process. The PMF source apportionment analysis was mainly performed by the JET in the Project Phase 2, and although the results of the analysis and other information were lectured to persons in charge of NAMEM and CLEM. They did not yet have sufficient understanding to conduct the analysis on their own.	CLEM mainly conducted PM sampling and gained experience in sampling operations and troubleshooting to acquire the necessary skills. Through the training in Japan on PM source contribution analysis, persons in charge of NAMEM and CLEM were able to deepen their knowledge not only in the analysis but also in the PM component analysis. Regarding PM source apportionment analysis, persons in charge of NAMEM and CLEM deepened their understanding by performing a series of processes, including setting up, executing the program, and interpreting the results.

3-8-2-1 Flue Gas Measurement at Stationary Sources

C/Ps are able to perform the flue gas measurement by themselves. The staff in charge of flue gas measurement has been changed due to resigned or sick leave. Staff D, staff E, and staff F were employed when JET was unable to travel to Mongolia due to the global pandemic of COVID-19. However, staff E was changed to other person. JET provided guidance to persons in charge in the field. In addition, JET provided guidance to persons in charge correcting measurement data through online remote guidance. Staff B trained other staffs, thus the technical level of staff B, staff D, F, G and H are improving. Staff B has also passed the examination for civil service in April 2022. The result of CA for the flue gas measurement at stationary sources is shown in Figure 3-8-1.



Source: JET

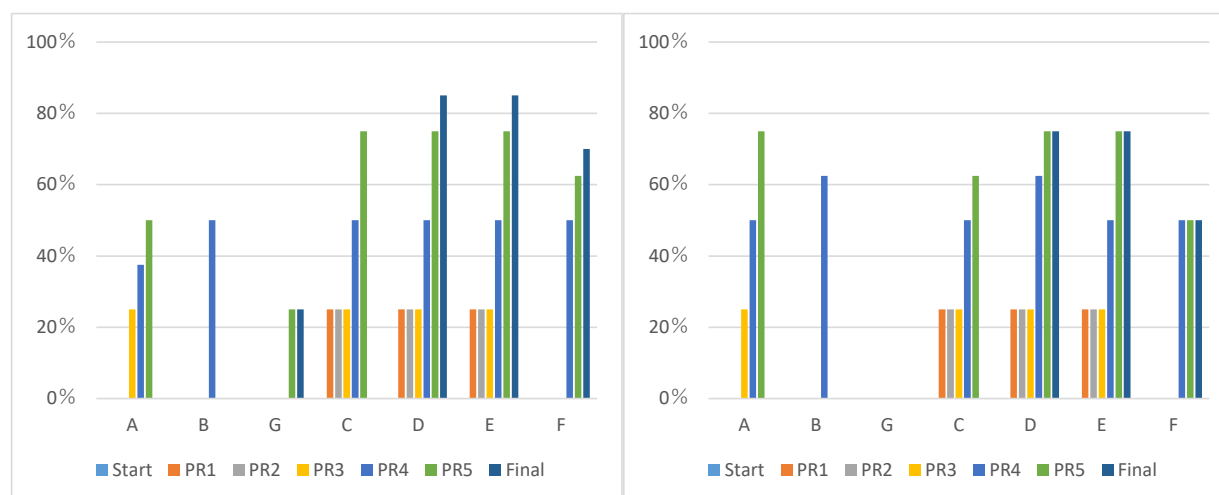
Proficiency level 100 %: Rate of ability to conduct output target of the field self-sufficiently and instruct to colleagues, and handle problems.

Figure 3-8-1 Result of CA regarding the Flue Gas Measurement at Stationary Sources

3-8-2-2 Emission Measurement of Automobiles

The person in charge of measurement and data analysis at DAAEP was absent due to separation from job or maternity leave, however, a full-time employee who has passed the civil service exam has been appointed and fixed from October 2021. Regarding capacity development to NRTC, JET was unable to travel during COVID-19 pandemic, therefore on-board emission measurement surveys were not conducted, and capacity development through practical work was not possible. Travelling has resumed since October 2021, and as part of the Eco-Drive pilot project, exhaust emissions using on-board emission measurement system was surveyed, and through this practice, capacity development to DAAEP and NRTC has progressed.

The progress in capacity development for on-board emission measurement measurements and data analysis is shown in Figure 3-8-1. “A”, “B”, and “G” are of DAAEP, and “C”, “D”, “E”, and “F” are of NRTC. Since December 2019, “A”, “C”, “D”, and “E” have not progressed in practical training for on-board emission measurement system due to the influence of COVID-19, and no improvement in the acquisition rate was seen, however, the acquisition rate after resuming travel improved due to technical transfer training. Around June 2022, “A” had maternity leave, “B” had resigned from job, and instead, “G” became in charge around August 2022. This is the reason for the low acquisition rate. In addition, “F” has been in charge since April 2022, and the acquisition rate of “F” has improved in technology transfer training.



Source: JET

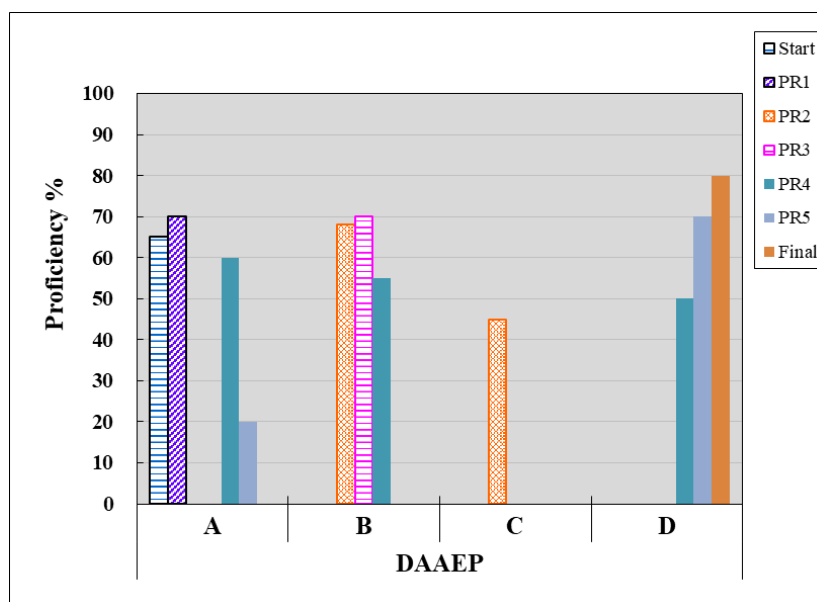
Left: Measurement technology, Right: Data analysis technology

Proficiency level 100 %: Rate of ability to conduct output target of the field self-sufficiently and instruct to colleagues, and handle problems.

Figure 3-8-1 Result of Capacity Assessment for On-board Emission Measurement and Data Analysis

3-8-2-3 Operation and Maintenance of AQMS

After the end of the Project Phase 2, two persons (hereafter referred to as A and B) in charge of DAAEP has been conducting the operation and maintenance of AQMS. One of the person in charge was transferred to another division in February 2019, and remaining staff A had a maternity leave from April 2020. Staff C has been conducting the operation and maintenance AQMS under guidance of Staff B since May 2020. However, staff C resigned in August 2021, and Staff B and staff D became responsible for the maintenance of the AQMS in addition to their other responsibilities. The staff B was trained in the Project Phase 2 and is responsible for procuring consumables and requesting repairs to overseas manufacturers, resigned in July 2022. The staff D has been in charge from September 2021, and JET has been providing online instruction on data transfer and on-site training since November 2021, which has improved staff D's proficiency. Staff A returned to work in April 2022, however, was assigned to other responsibilities in September 2022. The result of CA for the operation and maintenance of AQMS is shown in Figure 3-8-2.



Source: JET

Proficiency level 100 %: Rate of ability to conduct output target of the field self-sufficiently and instruct to colleagues, and handle problems

Figure 3-8-2 Result of CA regarding the Operation and Maintenance of AQMS

3-8-2-4 Emission Inventory and Simulation

According to the contract of “The letter of agreement on the role of emission inventory, simulation, and evaluation of air pollution control measure” described in 3-7-1, DAAEP is in charge of updating emission inventory, and NAMEM (IRIMHE) and NUM are in charge of simulation.

Capacity development status for emission inventory and simulation is shown in Table 3-8-2 and capacity development progresses for emission inventory and simulation are shown in Figure 3-8-3.

Regarding the capabilities in the organizational level in DAAEP, although “J”, who is the person in charge of updating emission inventory, is steady progressing in acquiring technology, “F” has taken maternity/paternity leave from February 2023. It is necessary to secure support personnel, etc. to maintain the system for updating emission inventory.

In NAMEM, the director of environment monitoring division, who understood the activities of emission inventory and simulation model in this Project, retired in April 2024. “C”, who had been involved in activities of emission inventory and simulation as an administrator, took a leave of absence. “H”, who managed the emission source registration database, is in charge of simulation and will continuously improve the capacity of simulation with IRIMHE and NUM.

IRIMHE has indicated its intention to be involved in the implementation of simulation model, along with the development of the meteorological model, with which it has already received cooperation. Since IRIMHE has the capacity of utilization of simulation model such as air pollution forecast system in *agaar.mn*, it is expected that IRIMHE utilize the capacity for evaluation of air pollution control measure.

In NUM, the original professor in charge of this Project under the joint implementation contract has moved to Japan and his research associate, “M”, is no longer able to be involved. A new professor of atmospheric physics has been assigned to this Project through an introduction by NAMEM. However, his understanding of condensable particle matter is not sufficient.

After this Project, each organization will be required to fulfill its role in accordance with the contract of “The letter of agreement on the role of emission inventory, simulation, and evaluation of air pollution control measure”, which was signed in April 2023. In particular, it would be desirable for NAMEM to contract IRIMHE or NUM to conduct simulation. Alternatively, a cooperative scheme with Japanese experts may be developed for executing simulations and analyzing the results.

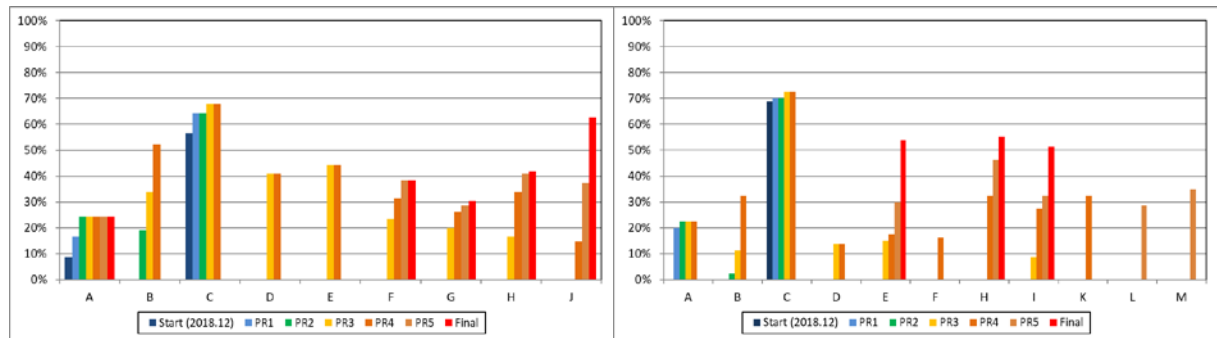
Table 3-8-2 Capacity Development Status for Emission Inventory and Simulation

Person in charge	Assigned date	Main activity	Capacity development status
DAAEP			
A	2019-09	I	“A” gradually improved his abilities through this online training. However, “A” has been on maternity leave and childcare leave since the end of January 2021.
B	2020-06	I, S	“B” elaborated the annual emission inventory report using the emission inventory for 2018. In developing the emission inventory for 2020, “B” actively organized data and calculated emissions based on the experiences obtained in the training. “B” also joined the training for executing simulation model. However, “B” left DAAEP at the end of March 2022.
F	2021-03	I	“F” is in charge of automobile emission inventory. “F” joined the training of developing emission inventory and executing simulation model. “F” does not seem to be very good at analysis using Microsoft Excel and editing operation using edit tool, thus “F” had a hard time in the operation even during the training. “F” has taken maternity/paternity leave since February 2023.
G	2021-03	I	Since “G” has ever been in the boiler inspection, “G” can barely calculate emissions. On the other hand, since “G” is familiar with information on HOB, “G” is in charge of organizing the source information of HOB. JET instructed “G” to continue to collect and check the data for calculating emissions and simulation after this Project.
J	2022-04	I	“J” is also responsible for the maintenance and management of AQMSs. “J” is willing to learn techniques such as organizing data for calculating emissions. As the result, “J” calculated emissions and elaborated emission inventory report. It is expected “J” to keep the capacity to calculate emissions after this Project.
NAMEM			
C	The Project Phase 1	I, S	“C” has participated since the Project Phase 1. “C” has basic knowledge, however, from the standpoint of the organization, she has few opportunities to practice, and has weaknesses in practical items. “C” is currently on leave of absence.

D	The Project Phase 2	I, S	“D” was in charge of updating emission inventory at the end of the Project Phase 2, thus it seems that “D” has no trouble for the basic operation of updating emission inventory. From September 2021, “D” has handed over the charge on emission inventory to “H” and “D” will be in charge of simulation, especially analyzing concentrations at AQMSs. However, “D” left NAMEM at the end of February 2022.
H	2021-09	I, S	“H” is now in charge of the simulations at NAMEM. It is expected that simulation will be carried out in cooperation with IRIMHE and NUM after this Project.
K	2022-03	S	“K” was newly hired by NAMEM and was in charge of simulation from March 2022. “K” has experience using simulation models such as CALPUFF in the past, thus “K” was expected to be in charge of simulation in the future. However, “K” retired NAMEM.
IRIMHE			
E	The Project Phase 2	S	“E” is in charge of updating emission inventory at the Project Phase 2, and “E” seems to have no trouble in the basic operation of updating emission inventory. Since “E” has knowledge and experience in conducting simulations of weather and air pollution forecasting, it is expected that “E” to use the skill for evaluation of air pollution control measures.
I	2021-07	S	“I” is in charge of developing the meteorological field by WRF. Since “I” has knowledge and experience in conducting simulations of weather and air pollution forecasting, it is expected that “E” to use the skill for evaluation of air pollution control measures.
NUM			
L	2023-04	S	As the manager of NUM's simulation implementation, “L” was supposed to be in charge of progress management. However, in September 2023, “L” was transferred to Japan, and the joint implementation was no longer possible.
M	2023-04	S	“M” had quickly learned the operations such as organizing emission data and editing input files. “M” was expected to be the main person in charge of NUM's simulation execution. However, “L”, the professor in charge of “M” has moved to Japan and “M” can no longer be involved in joint implementation.

In category of “Main activity”, “I” means emission inventory, and “S” means simulation.

Source: JET



Left: Emission inventory Right: Simulation

Source: JET

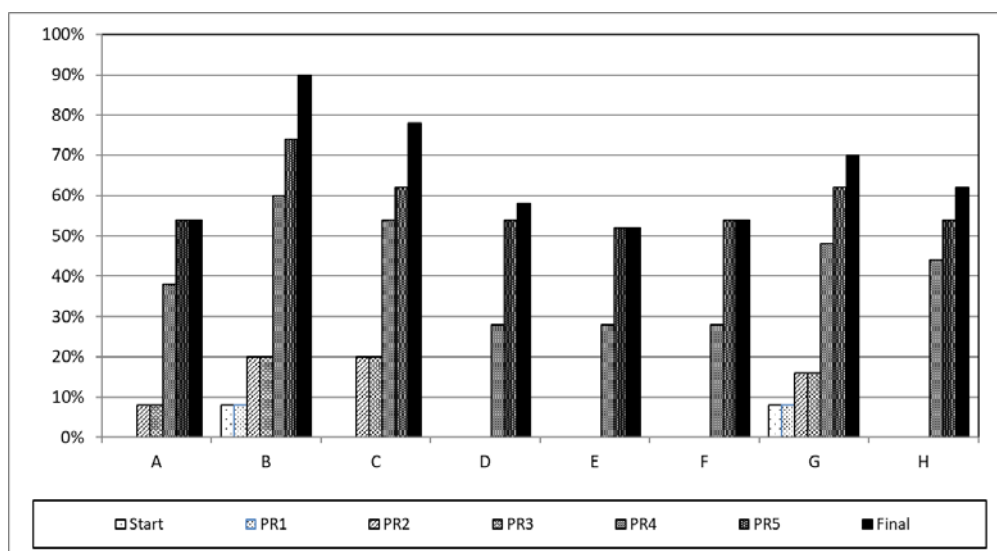
Proficiency level 100 %: Rate of ability to conduct output target of the field self-sufficiently and instruct to colleagues, and handle problems.

Figure 3-8-3 Result of CA regarding the Emission Inventory and the Simulation

3-8-2-5 PM Composition Analysis

PM sampling was planned to be started in April 2020 at first, however, the activity was postponed due to COVID-19 pandemic. The major part of technical transfer has carried out since December 2021, when the PM sampling has started. Capacity assessment of PM source apportionment study is shown in Figure 3-8-4.

Main C/P was CLEM and NAMEM. CLEM was mainly in charge of PM sampling, composition analysis, source apportionment study, and NAMEM was in charge of utilization of the results, planning of equipment for chemical composition analysis. The member “B” led overall activity, and “C” carried out most part of PM sampling. “D”, “E” and “F” mainly joined in the field of chemical composition analysis. The members gained experience in these field through the training in Japan (held in November 2022). “A”, “G”, “H” is in the position related to plan installation of equipment for chemical composition analysis, and “H” is expected to obtain further understanding by comparing the output from this activity with simulation modeling activity, since “H” also joins simulation modeling WG as well.



Source: JET

Proficiency level 100 %: Rate of ability to conduct output target of the field self-sufficiently and instruct to colleagues, and handle problems.

Figure 3-8-4 Result of CA for PM Source Apportionment Study

3-8-3 The Capacity Assessment of Organizational and Social Level

According to the following facts, it can be concluded that capacity of organizational level has been steadily strengthened through independent efforts by the Mongolian side.

- DAAEP has significantly increased the budget compared to the Project Phase 2, and by which DAAEP has purchased consumables and standard gases for flue gas measurement for stationary sources and AQMS, and repaired and renewed damaged equipment.
- Mongolian side have air quality distribution data in more detail by installation, operation and maintenance of additional 8 AQMSs.
- DAAEP applied to Mongolian National Accreditation System (MNAS), accreditation body in Mongolia, for ISO 17025:2017 laboratory accreditation for the flue gas measurement at stationary sources, and DAAEP received laboratory accreditation on 28 April 2022.
- High-level Forum on Clean Air by the Asia-Pacific Regional Action Program for Air Pollution was organized by MET with UNESCAP and UNEP on 2 to 3 March 2023.

According to the following facts, it can be concluded that capacity of social level has improved significantly from the following.

- In comparison to the Project Phase 2, Mongolian side became to consider that combustion tests should be performed for solid fuels evaluation and test results should be used as basis for evaluation. In fact, 66 combustion tests of improved fuels and fire starters were performed at

DAAEP's fuel combustion laboratory by request of ME, NCEPR, TTT, and other companies in 2023.

- UB City had been implementing inspections to confirm that boilers meet emission standards based on results of the flue gas measurements, and a similar approach is now being taken for flue gas measurements in provinces. With public recognition of the flue gas measurements of DAAEP, there have been requested from localities other than UB City to perform the flue gas measurements for boilers, and DAAEP performed it in Selenge and Dundgovi provinces and Erdenet and Darkhan cities.

A capacity assessment, in a form of a self-assessment test, was conducted on March 2022, March 2023 and April 2024 for Managers of key agencies, DAAEP and NAMEM, to compare the changes of organizational and social level capacity building. The test contained several questions related the organizational level and society level of each activity in JICA project was self-assessed. The perfect score of each question was five points, and the scoring system was set so that the higher score means higher capacity. The CA results for each output are shown in Table 3-8-3. Detailed CA results are shown in Annex 3-8-1.

DAAEP had subjectively overestimated competence, however, as it has become more capable of objectively assessing competence, and in March 2024 self-assessment scores were not as high. JET concludes that this is a good trend regarding the fact that objective evaluations are now possible.

Regarding organizational level, PM source apportionment analysis at the organizational level is getting higher due to the activities. On the other hand, although emission measurements of automobiles were conducted by the Project, the Mongolian side has not been able to proactively implement them due to the expense involved. Thus, mission measurements of automobiles were in low capacity.

Regarding social level, DAAEP, NAMEM, and NUM have signed a joint implementation agreement on the sharing of roles for emission inventory, simulation, and measure evaluation in 2023, however, it has not yet been fully operationalized. There is a lack of programs to develop human resources for emission inventory and simulation, and the Mongolian Government's capacity to measure automobiles emissions is low.

Table 3-8-3 The CA Results for Each Output

Output 1: Capabilities of emission monitoring for the major pollution sources and air quality monitoring are strengthened.				
	Assessment item	2022	2023	2024
1-1	DAAEP and IACC reinforce HOB inspections based on on-site stack gas measurements.			
	Organization level	4.38	3.75	3.75
1-2	DAAEP conducts emission measurements of automobiles.			
	Organizational level	3.00	2.25	2.00

	Social level	2.00	1.50	1.25
1-3	DAAEP strengthens AQMS utilization.			
	Organizational level	4.00	3.38	3.50
	Social level	4.00	3.00	3.00
Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO ₂ , and NO _x throughout the year are strengthened.				
2-1	NAMEM conducts PM apportionment study based on PM speciation throughout the year.			
	Organizational level	3.50	4.00	4.25
	Social level	1.00	2.00	2.00
2-2	DAAEP and NAMEM evaluate air pollution structure and health impact based on air quality simulation model and receptor model.			
	Organizational level	3.25	2.93	2.62
	Social level	2.55	3.00	2.83
Output 3: Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.				
	Organizational level	4.50	4.00	4.00
	Social level	4.50	3.00	3.00
Output 4: Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies.				
	Organizational level	4.33	3.00	3.00
	Social level	4.00	3.50	3.00
Output 5: Air pollution control measures are enhanced for PM, SO ₂ and NO _x emission reduction at major sources.				
5-1	DAAEP provides technical guidance to manufacturers for improved fuel production.			
	Organizational level	4.50	3.00	3.00
	Social level	4.50	3.00	3.00
5-2	The relevant agencies evaluate pilot projects results in terms of emission reduction, air quality improvement and exposure to citizens, and extract lessons learned.			
	Organizational level	3.83	3.00	2.50
	Social level	3.67	3.00	2.50
5-3	DAAEP submits technical documents to NCEPR for improved fuel standard, emission standard on stationary sources, mobile sources and other emission sources, and revision of ordinance.			
	Organizational level	4.25	3.50	3.50
	Social level	3.50	3.00	3.00
Output 6: Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.				
6-1	The relevant agencies discuss and elaborate written agreements on demarcation of roles in air quality management related with each Output and Activity of the Project.			
	Social level	4.67	4.00	4.00

Table 3-8-4 shows the number of human resources who have been trained in the Project Phase 3 from November 2018 to April 2024.

Table 3-8-4 Number of Trained Human Resources

Year	Administrative official	Administrative officials, residents, and workers
FY※2018	34 persons	38 persons
FY 2019	54 persons	54 persons
FY 2020	100 persons	100 persons
FY 2021	68 persons	69 persons
FY 2022	61 persons	84 persons
FY 2023	67 persons	97 persons
FY 2024	26 persons	31 persons

※FY: Fiscal Year of JAPAN

3-8-4 The Result of Capacity Assessment

The results of the CA are shown in Table 3-8-5. There are many sectors in which capacity has improved at the individual, organizational, and social levels. Future challenges remain to be addressed in the measurement of automobile emissions and human resources at the organizational level, and programs to develop human resources in automobile emissions measurement and emissions inventory and simulation as at the social level.

Table 3-8-5 Results of CA

Level	Advanced Sectors of Capacity Development	Low Sectors of Capacity Development
Individual	• Flue gas measurement at stationary sources • Operation and maintenance of AQMS • Emission measurements of automobile • PM source apportionment analysis • Development of Emission inventory	
Organizational	• Secure budget for DAAEP • Flue gas measurement at stationary sources by DAAEP • PM source apportionment analysis by CLEM and NAMEM • Collaboration between DAAEP and other agencies • Collaboration with donors	• Challenges remain in emission measurements of automobile • Challenges remain in securing support personnel to maintain organization of DAAEP to update emission inventory
Social	• Solid fuel evaluation based on combustion test results • Inspection of flue gas measurement at stationary sources	• Challenges remain programs to train personnel in emission measurements of automobile and emission inventory and simulation.

4 Achievement Status of Objectively Verifiable Indicators

4-1 Project Purpose

Achievement status of objectively verifiable indicators for project purpose shown in Table 4-1-1. Activities were significantly delayed from the original schedule due to the two-year postponement of the pilot project for improved household fuel and the suspension of activities in Mongolia due to COVID-19 and the postponement of the implementation of other pilot projects.

Table 4-1-1 Achievement Status of Objectively Verifiable Indicators for Project Purpose

Objectively Verifiable Indicator	Status of Achievement
Project Purpose: Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attentions to implementation of effective pollution control measures and to the necessary coordinating mechanism of DAAEP and the relevant agencies.	
1. One of pilot projects are adopted as full scale implementation by relevant authorities.	Achieved
2. At least one case of lessons learned from the pilot projects are utilized by the decision makers.	Partially achieved - Not only at the 10 intersections targeted in the pilot project, but also at other traffic signals in UB City, the use of the acquired technology reduced the number of interventions at traffic signals by the TCC and the number of traffic control operations by traffic police officers ignoring the lights of traffic signals. In addition, a standard of up to 240 seconds of intervention time by traffic police could be set. Thus, the lessons learned, while temporary, were used by the decision-making bodies. - However, the implementation of the system was only temporary, and there are still issues that need to be addressed before it can be spread throughout UB City and produce tangible outputs.
3. Relevant laws, regulations and standards on air pollution control measures are implemented in UB City. (At least establishment of one MNS, and/or 70% of compliance in the dust emission standards of existing MNS; MNS5043:2016 (General technical requirement of heat water boiler under 4.2MW) and MNS5919:2008 (Emission limit value and measurement method of power plant, steam boiler))	Partially achieved - A provision 16.1.6 was added to the Air Law, to obligate the fuel provider to sell only Euro 5 standard fuel with low sulfur content and to prohibit the retail of fuel with lower quality within the air quality improvement area in UB City. Although laws and regulations have been established, there are still issues to be addressed in terms of compliance. - The results of emission measurements at 240 sites conducted by DAAEP during the project period showed that Dust emission standards were achieved at more than 70% of the sites.

4-1-1 Objectively Verifiable Indicators of Project Purpose 1

Regarding Objectively Verifiable Indicators of Project Purpose 1, based on the outputs of the pilot project, the government added provision 16.1.6 to the Air Law on 22 April 2022, to obligate the fuel provider to sell only Euro 5 standard fuel with low sulfur content and to prohibit the retail of fuel with lower quality within the air quality improvement area in UB City. The introduction of Euro 5 standard fuel, which has been promoted through the pilot project, is expected to be fully adopted in the near future due to the establishment of the law. However, Mongolia has no refinery (currently under construction) and imports all vehicle fuels from Russia and China, where Euro 2 fuel is still being sold because it is cheaper than Euro 5 fuel. Therefore, publicity is needed to promote the use of Euro 5 fuel to UB citizens and businesses, measures to eliminate the price difference between Euro 2 and conventional fuel, and policies to ensure that only Euro 5 fuel will be sold in the future.

4-1-2 Objectively Verifiable Indicators of Project Purpose 2

In the pilot project for signal control, the TCC and the traffic police discussed a reduction in signal interventions and a change in the time of implementation of the interventions in late January 2023. Not only at the 10 intersections targeted in the pilot project, but also at other traffic signals in UB City, the use of the acquired technology reduced the number of interventions at traffic signals by the TCC and the number of traffic control operations by traffic police officers ignoring the lights of traffic signals. In addition, a standard of up to 240 seconds of intervention time by traffic police could be set. Thus, the lessons learned, while temporary, were used by the decision-making bodies. However, the implementation of the system was only temporary, and there are still issues that need to be addressed before it can be spread throughout UB City and produce tangible outputs. However, the Traffic Control Center are recognized the importance of signal control well and learned the technology for updating it, so it remains to be examined how the Center can inexpensively and continuously collect traffic volume data for signal control updating (e.g., collecting traffic volume data for each lane using AI technology from video taken at intersections). Therefore, the project is evaluated as having partially achieved Project Objective Indicator 2.

4-1-3 Objectively Verifiable Indicators of Project Purpose 3

As described above, the government added provision 16.1.6 to the Air Law on 22 April 2022, to obligate the fuel provider to sell only Euro 5 standard fuel with low sulfur content and to prohibit the retail of fuel with lower quality within the air quality improvement area in UB City. The use of Euro 5 fuel has been complied with in national public buses, and MMHI has issued a letter to the Municipal Transportation Authority to tender and use Euro 5 fuel for newly introduced Euro 5 buses. However, other fuels are still available.

4-2 Objectively Verifiable Indicators of Outputs

Achievement status of objectively verifiable indicators for outputs shown in Table 4-2-1. The pilot project of improved fuel for households has been postponed for two years, and activities in Mongolia had suspended due to COVID-19 and the implementation of other pilot projects had also postponed. In spite of these delays, objectively verifiable indicators of the outputs are mostly achieved. Some of the indicators couldn't be achieved due to breakup of NCEPR, which is responsible to implement the air pollution control measures.

Table 4-2-1 Achievement Status of Objectively Verifiable Indicators of Outputs

Objectively Verifiable Indicator	Status of Achievement
Output 1: Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.	
1-1. During the Project duration, at least 50 % of inspections for boiler registration based on emission measurements (including standard and simplified methodologies) are implemented by DAAEP and IACC.	Achieved
1-2. The emission measurement reports are submitted to the Deputy Governor of UB City at least 3 times during the Project duration.	Achieved
1-3. Emission monitoring for the major pollution sources and air quality monitoring information are shared regularly among the relevant agencies through coordination between DAAEP and NAMEM.	Achieved
1-4. The CEMS measurement is compared with the standard measurement once in a year.	Achieved
1-5. Distribution of emission measurements from automobiles in UB City is prepared based on the study with RSD at least once a year.	Achieved
Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO ₂ , and NO _x throughout the year are strengthened.	
2-1. The results of PM apportionment study are reported at least three times during the Project.	Achieved
2-2. Pollution structures are assessed at least 3 times during the Project duration including emission inventory, simulation model, PM speciation, receptor model, air quality monitoring, and population exposure throughout the year.	Achieved
Output 3: Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.	
3-1. Drafts of emission measurement methods and quality standards of improved fuel for households in Ger area are submitted to MASM.	Partially achieved
3-2. At least three of implementation plans of the pilot projects are prepared.	Achieved
Output 4: Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies.	
4-1. Analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) are presented to decision makers at least 2 times.	Achieved

Objectively Verifiable Indicator	Status of Achievement
4-2. Results of pilot project implementation and other Project results are utilized for the revision of NCEPR and for decision making on implementation/non-implementation of pollution control measures at least once.	Achieved
Output 5: Air pollution control measures are enhanced for PM, SO ₂ and NO _x emission reduction at major sources.	
5-1. At least three pilot projects selected by C/P-WG are implemented	Achieved
5-2. The results of each pilot project (emission reduction, improvement of ambient air quality and population exposure for PM, SO ₂ and NO _x) are presented to the relevant agencies.	Achieved
Output 6: Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.	
6-1. At least three of drafts on laws and regulations, such as fuel regulations, MNS emission standards and ordinances of UB City, are submitted.	Achieved
6-2. More than 3 air pollution control measures and technologies are funded by the sections of the relevant agencies in charge of allocating funds for air pollution control by utilizing technical appraisal guideline provided by the Project.	Partially Achieved The Technical Review Guidelines were completed in June 2024, but NCEPR was dissolved at the end of December 2023. No department or area of responsibility for air pollution control has yet been determined, and no department responsible for allocating funds has yet been determined.
6-3. At least three agreements are made on demarcation of roles of the relevant agencies for air pollution control measures in the Project.	Achieved (three)
6-4. The operational guideline is distributed to relevant agencies.	Will be done in 2023

4-2-1 Output 1

4-2-1-1 Objectively Verifiable Indicator 1-1

As for the Objectively Verifiable Indicator 1-1, the boiler inspection were smoothly implemented by the cooperation of DAAEP and IACC. DAAEP performed the flue gas measurement at 206 boilers from November 2018 to December 2022. This number represents 50.7% of all registered HOBs (406 locations). Objectively Verifiable Indicator 1-1 was achieved in December 2022. The equipment was provided by the project because the Mongolian side did not have the equipment at the beginning of the project in the Project Phase 1. 10 years have passed and the equipment is almost damaged, so it is necessary to purchase a new one. The budget for maintenance and management on the Mongolian side is increasing, however, all equipment is imported and expensive. The Mongolian side has hardly been able to purchase new equipment due to the huge amount of funds required. In November 2023,

JET prepared a document and explained the need to purchase equipment to Deputy Governor as the decision-making body.

4-2-1-2 Objectively Verifiable Indicator 1-2

As for the Objectively Verifiable Indicator 1-2, DAAEP prepares an annual report on its activities, including the name of the facility and the results of emission measurements. DAAEP has been reported in January 2019, January 2020, January 2021, January 2022, January 2023 and January 2024. Objectively Verifiable Indicator Outcome indicators 1-2 was achieved.

4-2-1-3 Objectively Verifiable Indicator 1-3

Objectively Verifiable Indicator 1-3 is “Emission monitoring for the major pollution sources and air quality monitoring information are shared regularly among the relevant agencies through coordination between DAAEP and NAMEM.”

Emission monitoring report is shared annually with relevant agencies by DAAEP, at the website of DAAEP, as annual reports of DAAEP, including stack gas measurement report of TPP2, TPP3, TPP4 and HOBs. Data of continuous emission monitoring system (CEMS) has been shared to the relevant agencies by MET, by keeping the online information system, and by sharing user name and password to relevant agencies.

Air quality monitoring information are shared regularly among the relevant agencies by annual reports etc. as described in 3-2-4-5.

Therefore, Objectively Verifiable Indicator 1-3 is achieved because DAAEP and NAMEM continued their activities from the period of the Project Phase 2.

4-2-1-4 Objectively Verifiable Indicator 1-4

Objectively Verifiable Indicator 1-4 is “The CEMS measurement is compared with the standard measurement once in a year.”

DAAEP measured exhaust gases of TPP3 and TPP4 periodically from the Project Phase 1. Additional information necessary for comparison with the CEMS measurement data became available from measurements in 2023.

C/P and JET compared CEMS data with DAAEP’s measurement data of TPP3 and TPP4, and results of comparison of both data are as follows;

- Regarding TPP3, there was a difference of about 8 times in NO_x concentration, and about 10 times in CO and Dust concentrations. It was found that the measurement locations were not consistent. CEMS is installed in the stack where exhaust of all the 7 boilers are combined.

DAAEP measured the exhaust at the outlet of boiler No. 7. NAMEM requested DAAEP to measure same gas as the CEMS measures.

- Regarding TPP4, there was a difference of about 3 times in CO concentration. TPP4 will try to renew standard gas for CEMS calibration in 2024.

Therefore, Objectively Verifiable Indicator 1-4 was achieved.

Objectively Verifiable Indicator 1-4 is one of the measures of Activity 1-2-2 "TPP3 and TPP4 will manage the quality of CEMS emission data," which is part of Activities 1-2 "TPP3 and TPP4 will strengthen emission management using CEMS." CEMSs have been operated from their installation in 2016 until 2024 continuously, which certifies proper maintenance and management of TPP3 and TPP4. Quality control is also carried out through appropriate calibration procedure. As it has become more difficult to procure standard gases for calibration due to the strengthening of customs management, NAMEM studied compliant ways, and then provided them to TPP3 and TPP4.

4-2-1-5 Objectively Verifiable Indicator 1-5

The outcome indicator 1-5 is "Based on the results of the RSD survey achieved from the of exhaust gas measurements from automobiles travelling in UB, the actual distribution is created at least once a year."

An RSD survey was conducted from May to June 2023, and a distribution of actual exhaust gas measurements of automobiles driving in UB city was created. Outcome indicators 1-5 were achieved in October 2023.

4-2-2 Output 2

4-2-2-1 Objectively Verifiable Indicator 2-1

As for the Objectively Verifiable Indicator 2-1 "The results of PM apportionment study are reported at least three times during this Project", analysis of all samples was completed in March 2023. The results of the composition analysis were reported three times: at a seminar in Mongolia on 26 August 2022, at a lecture in the training course in Japan in 11 November 2022, and at a seminar in Mongolia on 12 April 2023, thus the indicator 2-1 has been achieved.

Furthermore, in the technical seminar in December 2023 and Final seminar in April 2024, C/P by themselves explained their activity and the results of analysis to the participants including for other C/P group members.

4-2-2-2 Objectively Verifiable Indicator 2-2

Objectively Verifiable Indicators 2-2 "Pollution structures are assessed at least 3 times during this Project duration including emission inventory, simulation model, PM speciation, receptor model, air

quality monitoring, and population exposure throughout the year." was achieved. Condition of achievement is shown in Table 4-2-2.

DAAEP completed updating 2022 emission inventory in March 2024 and prepared 2022 emission inventory report in May 2024. This report was released on DAAEP's website in June 2024.

Simulation model for 2018 as a current year was developed in May 2022, and the model was used to execute simulations for 2020. JET explained these results to the Mongolian side at the seminar in October 2022 as well as at the academic seminar organized by UNICEF in February 2023.

PM₁₀ simulation model considering condensable particle matter was developed using the analysis result of PM₁₀ source apportionment. JET presented the air pollution structure using the simulation model of PM₁₀ in January 2024.

JET presented the result of emission and concentration for 2027 based on BAU scenario in March 2024.

DAAEP, NAMEM and NUM signed "Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models" in April 2023. According to the letter, it is expected that the Mongolian side to continuously assess air pollution structure after this Project.

Table 4-2-2 Completed Term for Updating Emission Inventory and Evaluating Air Pollution Structure and Exposure

Year	Updating Emission Inventory	Simulation and Evaluating Air Pollution Structure Based on this Result	Evaluation Exposure
2018	November 2021	October 2022	September 2023
2019	None	None	None
2020	September 2022	October 2022	September 2023
2021	October 2023	None	None
2022	May 2024	None	None
2027 (BAU Scenario)	February 2024	March 2024	March 2024

Source: JET

4-2-3 Output 3

4-2-3-1 Objectively Verifiable Indicators 3-1

The combustion test data of improved fuels conducted by DAAEP is organized. Regarding objectively Verifiable Indicator 3-1 "Drafts of emission measurement methods and quality standards of improved fuel for households in the Ger area are submitted to MASM", the quality standards of improved fuel for households has been revised in MNS 5679-2019 and MNS 5679-2022, and the indicator has achieved. Meanwhile, as noted in 3-4-1, standards for emission gas measurement methods are currently being considered by the UB City Urban Standards Control Bureau.

In order for the UB Urban Standards Control Bureau to establish a working group to study the standard, a letter was sent to DAAEP on 7th March 2024 regarding the submission of working group members. DAAEP submitted two candidates for stationary source emission gas measurement as working group members in the week of 18 March 2024, but the subcommittee has not yet been established.

4-2-3-2 Objectively Verifiable Indicators 3-2

In the 3rd JCC, changes in implementation plans and location for pilot project of improved fuel was approved. The automobile pilot projects were discussed with C/P-WG from May 2019, and the implementation plans of pilot project regarding traffic signal control, eco-drive, RSD, DPF, low-sulfur fuel, and low-emission automobiles were approved. Therefore, Objectively Verifiable Indicator 3-2 was achieved.

4-2-4 Output 4

4-2-4-1 Objectively Verifiable Indicator 4-1

The following contents were recommended to the decision making through briefings to the Deputy Governor and JCC, and seminars. As a result, Objectively Verifiable Indicator 4-1 "Analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) are presented to decision makers at least 2 times." was achieved in April 2024.

1. At the seminar in October 2022 and the 8th JCC in December 2022, JET evaluated an air pollution control measure by converting raw coal to improved fuel, implemented as a Mongolian national policy based on the evaluation of the air pollution structure in 2018 and 2020, and recommended for further improvements of improved fuel.
2. In November 2023, JET presented Ms. Nominchimeg, the Deputy Governor of UB City, and the evaluation result of air pollution control measure by converting raw coal to improved fuel implemented as a Mongolian national policy and recommended the effectiveness of air pollution control measures.
3. JET explained the detailed air pollution structure of PM₁₀ in the seminar on PM₁₀ simulation model considering condensable particle matter in January 2024.
4. JET explained the setting of BAU scenario for 2027 as a target year and the setting of air pollution control measure scenarios based on the result of pilot projects and the evaluating result at the seminar on 13 March 2024.
5. In April 2024, JET presented the compared results of improved fuels for household to Ms. Nominchimeg, the Deputy Governor of UB City. Specifically, the result presented by JET compared TTT's existing improved fuel and BCB produced by this Project and compared result

of the air pollution control measures between produced BCB and changing stoves. Then, JET recommended the effectiveness of air pollution control measures.

6. JET explained the setting of air pollution control measure scenarios based on the result of Pilot Projects and the evaluated result at the final seminar on 18 April 2024.

4-2-4-2 Objectively Verifiable Indicator 4-2

Objectively Verifiable Indicator 4-2 "Results of pilot project implementation and other Project results are utilized for the revision of NCEPR and for decision making on implementation/non-implementation of pollution control measures at least once" was achieved.

In September 2022, NCEPR was planning to introduce an additive as the air pollution control measure for automobile. JET surveyed the emission reduction effect of the additive using on-board emission measurement system and submitted a report to NCEPR secretariats. As the result, NCEPR decided not to introduce the additive for automobile measure.

4-2-5 Output 5

4-2-5-1 Objectively Verifiable Indicator 5-1

Six Pilot Projects was implemented based on the implementation plan that was achieved in Objectively Verifiable Indicator 3-2. The implementation term of these pilot projects is shown in Table 4-2-3. As a result of implementations, Objectively Verifiable Indicator 5-1 "At least three pilot projects selected by C/P-WG are implemented" was achieved.

Table 4-2-3 Implementation Term of Pilot Projects

Pilot Project	Implementation Term
Improved Fuel for Household	April 2022 to March 2024
Traffic Signal Control	July 2019 to April 2023
Low-Sulfur Fuel	July 2019 to March 2024
Eco-driving	July 2019 to February 2024
DPF	September 2019 to December 2023
RSD	July 2019 to January 2024

Source: JET

4-2-5-2 Objectively Verifiable Indicator 5-2

The seminar on the evaluation result of air pollution control measures based on the result of Pilot Projects was held with the Mongolian side on 13 March 2024. JET presented the evaluation result of emission reduction, improvement of ambient air quality and population exposure. As a result of these activities, Objectively Verifiable Indicator 5-2 "The results of each pilot project (emission reduction, improvement of ambient air quality and population exposure for PM, SO₂ and NO_x) are presented to the relevant agencies." was achieved in March 2024.

4-2-6 Output 6

4-2-6-1 Objectively Verifiable Indicator 6-1

For Indicator 6-1, "Three drafts of relevant laws and regulations (fuel regulations, emission standards, MNS, city ordinances, etc.) will be submitted", the four are shown below. Indicator 6-1 was achieved.

(1). Ban of Raw Coal Use

The draft addendum/update to No.62 Cabinet Decision of Mongolian Government of 2018 on the ban of raw coal use was approved by No.189 Cabinet Decision of Mongolian Government dated on 8 May 2020. In addition, the addendum to No. 62 Cabinet Decision of Mongolian Government of 2018 on Ban of Raw Coal Use was prepared in 2022, and approved by No. 223 Cabinet Decision dated on 8 June 2022.

(2). Air Quality Improvement Areas Enforcement Regulations

The Air Quality Improvement Areas Enforcement Regulation of 2019 to 2020 (revised version) was approved as the Joint Order of the Minister of Environment and Tourism and the Mayor of UB No. A/433-A/820, dated 14 August 2019.

The Air Quality Improvement Areas Enforcement Regulation of 2020 to 2021 (revised version) was approved as the Joint Order of the Minister of Environment and Tourism and the Mayor of UB No. A/604-A/112, dated 12 October 2020.

The revision of Air Quality Improvement Areas Enforcement Regulation for 2021 to 2022 was approved as Joint Order No. A/322-A/780 of the Minister of Environment and Tourism and the UB Mayor, dated 13 October 2021.

The revision of Air Quality Improvement Areas Enforcement Regulation for 2022 to 2023 was approved as Joint Order No. A/422-A/1354 of the Minister of Environment and Tourism and the UB Mayor, dated 17 October 2022.

Draft of Air Quality Improvement Areas Enforcement Regulation for 2023-2024 was prepared, and comments and opinions from each ward office and related organizations were solicited. The discussion at the mayor's council were prepared.

(3). Carbon Monoxide Poisoning Risk

The UB Mayor's Decree No. A/346 of 2022 and Implementation Bylaws for Carbon Monoxide Poisoning Risk Prevention and Risk Measures dated on 14 March 2022 by the UB Deputy Governor of Green Development and Air and Environmental Pollution Reduction Issues were approved. In addition, the Mayor's Ordinance No. /A1030 dated 6 September 2023 "Prevention of Carbon Monoxide Poisoning and Some Measures to Prevent Risks" was issued.

(4). Introduction of Euro 5 fuel

The Mongolian Government has decided to add a new regulation to Article 16.1.6 of the Air Law on 22 April 2022, prohibiting the sale of the highest grade fuel in the MNS and the retail and sale of lower grade fuel within air quality improvement areas in UB City. The decision was made to add a provision to prohibit the retail, sale, etc. of lower grade fuels within the air quality improvement area in the UB City.

4-2-6-2 Objectively Verifiable Indicator 6-2

The technical appraisal guideline was completed in June 2024. NCEPR dissolved at the end of December 2023. No department or area of responsibility for air pollution control has yet been determined, and no department responsible for allocating funds has yet been determined.

4-2-6-3 Objectively Verifiable Indicator 6-3

Regarding the agreement on the division of roles of relevant agencies, the movement of the project implementation period is as follows.

The division of roles among the relevant agencies for some measures to reduce pollutants emitted from automobiles, which was approved by Decision No. 19/03 of NCEPR on 24 January 2019.

Second is that a working group was set to perform implementation of sampling of Particulate Matter (PM) in the ambient air Quality of Ulaanbaatar and defined its role by NAMEM Director General Order A/199 on 19 November 2021.

The roles of DAAEP, NAMEM, and IRIMHE have not been defined in developing emission inventories, implementing simulation models, and assessing air pollution control measures. It is important that these organizations continue the tasks in their official business. Therefore, the Japanese side proposed to settle “Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models”, and assessing air pollution control measures at the 6th JCC in December 2021, and “Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models” which was signed by DAAEP, NAMEM, and NUM on 11 April 2023.

From the above, there are four cases, and the Objectively Verifiable Indicator 6-3 "Three agreements on the division of roles of each relevant organization will be concluded for air pollution countermeasures related to this project." has already been achieved.

4-2-6-4 Objectively Verifiable Indicator 6-4

Based on the experience of pilot projects, the operational guideline was elaborated in June 2024. The Mongolian side distributed the completed operational guideline to relevant agencies. As a result,

Objectively Verifiable Indicator 6-4 "The operational guideline is distributed to relevant agencies." was achieved.

5 Output through the Project Phase 1 to 3, and Its Collateral Effect

5-1 Emission Measurement from Stationary Sources

Before the Project Phase 1, flue gas of most of the stationary sources had not been checked officially with emission standards because Mongolian public sectors had no way to compare them with emission standards. In order to solve this issue, necessary equipment was provided to DAAEP and human resources were developed with standard measurement method.

As collateral effects, DAAEP recognized need to conduct on their own fuel combustion tests during Phase 2 and constructed a fuel combustion laboratory with the provided equipment. DAAEP considered obtaining ISO 17025 accreditation, which is able to guarantee measurement accuracy. DAAEP received laboratory accreditation of the flue gas measurement at stationary sources on 28 April 2022.

DAAEP became the only one organization in Mongolia that is capable of performing flue gas measurement including Dust measurement from HOBs and thermal power plants, which is recognized widely in Mongolia. DAAEP was requested to measure boiler flue gas not only from UB City but also from Selenge Province, Dundgovi Province, Erdenet City, and Darkhan City, and DAAEP performed it in those locations.

Since DAAEP is the only organization capable of performing the flue gas measurement when household fuels for stove are burned, after 2021, there are more and more requests for DAAEP to measure solid fuels at the fuel combustion laboratory. DAAEP performed 70 combustion tests of improved fuel and middling by request of ME, UB City, TTT, and other manufacturers in 2022, and 66 tests of improved fuels and igniters by request of ME, NCEPR, and UB City Council, TTT, and other manufacturers in 2023.

5-2 Air Quality Monitoring

In 2009, DAAEP started operating and maintaining 4 AQMSs after providing and training by “Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH”, German Development Cooperation. In 2010, NAMEM/CLEM started operating and maintaining 6 AQMSs with a loan from France. In order to avoid duplication of international aids, JICA and UB City agreed on the first Project activities without providing or training on AQMS. However, the results of the Project Phase 1 revealed that the operation and maintenance of AQMSs, and use of AQMSs data were insufficient, they agreed on activities regarding AQMS in the Project Phase 2 and this Project, and then improved as follows;

- 1) Development and operation of air quality disclosure system: Air quality disclosure system <http://agaar.mn/> was developed in 2014 as a component of the Project Phase 2, by cooperation of NAMEM, CLEM, DAAEP, JET, etc., and a contract with an IT company AstVision LLC paid by Mongolia Government. Air quality display devices were installed

and operated at roadsides near AQMSs, and at the entrances of MET, NAMEM, UB City Hall, etc. This caused side effects as follows;

- (1) Switching to stable data connection: NAMEM/CLEM contracted WiMAX wireless service of ULUSNET brand for all the AQMSs inside ULUSNET service area. Analog telephone line was contracted, and dial-up modem was installed for Urgakh Naran AQMS, which was outside of ULUSNET service area. Dial-up connection of Urgakh Naran AQMS was often failed, which was not suitable for air quality disclosure system. It was solved by replacing the dial-up modem with mobile-data modem, and then setting up VPN network for NAMEM/CLEM AQMSs. Maintenance of this AQMS was improved because most of the station conditions became able to be checked remotely via VPN through mobile data connection. This methodology (VPN through mobile data connection) was applied to all the other AQMSs when ULUSNET service was stopped in 2017.
- (2) Regarding operation and maintenance of AQMSs by DAAEP, not only technical issues of analyzers and data transfer, but also of administrative issues were commonly found, such as payment delay for electricity and data communication bills, or short of consumable parts caused by procurement delay. Air quality display devices made managers and deputy Governors to check data from AQMSs easily, which triggered them to solve administrative issues quickly.
- 2) Quantitative understanding of air pollution in the Ger districts: It was estimated that air pollution in Ger districts would be more serious than that in apartment areas because pollutants are likely to accumulate more seriously under inversion layer condition in narrower valley. However, in 2009 and 2010, AQMSs were installed inside apartment areas, or on the borders between the Ger and the apartment areas, but not within the Ger districts. Two AQMSs were installed about 100 m apart on either side of 4-n Zam (“the west intersection”), which was not effective distribution to understand air pollution of the city. First, two AQMSs (Tolgoit and Amgalan) were opened in the Ger districts by relocation of the existing AQMSs. Later in 2016, Bayankhoshuu AQMS was installed within the Ger districts, by which it was proved that air pollution in the Ger districts is significantly higher than air pollution in the apartment area.
- 3) Collaboration among stakeholders: The expert of CLEM for AQMS has accumulated wide variety of know-hows, by operation and maintenance of AQMS by EANET trainings²⁴ and by utilizing experts of equipment suppliers. He solved various problems and gave trainings to his colleagues and potential colleagues. The current DAAEP staff for AQMS operation and maintenance started without any know-hows after 2020 because there was less than one-week training from the previous staff. In addition, he did not have any connection to experts of

²⁴ Acid Deposition Monitoring Network in East Asia (EANET). The expert of CLEM for operation and maintenance of AQMS is also responsible on the EANET analyzers in Mongolia, and trained well through EANET activities.

suppliers. Through this Project, he understood that he can solve problems with support of CLEM experts, suppliers, JET, etc.

5-3 Emission Inventory and Simulation Modeling

Before the Project Phase 1 began, emissions by source had not been calculated. The capacity building through the Project Phase 1 to this Project has improved the capacity to prepare emission inventories, and DAAEP has been able to calculate air pollutant emissions almost every year since 2014 and elaborate annual emission inventory reports. The emission inventories have been used as input data for 72-hour air pollution forecast model constructed by IRIMHE as well as for dispersion simulation model in this Project.

In addition, an emission inventory manual was elaborated under the Integrated Programme for Better Air Quality in Asia (IBAQA Programme) by Clean Air Asia (CAA), which was implemented in Mongolia for three years from 2016 to 2018. The Emission Inventory Manual, which is currently being used by the provinces in Mongolia, uses the emission calculation methodology from the activities in the Project Phases 1 and 2. For emission factors for coal combustion sources, the manual includes values from the Project Phase 2 report, which reflect actual emissions in Mongolia.

NAMEM has published the Emission Inventory Manual as the official manual for Mongolia. Currently, emissions from HOBs and other sources in provinces other than UB City are calculated. In the future, NAMEM intends to make it possible to calculate emissions from small stoves for household in each province.

Since the results of dispersion simulation in the Project Phases 1 and 2 revealed that the main source of PM₁₀ and PM_{2.5} in winter was from small stoves for household in Ger districts, JET had proposed to the Mongolian side to introduce improved fuel as main air pollution control measure in winter. As a result, the Mongolian Cabinet Decision No. 98 National Program for Reduction of Air and Environmental Pollution on 20 March 2017 included the supply of improved fuel that meets standards to Ger districts, and the Mongolian Cabinet Decision No. 62 on 28 February 2018 banned the use of raw coal after 15 May 2019.

6 Trends in Law, Regulation and Activity by Other Donors

6-1 Relevant Laws and Regulations in Mongolia

Mongolia's legal system consists of the Constitution of Mongolia, and under the Constitution, the Law on the Protection of the Natural Environment (Law on the Protection of the Natural Environment) is the top law in the field of the natural environment. Based on the Natural Environment Conservation Law, laws and regulations related to soil, natural resources, water sources, plants, atmosphere, etc. have been established in the same row. There are laws and regulations related to the atmosphere, such as the Air Law and the Air Payment Law. Air Law stipulates rules related to air quality monitoring, air pollution countermeasures, air quality standards, air quality improvement areas, etc., and it is a law that is the foundation of air administration. The Air Payment Law stipulates the amount to be paid according to CO₂ emissions by source category, and is a law with a position of carbon tax.

The revision of the Air Quality Payment Law during the Project period is limited to minor changes such as the change of the organization name, but the revision of the Air Quality Improvement Area, Improved Fuel, Fund, etc. of the Air Law was implemented as follows.

Letter No. A/2958 by Minister of ME dated 25 August 2021 informed that improved fuel to the Ger households in Nalaikh district is not to be supplied due to lack of insufficiently technical conditions for fully equipped eastern plant, supply of improved fuel for the 2021-2022 heating season is difficult. Draft of "Air Quality Improvement Area Enforcement Regulation" was prepared, and revised order as Letter No. 01/3541 dated 6 September 2021 was submitted to MET. The Air Quality Improvement Area Enforcement Regulations for 2021 (Revised) was approved as Joint Order No. A/322-A/780 of MET and Tourism and the UB Mayor, dated 13 October 2021.

Air Quality Improvement Areas Enforcement Regulations for 2022 (Revised) was approved as Joint Order No. A/424-A/1353 of the Minister of Environment and Tourism and the Mayor of UB on 17 October 2022. With this revision, Nalaikh District was added to the Air Quality Improvement Areas and prohibition area for the use of all solid fuels was increased from 57 to 73 Khorroos. Every year, excluding 2023, the Air Quality Improvement Areas Enforcement Regulation was revised, and the number of areas where the use of raw coal is prohibited in UB City is expanding each year.

Draft on the quality standard regulation for improved fuel was prepared, and the technical demand for Improved Solid Fuels was approved by No. C/16 as of 14 May 2019 of Minister of Mongolian Agency for Standardization and Metrology. The Standard became valid from 15 May 2019. Quality standards of improved fuel for households has been revised in MNS 5679-2022, dated 17 October 2022. The Standard became valid from 18 October 2022.

The Air Pollution Control Fund was abolished by Decision No. 87 "On Measures for Government Special Fund" dated February 27, 2019 of the Government. Subsequently, amendment to the Law on Government Special Fund was approved on 13 November 2019. The amendment also removed the Air Pollution Control Fund from Article 29 "Air Pollution Charge" of the Law of Air. In addition, the amendment to the same law states that the Environment and Climate Fund will be in charge of

financial support for air and environmental pollution reduction measures in the future, however it is not yet functional. As in recent years, there is no consolidation of air pollution charge into the Environment and Climate Fund, which is managed directly by a Work Package of the Minister of ME. The Mongolian Government decided to amend the Air Law dated 22 April 2022 by adding a stipulation in Article 16.1.6 to provide retail and sale of the highest grade fuel of Mongolian National Standards (hereinafter referred to as “MNS”) and to prohibit the retail and sale, etc. of lower grade fuel in Air Quality Improvement Area of UB City. As a result of the amendment, this introduction of low-sulfur fuel (Euro 5 fuel) was approved as the full-scale project.

6-2 Other Donors Activities

(1). **World Bank**

The Ulaanbaatar Sustainable Urban Transport Project (UBSUTP) began in February 2022 and UBSUTP will be completed by the end of 2026 (website is <https://projects.worldbank.org/en/projects-operations/project-detail/P174007>). The aim of UBSUTP is to develop a comprehensive framework for sustainable urban mobility in UB, by introducing traffic control systems in UB, to alleviate congestion in traffic corridors, improve traffic safety, and address climate change. The total budget for the project is 100 million USD, and the FS survey was completed in 2022, and full-scale project implementation has been underway since 2023. Since the traffic control system introduction project is highly related to the signal control pilot project of this project, we will promote the effect by exchanging information with the World Bank project stakeholders.

(2). **UBCAP**

1) **Phase 1**

As part of UBCAP (Ulaanbaatar Clean Air Project) Phase 1, the World Bank implemented activities to improve energy efficiency, reduce insulation losses, and introduce new energy-saving technologies from 2012 to June 2019. Under the UBCAP, 12 kindergartens in UB city were insulated, and 1,500 heating systems were installed in 131 kindergartens, 17 schools, and 7 health centers. To improve the insulation performance of houses in the Ger area, an "Insulation campaign" was conducted and 474 households participated.

In addition, the following two standards were developed.

Standards for Energy Storage Technology (ETS) products for households to store electricity at night and use it during the daytime, as electricity is cheaper at night in Mongolia.

Development of creation of standards for the minimum required units (area, building, electricity, water and sewage) in the Ger areas.

2) Phase 2

UBCAP has been implementing Phase 2 from 2019 to 2021. 12 million USD scale loan project with ME and UB City as C/P. The size of the loan is 6 million USD for ME and 6 million USD for UB City, totaling 12 million USD.

The Phase 2 continues the activities of the Phase 1 and aims to provide comprehensive solution for heating and insulation by combining “Insulation Campaign” and “Nighttime Electric Storage Heater” programs.

Electric thermal storage (ETS) will be installed in 500-800 Gers. In addition, 50 Khorroos were selected from three districts, four ETS service centers and the construction of coal-free heat, water, and electricity pipelines for the facilities will be installed in the 50 Khorroos.

Indoor environmental measurement equipment will be provided to National Inspection Agency to examine whether indoor environmental standards are being met.

Following activities have been conducting in 2021.

I. "Comprehensive heating and insulation solutions" program

Night storage electric heater

Night storage electric heaters are more efficiency of energy and economical than conventional heaters. The heaters consume electricity from 9 PM. to 6 AM and houses keep warm throughout the day by stocking heat. Electricity at night discounts during the winter when night storage electric heaters are used. These heaters are manufactured by the German company, Steibl Eltron, and they can be used for 30 years. Individuals who participate in the comprehensive heating and insulation program can pay for the night storage electric heaters in installments of 66,000 MNT per month for 30 months without interest.

Insulation Campaign - 5

Households that are eligible for the comprehensive heating and insulation program have the right to insulate their homes completely. Completed insulation houses can reduce heat loss by 50% and save energy. The households can select materials provided by insulation suppliers in cooperation with the comprehensive program. The heat loss of all eligible households can be measured free of charge using the latest equipment. The eligible households can accept 70 percent subsidy from UBCAP for the cost of household.

II. Public awareness of air quality concentration of three AQMSs set up by NAMEM

The cost of the work to connect the measurement data from these AQMSs set up by NCPER to online air monitoring information system (<http://www.agaar.mn>) is funded by UBCAP.

(3). ADB

ADB commented that the ADB considers automotive measures as a very important area and would like to cooperate with the ADB in January 2020 on automotive measures such as emission control, fuel regulation such as EURO IV and V, traffic signal control system, RSD, DPF, etc. She commented that they would like to cooperate on these issues.

JET expert is also working with ADB on the results of combustion tests of the Meddling briquette, participating in an ADB project for improved fuel in 2018.

The full amount of PBL Phase 2 is 160 million USD, with 100 million USD already disbursed as the 1st tranche when the loan was approved in December 2019. The report confirming the status of policy implementation and achievement was prepared in November 2020, and the remaining 60 million USD was disbursed as the 2nd tranche on 14 December 2020

ADB is implementing the Ulaanbaatar Air Quality Improvement Program Phase 2 as Technical Assistance (TA) starting in 2019 in line with the PBL Phase 2 financing. TA in 2021 has five activities: (i) Implementation of Community Engagement Program, (ii) Edge system adaptation for Mongolia's needs for new energy-efficient public and private buildings, (iii) Improved air pollution modeling capacity, (iv) Provide support and consultation to the Ulaanbaatar Development Plan 2040 for the cabinet endorsement to improve climate resilience, green construction, and energy efficiency, and (v) conduct study to introduce new affordable nighttime heating tariffs for low-income Ger households to curtail their continued reliance on budget subsidies, and provide recommendations.

(4). UNICEF, SDC

Under the budget of SDC, UNICEF has been implementing 1) Measures for indoor pollution in kindergartens, 2) Monitoring, and 3) Online system. UNICEF has installed double-windowed in one kindergarten in a low-income area. National data is analyzed to assess energy efficiency. UNICEF measure the indoor environment with an analyzer and define exposure as evidence for policy.

As UNICEF has completed the above project activities, it is considering additional activities using the remaining budget.

(5). UNDP

UNDP implemented forecast traffic demand by using Visium demand forecasting system. The training was conducted for five days in February 2018 by PTV Group, certified by the German manufacturer. The target group consisted of two to three people from the traffic control center, one person from the university, and one person from the Mayor's Office. The training includes helping them calculate the traffic flow and other factors when the road is closed.

(6). German Federal Ministry for the Environment

Cooperation from the German government to NAMEM had been implemented. The cooperation includes training in air quality measurement, emission inventory and air dispersion simulation. The cooperation period was from the end of 2016 to October 2019, and the summary seminar was held in October 2019.

(7). Donor Stakeholder Meeting (Reference)

1) First Stakeholder Meeting

JICA Mongolian Office organized a first stakeholder meeting on December 11, 2018, with participants of donors such as ADB, GIS, and SDC. JET explained the Project outline and the participating donors had active discussion on air pollution controls. Activity schedule of donors whom participated in the meeting are shown in Table 6-2-1 and Figure 6-2-1.

Table 6-2-1 Agenda for First Donor Stakeholder Meeting

15:00 - 15:30	Registration and welcome coffee
15:30 – 15:45	Opening Remarks: Ms. B. Tsatsral, Head of Air Pollution Reducing Department, UB City Mr. Mutsumi Sato, Chief Representative of JICA Mongolia Office
15:45 – 15:55	Self-Introduction of the Participants
15:55 – 16:10	Presentation on Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3 Mr. Toru Tabata, Team Leader, JICA Expert Team
16:10 – 16:50	Discussion
16:50 – 17:00	Closing Remarks: Mr. Taizo Yamada, Senior Advisor (Environmental Management), JICA HQ
17:00	Refreshments

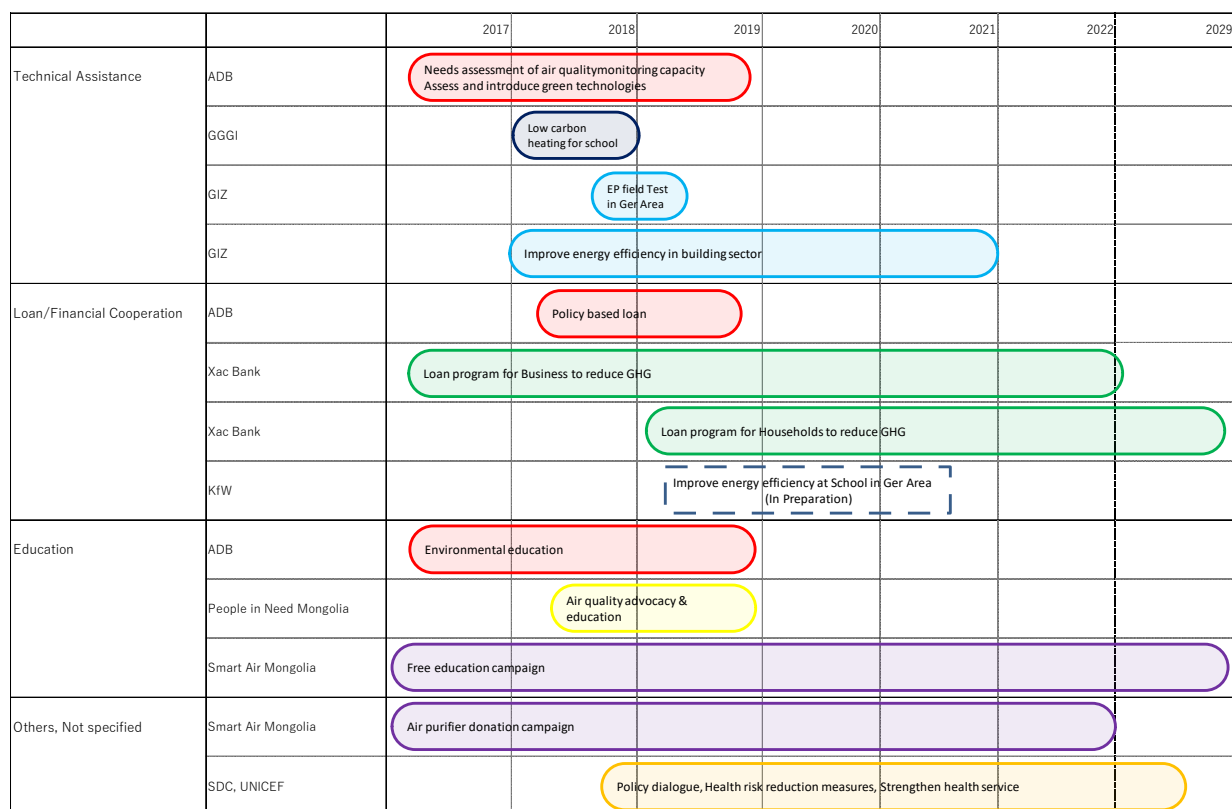


Figure 6-2-1 Activity Schedule by Donors

2) Second Donor Stakeholder Meeting

Second Donor Stakeholder Meeting was held on December 6, 2019, hosted by JICA Mongolia Office and attended by donors from ADB, GIZ, SDC and others. Agenda for Second Donor Stakeholder Meeting is shown in Table 6-2-2.

Table 6-2-2 Agenda for Second Donor Stakeholder Meeting

14:00 – 14:30	Registration and Welcome Coffee
14:30 – 14:40	Opening Remarks:
	D. Munkhjargal, Project Leader of Air Pollution, UB City
	Eriko Tamura, Chief Representative, JICA Mongolia Office
14:40 – 14:55	Overall Progress of “Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3”
	Toru Tabata, Team Leader of JICA Expert Team
14:55 – 15:05	Progress of Pilot Project of Automobile Emission
	Toru Tabata, Team Leader of JICA Expert Team

15:05 – 15:15	Progress of Pilot Project of Improved Fuel Hajime Endo, JICA Expert
15:15 – 15:30	Q&A, Discussion
15:30 – 15:50	Update of relevant activities by the development partners
15:50 – 16:00	Wrap-up Comment: Taizo Yamada, Senior Advisor (Environmental Management), JICA HQ

(8). UNICEF-sponsored donor seminar (Reference)

“HUMAN RIGHTS TO SAFE AND HEALTHY ENVIRONMENT: Air pollution, scientific evidences and solutions Science and technology conference” organized by UNICEF, MET and NUM and co-sponsored by SDC, UNDP and JICA was held on 7 February 2023. Donors from the World Bank, ADB, JICA, and other donors, NUM, and project stakeholders reported on the progress of air pollution control projects and had discussions.

Table 6-2-3 UNICEF-sponsored Donor Seminar

8:30 – 9:00	Registration and Welcome Coffee
9:00 – 9:30	Opening - Mr. B. Bat-Erdene, Minister of Environment and Tourism - Mr. Benoît MEYER-BISCH, Deputy Head of SDC - Prof. Dr. D. Badarch, President of National University of Mongolia - Mr. Evariste Kouassi Komlan, Representative of UNICEF Mongolia - Mr. Tanaka Shinichi, Chief Representative, JICA Mongolia
9:30 – 11:00	Session 1: Air pollution sources, AQ monitoring Presentation: 5 (Each presentation -10-15 min, total 60 min) Summary of poster presentation by the moderator (10 min) Q & A, conclusion (20 min)
11:20 – 13:00	Session 2: Social, economic and health impacts of air pollution Presentation: 4 (Each presentation 15 min, total 60 min) Panel discussion: (20 min) Q&A, conclusion (20 min)
14:00 – 16:00	Session 3: Engineering and technology solutions

16:00 – 16:40	Session 4: Results' discussion
16:40 – 17:00	Conference closing

(9). Cooperation with Ministry of the Environment, JAPAN (Reference)

Survey of co-benefit environmental pollution control measures by Ministry of the Environment, Japan, which was conducted from FY 2014 to FY 2018, the evaluation method of co-benefit effects was studied using the equipment provided Project Phase 1 and 2, the survey quantified and verified, and the capacity of HOB operators in operation and maintenance management techniques.

The study from FY 2019 to FY 2020, examination of evaluation method of co-benefits effects, quantitative verification and capacity building related on HOB operators' operation and maintenance management technologies were conducted. Discussions and coordination with relevant agencies for JCM project registration were conducted and applications were submitted. The FY2021 survey, the project is focusing on the cooperative support for gas-fired HOB (promotion of demonstration model projects, implementation of co-benefits assessment, promotion of registration for JCM projects, dissemination and expansion of the technology, survey on local policies and trends, etc.) and efforts to contribute to capacity building for local government officials, etc.

(10). Clean Air Asia (CAA) (Reference)

The CAA's Integrated Programme for Better Air Quality in Asia (IBAQ Programme) was launched in 2014 and Mongolia was selected as one of the target countries. At the request of the Ministry MET in 2015, development of whole Mongolia emission inventory was included in the program.

The implementation period of this program in Mongolia is a three-year activity from FY 2016 to FY 2018. The objective was to develop an emission inventory manual that could be applied throughout Mongolia and to provide training on the manual, which would lead to capacity building for Mongolians.

The CAA contracted with Asia Center for Air Pollution Research (ACAP), Japan Environmental Sanitation Center, and ACAP recommissioned Suuri-Keikaku Co. Ltd. to prepare the emission inventory manual for Mongolia.

On 12 March 2019, the final seminar on the emission inventory manual of Mongolia was held at the MET. The seminary was attended by approximately 20 participants from NAMEM, IRIMHE, DAAEP, UB Municipal Audit Office, etc. Mr. Nakata provided overview of the emission inventory manual. In the emission inventory manual, the calculation method from the activities in the Project Phase 1 and 2 Project are applied to the entire country of Mongolia. The emission factor for coal combustion is based on the value in the Project Phase 2 report, which reflects the actual emission situation in Mongolia.

In the future, the MET intends to use this emission inventory manual to monitor the emission levels regularly in each prefecture after legal development.

(11). Korea

Korea will provide a soft loan of USD 14 million to CLEM, and JET has assisted CLEM in preparing a list of equipment needed for PM component analysis. As of October 2020, the preparatory study by Korea was scheduled to be conducted until April 2020, however, has been suspended due to COVID-19. The soft loan was resumed and Korean side submitted the detailed report to the Mongolian. Korean side is now expected to bid on the design of the new laboratory building for CLEM.

KOICA plans to provide AQMS equipment and monitoring systems for grant aid. MET, the host institution for AQMS, plans to provide 7 to 10 AQMSs throughout Mongolia, except in UB City. The project period is from 2023 through 2027, and the budget is 8,846,100 USD. Since the project is grant aid, the AQMS equipment is expected to be made in Korea.

6-3 Collaboration with JICA Project

6-3-1 JICA Verification Survey with the Private Sector for Disseminating Japanese Technologies
JICA implemented the "Dissemination and Demonstration Project on Black Smoke Reduction Plan by DPF for Diesel Route Buses" from November 2017 to September 2019. In the dissemination and demonstration project, DPFs were installed in 24 route buses, and the technology to reduce the burden on bus operating companies, legal systems and preferential measures, and business schemes were examined in order to promote the use of DPFs in Mongolia.

Since the DPFs installed in 24 buses are expected to be scrapped, the Municipal Public Transport Bureau will transfer the DPFs to other buses in this project with the support of Japanese experts.

6-3-2 JICA Training Course in Japan

Two participants from IRIMHE developed action plans during "Capacity Building for Air Quality Management" (21 August 21 – 18 September 2019). Specialist Yamada, who was in charge of providing operational guidance for the Project, guided the preparation of the Action Plan, thereby creating synergy with the Project.

The FY2020 Subject-Specific Training "Capacity Building for Air Quality Management" was scheduled to be conducted online from 25 January to 5 February 2021, and in Japan from 4 to 26 October 2021, however, due to COVID-19, the Japan training in October 2021 was cancelled and the training in 2022 will also be conducted online from the end of January to mid-February 2022. However, due to COVID-19, the training in Japan in October 2021 was cancelled and will be conducted online again from the end of January to mid-February 2022. One participant from DAAEP, participated in the online training in January 2022.

The FY2022 Subject-Specific Training, "Capacity Building for Air Quality Management," was conducted from 8 March to 6 April 2023. Two project members served as instructors, however, no one from Mongolia participated in the training.

The FY2023 Subject-Specific Training, "Capacity Building for Air Quality Management," was conducted from 24 January to 22 February 2024. Two project members served as instructors, however, no one from Mongolia participated in the training.

7 Issues, Improvements and Lessons on Project Implementation and Management

7-1 Output 1: Main issues

7-1-1 Issues

During five-year duration of the project, from November 2019 when the Project began to October 2023, the JCC chairpersons changed six times and the JCC vice-chairpersons changed eight times. Therefore, a challenge was how to share the project's overview, progress and results to the JCC chairpersons and JCC vice chairpersons.

7-1-2 Improvements

As for the JCC Chairperson, DAAEP, C/P, briefed the JCC Chairperson on the Project, and JET requested a meeting with Deputy Governor to explain the progress and challenges of the project. As for the JCC vice chairperson, the Project kept abreast of the vice chairperson's arrival and prepared presentation of outline of the project and explained immediately to fledgling JCC vice-chairperson outline, progress, and plans of the project and gave the vice chairperson a progress report so that he would understand the project and the project management would be as smooth as possible.

7-1-3 Lessons

The Japanese and the Mongolian sides have explained the project to the JCC Chairpersons and JCC Vice-Chairpersons, however, it is not easy for them to understand the project due to wide range of the project activities. Again, it was necessary for both the Mongolian and Japanese sides to try to increase opportunities to explain the progress and results to the JCC chairperson and JCC vice chairperson.

7-2 Output 1: Maintenance of Air Quality Monitoring Stations

7-2-1 Issues

As reported in 3-2-4-2, air quality analyzers of DAAEP AQMS often showed abnormal values, malfunctioned and stopped. For each issue, it was necessary to diagnose problems, to make necessary plans such as maintenance, part replacements, repairs, overhauls or renewal, to explain the plan to managers, to obtain authorization on the plan with authorization on budget and/or work hours, and then to execute the plan. It was necessary to maintain analyzers periodically to prevent failures. However, there was only one position in charge, and education from previous person to new person was always less than one week, which made difficult to develop or to maintain the capacity of DAAEP's expert. In 2012 before JICA started capacity development for AQMS as an activity of the Project Phase 2, air quality monitoring was often suspended even by electricity supply suspension due to unpaid electricity bills.

7-2-2 Improvements

In the field of technical capacity development, JET supported DAAEP to be able to continue operation and maintenance even after this Project, by enhancing cooperation with CLEM, the suppliers and the local distributors. As a result, DAAEP increased chances to solve issues without JET.

In the field of knowhow enhancing for AQMS operation and maintenance, shared email address and mailing list was started to be used, and manuals and references were started to be stored in cloud storage. New person in charge will be able to search know-hows in email and cloud storage archives.

By developing and maintaining a public relations system for air quality through smartphone applications and websites, it was promoted to use air quality information by citizens, NGOs, and media. Air quality displays were installed and operated at the entrance halls of MET, NAMEM and UB City Hall. It made department heads, city managers and accounting departments quicker on official procedures such as electricity bill payment, reduced work loads of air quality monitoring experts on official procedure, and increased hours for technical works.

7-2-3 Lessons

Equipment installation, renewal, and trainings on daily operation are often handled by the suppliers and/or projects. However, operation and maintenance issues commonly increase after the installation inspection and/or project completion. It was commonly found for any equipment for which communication between the users and the supplier on technical issues was not well developed. In any organization of top-down relationships, even if electricity supply is suspended or analyzer issues is found, work load will be high even for getting approval for bill payment or for visiting AQMS, by which malfunctioning analyzers and measurement suspension continue and increase. In order to enhance the capacity in operation and maintenance, and to continue operation and maintenance well at the time of any projects end, it is necessary to develop operation and maintenance plan utilizing resources of local experts, distributors and suppliers.

In order to develop an environment in which official procedures will be smooth for AQMSs, it is important to develop and operate a system that shares air quality on-time, and to promote the system to be monitored by citizens, NGOs and media.

7-3 Output 2: Capacity development on making Emission inventory and Analyzing Air Pollution Structure

7-3-1 Issues

Since the Project Phase 1, whenever the person in charge of updating emission inventory or executing simulation changed, there was almost no handover of tasks. In order to avoid difficulties in handing over the tasks, a manual for updating emission inventory was created in the Project Phase 2 and training on the updating operation was conducted several times in all the Phases. From now, smooth

capacity transfer to relevant organizations and newly assigned persons will be key to update emission inventory smoothly.

DAAEP, NAMEM (IRIMHE), and NUM signed “Joint Implementation Agreement on the Evaluation of Air Pollution Measures using Simulation Models” in April 2023. NAMEM does not assign any expert with the capacity to execute simulation model and thus is not able to transfer the knowledge of the execution method to NUM.

In updating emission inventory by DAAEP, the data provided from persons in charge of each district had many lacks and errors and cleaning of the data was time consuming. In Mongolia, National Source Registration Database System was developed and information about individual sources has been entered in the same format from smartphones and stored in the database. However, problems such as the inability to access to the system have been reducing the accuracy of the collected data.

7-3-2 Improvements

As mentioned above, a manual for updating emission inventory has been developed in the Project Phase 2. JET requested newly assigned personnel to read the manual carefully and put it into practice, and if there were any questions, JET answered questions and provided lecture. As a result, the person in charge of DAAEP has grown to a level to update the emission inventory almost by oneself.

At the 8th JCC, since the Mongolian side did not have the capacity to execute CALPUFF model, MET and NAMEM requested JET to execute the simulation model during this Project and the request was agreed with a condition that capacity development will be followed after model execution. The results of simulation and its method of use including procedures were shared at seminars, and JET supported to improve capabilities of the Mongolian side.

Regarding the issues related to the National Source Registration Database System, DAAEP and NAMEM requested the system developer to improve the system through NCEPR. The system developer responded to coop with the request if DAAEP and NAMEM submit a summary of their requests. NAMEM submitted a summarized request, and some functions, such as improved access, was updated thus NAMEM can operate the system. On the other hand, other issues still remain, such as the fact that the system does not include the ability to automatically calculate emissions.

7-3-3 Lessons

After identifying the strength of the relevant agencies and assigning activities according to their responsibilities and capabilities, an agreement was elaborated and contracted as described above. In the future, it will be the responsibility of each agency to secure the budget and human resources in accordance with the agreement. In addition, it is expected that capacity development among the organizations to achieve their goals will not only facilitate activities, but will also contribute to the capacity development within organizations.

The simulation conducted by JET during this Project is temporary. After this Project, based on “The letter of agreement on the role of emission inventory, simulation, and evaluation of air pollution control measure” contracted in April 2024, it is necessary for NAMEM with IRIMHE and NUM to

find air pollution structure by conducting simulation model and be able to quantitatively evaluate the effect on air pollution control measures. Alternatively, it is assumed that a cooperative scheme with Japanese experts will be established for executing simulation model and analyzing the results.

JET believe that the improvement of the system that lead by request of the Mongolian side for system improvement was a big step forward. It is expected that continuous requests for remaining issues will lead to further improvement of the system, and lead to efficient emission calculation.

7-4 Improved fuel

7-4-1 Issues

As described in 1-3-1 above, since 15 May 2019, use of raw coal by citizens and companies excluding special permitted companies, electric and thermal energy production was banned in UB City, and UB City had set up 2 checkpoint at entrance of UB City to inspect raw coal and improved fuel. Accordingly, permits were required to bring coal, middling, and improved fuel into and out of UB City, and coal from various regions could no longer be procured or transported. In addition, binder, the raw material for improved fuel, is not manufactured in Mongolia and is not sold in the market, thus it was not easily available for purchase.

7-4-2 Improvements

Regarding manufacture of the BCB, DAAEP and JET consulted with TTT, however, the Project had no choice to use only the middling and binder used by TTT as a national policy, thus, the BCB has was manufactured using them as raw materials. The BCB was better environmental performance than TTT's improved fuel.

In order to implement the verification study of the pilot project, it was necessary to transport the BCB from UB City to a campsite as the study site. Since a permit was required to remove coal and improved fuel from UB City, and permits were taking time, DAAEP and JET consulted with IACC and applied for a permit to remove the BCB in advance and transported it. Similarly, to transport TTT's improved fuel from UB City was required a transport permit, so the Project decided to bring the fuel directly from TTT's improved fuel manufacturing plant in Tuv Province to the campsite.

7-4-3 Lessons

Originally, it would have been possible to manufacture an improved fuel with better environmental performance than the manufactured BCB this time by using a raw material with the same calorific value and ash content as TTT's middling and low sulfur content that can supply 650,000 tons annually. However, the BCB was manufactured under the restrictions of the national policy that required the use of middling and the permission to deliver raw coal to UB City. Since the national policy bans the use of raw coal and the production and sale of improved fuel by only one company, TTT, it was difficult to manufacture improved fuel that differs significantly from the improved fuel manufactured by the national policy.

7-5 Equipment

7-5-1 Issues

The equipment of Japanese manufacturers for flue gas measurement at stationary sources was mainly provided in the Project Phase 1 and 2. In the Project Phase 2, an equipment flue gas measurement failed, and project budget was used to repair it, and the Mongolian side was trained on procedures for repair from a viewpoint of sustainability. In this project, C/Ps needed to purchase new equipment or repair equipment because it had been more than 10 years since it was provided and the equipment had become aging. However, the challenge was that there were no distributors, so it was impossible to purchase or request repairs.

In other fields as well, in Mongolia, all equipment and consumables for environmental measurements and flue gas measurements at stationary sources are imported, and the market size is small, and there is almost no demand, so prices are high and procurement is taking a long time. In addition, all standard gases used to calibrate equipment to ensure the accuracy of these measurements were also imported, which could not be easily procured because a gas license is required to import in Mongolia.

7-5-2 Improvements

In order to purchase new equipment as much as possible in Mongolia from a viewpoint of sustainability, JET confirmed with Japanese manufacturers where they would like to purchase equipment from Mongolia, and provided C/Ps with countries where they could purchase and contact information. As a result, DAAEP contacted the suppliers themselves, and the purchases have been made continuously.

When a same equipment was repaired in 2019, JET served as an intermediary between DAAEP and the Japanese manufacturer and provided a variety of assistance. When the same equipment was repaired in 2021, DAAEP was able to request the Japanese manufacturer to repair the equipment on their own, however, there was no handover between the persons in charge and JET provided assistance with the transportation.

For consumables needed for activities, procurement periods and prices were compared locally and in Japan, and low cost and less taking a time items were considered and promptly purchased. When shipping from Japan, invoice and packing lists were prepared to ensure smooth customs clearance.

Regarding standard gases, various Mongolian organizations asked JET to provide information on where to purchase them. For DAAEP, which is able to purchase materials and equipment directly from foreign countries, JET provided information on distributors in China whose accuracy of standard gases is guaranteed. For other agencies that had to purchase through domestic trading companies, JET were introduced to trading companies through another agency to assisted in procurement of those agencies.

7-5-3 Lessons

Although equipment to be used should be purchased and repaired in Mongolia whenever possible, JET realized once again that Mongolian market is too small to procure and repair equipment in Mongolia. In addition, C/Ps did not purchase equipment on their own and have little knowledge and experience, thus, JET was newly aware of the need to make a list of not only domestic distributors but also foreign suppliers.

In Mongolia, where there are few distributors of foreign manufacturers, it is necessary to contact foreign countries to request equipment repairs, purchase of consumables, and so on. Although it is necessary to have staff with English language skills, DAAEP has limited staff with language skills, and JET explained to DAAEP that DAAEP needed a staff with English language skills, even if a temporary employee could be hired.

7-6 Response to travel restriction

7-6-1 Issues

The site survey was cancelled from March 2020 to September 2021 due to travel restrictions caused by COVID-19. In the meantime, there were significant constraints on the project activities, resulting in a lack of capacity development requiring on-site work and a postponement of the pilot project.

7-6-2 Improvements

The implementation period of this project was scheduled to be implemented for four and a half years from November 2018 to April 2023 based on the minutes (M/M) of the consultation of the first Joint Coordination Committee (the 1st JCC) on December 12, 2018. In response to the gap in the field survey due to COVID-19, the extension of the project period was discussed at the 4th Joint Coordination Committee (the 4th JCC) on February 22, 2021, and it was decided to postpone it to 5 years and 9 months from November 2018 to July 2024.

In addition to the above-mentioned project extension, many activities were hindered by the assumption that JETs would be dispatched to the site. To minimize these impacts, the JET held regular project management-level meetings with the Acting Secretary of the DAAEP from July 2020. In addition, JET held regular meetings with personnel in charge of improved fuel, automobile air pollution countermeasures, and inventory simulation, and provided technical guidance remotely in Japan. In addition, activities 1-4-10 related to the connection to the monitoring network of Dambadarjaa AQMS, which was added at the 5th JCC, were also implemented remotely, and the activities were completed in April 2022.

7-6-3 Lessons

The fact that we held regular meetings on project management, automobile air pollution, inventory, etc. remotely during the period when we could not travel to the site due to COVID-19 was very effective in proceeding the project as much as possible. The remote-controlled capacity development

has led to smooth local activities after the project resumes local activities, which has been a very effective response.

7-7 Flexible adjustment of the Project activities

7-7-1 Issues

An on-board emission measurement system provided to NAMEM in the Project Phase 2 is no longer using the equipment due to the absence of the person in charge, and this system was transferred to NRTC. In addition, a person in charge of data analysis technology for emission gas measurement using an on-board emission measurement system at DAAEP had been replaced, however, there was no handover of the technology within DAAEP. Therefore, a challenge is that measurement and data analysis technologies using on-board emission measurement system have not yet been established. At the 3rd JCC, the Mongolian side requested JET to provide trainings again DAAEP and NRTC regarding automobile emissions measurement and data analysis utilizing the on-board emission measurement system.

DAAEP had a problem of no transferring air quality monitoring data of Dambadarjaa AQMS, provided by Seoul Municipality of Korea, to online information system of AQMS. At the 4th JCC, the DAAEP requested the Japanese side to support transfer of the monitoring data of Dambadarjaa AQMS to the air quality monitoring network.

DPFs have been installed in 24 large buses under the project “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of PM from Diesel Buses by DPF”. The DPF equipment has been handed over to the relevant agencies of the UB city. The buses with DPFs will retire in December 2021. A challenge was that the plan to transfer the DPFs to another bus for use by then had not been implemented. At the 5th JCC, the Mongolian side requested Japanese side to provide technical support for the transfer of DPFs.

In order to understand the actual state of air pollution and to establish and evaluate air pollution control measures based on the results, involvement of various administrative agencies is required. However, it was difficult for C/Ps alone to coordinate closely with their respective administrative agencies.

7-7-2 Improvements

Although above 4 challenges were not included in the project activities, as described below, JET was flexible in responding to the Mongolian side's requests and implemented the activities.

Regarding on-board emission system, From the viewpoint of making effective utilize the provided system and to conduct measurement for the pilot project, Activity 1-3-3 “JICA Experts conduct training to NRTC, in addition to DAAEP, on automobile emission measurement using the on-board emission measurement system, and DAAEP and NRTC implement automobile emission measurement using the on-board emission measurement system.” was added at the 4th JCC, and JET provided refresher training to Mongolian agencies on emission measurement using it.

The Japanese side considered that it was important to release measured data at Dambadarjaa AQMS in Ger area to public, and Activity 1-4-10 “DAAEP with JICA Experts establishes data transfer system of air quality monitoring data of Dambadarjaa station to the online information system of AQMS.” was added at the 5th JCC. Since JET was unable to travel to Mongolia due to the global pandemic of COVID-19, JET coordinated with DAAEP to implement the project used a remote function from Japan. In addition, air quality monitoring data of Dambadarjaa AQMS was published in online information system of AQMS.

Activity 1-3-4“PTD with JET transfer the DPFs which were installed on 24 large buses by the project “Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of PM from Diesel Buses by DPF” to other buses.” was added at 6th JCC because the DPFs provided in other JICA projects will be effectively utilized and DPFs will greatly contribute to the reduction of PM emissions from automobiles. JET implemented technical support to PTD to transfer DPFs to other buses.

In order to work in closer cooperation with each relevant agency, since the Project Phase 1, the project designated agencies in charge of air pollution control as C/P, agencies involved in air pollution control in collaboration C/P was designated as C/P-WG, and a structure was established to have multiple agencies involved in the Project. By creating a forum for the exchange of opinions on both the Japanese and the Mongolian sides, the Project was able to strengthen cooperation among relevant agencies involved in Mongolia.

7-7-3 Lessons

JET responded to the Mongolian side's request with the recognition that the problems were ones that they could not solve themselves and that additional activities were needed. Activities was added because it would lead to air pollution control. This allowed JET to build good relationships with the relevant agencies and facilitate the activities.

JET believes that it is difficult for one agency to solve issues such as air pollution, and that collaboration among multiple agencies involved will bring closer to solving air pollution. However, it is assumed that there may be differences in ideas due to the circumstances of each relevant agency. Therefore, JET thinks that a forum for each organization to share their opinions at JCC and C/P-WG meetings well be created and that so, a direction for solving issues is able to be found.

8 Final Seminar

8-1 Overview

The program of the final seminar held on 18 April 2024 is shown in Table 8-2-1. The announcement materials are shown in Annex 8-1-1. At the final seminar, participants presented their efforts and results from the previous projects, and discussed future issues for air pollution countermeasures.

Summary of presentations are shown in 8-2.

8-2 Summary of Presentations

(1). Stationary Source Emission Measurement

DAAEP applied for ISO 17025 2017 laboratory accreditation for fixed source emission measurement and received laboratory accreditation in April 2022.

DAAEP measured 240 boilers between 2019 and 2023. In addition, regarding the measurement of combustion emissions in fuel combustion tests, 19 times were conducted with TTT's improved fuel in 2019, a total of 45 samples in 2021, a total of 70 samples in 2022, and a total of 66 samples in 2023.

(2). Air Quality Monitoring and Maintenance Status

The network of air quality monitoring and measurement stations has been improved, and the Mongolian system has been established to process air quality measurement data, process and report monitoring data, and assess air quality using air quality indicators (AQI). However, it is important to secure the necessary budget for the continuation and maintenance of stable monitoring. The mayor and decision-makers understand this, and daily maintenance and management is now possible, but time has passed since the renewal of the measuring station equipment (including the data transfer system) in 2014, and it is necessary to renew the equipment. In addition, it is necessary to procure models that are compatible with existing data transfer systems.

(3). PM Source Component Analysis by PM Apportionment Study

In the Project Phase 2, the PM component analysis was performed only in winter, so it was limited to the PM source contribution analysis only in winter, but in this Project, the PM component analysis was sampled for one year and the component analysis was conducted in Japan. Analysis over the course of the year revealed that the high concentrations in the winter are mainly condensed particles containing organic carbon and secondary particles such as Sulfate. On the other hand, it was confirmed that the contribution of soil particles was high in non-winter season. Through these analyses, it became possible to prioritize countermeasures.

(4). Emission Inventory

The emission inventory can be updated regularly. Issues include utilizing the source registration system necessary to update the emission inventory, improving the accuracy of the emission factors of the stove, analyzing the sulfur content used in the improved fuel, and continuing to work among personnel.

(5). Simulation Modeling

The concentration of PM₁₀ in the diffusion simulation conducted in the Project Phase 1 was underestimated compared to the concentration of the measuring station. In Phases 2 and 3, the estimation accuracy of PM₁₀ was improved by constructing a simulation model that takes into account the error in activity and emission factors, the effects of secondary particles, and condensable dust. Future issues include the transfer of technology between the persons in charge, cooperation between the implementing agencies and relevant organizations based on a joint implementation agreement, and the use of the technology to evaluate air pollution countermeasures.

(6). Automobile Countermeasures

Using a passenger car (gasoline vehicle) and a light-duty truck (diesel vehicle), the effect of using the additive on improving NOx and PM fuel consumption was verified using on-board emission measurement system. As a result, this Project could not confirm any significant improvement effect on NOx, PM (only for light-duty trucks) and fuel consumption for both passenger cars and light-duty trucks. It was very useful to confirm the effectiveness of various automobile measures by on-board emission measurement system.

In order to reduce air pollutants from automobiles, it is necessary to introduce low-sulfur fuel (Euro 5) and low-emission buses. Therefore, vehicles imported into Mongolia must comply with the latest emission regulations and continue to use Euro 5 fuel.

Toward the spread of eco-driving, a document was created that organized how to educate drivers and operation managers about eco-driving and how to operate it on a daily basis using operation management equipment (analysis and evaluation of driving → guidance and education → practice of eco-driving).

It is important to eliminate high-emission vehicles from UB City by introducing high-emission vehicle control regulations and establishing an inspection system using RSD and opacimeters based on the RSD threshold.

Regarding the operation of the traffic control system (signal control), utilizing the technology acquired through the training in Japan, the number of seconds for each time area of traffic lights at 17 intersections in the center of UB was revised. As a result of examining the changes in traffic

conditions before and after signal adjustment in terms of traffic volume, congestion length, travel time, and intervention in signal, a partial effect was seen as traffic volume increased and congestion length decreased due to signal adjustment. At present, there are too many cars running, so it is difficult to improve traffic conditions just by adjusting the traffic lights throughout UB, so it is necessary to take multiple measures such as changing the signal display, arranging lanes, improving roads, improving public transportation, adjusting traffic demand, and improving traffic manners.

(7). Air Pollution Counter Measures for Ger Stoves

From Medium- to long-term measures for Ger stoves include measures such as city gas by coal gasification, LPG and DME by coal liquefaction. Medium- to long-term measures are drastic measures against air pollution, but since it is difficult to start within a few years, it is necessary to take measures against air pollution through short-term measures until then. As a short-term measure, it is effective to promote improved fuels such as BCB. Since the production cost of BCB is 22% higher than that of TTT's fuel, in order to make BCB a full-scale business, it is necessary to reduce the production cost by reviewing the suppliers of desulfurizers, establishing biomass procurement methods, and improving efficiency.

(8). Evaluation of air pollution countermeasures and their effects

JET evaluated the PM and SO₂ reductions for the BAU scenario in 2027 for the pilot projects BCB, signal control, low sulfur fuel and low emission vehicles (all vehicles, buses only), eco-drive, DPF (bus only) and RSD. Measures to convert the modified fuel to BCB have reduced the annual average calculated concentration by 59% for SO₂ and 27% for PM₁₀ on average at the measuring stations. In the automotive pilot business, the effect of reducing the concentration of SO₂ was up to about 5%, and the effect of reducing the concentration of PM₁₀ was up to about 12%. This is due to the large proportion of the concentration from small stoves for home use to the overall concentration as a factor in the low reduction effect of automobile measures.

In the future, it will be important to propose the results of quantitative evaluation of the effectiveness of countermeasures by diffusion simulation to higher-level organizations and use them in the selection of measures against air pollution.

(9). Technical Review Guidelines for Measures against Air Pollution

The technical review guideline is scheduled to be completed at the end of June 2024. According to the guidelines, the project will be reviewed based on the results of the pilot project evaluation and implementation, and a pilot project with high effectiveness in air pollution control will be selected, with the aim of leading to a full-scale project. Regarding the implementation of air pollution countermeasures, the division of duties between the government and UB City has not yet been determined, but the air pollution countermeasures implementing organization will be transferred to

UB City. Since various organizations are involved in air pollution countermeasures, we will finalize the technical review guidelines with that in mind.

Table 8-2-1 Final Seminar Program

Date: April 18, 2024 (Thursday) 9:00-17:00 Location: Blue Sky Hotel 1. Opening remarks (9:30-9:45) Deputy Governor, Embassy of Japan in Mongolia, JICA Office in Mongolia Photography (9:45-9:55) 2. Project overview (9:55-10:15) DAAEP Secretary/Tabata Summary 3. Measurement of fixed source emissions (10:15-10:25) 3.1 Emission measurement at HOB, power plant and combustion test chamber Mr. Jargalbaatar (DAAEP) 4. Air quality monitoring (10:25-10:45) 4.1 Changes in air pollution (including improvement in monthly/annual reports) Mr. Unurbat (NAMEM) 4.2 Maintenance status of the DAAEP measurement station (including rehabilitation, new establishment, and maintenance) Mr. Adiyaochir (DAAEP) 5. Identifying the source of contamination (10:45-11:30) 5.1 PM Source Contribution Analysis Mr. Barkhasragchaa (CLEM) 5.2 Emission inventory Mr. Adiyaochir (DAAEP) 5.3 Diffusion simulation Ms. Amarzaya (NAMEM) Discussion on Themes 3-5: Moderator Director of DAAEP (11:30-12:00) Lunch (12:00-13:00) 6. Measures against air pollution in automobiles (13:00-14:45) 6.1 Use of an in-vehicle meter DAAEP 6.2 Introduction of low-sulfur fuel (Euro 5) Ministry of Mining and Heavy Industry 6.3 Introduction of low-emission buses Municipal Transportation Bureau 6.4 Promotion and awareness of eco-driving Section Chief, Traffic Policy Coordination Division, Ministry of Road Traffic Development 6.5 Introduction of RSD Section Chief, Traffic Policy Coordination Division, Ministry of Road Traffic Development 6.6 Operation of traffic control system (signal control) Head of Traffic Control Center Break (14:45-15:00) 7. Measures against air pollution in Ger stoves (15:00-15:20) 7.1 Regarding TTT's modified fuel and biomass blended briquette and semi-coke blended briquette Mr. Davaajargal (DAAEP) 8. Evaluation of measures against air pollution (15:20-16:00) 8.1 Evaluation of air pollution countermeasures based on the pilot project Mr. Nakata, JICA Expert 8.2 Technical review guidelines for measures against air pollution Summary of Tabata Discussion on Themes 6-8: Moderator Tabata summary (16:00-16:20) 9. Summary - Toward implementing future air pollution measures based on short-term, medium-term, and long-term perspectives (16:20-16:45) Mr. Tabata 10. Comprehensive summary of the project from the Project Phase 1 to Phase 3 (16:45-16:55) Mr. Taizo Yamada (former JICA specialist) 11. Closing Remarks (16:55-17:00) Secretary of DAAEP

9 For the future

9-1 Priority Measures Identified and Summarized by This Project

Based on the facts identified through this Project for Capacity Development for DAAEP and related organizations and, priority measures to solve air pollution in medium- to long-term are summarized in Table 9-1-1.

Table 9-1-1 Measures for Solving Air Pollution of Ulaanbaatar

1. Countermeasures for large scale and medium scale stationary source	(1) Power plant countermeasures ➤ Measures to increase supply capacity of power and hot water ➤ Inspection, and operation and maintenance of air pollutant concentrations of flue gas of existing thermal power plants ➤ Installation of full package of air pollution control measures for new heat and/or power plant ➤ Improving capacity and efficiency of electricity distribution (2) HOB counter measures ➤ Closing HOBs by connecting buildings to central hot water supply network ➤ Installation and maintenance of flue gas cleaning equipment such as cyclone or scrubber ➤ Building additional large-scale heat supply facility to closing HOBs
2. Countermeasures for small scale stationary source	(1) Further improvement of improved fuel for household ➤ Promote further improved fuel through the steps below ➤ Combustion test for any further improved fuel at least 3 times at DAAEP's fuel combustion test chamber in order to know representative data of any fuels ➤ Selecting improved fuel of which PM and SO₂ emission factors is lowest, and starting and continuing fire is not difficult in the stoves for household, among the tested fuels ➤ BCB tested by this Project is the best currently (2) Stoves for household ➤ Prohibiting sale and use of traditional type stoves that don't satisfy MNS 5216:2016 (3) Introduction of alternative fuel for household ➤ LPG and/or pipeline gas and/or ➤ Improvement of LPG distribution and/or installation of gas pipes in UB city, safety guidelines for gas, safety education for gas users ➤ Electrification
3. Countermeasures for automobile	Preventing air pollution caused by automobile emissions and preventing the spread of economic losses due to time loss in traffic jams ➤ Popularization of Euro 5 fuel and low emission vehicles ➤ Implementation of emission regulations using RSD ➤ Application of signal control for all the signals in UB city ➤ Measures through road improvement ➤ Improvement of road signs and lane division ➤ Optimization of road structure, review of road network ➤ New construction of next-generation transportation system ➤ Metro, Monorail, BRT, etc.

9-2 Activities through This Projects and Its Recommendation of Utilization by Mongolian Side from Now

Table 9-2-1 shows capacities developed by Phases 1 to 3 of this Project and its utilization that is recommended to be done by Mongolian side from now.

The efforts that will be necessary on the Mongolian side in the future. In the measurement of emissions from stationary and mobile sources and air quality monitoring, which are the main capacity development items, the proficiency of the Mongolian side is improved through capacity development, and the system is in place that can be implemented only in Mongolia. However, in order to maintain the measurement and maintenance system after the end of the project, it is necessary to secure a budget for renewal costs and other expenses and to develop sustainable human resources. In implementing air pollution countermeasures in the future, it is important to create a comprehensive air pollution countermeasures master plan that combines urban planning and air pollution countermeasures from a medium- to long-term perspective, and to secure a continuous budget to implement the plan.

Table 9-2-1 Activities through this Projects and its Recommendation of Utilization by Mongolian Side from Now

	Activities through this Projects	Recommendation of Utilization by Mongolian Side from Now
Capacities	➤ Measurement of air pollutants in stationary emission sources	➤ Maintenance of monitoring team ➤ Securing the cost of updating measuring equipment
	➤ Air Quality Monitoring ➤ Release of air quality information	➤ Maintaining the operation and maintenance team ➤ Securing maintenance costs and renewal costs of analytical equipment
	➤ Regular update of emission inventory	➤ Maintaining the emission inventory update team
Air pollution control measures	➤ Manufacture of improved fuel ➤ Combustion test of various modified fuels in combustion test chamber	➤ Further improvement of fuel ➤ Further cost reductions ➤ Securing procurement costs for improved fuel
	➤ Basic understanding of operational changes in signal control	➤ Change in signal control and operational changes to the entire UB city
	➤ Understanding of low-sulfur fuels and their necessity, as well as the vehicle specifications of low-emission vehicles and the necessity for their widespread use	➤ Further Promotion of Euro 5 fuel
	➤ Understanding eco-driving	➤ Activities to raise awareness among citizens and businesses using the equipment provided
	➤ Measures against high-emission vehicles by the pilot operation of RSD	➤ Procurement of RSD and development of legislation to regulate automobile emissions using the same equipment
		➤ Continuously securing a budget for air pollution control
		➤ Future development of city gas network

9-3 To Achieve the Overall Goal after this Project Completion

9-3-1 Prospects for Achieving the Overall Goal

Table 9-3-1 shows the overall goal of the Project and its indicators.

Table 9-3-1 Overall Goal of the Project and its Indicators

Overall goal of the Project	Emission reduction at major emission sources is enhanced towards air quality improvement in UB City.
Indicator 1	PM ₁₀ 43% and SO _x 65% of emissions from small stoves for household and automobile is reduced compared with the BAU baseline.
Indicator 2	The outputs of the Project will be reflected in the policies and strategies of the next "National Program to Reduce Air and Environmental Pollution" and related laws and regulations.

The Project is expected to contribute to strengthening measures to reduce air pollutants in UB city. In addition to the measures to reduce air pollution being implemented by the Mongolian side, measures utilizing the results of the Project can be expected to reduce pollutants emissions further.

Indicator 1 of the overall goal can be achieved if BCB developed and tested further in the pilot project will be used commonly instead of the current improved fuel, low-sulfur fuel will be fully in UB City, public buses will be fully replaced by low-emission vehicles and their exhaust will be kept as clean as original, and any high emission vehicles over than vehicle emission standard will not be used inside UB City by full-scale usage of RSD.

Indicator 2 of the overall goal is expected to be achieved by Mongolian side continuing their efforts to solve air pollution even after the Project, for example, by any of the pilot projects will be adopted in the next "National Program for Air and Environmental Pollution Reduction", or the emission measurement method that was developed by this Project for improved fuels will be standardized.

9-3-2 Issues on Achievement of Overall Goal 1

Table 9-3-2 summarizes the issues of budgetary measures and legal development for the Mongolian side to implement the three pilot projects as full-scale projects. Since air pollution countermeasures require some budget, budgetary measures are particularly necessary.

Table 9-3-2 Budgetary Measures and Legal Development

Pilot project name	Necessary budgetary measures	Necessary legal development
BCB	➤ Additional cost to manufacture BCB that will be enough for UB City ➤ Budget to renovate the improved fuel manufacturing equipment for BCB	➤ Quality standard for blend of biomass and coal is necessary although there is individual standard for coal and biomass ➤ Emission standard for fuels for household use
Dissemination of low-sulfur fuel and low-emission vehicles for public buses	➤ Procurement costs to renew all the public buses to EURO V or VI ➤ Budget for EURO 5 fuel for EURO V or VI buses	➤ Improvement of necessary laws for the dissemination of low-emission vehicles
Operation of RSD	➤ RSD procurement budget (approx. 200,000 EUR)	➤ Improvement of the legal system associated with the introduction of RSD

9-3-3 Necessary Implementation Framework on the Mongolian side to Achieve the Overall Goal and Necessary Future Implementation Plan

Through the capacity development by measurement and pilot projects, the Project found that emission reduction of PM₁₀ by 43% and SO_x by 65%, as agreed as Overall Goal 1, can be achieved by the three above. In order to achieve the emission reduction systematic and steadily, it is recommended to be included in the next national program.

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9-3-3-1 BCB

It is essential for UB City to establish a manufacturing system and for DAAEP to continue the current delivery and sales system for the current improved fuel.

It is required to establish a manufacturing system, such as a warehouse for storing biomass and a new facility for drying and crushing biomass, and renovating the existing manufacturing line into a manufacturing line for BCB.

Although it has been found that enough quantity of biomass can be supplied from the surrounding province, it is necessary to secure suppliers and establish a delivery system so that biomass can be supplied continuously and stably.

The current improved fuel requires expensive binder imported from China. Potatoes, which are the raw material for the binder, are produced in large quantities in Mongolia. It is desirable to support domestic manufacturers and use domestically produced binders for the development of the manufacturing industry in Mongolia.

Stable procurement and the establishment of a delivery system can also be expected to reduce the cost of manufacturing improved fuel using biomass.

9-3-3-2 Dissemination of Low-sulfur Fuel and Low-emission Automobiles

Import of Euro 5 fuel is increasing. However, it is a challenge to contract a certain import volume because its demand in Mongolia is not expected. It is desirable for MMHI to continue educating consumers in order for importers to increase the amount of Euro 5 fuel procured and imported, which has been supported by this Project, to increase source countries for stable imports, and to encourage construction of the refinery in Mongolia.

Most of the cars registered in Mongolia are imported used cars. Emission standard for new vehicle production or import, such as Euro-V or Japan-2009, is not yet enforce in Mongolia. Therefore, it is desirable for MRTD to promote emission standards and legislation for new and used cars to increase the share of low-emission vehicles.

9-3-3-3 Automobile on-Road Inspection using RSD

With the introduction of RSD, it will be possible to inspect a large number of vehicles without a significant burden on inspectors compared to the current on-road inspections. Therefore, it is desirable to establish a legal system to regulate high-emission vehicles through on-road inspections using RSD and opacity meters, and to establish these on-road inspection systems by MRTD.

Appendix

Appendix 1 Project Design Matrix (PDM) Final Version

Ver. 1.9
Dated: 16 May 2024

Project Title: Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 3

Implementing Agency: Department of Against Air and Environmental Pollution (DAAEP) of Ulaanbaatar (UB) City, Ministry of Environment and Tourism (MET) and Counterpart Working Group (C/P-WG)

Target Group: DAAEP, MET, C/P-WG and Relevant Agencies

Duration of the Project: November 2018 – July 2024 (5 years and 9 months)

Project Site: UB City

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Emission reduction at major emission sources is enhanced towards air quality improvement in Ulaanbaatar City.	1. 65% in SO _x and 43 % in PM ₁₀ emissions from small stoves for household and automobiles are reduced compared with the BAU baseline. 2. The results of the Project are reflected in the policy and strategy, such as the next NPREP (National Program on Reducing Environment Pollution) and related laws and regulations.	1. Comparison between BAU and updated inventory for target year (3 to 5 years after completion of the Project) 2. The next NPREP (National Program on Reducing Environment Pollution) and its related documents 3. Interview survey to the relevant agencies	
Project Purpose Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attentions to implementation of effective pollution control measures and to the necessary coordinating mechanism of DAAEP and the relevant agencies.	1. One of pilot projects are adopted as full scale implementation by relevant authorities. 2. At least one case of lessons learned from the pilot projects are utilized by the decision makers. 3. Relevant laws, regulations and standards on air pollution control measures are implemented in UB City. (At least establishment of one MNS, and/or 70% of compliance in the dust emission standards of existing MNS; MNS5043:2016 (General technical requirement of heat water boiler under 4.2MW) and MNS5919:2008 (Emission limit value and measurement method of power plant, steam boiler))	1. The Project reports 2. Interview survey to the relevant agencies 3. Laws, regulations, MNS standards , and ordinances of UB City	
Outputs			
Output 1: Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.	1-1. During the Project duration, at least 50% of inspections for boiler registration based on emission measurements (including standard and simplified methodologies) are implemented by DAAEP and IACC. 1-2. The emission measurement reports are submitted to Project Leader of UB city in charge of air and environmental pollution at least 3 times during the Project duration. 1-3. Emission monitoring for the major pollution sources and air quality monitoring information are shared regularly among the relevant agencies through coordination between DAAEP and NAMEM. 1-4. The CEMS measurement is compared with the standard measurement once in a year. 1-5. Distribution of emission measurements from automobiles in UB City is prepared based on the study with RSD at least once a year.	1. Emission measurement reports by DAAEP / IACC 2. The Project reports 3. Boiler registration database 4. Air quality monitoring monthly reports and annual reports 5. CEMS data	1. Legal and political framework for air quality management is maintained, which defines decision making mechanism such as NCEPR and professional agencies like DAAEP and NAMEM. 2. The COVID-19 pandemic situation will be improved and JICA will be able to send JICA Experts

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Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO ₂ , and NO _x throughout the year are strengthened.	2-1. The results of PM apportionment study are reported at least three times during the Project. 2-2. Pollution structures are assessed at least 3 times during the Project duration including emission inventory, simulation model, PM speciation, receptor model, air quality monitoring, and population exposure throughout the year.	1. The Project reports	to Mongolia toward April 2021 until the end of the Project.
Output 3: Capabilities of technical evaluation and preparation of air pollution control measures for implementation are strengthened.	3-1. Drafts of emission measurement methods and quality standards of improved fuel for households in Ger area are submitted to MASM. 3-2. At least three of implementation plans of the pilot projects are prepared.	1. The Project reports	
Output 4: Decision making process for air pollution control is improved by utilizing the Professional agencies including DAAEP, NAMEM and the relevant agencies.	4-1. Analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) are presented to decision makers at least 2 times. 4-2. Results of pilot project implementation and other Project results are utilized for the revision of NCEPR and for decision making on implementation/non-implementation of pollution control measures at least once.	1. The Project reports 2. Reports on NPREP	
Output 5: Air pollution control measures are enhanced for PM, SO ₂ and NO _x emission reduction at major sources.	5-1. At least three pilot projects selected by C/P-WG are implemented 5-2. The results of each pilot project (emission reduction, improvement of ambient air quality and population exposure for PM, SO ₂ and NO _x) are presented to the relevant agencies.	1. The Project reports	
Output 6: Legal framework, resource allocation and coordinating mechanism as a Platform for the Air Quality Management Cycle are strengthened for the Outputs 1 to 5.	6-1. At least three of drafts on laws and regulations, such as fuel regulations, MNS emission standards and ordinances of UB City, are submitted. 6-2. More than 3 air pollution control measures and technologies are funded by the sections of the relevant agencies in charge of allocating funds for air pollution control by utilizing technical appraisal guideline provided by the Project. 6-3. At least three agreements are made on demarcation of roles of the relevant agencies for air pollution control measures in the Project. 6-4. The operational guideline is distributed to relevant agencies.	1. Laws and regulations, fuel regulations, MNS emission standards and ordinances of UB City 2. Minutes of Meeting of NCEPR 3. Official documents including UB city Governor's orders 4. Operational guideline	

Activities	Inputs		
1-1 DAAEP and IACC ¹ reinforce HOB inspections based on on-site stack gas measurements. 1-1-1 DAAEP and JICA Experts assess the technical transfer on-site stack gas measurement. 1-1-2 DAAEP with JICA Experts re-constructs 2 teams of stack gas measurement. 1-1-3 IACC and the relevant agencies with JICA Experts implement HOB inspection based on on-site stack gas measurement. 1-1-4 IACC with JICA Experts introduces simplified measurement method by using IACC's portable gas measurement equipment including parallel measurement with JIS method, elaboration of manuals and manufacturer's calibration. ² 1-1-5 DAAEP and IACC with JICA Experts elaborate emission measurement reports.	Japanese side 1. JICA Experts (necessary fields) (1) Chief Advisor (2) Air Pollution Control Planning and Policy (3) Emission Measurement for Stationary Sources (4) Ambient Air Quality Monitoring	Mongolian side 1. C/P and C/P-WG (1) JCC Chairperson (2) JCC Vice-Chairperson (3) Project Director (4) Project Manager (5) Necessary C/P and C/P-WG staff according to the fields of JICA Experts	1. There are no frequent leaves, transfers or resignations of C/P and C/P-WG members. 2. Necessary coordination among UB city, districts,

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1-2 TPP3 and TPP4 with JICA Experts enhance emission gas control by utilizing CEMS. 1-2-1 TPP3 and TPP4 with JICA Experts elaborate and implement CEMS operation and maintenance plan. 1-2-2 TPP3 and TPP4 with JICA Experts perform quality control of emission gas data of CEMS. 1-2-3 TPP3 with MET and the relevant agencies elaborates online emission data reporting system for the CEMS. 1-2-4 NAMEM and the relevant agencies share and evaluate CEMS emission data. 1-2-5 NAMEM compiles monitoring data of emissions from TPP2, TPP3, TPP4 and new large heat supply facilities and share them with relevant agencies. 1-3 MRTD and PTD introduce relevant regulations of automobiles based on emission measurement. 1-3-1 MRTD and PTD with JICA Experts implement automobile emission measurements by RSD, assess distribution of automobiles emission intensity and define target automobiles to be regulated. 1-3-2 MRPA and IACC with JICA Experts implement automobile fuel surveys. 1-3-3 JICA Experts conduct training to NRTC, in addition to DAAEP, on automobile emission measurement using on-board emission measurement system, and DAAEP and NRTC implement automobile emission measurement using on-board emission measurement system. 1-3-4 Public Transportation Department of the Capital City with JICA Expert transfer the DPF which were installed on 24 large buses by the project "Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of Particulate Matter (PM) from Diesel Buses by DPF" to other buses. 1-4 DAAEP and NAMEM with JICA Experts strengthen AQMS utilization. 1-4-1 CLEM and JICA Experts assess the current status of equipment in reference laboratory of CLEM and identify necessary actions if necessary. 1-4-2 DAAEP reinforces AQMS operation and maintenance based on the plan by the Project Phase 2. 1-4-3 DAAEP with JICA Experts starts air quality monitoring at pilot project area for improved household fuels by utilizing mobile AQMS. 1-4-4 DAAEP with JICA Experts reinforces the AQMS at Bayankhoshuu station. 1-4-5 ~~DAAEP and NAMEM with JICA Experts implement parallel measurement by FPM sampler for PM concentration, and implement quality control of PM measurements of AQMS.~~ 1-4-6 DAAEP and NAMEM with JICA Experts maintain the online information system of AQMS. 1-4-7 DAAEP and NAMEM share real-time monitoring data with the relevant agencies through the online information system. 1-4-8 DAAEP and CLEM with JICA Experts analyze air quality monitoring data and elaborate air quality monitoring reports. 1-4-9 The relevant agencies utilize air quality monitoring data. 1-4-10 DAAEP with JICA Experts establishes the data transfer system of air quality monitoring data of Dambadarjaa station to the online information system of AQMS. 2-1 NAMEM and JICA Experts conduct PM apportionment study based on PM speciation throughout the year. 2-1-1 CLEM and JICA Experts elaborate PM sampling plan throughout the year, and implement PM samplings. 2-1-2 JICA Experts perform PM speciation analysis in Japan. 2-1-3 NAMEM and CLEM with JICA Experts learn PM speciation technologies (ion analysis, element analysis and carbon analysis). 2-1-4 NAMEM and CLEM with JICA Experts formulate equipment and laboratory plan for PM speciation. 2-1-5 DAAEP and NAMEM with JICA Experts perform PM apportionment study based on receptor modeling. 2-2 DAAEP and NAMEM with JICA Experts evaluate air pollution structure and health impact based on air quality simulation model and receptor model. 2-2-1 DAAEP and NAMEM elaborate plans for updating emission inventory. 2-2-2 DAAEP, TCC and PTD implement studies for mobile sources including update of emission inventory, examination of traffic signal control, traffic volume and automobile traveling speed. 2-2-3 DAAEP and JICA Experts select the pilot areas and assess Ger stoves usage pattern (type and model of stoves, seasonal pattern of usage, insulation of Ger housing and coal consumption). 2-2-4 DAAEP and NAMEM with JICA Experts implement studies for other emission sources as necessary.	(5) Ambient Air Quality Analysis (6) PM₁₀ and PM_{2.5} Sampling (7) PM₁₀ and PM_{2.5} Apportionment Study (8) Emission Inventory (Stationary, Mobile and Others) (9) Air Quality Simulation Modeling / Air Pollution Control Measures Evaluation (10) Auto-mobile Emission Control 1 (Traffic Signal Control) (11) Auto-mobile Emission Control 2 (RSD and others) / Emission Measurement 2 (12) Clean Coal Technology for Air Pollution Control Measures (13) CEMS Data Analysis (14) Stationary Source Emission Control Measures (15) Air Quality Administration (16) Public Awareness and Public Relations 2. Training (1) Local seminars and workshops (2) Training course in Japan 3. Provision of necessary equipment 4. Local cost Necessary expenses for activity of JICA Experts 2. Facility (1) Provision of necessary office space in DAAEP and MET (including internet access) (2) CLEM Laboratory (3) Storage Space for Equipment 3. Local cost (1) Counterpart expenses such as salary, allowance, travel cost and accommodation (2) Project administrative expenses	khoroos and communities in Ger area is secured by Mongolian side for implementation of pilot projects.

2-2-5 DAAEP and NAMEM with JICA Experts elaborates BAU (Business as usual) scenario for the future year based on TPPs future development plans, projection of number of automobile, population, economic growth, emission regulation, fuel quality regulation and so on. 2-2-6 DAAEP and NAMEM update emission inventory for the present year and the future year for the BAU scenario. 2-2-7 DAAEP and NAMEM update the air quality simulation model for PM₁₀, SO₂ and NO_x. 2-2-8 DAAEP and NAMEM evaluate the air pollution structure of UB city. 2-2-9 DAAEP and NAMEM evaluate indicative population exposure of PM₁₀ based on population weighted concentration and so on.		
3-1 DAAEP and the relevant agencies elaborate a draft MNS on an emission measurement method of improved fuel and fuel quality, and propose it to MASM. 3-2 JICA Experts collect information about fuel gas usage in Mongolia, elaborate safety standards for gas based on Japanese experiences, and then submit it to Ministry of Energy. 3-3 DAAEP and the relevant agencies elaborate implementation plans and terms of reference for pilot projects such as improved fuel, HOB, traffic signal control, eco-driving, RSD, smoke belching program based on portable emission device, DPF, low sulfur fuel and low emission automobiles.		
4-1 DAAEP and NAMEM submit to the decision makers the analysis of air pollution status, short-, medium- and long- term air pollution control strategies (including BAU analysis) and evaluation of air pollution control measures (including implemented and planned) . 4-2 Relevant agencies with pilot projects elaborate technical guidelines and utilizes them. 4-3 The relevant agencies discuss and endorse the selection of pilot projects. 4-4 NCEPR and the relevant agencies approve large scale investments based on pilot projects implementation and assessment. 4-5 NCEPR, or the sections of the relevant agencies in charge of allocating funds for air pollution control in the Mongolian government such as the Environment and Climate Fund utilizes the Outputs of the Projects and pilot projects implementation and assessment.		
5-1 DAAEP with Health Department of Capital City and the relevant agencies implements public awareness and advisory activities for citizens including school students and parents. 5-2 MET and DAAEP publish progress of the Project by newsletter, newspaper articles, web-site and other medias. 5-3 DAAEP and JICA Experts provide technical guidance to manufacturers for improved fuel production. 5-4 The relevant agencies with JICA Experts implement pilot projects according to the implementation plan by Activity 3-3. 5-5 The relevant agencies with JICA Experts evaluate pilot projects results in terms of emission reduction, air quality improvement and exposure to citizens, and extract lessons learned. 5-6 The relevant agencies with JICA Experts report the pilot projects results to NCEPR. 5-7 TPP3 and TPP4 analyze CEMS data, and examine viable air pollution control measures. 5-8 TPP3 and TPP4 with JICA Experts elaborate emission reduction plans.		Pre-conditions 1. Appropriate number of qualified staff of C/P and C/P-WG is assigned. 2. Adequate amount of budget related with the Project implementation is secured. 3. Necessary human resources mobilization related with pilot projects is secured by Mongolian side.
6-1 The relevant agencies discuss and elaborate written agreements on demarcation of roles in air quality management related with each Output and Activity of the Project. 6-2 DAAEP with JICA Experts submits technical documents to NCEPR for improved fuel standard, emission standard on stationary sources, mobile sources and other emission sources, and revision of ordinance. 6-3 NCEPR and the relevant agencies elaborate fuel standard and emission standard, and submit them to MASM. 6-4 Relevant ministries / relevant agencies of UB city elaborate laws, regulations and ordinances on air pollution control measures, and submit them to national parliament / city council. 6-5 JICA Experts provide training on air pollution control measures and technical appraisal guidelines for staff of the sections of the relevant agencies in charge of allocating funds for air pollution control. 6-6 Staff of the sections of the relevant agencies in charge of allocating funds for air pollution control with JICA Experts improve relevant operations with allocating funds for air pollution control measures, if necessary. 6-7 Mongolian side enhances donor coordination in air pollution control. 6-8 Relevant agencies of pilot projects with JICA Experts develop an operational guideline for elaboration, implementation and evaluation of air pollution control measures based on pilot projects implementation.		

*1 According to City Governor Ordinance A/1649 "Partial Measures Related to the Abolition of Inspection Agency of the Capital City" dated December 30, 2022, Audit Division was added to DAAEP.

*2 Since the Audit Division and the Air Quality Measurement and Operation Division of DAAEP do not perform simplified measurement, Activity 1-1-4 was terminated through December 30, 2022.

AQMS: Air Quality Monitoring Station

BAU: Business as Usual

CEMS: Continuous Emission Monitoring System

CFWH: Coal Fired Water Heater

C/P: Counterpart

C/P-WG: Counterpart Working Group

DAAEP: Department of Against Air and Environmental Pollution of Capital City

DPF: Diesel Particulate Filter

FRM: Federal Reference Method

HOB: Heat Only Boiler

IACC: Inspection Agency of the Capital City

MASM: Mongolian Agency for Standardization and Metrology

MET: Ministry of Environment and Tourism

MMHI: Ministry of Mining and Heavy Industry

MNS: Mongolian National Standard

MRPA: Mineral Resources and Petroleum Authority

MRTD: Ministry of Road and Transport Development

NAMEM: National Agency for Meteorology and Environment Monitoring

NCEPR: National Committee for Environment Pollution Reduction

NPREP: National Program on Reducing Environment Pollution

NRTC: National Road Transport Center

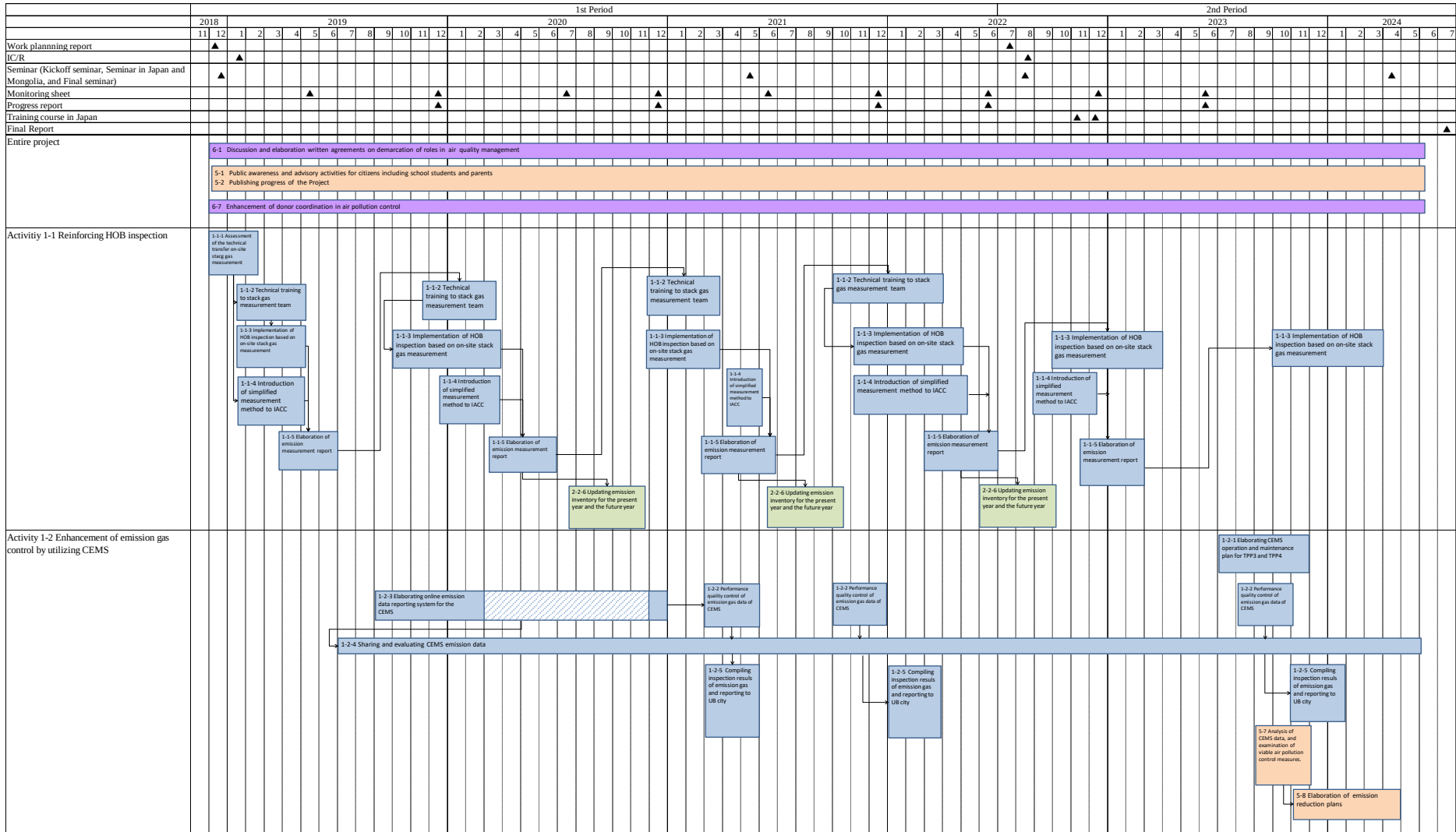
PTD: Public Transportation Department of the Capital City

PM: Particulate Matter

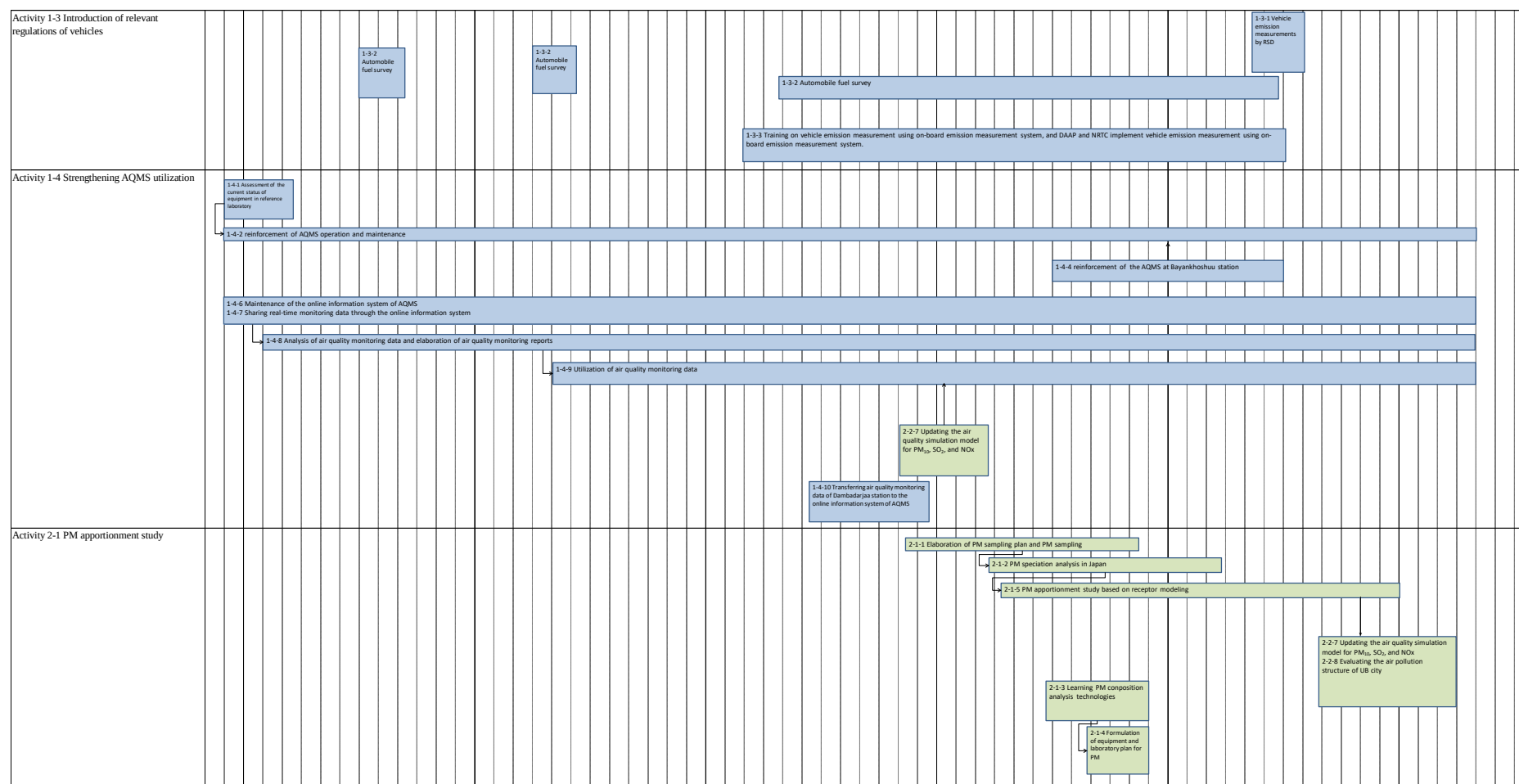
RSD: Remote Sensing Device

TCC: Traffic Control Center of the Capital City

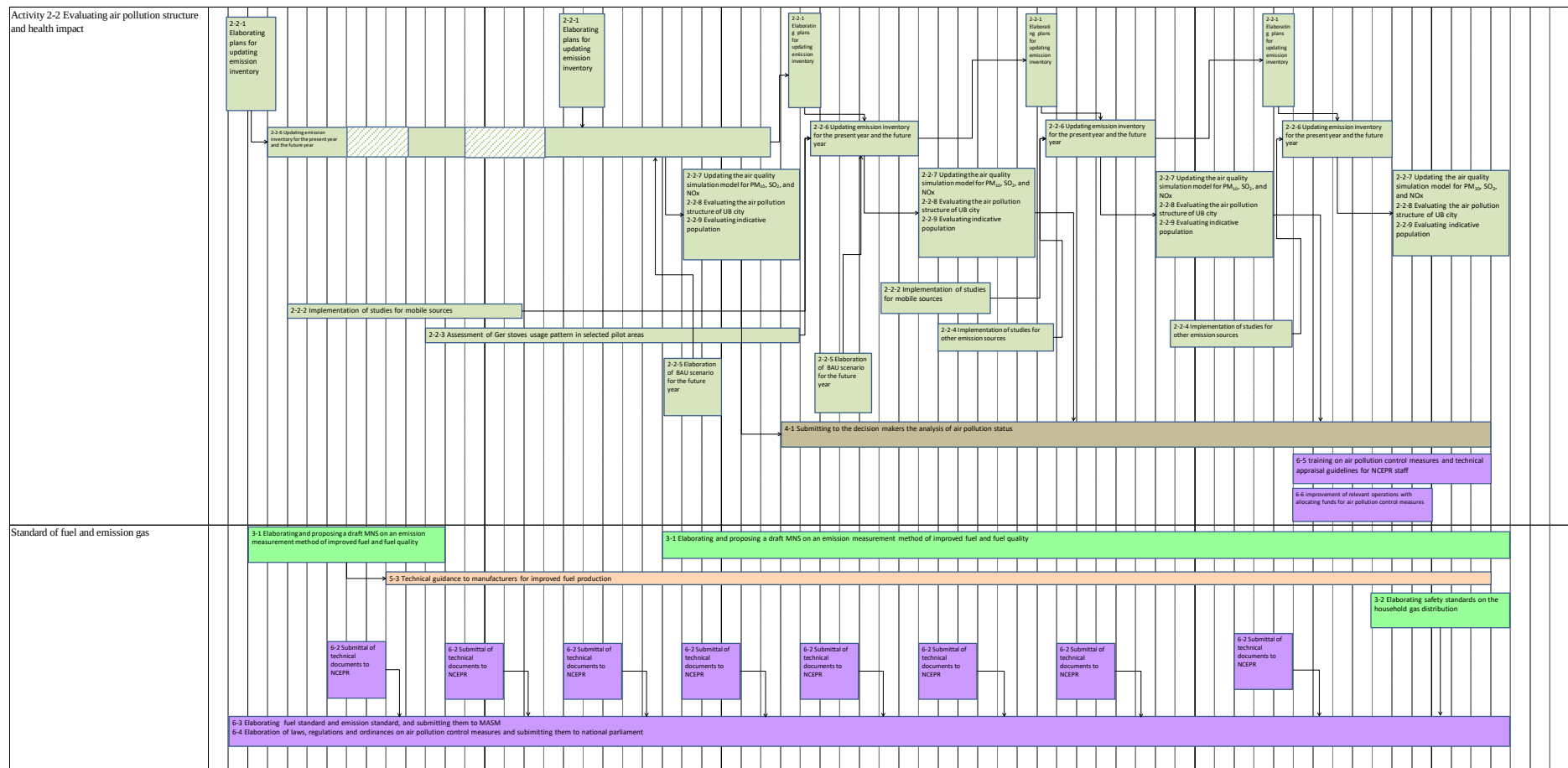
TPP: Thermal Power Plant



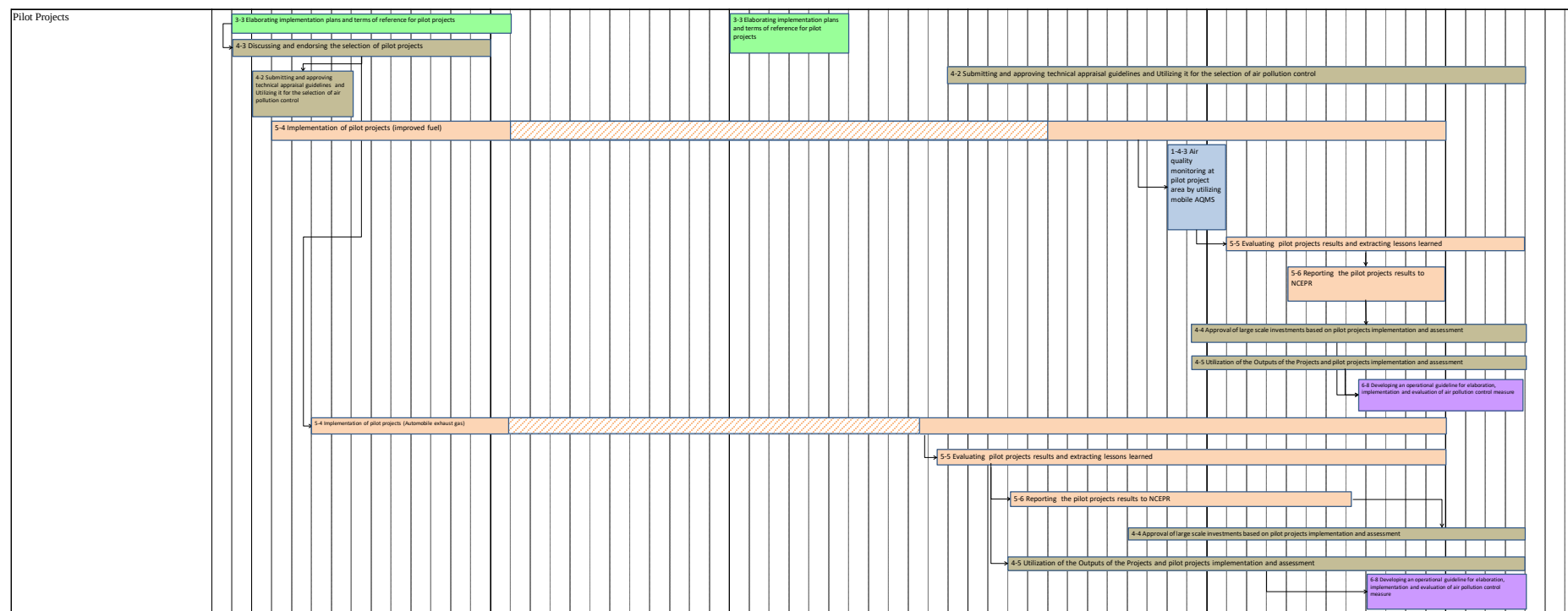
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Appendix 3 Plan of Operation

Activity	1st period																								2nd period																							
	2018				2019				2020				2021				2022				2023				2024																							
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7			
Work Planning Report																																																
IC/R																																																
Seminar (Kickoff seminar, Seminar in JAPAN and Final Seminar)																																																
Monitoring Sheet																																																
Progress Report																																																
Training Course in JAPAN																																																
Project Final Report																																																
Output 1: Capabilities of emission monitoring for the major pollution sources and of air quality monitoring are strengthened.																																																
Activity 1: DAAP and IACC reinforce HOB inspections based on on-site stack gas measurements.																																																
1-1-1 DAAP and JICA Experts assess the technical transfer on-site stack gas measurement.																																																
1-1-2 DAAP with JICA Experts re-constructs 2 teams of stack gas measurement.																																																
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1-1-5 DAAP and IACC with JICA Experts elaborate emission measurement reports																																																
Activity 1-2: TPP3 and TPP4 with JICA Experts enhance emission gas control by utilizing CEMS.																																																
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1-2-5 NAMEM compiles monitoring data of emissions from TPP2, TPP3, TPP4 and new large heat supply facilities and share them with relevant agencies.																																																
Activity 1-3: MRTD and PTSD introduce relevant regulations of vehicles based on emission measurement.																																																
1-3-1 MRTD and PTSD with JICA Experts implement vehicle emission measurements by RSD, assess distribution of vehicles emission intensity and define target vehicles to be regulated.																																																
1-3-2 MRPA and IACC with JICA Experts implement automobile fuel surveys.																																																
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1-3-4 Public Transportation Service Department of the Capital City (hereinafter referred to as "PTD") with JICA Expert transfer the DPF which were installed on 24 large buses by the project "Verification Survey with the Private Sector for Disseminating Japanese Technologies for Emission Reduction of PM from Diesel Buses by DPF" to other buses.																																																
Activity 1-4: DAAP and NAMEM with JICA Experts strengthen AQMS utilization.																																																
1-4-1 CLEM and JICA Experts assess the current status of equipment in reference laboratory of CLEM and identify necessary actions if necessary.																																																
1-4-2 DAAP reinforces AQMS operation and maintenance based on the plan by Phase 2.																																																
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Output 2: Capabilities to analyze and evaluate pollution structure of PM, SO ₂ and NO _x throughout the year are strengthened.																																																
Activity 2-1: NAMEM and JICA Experts conduct PM apportionment study based on PM speciation throughout the year.																																																
2-1-1 CLEM and JICA Experts elaborate PM sampling plan throughout the year, and implement PM samplings.																																																
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2-1-4 NAMEM and CLEM with JICA Experts formulate equipment and laboratory plan for PM speciation.																																																
2-1-5 DAAP and NAMEM with JICA Experts perform PM apportionment study based on receptor modeling.																																																

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Appendix 4 List of Annexes

Annex 1-4-1	Project Design Matrix (PDM) Ver. 1.0
Annex 1-4-2	PDM Ver. 1.1
Annex 1-4-3	PDM Ver. 1.2
Annex 1-4-4	PDM Ver. 1.3
Annex 1-4-5	PDM Ver. 1.4
Annex 1-4-6	PDM Ver. 1.5
Annex 1-4-7	PDM Ver. 1.6
Annex 1-4-8	PDM Ver. 1.7
Annex 1-4-9	PDM Ver. 1.8
Annex 1-4-10	PDM Ver. 1.9
Annex 1-5-1	Document related to the setting Overall goal
Annex 2-2-1	Related Technical Data and Documents Using in the Project
Annex 2-2-2	Cabinet Ordinance and City Governor Ordinance
Annex 2-2-3	Newsletters
Annex 2-4-1	Minutes of Meeting (M/M) of the 1 st Joint Coordinating Committee (JCC)
Annex 2-4-2	M/M of the 2 nd JCC
Annex 2-4-3	M/M of the 3 rd JCC
Annex 2-4-4	M/M of the 4 th JCC
Annex 2-4-5	M/M of the 5 th JCC
Annex 2-4-6	M/M of the 6 th JCC
Annex 2-4-7	M/M of the 7 th JCC
Annex 2-4-8	M/M of the 8 th JCC
Annex 2-4-9	M/M of the 9 th JCC
Annex 2-4-10	M/M of the 10 th JCC
Annex 2-4-11	M/M of the 11 th JCC
Annex 3-2-1	Comparing CEMS Data with the Measurement Result by DAAEP
Annex 3-2-2	Flue Gas Monitoring Result
Annex 3-2-3	Example for Weekly Report of Air Quality Monitoring
Annex 3-3-1	Presentation Including the Equipment and laboratory plan for PM speciation in Training in Japan (PM Source Apportionment)
Annex 3-3-2	Online Capacity Development of Emission Inventory (2020-09-10)
Annex 3-3-3	Handout for the Seminar on the Emission Calculation Result for 2020 (2022-03-17)
Annex 3-3-4	Handout for the Explanation of Capacity Development on other sources (2024-03-07)
Annex 3-3-5	Summary for the Traffic Count Survey in 2019
Annex 3-3-6	Handout for the Seminar on the Effect on Air Quality before and after Introduction of Improved Fuel (2022-10-05)
Annex 3-3-7	Handout for the Seminar on PM ₁₀ Simulation Model Considering Condensed Particle Matter (2024-01-24)
Annex 3-3-8	Handout for the Seminar on PWE and the Evaluation of Pilot Projects (2024-03-13)
Annex 3-4-1	Safety Guideline on the Household Gas Distribution
Annex 3-4-2	Pilot Project Plan Relating to Mobile Emissions

Annex 3-4-3	Introduction of the Pilot Project relating to Mobile Emissions
Annex 3-5-1	Handout for the Academic Seminar Hosted by UNICEF
Annex 3-5-2	Technical Guideline for Household Improved Fuel
Annex 3-5-3	Technical Guideline for Signal Control
Annex 3-5-4	Technical Guideline for Eco-driving
Annex 3-5-5	Technical Guideline for PM Reduction Device (Diesel Particulate Filter; DPF)
Annex 3-5-6	Technical Guideline for Remote Sensing Device (RSD)
Annex 3-5-7	Handout for the Pilot Project on Household Improved Fuel
Annex 3-6-1	Publication of the Project on Facebook by JICA Mongolian Office
Annex 3-6-2	Handout for the Combustion Test Result of Semi-coke blended Coal Briquette and Biomass Blended Coal Briquette (BCB)
Annex 3-6-3	Presentation for the Consultative Meeting “Improve Method for the Quality of Improved Fuel”
Annex 3-6-4	Production Method of BCB
Annex 3-6-5	Result Report of On-board Emission Measurement Survey
Annex 3-6-6	Manual for Eco-driving
Annex 3-6-7	Result Report of RSD Survey in 2023
Annex 3-6-8	Document for Operating Regulations and Laws of RSD
Annex 3-7-1	Technical Guideline for Technical Evaluation of Air Pollution Control Measures Proposals
Annex 3-7-2	Operational Guideline for Elaboration, Implementation and Evaluation of Air Pollution Control Measures
Annex 3-8-1	Aggregate Result of the Capacity Assessment at the Organization and Society Level
Annex 8-1-1	Handout for the Final Seminar

Each of the above Annexes is available only as data.