MOEJ

Final Report

City-to-City Collaboration for Zero-Carbon Society in FY2023

Zero Carbon Society Development by Conversion of Energy from Coal in Ulaanbaatar City

March 2024

Oriental Consultants Co., Ltd.
Sapporo City

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List of Abbreviations

Abbreviation	Meaning
ADB	Asian Development Bank
AI	Artificial intelligence
BAU	Business as Usual
BCP	Business Continuity Plan
BESS	Battery Energy Storage System
CCTV	Closed-circuit television
CES	Central Energy System
CGS	Co-Generation System
CHP	Combined Heat and Power
COP	Conference of the Parties
C2P2	Clean City Partnership Program
DMS	Distribution Management System
EV	Electric Vehicle
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
GWP	Global Warming Potential
GX	Green Transformation
HOB	Heat Only Boiler
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JFJCM	Japan Fund for the Joint Crediting Mechanism
NDC	Nationally Determined Contribution
PV	Photovoltaics
UNFCCC	The United Nations Framework Convention on Climate Change
VRE	Variable Renewable Energy
ZEB	Net Zero Energy Buildings
ZEH	Net Zero Energy House

Chapter 1 Project Overview

1.1 Project Background and Objective

According to the report of Working Group III of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in 2022, approximately 70% of global GHG emissions originate from cities, and it is essential to accelerate climate action in cities to achieve the 1.5-degree target set in the Paris Agreement. In Japan, the national and municipal governments are working together to create more than 100 Decarbonization Leading Areas under the Regional Decarbonization Roadmap formulated in June 2021, with the aim of achieving zero-carbon cities, and efforts are underway to expand these initiatives throughout Japan.

In order to realize world-wide decarbonization, it is necessary to accelerate the efforts toward building a sustainable zero-carbon society, especially in areas of rapid economic growth, such as parts of Asia. To this end, international efforts are being strengthened to support urban initiatives to decarbonize cities, which are the places that support socio-economic development.

As an example of such efforts, the Japanese Ministry of the Environment launched the Clean City Partnership Program (C2P2) with JICA in February 2023 centered around city-to-city collaboration in order to address the current challenges faced by cities around the world in a multifaceted manner. This program will provide comprehensive and synergistic support to partner cities to address urban challenges related to climate change, environmental pollution, the circular economy, and nature regeneration (“nature positive”) through further mobilization of technology and funds in collaboration with Japanese municipal governments, private companies, and financial institutions. It will also promote collaboration with other key stakeholders, including G7 and other like-minded countries and international development finance institutions.

In this project, Japanese research institutes, private companies, universities, etc., together with Japanese cities that have experience and expertise in decarbonization, will conduct study projects to support partner cities' efforts to create a zero-carbon society and to introduce facilities and equipment that contribute to the creation of a zero-carbon society.

1.2 Project Overview

Entrusted Project Name:	City to City Collaboration for Zero-carbon Society in FY2023 Zero Carbon Society Development by Conversion of Energy from Coal in Ulaanbaatar City
Implementation Period:	August 4, 2023, to March 10, 2024
Ordering Party:	Global Environment Bureau, Ministry of the Environment
Consignee:	Oriental Consultants Co., Ltd.

1.3 Implementation Structure

The project implementation was initiated by the Environmental Bureau of Sapporo City and the Ulaanbaatar City Governor's Office. The relevant parties discussed via a workshop in cooperation with the Vice-Mayor of Ulaanbaatar City overseeing infrastructure development.

The World Winter Cities Association for Mayors is an international network advocated by

Sapporo City in 1981, comprising 22 cities in nine countries. Since Ulaanbaatar City became a member in 1998, both cities have exchanged information and technologies. Sapporo City declared its goal of becoming a “Zero-Carbon City” and making a target of reaching virtually zero GHG emissions in 2050, with measures promoted around these clear goals. Accordingly, Sapporo City is expected to support efforts and technologies to build a decarbonized society in Ulaanbaatar City, which is also located in a cold and snowy region.

In the project, knowledge was shared through workshop.

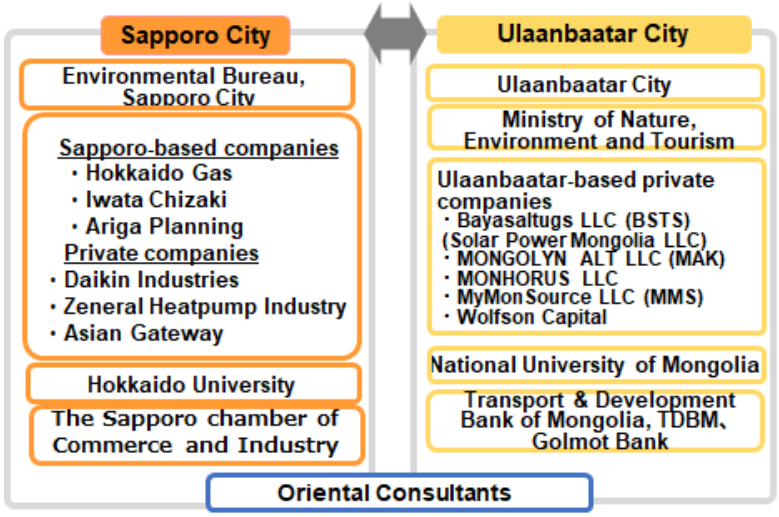


Figure 1-1 Implementation Structure

1.4 Entrusted Project Contents

In this project, activities and surveys were conducted to contribute to the conversion from coal, which Ulaanbaatar is heavily reliant on, and develop related projects in order to reduce emissions of greenhouse gases. For project development, preparations were made for large-scale solar power generation projects utilizing the JCM subsidy scheme and surveys were conducted on the feasibility of JCM projects utilizing hydrogen, geothermal heat pumps, heat pump air conditioners, or batteries and “smart” road projects. Interviews were conducted with local private-sector companies in order to analyze the local needs related to decarbonization while also identifying products and companies in Sapporo or Hokkaido useful for decarbonization.

Activities were also conducted relating to the sharing of expertise and information about environmental measures in Sapporo in order to contribute the development of future measures and plans in Ulaanbaatar.

In this report, the Chapter 1 provides an overview of the project, Chapter 2 outlines climate change measures and initiatives in Ulaanbaatar, Chapter 3 outlines carbon neutral measures and initiatives in Sapporo, Chapter 4 contains an overview of identified issues and future actions based on surveys related to the energy and transportation sectors conducted as a part of this project, and Chapter 5 presents the feasible JCM decarbonization projects developed this fiscal year.

Table 1-1 Process for Project Implementation

Project Items	FY2023									
	6	7	8	9	10	11	12	1	2	3
Meetings and reporting		Agreement			Mid-term report				Final report	
Specification Items										
(1) Study on promotion of JCM commercialization of large-scale solar power generation projects										
(2) Feasibility study of JCM projects										
(3) Support for institution-building and system development										
Details										
Survey and analysis of current status										
Identification of issues and needs										
Study of JCM project models (including study of business plans, financial plans, etc.)										
Introduction of proposed measures and case studies (e.g., introduction of initiatives in Japan) Information sharing with related organizations										
Field survey										
Workshop										
Presentations at related meetings, coordination, etc. (related conference in Japan)										
Monthly report										
Report preparation								Draft report		Submit

1.5 Overview of Ulaanbaatar City and Sapporo City

（1） Ulaanbaatar City

Ulaanbaatar City is administratively designated as a “capital city” with the same territorial sovereign function as the province. The city area is 4,704 m^2, comprising nine districts. The Ulaanbaatar City area occupies only 0.3% of the national land.

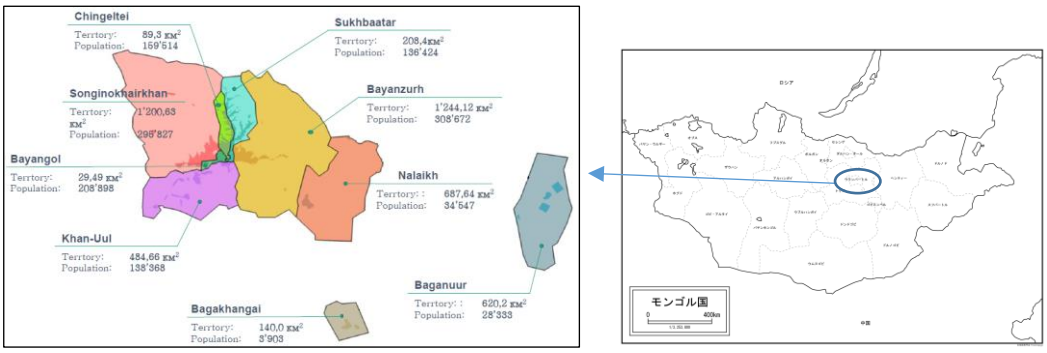


Figure 1-2 Map of Ulaanbaatar City

Ulaanbaatar is one of the coldest capitals in the world, with the daytime temperatures as low as minus 15 to minus 30 degrees Celsius, sometimes even minus 40 degrees Celsius, in December and January. Home heating is needed for eight months of the year, from mid-September to mid-May.

The population in Ulaanbaatar City was approximately 0.8 million in 2000. Due to the population inflow from other regions since then, the population was rapidly grown to approximately 1.69 million in 2020, making up around 49% of approximately 3.45 million of the entire population in Mongolia. Although the average population growth rate in Mongolia is around 3%, that of Ulaanbaatar City over five years to 2018 was 5.6%, indicating progressive centralization.

The future population of Ulaanbaatar City is expected to exceed 2 million in 2040.

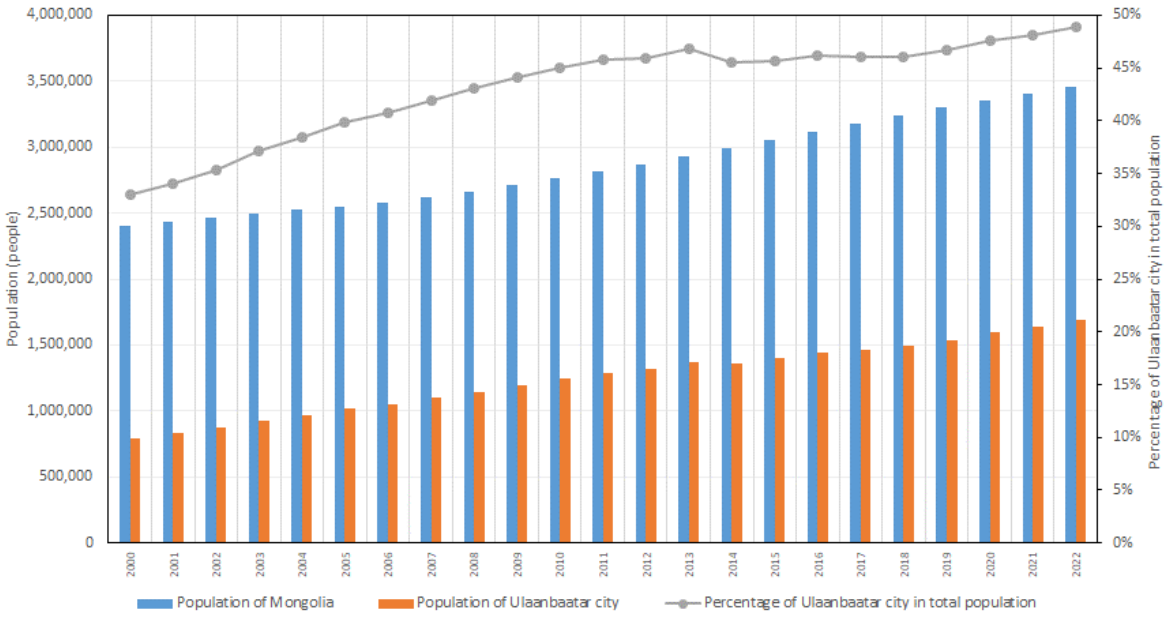


Figure 1-3 Population Trends in Mongolia and Ulaanbaatar City (20000 to 2022)

Source: Mongolia National Statistic Office database

Many of the residents removed from other regions have settled in the ger area where people build ger houses in a disorderly manner without administrative approval. Today, the population of ger areas in Ulaanbaatar City has reached about 0.84 million, which is more than a half of the population in the capital. In Ulaanbaatar City, the development of infrastructure has not kept pace with the rapid population inflow. Furthermore, the city also faces the serious issues power shortages during peak power demand and traffic congestion in the city center.

Mongolia joined the Paris Agreement, an international framework for reducing greenhouse gas (GHG) emissions and other initiatives after 2020 and committed to reduce GHG emissions. It is a priority of Mongolia's National Determined Contribution (NDC) to improve energy efficiency and reduce CO_2.

（2） Sapporo City

Sapporo is the political, economic, and cultural center of Hokkaido and Japan's northernmost ordinance-designated city, with a population estimated at around 1.97 million in 2023, a cold climate and average annual snowfall of approximately 5 m. Due to this climate, the residential heating energy consumption is about three times higher than the national average in Japan. Carbon dioxide comprised 98% of the greenhouse gas emissions emitted from Sapporo in 2016 and emissions by sector, households, businesses, and transportation comprised 90% or so.

The Hokkaido region, home to Sapporo, witnessed a flourishing coal industry as coal mining became prominent. In 1966, the industry marked a milestone by producing a record 22.95 million tons of coal. During the 1960s, Sapporo's population and economy both soared, leading to a high concentration of people in the city. However, the coal industry also brought with it severe air

pollution and various other pollution types unique to colder regions. Fortunately, the city seized the opportunity to develop a district heating system during the 1972 Winter Olympics, paving the way to move from coal to more sustainable energy sources like natural gas and alternative fuels. Recently, the region has started to utilize renewable energy sources such as wood biomass and snow and ice heat. These energy transitions have positioned Sapporo as a trailblazer city in tackling the same contemporary energy challenges as those faced by Mongolia.

Sapporo City has set a goal of reducing greenhouse gas emissions by 55% relative to 2016 levels by the year 2030. This objective is a significant step toward achieving the goal of becoming a zero-carbon city by 2050. To accomplish this target, the city is promoting the adoption of zero-energy buildings (ZEB) and zero-emission buildings (ZEH) as comprehensive energy-saving measures, while introducing renewable energy sources like solar power generation as a way of expanding the incorporation of clean energy. Furthermore, the city is endorsing the installation of renewable energy sources in buildings as a means of expanding the introduction of sustainable energy. In addition, Sapporo City Hall, being one of the largest businesses in the city, contributes approximately 6% of the city's greenhouse gas emissions; to demonstrate its leadership in achieving the city-wide target, greenhouse gas emissions reduction target for city hall has been set 5% higher than the citywide goal, at 60% reduction relative to 2016 levels by the year 2030. The city government is also setting an example by proactively introducing energy-saving measures and renewable energy in city-owned facilities.

Chapter 2　State of Ulaanbaatar City and its Efforts against Climate Change

2.1 Current State of GHG Emissions in Mongolia and Related Issues

（1） Current GHG emissions

Mongolia has very rich coal resources and given how affordable it is, coal is the main fuel consumed in the country. More than 90% of fuel consumption for power generation, heating and cooking is coal, indicating that the country is highly dependent on coal as an energy source. Furthermore, due to the climate of the country, it is necessary to secure energy sources for heating during the cold season. Under these circumstances, although Mongolia only emits 0.1% of the world's GHG, the percentage of GHG emitted from burning coal is exceedingly high.

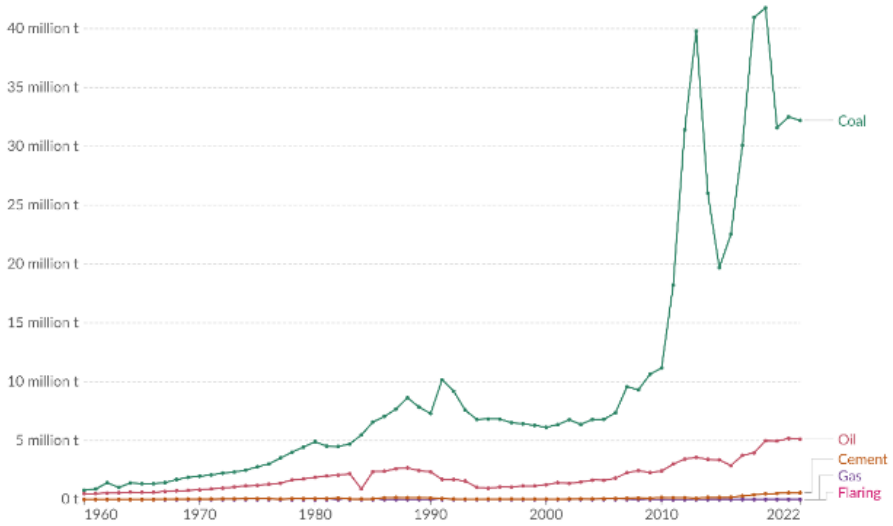


Figure 2-1 CO_2 Emissions by Fuel and Industry, Mongolia

Source: Our World in Data[1]

GHG emissions per capita in Mongolia has increase since 2010, exceeding that of Japan and the global average. Accordingly, GHG emissions in Mongolia is expected to further increase with population growth if reduction measures such as by saving energy or introducing renewable energy are not promoted.

[1] https://ourworldindata.org/co2/country/mongolia

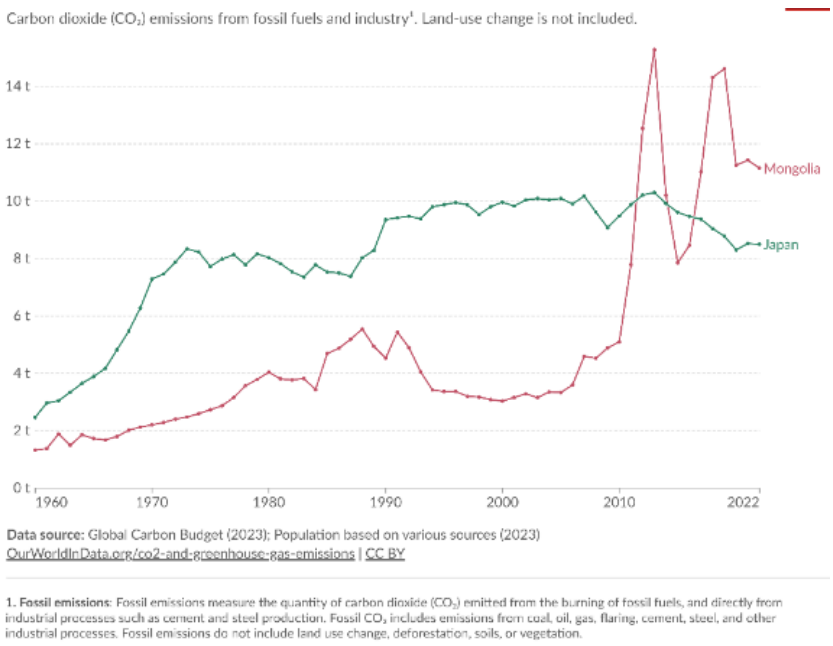


Figure 2-2 Per Capita CO_2 Emission

Source: Our World in Data[2]

（2） Current GHG emissions in the energy sector

The energy sector, including power generation and heating, is the largest source of GHG in Mongolia. The following graph shows the amount of CO_2 emitted to generate 1kWh of energy; since 2010, Mongolia has been significantly above the global average.

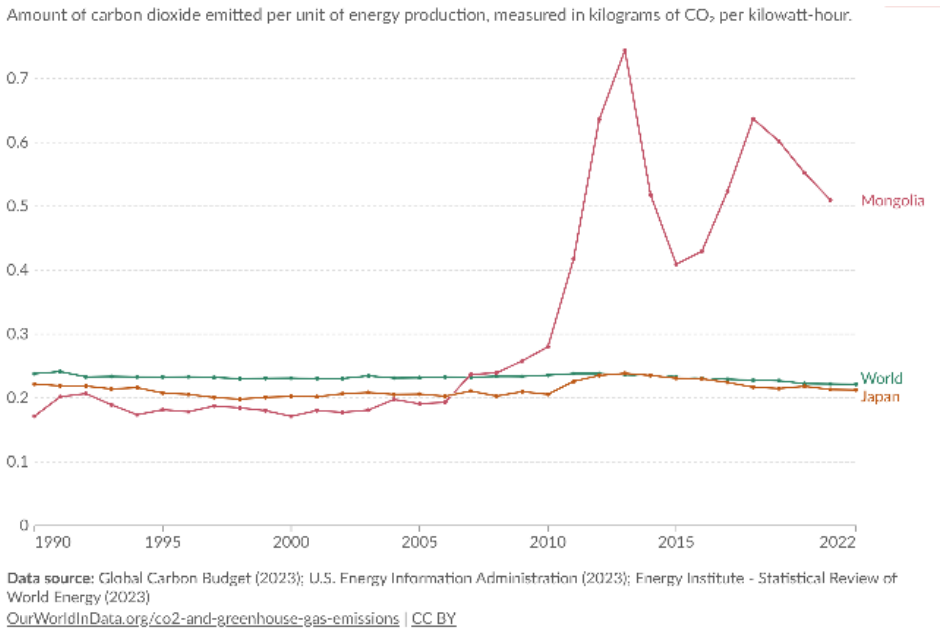


Figure 2-3 Carbon Intensity of Energy Production

Source: Our World in Data[3]

[2] https://ourworldindata.org/co2/country/mongolia
[3] https://ourworldindata.org/co2/country/mongolia

2.2 Measures Against Climate Change in Mongolia

2.2.1 Overview of measures against climate change

In the NDC, the Mongolian Government aims to reduce GHG emissions by 22.7% by 2030. Policies of the Mongolian Government against climate change are described as follows:

Table 2-1 Mongolian Policies Related to Climate Change

Year	Policy title, etc.
2014	Green Development Policy
2015	INDC submitted
2020	National Development Policy “Vision 2050”
2020	NDC updated

Source: Prepared by the Survey Team

2.2.2 Policy concerning measures against climate Change

（1） Green Development Policy

During the United Nations Conference on Sustainable Development in 2012, the significance of “green economy,” which balances sustainable development goals, environmental conservation, and economic growth, was recognized. Following this, in 2014, the Green Development Policy was formulated in Mongolia, in which one of the strategic objectives is to “promote a sustainable consumption and production pattern with efficient use of natural resources, low greenhouse gas emissions, and reduced waste.” As GHG emission mitigation policy measures to be achieved by 2030, Mongolia will “reduce building heat losses by 20 percent by 2020, and by 40 percent by 2030, compared to 2014.” In addition, a numerical target of “ensuring that the share of renewable energy used in total energy production is at 20 percent by 2020, and at 30 percent by 2030” was also established.

（2） Vision 2050

Vision 2050 is a long-term development policy of the country approved by Parliament in May 2020, setting nine basic goals (human development, good governance, safe and secure society, green development, shared national values, quality of life and middle class, reginal and local development, Ulaanbaatar and satellite cities, and economic development) and 50 medium- and long-term development objectives.

Vision 2050 has the goal of developing a low-carbon, highly productive, and comprehensive green economy and contribute to international efforts to mitigate climate change. Achieving self-sufficiency in electricity and increasing eco-friendly sources of energy are included.

（3） Nationally Determined Contribution (NDC)

In October 2020, the Mongolian Government submitted updated NDC to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). Based on the Government Decree No.407 of November 2019, the Mongolian Government set its GHG emission reduction target by 2030, reducing 74.3 Mt CO2-eq of GHG emissions in the business as usual (BAU) scenario in 2030 to 57.4 Mt CO2-eq, decreasing by 22.7% compared to the BAU in 2030.

Under reduction targets and the action plans for each sector of the NDC, restricting the use of coal within the city of Ulaanbaatar and/or utilizing renewable energy, and improving insulation in buildings are included. For the energy production and distribution sector, the goal is to reduce GHG emissions by 49% overall by 2030 through the implementation of renewable energy and use of combined heat and power (CHP) coal-fired power plants.

Table 2-2 Mitigation Actions and Measures of Mongolia's NDC Target

Actions Planned	GHG Emissions Reduction, (Gg CO2-eq.)
1. ENERGY SECTOR	
1.1 Energy sector(production)	
・Use renewable energy sources ・Reduce electricity and heat transmission and distribution grid losses ・Improve efficiency of energy production	8,340.5
1.2 Energy sector(consumption)	
Transportation ・Switch to Euro-5 standard fuel ・Switch the coal export transportation to rail transport from auto transportation ・Switch the heating of passenger train to electric heating	1,048.8
Construction ・Insulate old precast panel buildings in Ulaanbaatar City ・Limit the use of raw coal in Ulaanbaatar city and switch to the use of improved fuel	830.1
Industry ・Energy saving measures	1,045.2
1. Total GHG emission reduction from the energy sector	11,264.6
2. NON-ENERGY SECTOR	
Agriculture ・Regulate and reduce the livestock number ・Improve the livestock manure management	5,283.3
Industrial Processes and Product Use (IPPU) ・Use waste heat from cement plants ・Use fly ash in cement production ・Use coal bed methane	234.1
Waste ・Reduce the waste volume for landfill through the improved waste treatment and recycling process ・Increase the share of the population with access to improved sanitation and hygiene facilities	106.1
2. Total GHG emission reduction from the non-energy sector	5,623.5
Total GHG emission reduction	16,888.1

Source: MONGOLIA'S NATIONALLY DETERMINED CONTRIBUTION

2.3 Energy Measures in Mongolia

Policies in the energy sector of Mongolia are aimed to ensure energy security, ensure sustainable development of the energy sector, establish a foundation for the swift introduction of renewable energy, and in the medium term aim to become an energy-exporting country.

Table 2-3 Policies and Laws on Energy in Mongolia

Year	Name of Policy or Law
2001	Energy Law of Mongolia
2007	Renewable Energy Law
2015	State Policy on Energy 2015-2030
2021	New Recovery Policy

Source: Prepared by the Survey Team

（1） Energy Law of Mongolia

This law was enacted in 2001 and revised in 2015. It aimed for institutional integration in the implementation of commercial activities to operate the energy sector based on market principles by improving legal regulations for investors in the energy sector.

（2） Renewable Energy Law

The Renewable Energy Law was enacted in 2007, stipulating the regulations regarding the generation and provision of renewable energy to promote its utilization. It was revised in 2015 and again in 2019. The 2015 revision decided how to calculate the fixed-price purchase system in addition to consumer electricity fees and both tariffs and value-added tax were exempted. In the 2019 revision, an upper-limit of the fixed-price purchase system for connecting solar and wind power systems to the grid was set. The introduction of a competitive bidding system and purchase procedures for electricity supplied to the distribution grid from small-scale consumers was also outlined.

（3） State Policy on Energy 2015-2030

This is the state policy establishing the energy sector’s medium to long-term goals to 2030. The policy is split into 2 phases (Phase 1 from 2015 to 2023 and Phase 2 from 2024 to 2030) and establishes quantitative goals. One such quantitative goal is the percentage of renewable energy as an energy source; compared 7.62% in the base year of 2014, the goal set for 2023 as 20% and 30% for 2030. Another goal is to establish a system connecting the various regions with high-capacity transmission lines and incorporating a bidirectional energy management system into the grid system in 2024-2030.

（4） New Recovery Policy

This policy was passed in 2021 with the aims of alleviating the impacts of the Covid-19 pandemic on Mongolia’s economy, enhancing economic independence, establishing the foundational conditions for implementing Vision 2050, and promptly resolving constraints to development. This

policy includes a program of medium-term goals to be implemented over a maximum of ten years in order to resolve the "energy" issue, which is one of the six main constraints on development[4]. The "Energy Recovery" action plan includes the targets of constructing powerplants, making mines energy self-sufficient, and meeting the ever-increasing electricity and heating demands of the capital Ulaanbaatar.

2.4 Efforts Against Climate Change in Ulaanbaatar City

（1） Vision 2050,

Vision 2050, formulated with the support of the United Nations in 2020, indicates a GHG reduction target by 2030. Since around a half of the country population is concentrated in Ulaanbaatar, where a coal-fired power plant (cogeneration) is also located, it is also where most energy is consumed, giving it a significant role in GHG reduction for the whole country. Vision 2050 prioritizes measures against climate change in city policies and plans and aims to establish a mechanism to boost effective planning and management capacity and secure a budget to improve urban infrastructure.

Table 2-4 GHG Reduction Targets of Ulaanbaatar City

Unit: Gg CO2-eq.

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Reduction target	1,524	1,671	1,818	1,966	2,113	2,406	2,700	2,993	3,287	3,580

Source: Prepared by the Survey team based on "Vision 2050", Ulaanbaatar City, 2020

（2） Ulaanbaatar City Action Plan 2020-2024

Targets of the item of "green development policy" in the Ulaanbaatar City Action Plan 2020-2024 determined in 2020 include reducing heat loss of housings and apartments in the city, enhancing air quality control capacity, expanding forest areas, and increasing GHG absorption.[5]

Under BNbD 25-01-20[6], the building heat insulation standards apply to new or refurbished apartments, and public, industrial, and agricultural facilities as well as warehouse buildings with an area over 50 m^2. Heat insulation standards, energy efficiency of ventilation, required energy and energy consumption of buildings are reviewed. With the update of standards, BNBD23-02-09, heat insulation standards established in 2009 became ineffective.

（3） Ulaanbaatar 2020 Master Plan

Moreover, the priority in the Ulaanbaatar 2020 Master Plan and Development Approaches for 2030 formulated in 2014 is that "Ulaanbaatar will be a safe, healthy and green city resilient to climate change", reflecting the aim of building a smart city with Mongolian features.

[4] The other constraints are trade port recovery, industrial recovery, urban and rural recovery, green development recovery, and public sector efficiency.
[5] https://road.ub.gov.mn/?p=7411
[6] https://legalinfo.mn/mn/detail?lawId=211242&showType=1

The direction of the Master Plan 2020 succeeds the Master Plan 2040 which is currently being formulated and defines the integrated development of cities corresponding to climate change and helping save energy/resources and neighboring satellite cities and other policies.

2.5 Urban Transportation Initiatives in Ulaanbaatar

（1） UB City Master Plan 2020

The plan for the traffic sector decentralizes the urban structure and connects the city center and sub-centers to reduce traffic congestion, connecting them with 6 east-west corridors, 9 north-south corridors, and 4 ring roads. The plan also proposes regional development through the development of satellite cities to redistribute Ulaanbaatar's population along with the development of Bogdkhan Railway, the development of a road network to connect to the satellite cities and villages, Asian Highway 3 (AH-3) bypass construction, and the development 4 logistics hubs as a regional transportation network.

（2） UB City Road Network Development Medium- and Long-Term Master Plan (UBRD2030)

In order to improve traffic congestion that is expected to worsen in the future, UBRD2030 proposes a road network improvement plan that aims for transport capacity improvement, traffic congestion improvement, and decreased travel times within the city by 2030. This plan includes the development of 6 east-west roads, 10 north-south roads, and 4 ring roads. The total length of the road network is also planned to be expanded from 779.3 km to 1,026.2 km by 2025 and 1276.3 km by 2030.

Chapter 3　Support for Capacity-Building in Ulaanbaatar City

This chapter covers specific examples of decarbonization initiatives in Sapporo, a city that shares the same cold climate as Ulaanbaatar City. The aim is to share the case study with Ulaanbaatar City and help promote the city's policies and encourage capacity-building.

3.1 Sapporo's Initiatives Toward Carbon Neutrality

3.1.1 Zero-carbon city initiatives

(1)　Sapporo Climate Change Action Plan

Sapporo City aims to become a "Zero-Carbon City" by slashing greenhouse gas emissions from the city to almost zero by 2050. The city also declared a "climate emergency" for the purpose of increasing awareness of climate change among citizens and businesses and encourage initiative-taking action.

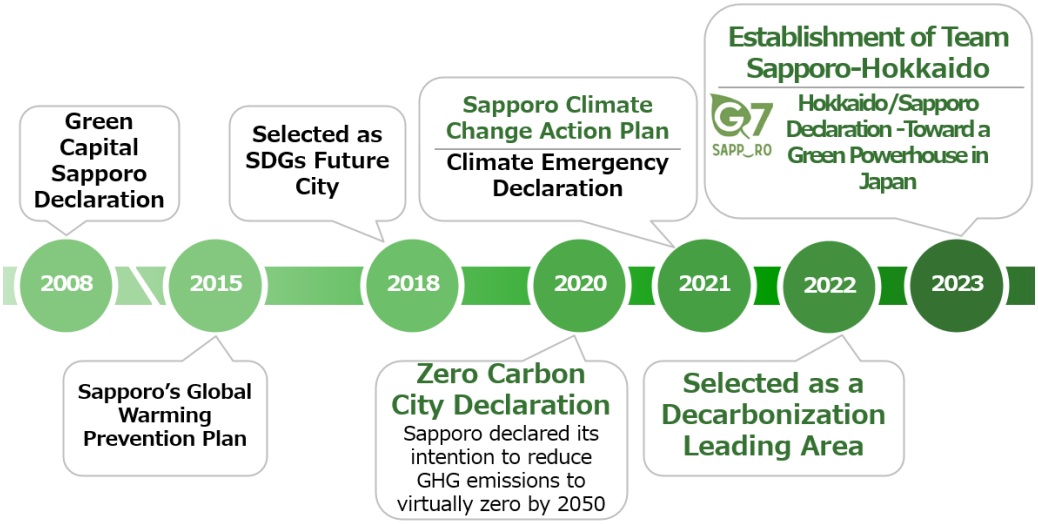


Figure 3-1 Progress of Sapporo's Initiatives Toward Becoming a Zero-Carbon City

Source: Sapporo City

In 2021, Sapporo formulated the Sapporo Climate Change Action Plan to consolidate measures to be implemented by 2030 with the aim of becoming a "Zero Carbon City." Sapporo is aiming to reduce GHG emissions by 55% compared with the level in 2016 (5.37 million t-CO_2) by 2030 as it works toward the goal of achieving zero carbon status by 2050.

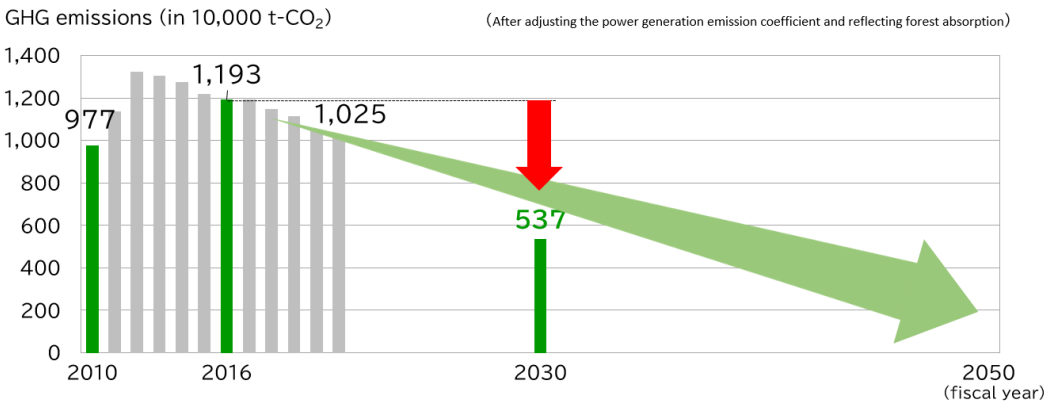


Figure 3-2 Sapporo's GHG Emissions Goals

Source: Sapporo Climate Change Action Plan

Sapporo City is implementing a comprehensive approach that emphasizes thorough energy-saving measures and expanding renewable energy sources while setting an example to its citizens and businesses by taking the lead in reducing its own emissions to meet the city-wide targets. The multifaceted city-wide efforts include establishing concrete objectives, supporting initiatives via its own systems and subsidies, and disseminating information to citizens.

(2) Current status and reduction targets for GHG emissions in Sapporo

Across Sapporo, total greenhouse gas emissions in 2021 amounted to 10.25 million tons of CO_2, which represents a reduction of 14% compared to 2016. Of these emissions, 37% are household emissions, 33% are from businesses, and 22% is from transport. This accounts for a total of approximately 90% and the remainder is from industry and waste management. Due to Sapporo's heavy snowfall and cold temperatures, energy consumption greatly increases during the winter and GHG emissions increase to 1.5 times that of the national average. The heating energy consumption in households is approximately three times the national average, while utility expenses are 1.25 times higher.

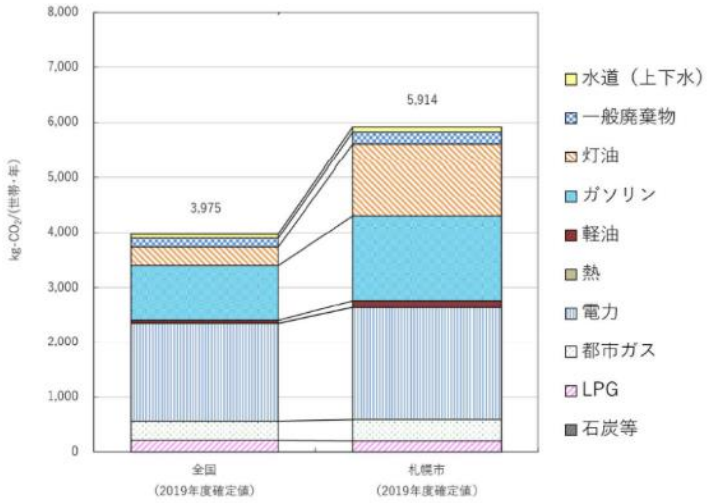


Figure 3-3 Comparison of Household GHG Emissions Between Sapporo and the National Average (final figures from FY 2019)

Source: "Sapporo City Climate Change Action Plan" Progress reports (preliminary 2021 and final 2019).

The city is promoting a shift away from equipment using paraffin and heavy oil as energy sources and aims to achieve an installation rate of around 80% of heating equipment using electricity or gas as the energy source in homes, a 70% installation rate of hot-water supply equipment and a 100% diffusion rate of high-efficiency lighting such as LEDs.

Table 3-1 Sapporo City Initiatives and Targeted Reductions by Measure (t-CO_2)

Measure	Action	Target Reduction Amount
Energy-saving Thorough energy-saving measures	(1) Promotion of ZEH	Approx. 1.74 million
	(2) Promotion of ZEB	Approx. 1.25 million
	Subtotal	Approx. 2.99 million
Renewable energy Expansion of introduction of	(1) Promotion of introduction of renewable energy for buildings, etc.	Approx. 2.18 million
	(2) Promotion of introduction of renewable energy in the	

Measure	Action	Target Reduction Amount
renewable energy	region	
	Subtotal	Approx. 2.18 million
Transportation Decarbonization of transportation	(1) Promotion of dissemination of zero-emission vehicles	Approx. 1.32 million
	(2) Promotion of the use of public transportation	
	(3) Promotion of compact cities	
	Subtotal	Approx. 1.32 million
Resource Resource circulation and carbon sink measures	(1) Promotion of resource-saving and circulation	Approx. 70,000
	(2) Promotion of conservation, creation, and utilization of forests, etc.	Approx. 2,000
	Subtotal	Approx. 70,000
Lifestyle transformation and technological renovation	(1) Lifestyle transformation	-
	(2) Technological renovation	
Total		Approx. 6.56 million

Source: Sapporo City Climate Change Action Plan (2021, Sapporo City)

（3） Subsidies for energy-efficient equipment and energy sources

Subsidies are available to support residents' conversion from kerosene heaters and water heaters to electric or gas cold climate air conditioners and heat pump hot water heater or energy-efficient appliances, such as Eco Cute. These subsidies cover a portion of initial expenses for the equipment and aim to reduce GHG emissions.

Figure 3-4 Applicable Equipment under the Sapporo Energy-Saving Equipment / Energy Source Conversion Subsidy

Source: Official website of Sapporo

3.1.2 Selection as a leading decarbonization region

The Japanese government selected "Decarbonization Leading Areas" as it aims for regional decarbonization, with the rural areas taking a leading role. Regional municipal governments, corporations, and financial institutions take the lead in selecting leading initiatives suited to the specific characteristics of the area to receive Regional Decarbonization Transition / Renewable Energy Promotion Grants.

Sapporo City was selected as a Decarbonization Leading Area in 2022. The city aims to achieve virtual zero CO_2 emissions from electricity consumption in the civilian sector and formulate a

model for regions in cold climates with heavy snowfall through industry, academia, and government collaboration.

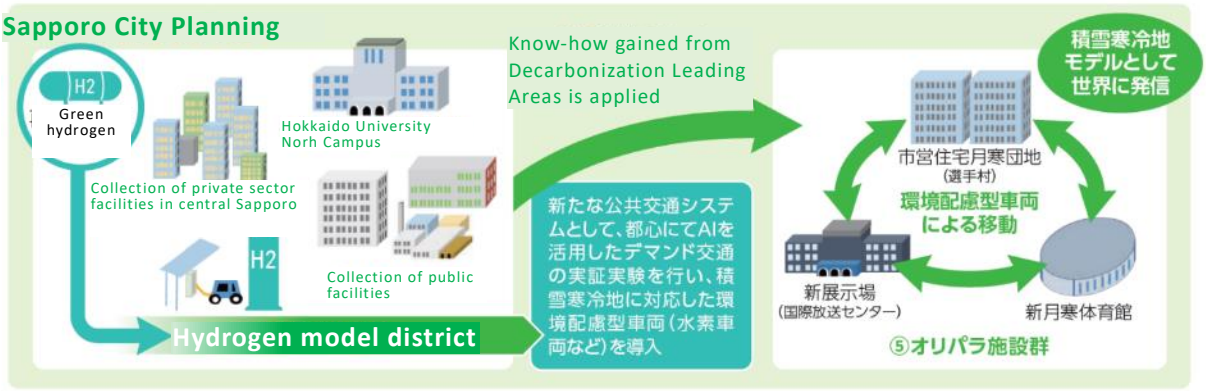


Figure 3-5　Overview of Leading Sapporo Decarbonization Areas.

Source: Sapporo Climate Change Action Guidebook.

For private facilities within the Sapporo city center where an energy network utilizing a cogeneration system (CGS) has been introduced, ZEB (Zero Energy Building) certification, the introduction of renewable energy sources (such as solar energy generation, woody biomass as a heat source), and conversion to carbon-neutral gas is also being promoted to decarbonize electricity and heating.

Within the hydrogen model city zone, stationary hydrogen stations will be installed to demonstrate the operation of fuel cell trucks. At the Hokkaido University Kita Campus, a carbon-free energy system with BCP (Business Continuity Plan) functions is being built in the 6th building of the Integrated Research Facility.

The introduction of renewable energy to public facilities is also being expanded through various methods such as ZEB (Zero Energy Building) conversion, monitoring of electricity demand and rolling out private-sector initiatives, to achieve thorough energy-saving measures.

3.2 GX investment initiatives

The “Hokkaido/Sapporo Declaration -Toward a Green Powerhouse in Japan” was made on the occasion of the 2023 G7 Ministers’ Meeting on Climate, Energy, and Environment held in Sapporo declaring that the city would work toward decarbonization, aim for the revitalization of the regional economy through local production and consumption of energy, and contribute to national and worldwide Green Transformation (GX).

Accordingly, Hokkaido/Sapporo established the collaborative consortium “Team Sapporo-Hokkaido” in June 2023 with the aim of becoming the renewable energy supply hub of Japan and a global “finance center” for Asia and the rest of the world having amassed investments, human resources, and information about GX from across the globe. The consortium aims to concentrate on key initiatives including GX projects such as the introduction of hydrogen, offshore wind power generation, or next-generation semiconductors; human resource development; and fund financing over a 2-year period. The consortium aims to attract 150 trillion yen over the next 10 years.

Team Sapporo-Hokkaido is focusing on eight GX projects (Sustainable Aviation Fuel (SAF), hydrogen, offshore wind power-related industry, batteries, next-generation semiconductors, electric

and hydrogen carriers, submarine direct-current transmission grid, and data centers) and six key initiatives (information platform, supply and demand of renewable energy, fund financing, special zone, human resource development, and information dissemination / international cooperation) from which efforts will be expanded. Through these efforts, it is expected that Hokkaido's renewable energy potential, which is the greatest in Japan, will be utilized to its full potential.

3.3 Hydrogen Initiatives

In 2018, Sapporo formulated its hydrogen utilization policy. It outlines the city's initiatives in preparation for full-scale adoption of hydrogen energy around 2030.

As an initiative to promote future dissemination, it is planned to designate a "model area that is resilient against disasters and eco-friendly" utilizing hydrogen energy which does not emit CO_2 when used and can provide electricity and heat even at times of power outages. It is planned to build fixed hydrogen stations where FC bus, trucks, and other large vehicles can refill, and leisure facilities installed with pure hydrogen fuel cells. Construction on hydrogen fuel stations and use is planned to begin in 2024.

Additionally, one of the targets is to use clean hydrogen produced by renewable energy, such as hydrogen produced using surplus from offshore wind power generation in Ishikari, Hokkaido.

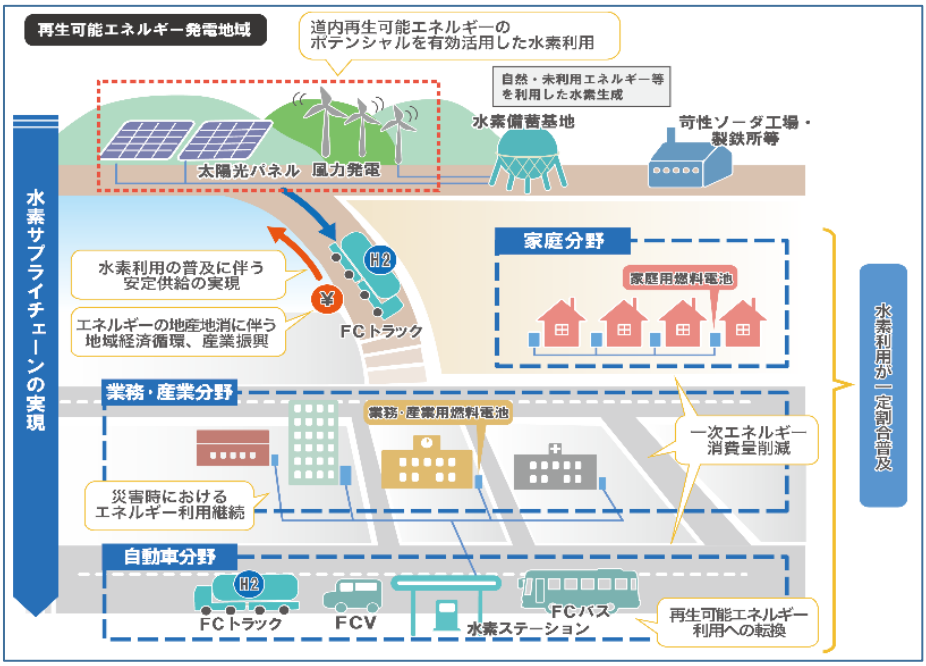


Figure 3-6 Image of Sapporo's hydrogen use goals for 2030 and beyond

Source: Sapporo City Hydrogen Use Policy

Chapter 4 Workshops and Courses

This chapter describes the Issues and future initiatives regarding the investigations related to energy and transportation sectors undertaken in this fiscal year's projects. It also includes the efforts and plans for decarbonization by private companies in Ulaanbaatar, as well as the products and technologies related to decarbonization by companies in Sapporo and Hokkaido. Finally, it describes an overview of the workshop conducted in Ulaanbaatar.

4.1 Issues in Ulaanbaatar

4.1.1 Issues in the Energy Sector

（1） Issues Related to Power Generation

Mongolia's electricity demand is on the rise, not only due to the expansion of industrial sectors such as mining but also due to daily consumption in the residential sector. Mongolia is rich in coal resources, which are readily available at low cost. The power generation in Ulaanbaatar relies on Combined Heat and Power (CHP) coal-fired power plants, with over 90% of the fuel consumption covered by coal, indicating an extremely high dependence on coal.

During peak hours from 5 PM to 10 PM, there is a shortage of electricity, leading to imports from neighboring countries. Mongolia covers 80% of its electricity needs domestically, but imports about 20% from neighboring countries, posing issues in energy security and foreign currency outflow. Additionally, the existing CHP plants, constructed between 1960 and 1980, are aging and becoming inefficient.

Table4-1 Mongolia's Electricity Generation and Imports by Source (2017-2021), Unit: GWh

	2017	2018	2019	2020	2021
CHP	5,826.9	6,152.4	6,346.6	6,493.6	7,109.6
Diesel Generation	3.7	3.7	3.0	2.7	1.1
Solar Power	19.7	51.5	109.0	108.9	156.9
Hydro Power	84.5	78.2	85.4	83.3	83.1
Wind Power	154.4	339.0	459.3	457.2	563.0
Total Domestic Generation	6,089.1	6,624.8	7,003.3	7,145.7	7,913.6
Imported Electricity	1,522.5	1,683.6	1,715.8	1,705.6	1,861.8

Source：Energy Regulatory Commission- 2021 Statistics on Energy Performance

In the latest Nationally Determined Contribution (NDC), the Mongolian government has emphasized the reduction of CHP utilization as one of the mitigation measures to reduce GHG emissions. To meet the increasing electricity demand and to scale down the use of aging CHPs, it is necessary to expand the introduction of renewable energy. Going forward, there is a need to accelerate the introduction of cost competitive VRE capacity without significantly impacting the existing system operations.

（2） Issues Related to the Introduction of Renewable Energy

1) The constraints of Ulaanbaatar's power grid

Mongolia's power system is composed of four transmission networks, with Ulaanbaatar being part of the Central Energy System (CES). The CES is not fully integrated with the Western and Eastern energy systems. Moreover, the CHPs in Ulaanbaatar operate near full capacity to meet heating demands, making it difficult to adjust the power generation flexibly.

Electricity generated from renewable energy sources, such as solar and wind, is subject to variability due to weather conditions, making the control of power generation challenging. Sudden load fluctuations due to demand changes and output variability of VRE can lead to an imbalance in the power supply and demand, adversely affecting the power plant equipment and, in the worst case, leading to large-scale blackouts.

In Ulaanbaatar, due to limitations in power interchange between domestic regions and the difficulty in adjusting the power generation of CHPs, there is a lack of flexibility to respond to sudden load fluctuations caused by demand changes and output variability of VRE, which imposes limitations on the introduction of renewable energy. Moreover, currently, a large part of the supply and demand adjustment function depends on international interconnections with neighboring countries, Russia, and China. For this reason, when introducing new renewable energy sources such as solar power, there is a requirement to install batteries simultaneously.

2) Transmission Capacity and VRE Output Forecasting Constraints

In Mongolia, there is progress in introducing large-scale renewable energy projects in locations far from Ulaanbaatar. The increased generation in remote areas is causing issues with the transmission and distribution network's system capacity becoming strained. Additionally, renewable energies such as solar and wind power have large output fluctuations, and the forecasting of these VRE outputs can often diverge significantly from actual demand. It is fair to say that reliable generation forecasting for VRE is not yet fully in practice.

In the future, as RE is expanded, it will be necessary to strengthen measures to cope with load fluctuations due to the increase in renewable energies. Improvements in VRE generation forecasting capabilities, enhancement of transmission line capacity, and reinforcement of the distribution system are required. The installation of IoT devices such as smart meters on VRE generators to collect monitoring data on generation, and the introduction of Distribution Management Systems (DMS) for renewable energies generation, can be considered for efficient system operation through overall system supply and demand management.

As an adjustment capability for load fluctuations, it is also necessary to promote the use of storage batteries, pumped-storage power systems, and the introduction of distributed renewable energy. Storage batteries can be installed at each renewable energies power plant to keep output fluctuations within a certain range. Additionally, installing storage batteries on the system side can contribute to the stabilization of the system.

（3） Issues Related to Electricity Pricing

In Ulaanbaatar, the selling prices for electricity and heat are set lower than the actual costs, and currently, the consumer electricity rate is on average about 5 cents per kWh. Due to the low electricity prices, power plants are operating at a loss the more electricity they sell. With this pricing system, the costs associated with power generation cannot be recovered, leading to financial difficulties for domestic energy-related institutions and making it challenging to allocate funds for equipment updates. Maintaining energy infrastructure and investing in equipment, overhauls, and appropriate levels of technological innovation for energy companies have become difficult. The low unit price of electricity is hindering the establishment of funds for new large-scale projects and private enterprise participation.[7]

The power from renewable energy producers is being purchased at prices set below 12 cents per kWh. The generation prices for renewable energies sources from solar and wind power are higher than those for power derived from CHPs. On the other hand, the purchase prices for renewable energies are set low relative to their costs. The financial burden becomes significant due to the purchase of renewable energies sources during low demand periods, leading the government to implement restrictions on the purchase of renewable energies sources.

（4） Issues Related to District Heating

In Mongolia, 60% of the total final energy consumption is attributed to thermal demand, primarily for heating. In Ulaanbaatar, the issue of heat supply for winter heating is significant due to temperatures dropping below minus 30°C during winter.

The main district heating systems supplied to many buildings in the urban areas of Ulaanbaatar are central heating provided by CHP plants and Heat Only Boilers (HOBs) that supply heat to specific areas. Both systems utilize steam and hot water and are dependent on coal.

CHPs supply heat along with electricity, and the supply of heat and electricity is closely linked. There are issues, such as CHPs needing to operate at full capacity even when electricity demand is low, primarily to meet heat demand during winter, as the demand for heat and electricity does not always coincide. HOBs use coal as fuel to produce hot water, warming nearby apartment buildings and schools. Some of these heating systems are operating beyond their service life, suffering from significant heat loss due to aging and likely emitting large amounts of GHGs.

In the Ger areas, where district heating is not established, heating is provided by individual small stoves using coal in each household.

During the severe cold period of 2020–2021 (minus 39°C), the heat demand was 2,992 Gcal/h.[8] On the other hand, the total heat supply capacity of Ulaanbaatar, when all boilers, turbines, and heating equipment operate without any reserve capacity during peak cold load, was 2,534 Gcal/h, which does not meet the demand.[9]

The government plans to convert to LPG for fuel to reduce GHGs and combat air pollution in the

[7] JICA "Final Report on Information Gathering and Verification Survey for Low-Carbon and Stabilization of the Mongolian National Power System," 2022, p.8
[8] Mongolia Ministry of Energy "HEATING SUPPLY OF ULAANBAATAR CITY," 2022
[9] Mongolia Ministry of Energy "HEATING SUPPLY OF ULAANBAATAR CITY," 2022

city, but in the future, the utilization of ground source heat pumps and sand storage heating systems, which do not emit CO2 during combustion, will be necessary.

4.1.2 Issues in the Transportation Sector

（1） Traffic Conditions in Ulaanbaatar

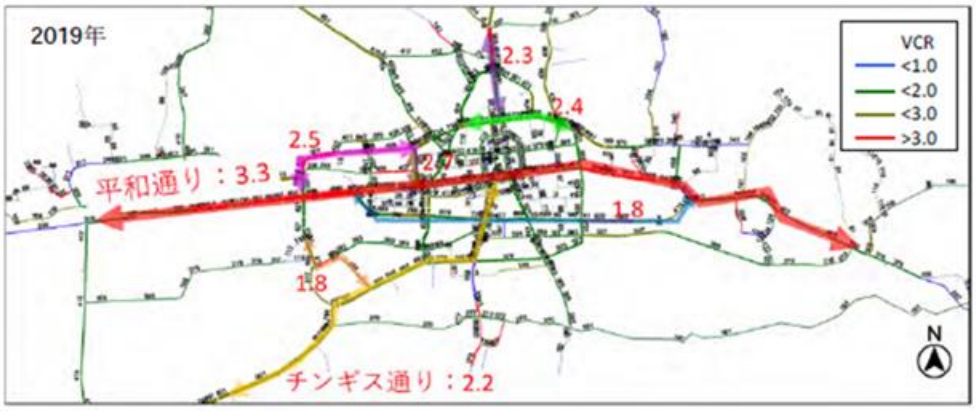
In Ulaanbaatar, the number of vehicles has significantly increased in recent years due to rapid population growth. The number of registered vehicles in Ulaanbaatar in 2020 was about 600,000, which is 2.7 times higher than in 2010. This increase in vehicles has led to serious traffic congestion in the city center. For example, on Peace Avenue, a major east-west corridor in 2019, there were sections where the congestion level, an indicator representing traffic congestion calculated by traffic volume/capacity, exceeded 3.0.

CO2 emissions from automobiles are influenced by driving speed; for instance, if the driving speed improves from 20 km/h to 60 km/h due to congestion mitigation, vehicle fuel efficiency improves, and as a result, CO2 emissions can be reduced by about 40%. Therefore, smoothing the flow of traffic in the city and improving driving speed are crucial issues for reducing CO2 emissions.

The main cause of congestion in Ulaanbaatar is considered to be a lack of traffic capacity relative to the number of vehicles, a hardware issue. However, this section organizes the issues in terms of software aspects, such as traffic management and diversion of traffic volumes, including public transportation services.

Source: Study on Traffic Congestion Mitigation Measures in UB City

Figure 4-1 Transition of Vehicle Registration Numbers in Ulaanbaatar (2010-2020)



Source: Report on Information Gathering and Confirmation Survey for Transport and Traffic Infrastructure Development in Ulaanbaatar, Mongolia (March 2022), Japan International Cooperation Agency (JICA)

Figure 4-2 Traffic Congestion Conditions in Ulaanbaatar City

1） Issues Related to Traffic Management

Currently, there are 408 intersections in Ulaanbaatar, out of which only 154 (38%) are equipped with traffic signals. There is a need to increase the number of signalized intersections as there remain intersections that require signal control. Moreover, due to budgetary constraints, updates to signal facilities have not been made, resulting in the degradation of management precision, such as CCTV. Furthermore, the signal timing settings at intersections have not been optimized according to actual traffic volume and conditions, and there is a lack of optimization in signal timings. There is a need for advanced traffic management that adjusts signal timings according to real-time traffic conditions.

2） Issues Related to Public Transportation Services

In Ulaanbaatar, buses are the only public transportation available. The lack of other public transport options leads to an insufficient supply to meet the mobility demand. Many bus users are traveling to and from the city center. On the other hand, due to inadequate road development, bus routes are concentrated on Peace Avenue, which runs east-west. As a result, the number of buses and passengers is high, especially during rush hours, leading to cases where buses are strung together, losing rapid transit capability. In recent years, a fare collection system has been introduced, and there is an expectation to efficiently manage and operate buses according to demand using such customer usage data.

Additionally, the current level of bus service is not high. Although bus priority lanes exist, they are not always effective as they are often invaded by general traffic or extended by queues of cars waiting for parking, which results in a lack of punctuality. It is necessary to improve the efficiency of public transportation management and enhance the service level of buses to provide more convenient services that can encourage the shift from private car use.

Source: Report on Information Gathering and Confirmation Survey for Transport and Traffic Infrastructure Development in Ulaanbaatar, Mongolia (March 2022), Japan International Cooperation Agency (JICA)

Figure 4-3 Overlapping Bus Routes

4.2 Initiatives for Issues

4.2.1 Initiatives in the Energy Sector

（1） Status of Renewable Energy Introduction

Mongolia, with over 70% of its total area consisting of grasslands and the Gobi Desert region, enjoys long sunshine hours and favorable wind conditions, offering significant potential for the utilization of renewable energy. It is said that about 10% of the country is suitable for wind power generation. The share of renewable energy in Mongolia's energy mix reached 18% in 2022.

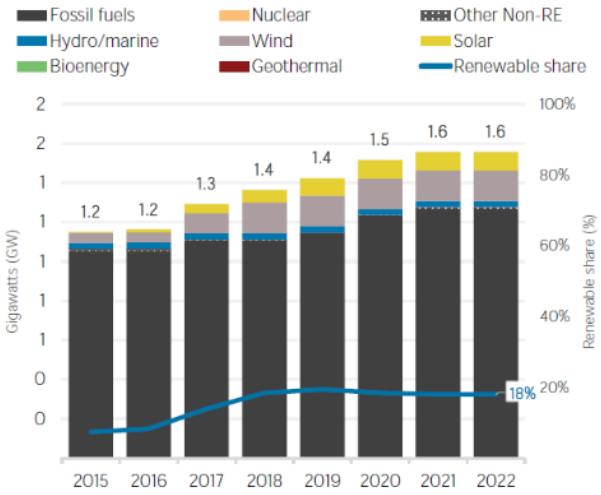


Figure 4-4 Transition of Mongolia's Power Generation Capacity by Energy Source

Source：IRENA[10]

The proportion of renewable energy, particularly wind power, in the total domestic power generation has been increasing in recent years. However, the share of renewable energy in the total domestic power generation remains at about 10%.

[10] Energy Profile Mongolia, https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/Mongolia_Asia_RE_SP.pdf

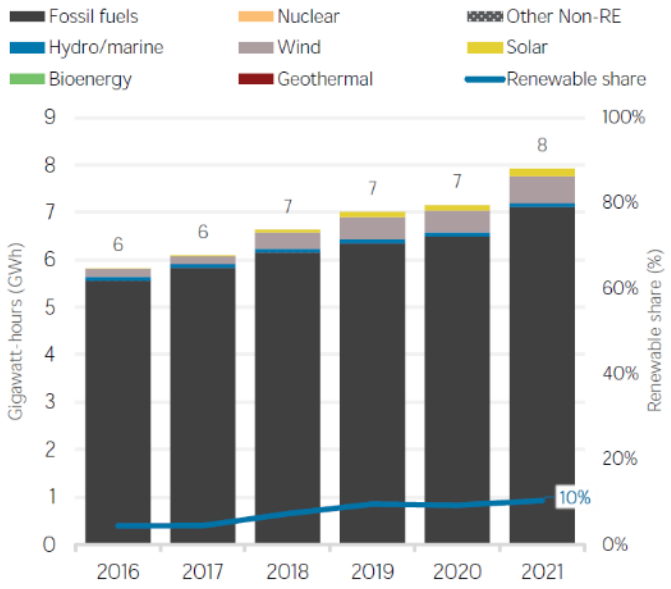


Figure 4-5 Transition of Mongolia's Power Generation Electricity Volume Composition by Energy Source

Source：IRENA[11]

（2） Enhancing Load Following (Battery Storage, Pumped Hydroelectric Energy Storage)

1) Battery Storage

The introduction of battery storage can be considered as an adjustment capability for load fluctuations due to the introduction of renewable energy. By installing batteries at renewable energies power plants, the unstable output of solar and wind power, which constantly varies, can be smoothed out, mitigating output fluctuations. Additionally, it enables peak shaving for electricity demand and effective utilization of surplus power. In Ulaanbaatar, the peak electricity demand occurs between 5 PM and 10 PM. By utilizing batteries, surplus electricity during daytime and late-night hours can be stored and then discharged during peak demand times, supplying power to the grid, and responding to electricity peaks.

Furthermore, installing batteries on the system side can contribute to system stabilization and system control measures. As an adjustment capability to maintain the power supply-demand balance, large-capacity system batteries can absorb and mitigate the output fluctuations of renewable energies. System batteries can also help alleviate system congestion by charging with surplus renewable energies.

System batteries can contribute to the stability of the power system in several ways, such as peak cutting, reducing imported electricity, improving system efficiency by absorbing surplus renewable energy, responding to sudden load and frequency fluctuations, preventing large-scale outages in case of power plant failures, and more. They can also reduce the burden on CHPs and are expected to contribute to the reduction of GHGs.

Large-scale energy storage batteries for transmission and distribution system stability include

[11] Energy Profile Mongolia Same as above

lithium-ion batteries, sodium-sulfur batteries, and redox flow batteries.

Table 4-2 Characteristics of Large-Scale Energy Storage Batteries

	Lithium-ion Battery	Sodium-Sulfur Battery (NAS Battery)	Redox Flow Battery
Characteristics	- Operates at room temperature, easy to handle - Lightweight and compact - Capable of rapid charging and discharging	- High-temperature operation - Compact - Design increases in parallel numbers for rapid charging and discharging	- Operates at room temperature, easy to handle - Easy to scale up to large capacities
Charging/Discharging Principle	Charging and discharging by moving lithium ions between the anode and cathode	Charging and discharging by moving sodium ions between the anode and cathode	Charging and discharging using the valence change of vanadium ions (movement of hydrogen ions)

Source: The Institute of Applied Energy (IAE), a general incorporated foundation.[12]

NAS batteries are capable of megawatt-class energy storage. As part of the Asian Development Bank's (ADB) "Upscaling Renewable Energy Sector Project," a Japanese-made NAS battery (with a rated output of 600kW and storage capacity of 3.6MWh) was introduced in Uliastai, Zavkhan in 2022. This was done in conjunction with the construction of a 5MW solar power plant, funded by the Bilateral Credit Offset Mechanism Japan Fund (JFJCM). Additionally, under the ADB's loan, a Chinese-made NAS battery (with a rated output of 80MW and storage capacity of 200MWh) was introduced at the Songino Substation on the outskirts of Ulaanbaatar, with trial operations beginning at the end of 2023, as part of the "First Utility-Scale Energy Storage Project."

On the other hand, in Mongolia, the Power Purchase Agreement (PPA) prices for renewable energy sources are higher than those for coal-fired power, which means that the use of batteries charged with renewable energy power presents an economic challenge.

2) Pumped Hydroelectric Power Stations

Along with battery storage, pumped hydroelectric power stations are also mentioned as an adjustment capability for load fluctuations due to the introduction of renewable energy. Pumped-storage hydroelectricity is expected as an energy storage device. Pumped hydroelectric power stations use the difference in elevation between an upper and a lower reservoir to pump water during periods of low demand and store it for generation during peak demand periods. By controlling the potential energy of water, energy can be stored and generated as needed, altering the value of electricity, and providing flexibility in the operation of the power system. However, it has been pointed out that pumped hydroelectricity is limited by installation location, requires significant equipment and operational maintenance costs, and there is approximately a 30% energy loss during

[12] "Understanding Carbon Neutral with Illustrations," 2021

the pumping process which could pose a challenge for cost recovery.

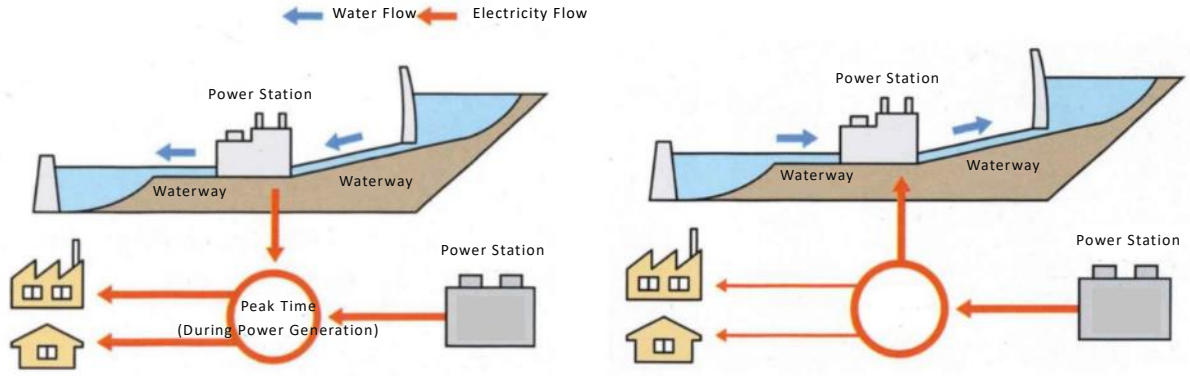


Figure 4-6 The Mechanism of Pumped Hydroelectric Power Stations
Source: Institute for Global Environmental Strategies, with some modifications.

（3） The Situation Regarding Hydrogen

Hydrogen has the function of energy storage. It is an energy carrier that can store, move, and supply energy generated from other sources. Hydrogen, when combusted, converts to thermal energy without emitting carbon dioxide, and is therefore considered to contribute to decarbonization.

Historically, hydrogen has primarily been produced using fossil fuels such as coal, oil, and natural gas. Currently, technologies for large-scale hydrogen production from renewable energy generation are being established, and the idea of storing surplus renewable energy as hydrogen and consuming it is being considered. If the storage and transportation technologies for hydrogen, its utilization technologies, and their cost improvements advance, it may open the possibility for economically viable green hydrogen.

Table 4-3 Categorization of Hydrogen Production Technologies by Color

Color of Hydrogen	Primary Energy Resource	Hydrogen Production Technology
Green	Renewable Energy	Electrolysis of water when using electricity
Grey	Fossil Fuels	Gasification technology without using CCS
Brown	Coal	Gasification technology

Mongolia has a keen interest in hydrogen production technology as part of its move away from reliance on coal. To support policy formulation related to hydrogen, the Mongolian Hydrogen Council was established in 2021. In November 2023, the Japan International Cooperation Agency (JICA) invited 13 Mongolian hydrogen stakeholders to Japan for lectures and site visits related to hydrogen.

Mongolia is anticipated to develop policies and concrete plans concerning hydrogen in the future. As of now, foundational surveys on the feasibility and application of hydrogen production in

Mongolia are limited to international institutions, universities, and some private companies.

According to a study conducted in 2021 on the potential of green hydrogen from renewable energy, Mongolia, with its abundance of land suitable for renewable energy installation, could potentially produce green hydrogen at relatively competitive prices in the future. Additionally, the use of green hydrogen is mentioned for large cargo transportation at the Oyu Tolgoi mine and as fuel for public buses in Ulaanbaatar. However, the same study also states the need to first formulate a comprehensive policy related to hydrogen that is integrated with national policies and targets, including other climate change measures.

（4） Issues Related to Heat Pumps

1) Heat Pump Air Conditioning

Heat pump air conditioning systems collect and move heat from the air to serve as a heat source for heating. Recently, heat pumps that can operate in areas with sub-zero temperatures during winter have been developed. During heating, these systems gather heat from outside to transfer indoors, providing heating with less electrical consumption and potentially reducing carbon dioxide emissions.

However, heat pump air conditioning, while energy-efficient, uses electricity and could thus increase the already strained power demand in Mongolia. Additionally, it can be more expensive than the existing coal-dependent CHP and HOB heating costs. Another issue with heat pump air conditioning is that it uses refrigerants, which can have a higher global warming potential (GWP) than carbon dioxide if those refrigerants are not carefully selected and managed.

2) Ground Source Heat Pumps

Ground source heat pumps involve installing a geothermal heat exchanger underground to use geothermal heat instead of outside air for heat exchange. The ground temperature is stable throughout the seasons, cooler than the outside air in summer and warmer in winter. Geothermal heat pumps can replace coal combustion for heating. They consume less energy than air conditioners, which can result in significant energy savings and CO2 emission reductions. However, there is a concern that the effectiveness of geothermal heat can gradually decrease as the ground loses heat with use.

Installation methods include borehole, foundation pile, and horizontal systems, which require either depth or a wide area. Therefore, their use in urban areas can often be limited. In Ulaanbaatar, there is potential for use in the ger districts not connected to central heating.

With support from the JFJCM under the ADB's "Improving Access to Health Services for Disadvantaged Groups Investment Program," the introduction of ground source heat pumps has been underway since 2022 for three new family health centers in the ger districts outside Ulaanbaatar City. Further, the ADB is planning to introduce medium-depth ground source heat pumps that use heat from about 2 km underground.

3) Solar-Assisted Ground Source Heat Pumps

Solar-assisted ground source heat pumps are hybrid technologies that combine ground source heat pumps with solar thermal collectors, generating heat from both technologies to maximize the efficiency of the heat pump. Solar-assisted ground source heat pumps can achieve a higher COP and potentially reduce the overall electricity consumption of the system. Additionally, the extra thermal energy obtained from the solar thermal collectors can reduce the length of boreholes needed, possibly cutting the initial investment costs of ground source heat pumps.

Supported by Japan's Ministry of the Environment's "Low-Carbon Technology Research and Development Program for Developing Countries," General Heat Pump Industrial Co., Ltd. is conducting renovation and demonstration of a geothermal-solar hybrid heat pump heating system in Mongolia. Once operational, it is expected to provide insights into cost reduction and future deployment strategies for solar-assisted geothermal heat in extremely cold climates, and further developments are anticipated.

4.2.2 Efforts in the Transportation Sector

Over the past decade, the total length of roads in Ulaanbaatar has increased from 954 km to 1136 km, an increase of about 20%, but the number of vehicles has more than doubled from approximately 234,000 to about 720,000, with the average traffic speed during peak times falling below 10 km/h. Given this situation, the status of congestion mitigation efforts being implemented and planned in Ulaanbaatar was investigated.

Table 4-4 Examples of Measures for Congestion Mitigation in Ulaanbaatar City

Traffic Issues	Measures	Status of Implementation
Efforts Related to Traffic Management	Vehicle Traffic Restrictions by Number Plate	In Progress
	Regulation of New Number Plate Issuance	Planned
	Provision of Road Traffic Information Using Web, etc.	In Progress
Efforts Related to Public Transportation Services	Relocation of Inter-City Bus Terminals	In Progress
	Reorganization of Bus Routes	In Progress
	Rental Electric Scooter Service	In Progress
Other	Construction of Large Parking Lots	Planned
	Establishment of Logistics Centers	Planned

（1） Efforts Related to Traffic Management

1） Vehicle Traffic Restrictions by Number Plate

In Ulaanbaatar, vehicle traffic restrictions based on number plates have been legislated to address congestion. Mongolian number plates consist of four digits followed by three letters that represent the region. The number plate restrictions regulate traffic during weekdays from 8 AM to 8 PM based on the last digit of the number plate. Table 4.6 shows the last digit of the number plate and the days when traffic is restricted, with regulations in place so that about 80% of vehicles in Ulaanbaatar are able to circulate on weekdays. During particularly busy times, such as holidays and the period

before the start of a new school term, restrictions are imposed based on the odd or even last digit of the number plate. The range of areas subject to number plate restrictions, as shown in Figure 4.7, includes the majority of central Ulaanbaatar, encompassing major service facilities such as offices, hospitals, banks, schools, shopping, and leisure facilities.

Since electric vehicles are exempt from vehicle traffic restrictions by number plate, an increase in the number of electric vehicles is anticipated in the future. However, due to reasons such as the price of electric vehicles, the lack of charging facilities, and performance degradation during the winter, there is a possibility that rather than owning electric vehicles to avoid number plate-based traffic restrictions, the number of people owning two gasoline-fueled vehicles may increase, contributing to the rise in the number of vehicles in Ulaanbaatar.

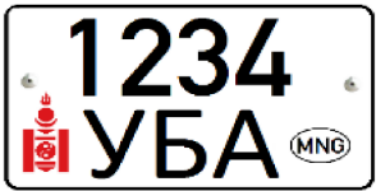


Figure 4-7 Mongolian License Plates and Regulated Areas

Source: Ulaanbaatar City Website

Table 4-5 Correspondence Between Traffic Restriction Days and Number Plate Digits

Days When Traffic is Restricted	Last Digit of Number Plate
Monday	○○○1, ○○○6
Tuesday	○○○2、○○○7
Wednesday	○○○3、○○○8
Thursday	○○○4、○○○9
Friday	○○○5、○○○0

2） Regulation of New Number Plate Issuance

In Ulaanbaatar, the number of registered vehicles has been increasing annually, and by the end of 2023, the number of registered vehicles is about 700,000. In light of this situation, the city of Ulaanbaatar is considering regulating the issuance of new number plates to keep the total number of vehicles to 730,000.[13]

[13] Ulaanbaatar City Website "https://ulaanbaatar.mn/news/18962"

3） Provision of Road Traffic Information Using Web and Other Means

Real-time road traffic conditions provided by CCTV camera footage are available on the website of the Ulaanbaatar City Traffic Control Center.[14] The Traffic Control Center publishes congestion information and CCTV footage, which is also shared on social media (Facebook) and radio during morning and evening peak hours for the convenience of the public

Figure 4-8 Example of Road Traffic Condition Provision Using CCTV Camera Footage

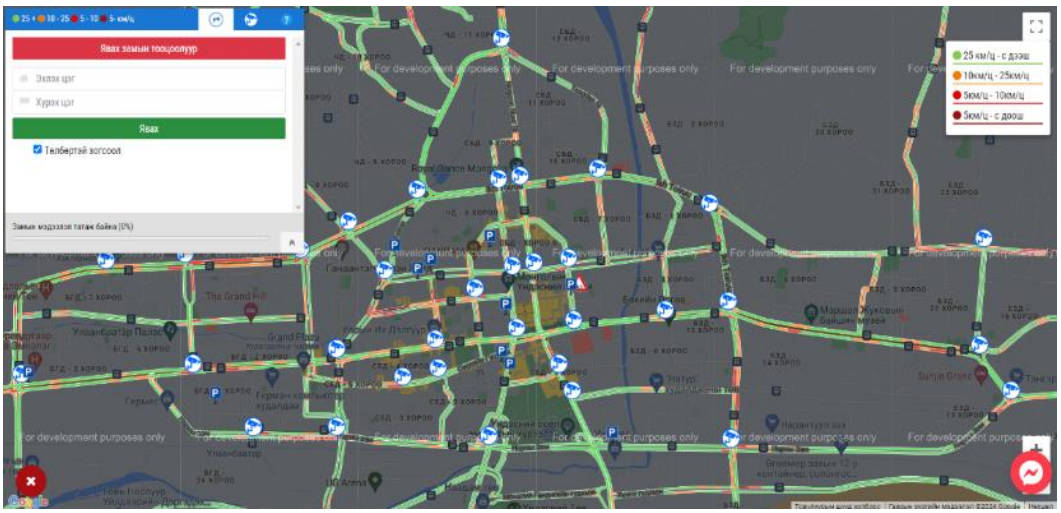


Figure 4-9 Provision of Traffic Information Using Social Media

Source: Ulaanbaatar City Traffic Control Center Website

（2） Efforts Related to Public Transportation Services

1） Relocation of the Inter-City Bus Terminal

In the center of Ulaanbaatar, there was the Dragon Bus Terminal, which served as the endpoint for inter-city buses. The Dragon Bus Terminal was the hub for regional operations connecting 36 cities in the northwest direction from Ulaanbaatar, typically hosting 65 buses and about 5,000 passengers, and during peak times, up to 150 buses and 12,000 passengers. Being one of the larger facilities in Ulaanbaatar, the Dragon Bus Terminal induced significant traffic, causing congestion

[14] Ulaanbaatar City Traffic Control Center "https://ubtraffic.mn/#"

in the surrounding roads.

In light of this, the Dragon Bus Terminal was relocated in August 2023 to a site 1.5 kilometers west of the city center, with the aim of moving the flow of people and vehicles away from the downtown area. The new location has an expanded site area and improved facilities, including waiting rooms and eateries, enhancing service quality.

Figure 4-10 The relocated Dragon Bus Terminal

2） Reorganization of Bus Routes

In Ulaanbaatar, between 400,000 and 500,000 people use the bus daily, and in 2023, about 1,000 buses operated on the 110 routes shown in Figure 4.11. Considering the situation where many routes passed through the city center and there were many overlapping routes, a reorganization of the bus routes was implemented.[15]

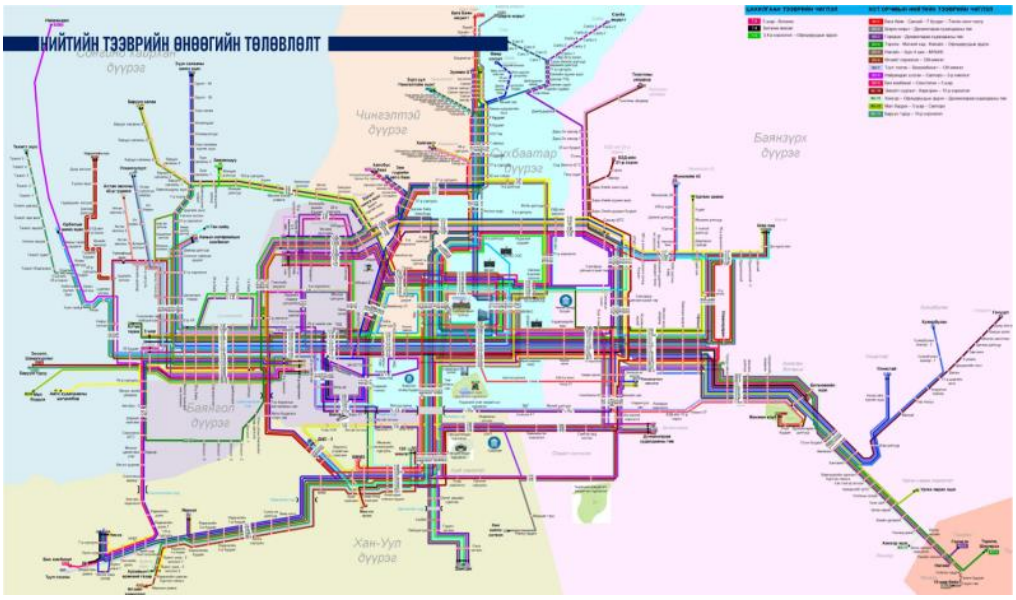


Figure 4-11 Old Bus Route Map

Source：Ulaanbaatar City Website

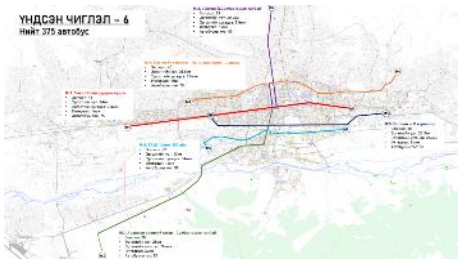
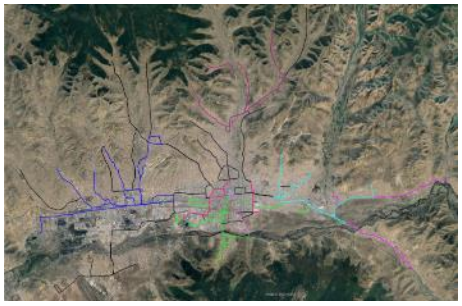
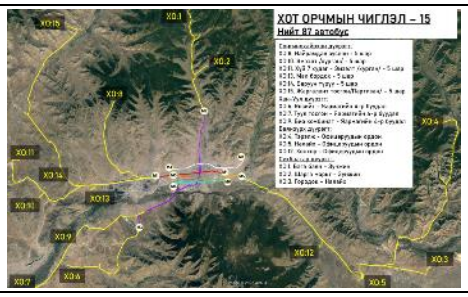
The new routes reduced overlaps, and the length of each route was shortened. The routes were set in four major classifications. An overview of the new routes is organized in Table 4.7. Along with the revision of bus routes, a review of bus fares is also being considered. The current bus fare,

[15] Source：Ulaanbaatar City Website https://ulaanbaatar.mn/news/18923

set in 2014, is 200 tugriks (about 10 yen) for children and 500 tugriks (about 25 yen) for adults, with free transfers allowed within 30 minutes. The fare revision proposal suggests setting the adult fare at 1,000 tugriks (about 50 yen) for up to 4 rides per day, considering the frequency of transfers.

The first day of the revised bus routes caused significant confusion and backlash among citizens, indicating insufficient preparation for the transition to the new routes and lack of public awareness. It is necessary to continuously monitor the situation going forward.

Table 4-6 New Bus Route Map

	Route Classification	Number of Routes	Route Map
1	Main Routes (City Center)	6 Routes	
2	Circular Routes Connecting Main Routes (Around City Center)	8 Routes	
3	Shortcut Routes	40 Routes	
4	Suburban Routes	15 Routes	

Source：Ulaanbaatar City Website

3） Rental Electric Scooters

The introduction of rental electric scooters is advancing as a measure for diversifying mobility and easing congestion. Ports have been installed at various facilities throughout the city, and about

3,000 electric scooters have been introduced. However, service providers are facing issues with theft, and users are citing the lack of safe passage space as a challenge. Additionally, during the winter, when congestion is most severe, the use of rental electric scooters is difficult, making it challenging to consider them as a year-round congestion mitigation measure.

Figure 4-12 Port for electric scooters and usage situation at a stop

（3） Other Traffic Congestion Measures

1） Construction of Large Parking Lots

As part of congestion mitigation efforts, the construction of large multi-story parking lots at public institutions is planned with the goal of eliminating on-street parking and improving traffic flow. In addition, to enhance the efficiency of parking lot operations and user convenience, the introduction of a system that centrally manages and publishes the availability of all parking lots is being considered. There are also plans to install electric vehicle charging facilities in parking lots to promote the adoption of electric vehicles.

Figure 4-13 Outline of new large-scale parking lot construction

Source: Borrowed from Ulaanbaatar Development Corporation

2） Establishment of Logistics Centers

Currently, the "Ulaanbaatar Railway Station" is located in the city center and is used as a logistics hub. As a result, it induces a lot of traffic and contributes to congestion. In light of this, the city of Ulaanbaatar is considering constructing a logistics center 34 km away from the city center to limit the traffic caused by downtown logistics and improve traffic congestion16. The construction is scheduled to start in 2024, and the Mayor of Ulaanbaatar has held consultations with logistics operators and sought opinions on the operation of the logistics center.

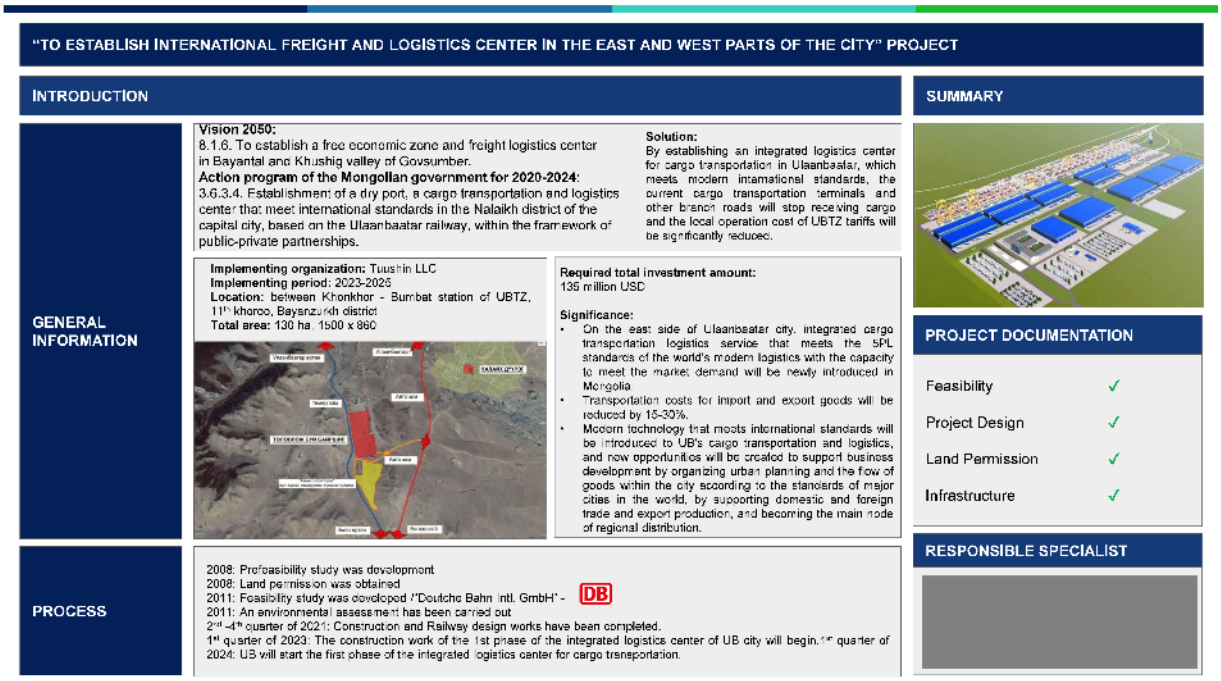


Figure 4-14 Outline of logistics center establishment

Source: Borrowed from Ulaanbaatar Development Corporation

（4） Technologies Expected to be Utilized

Referring to the efforts made by Ulaanbaatar city and others, technologies expected to be utilized in these initiatives and related technologies have been organized. Here, the focus is on smart technologies utilizing DX (digital transformation) and similar advancements.

Table 4-7 Technologies Expected to be Utilized for Smart Transportation

Issues	Measures	Technology - Initiatives
Efforts Related to Traffic Management	Vehicle Traffic Restrictions by Number Plate	- Traffic volume measurement using AI cameras - Advanced signal control (traffic signal control using AI)
	Provision of Road Traffic Information Using Web, etc.	
Efforts Related to Public	Relocation of Inter-City Bus Terminals	- Smart bus stops (providing bus approach and transfer information, even in cold climates)

16 Source：Ulaanbaatar City Website https://ulaanbaatar.mn/news/18954

Issues	Measures	Technology - Initiatives
Transportation Services		- Automation of bus control within terminals
	Reorganization of Bus Routes	- Proper use of user data (advanced fare collection systems, collection of bus boarding data using AI) - Understanding of travel conditions (connectivity of vehicles)
	Rental Electric Scooter Service	- AI-based demand-responsive transport - Introduction of rideshare taxis

1） AI-based Traffic Signal Control

This signal control method utilizes AI technology to realize a traffic control system that is as advanced as, or more advanced than, centralized control systems at a low cost. Specifically, traffic information near intersections obtained from radio wave radars and images is used to generate traffic information through an AI model trained on this data, including information about pedestrians and probe information (location data) from vehicles. This information is then input into autonomous, distributed traffic signals, which have a model implemented to calculate the optimal control parameters using AI, to control traffic signals. Furthermore, by exchanging traffic signal control information between intersections, an adaptive autonomous, distributed traffic control method is established that changes the signal display time according to this information.

Although currently at the level of a demonstration experiment, the experiment has shown that compared to conventional traffic lights, the AI signals can reduce average travel time by about 15-20% due to improved signal control performance at intersections, better pedestrian detection at crosswalks, etc., thus improving time benefits and contributing to CO2 reduction.

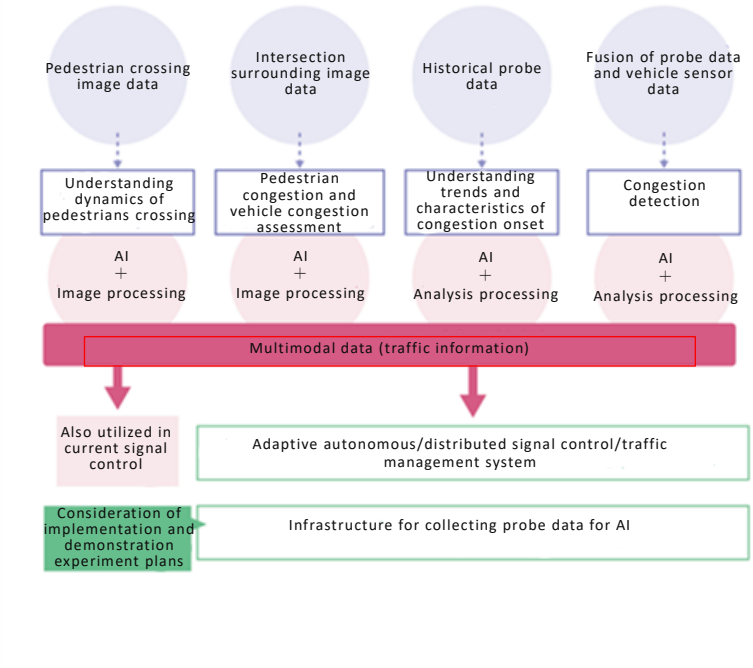


Figure 4-15 Overview of AI-based Traffic Signal Control

Source：NEDO Website https://webmagazine.nedo.go.jp/pr-magazine/focusnedo88/sp1-3.html

2） Smart Bus Stops

Smart bus stops automate the exchange of bus timetable information and allow the display of approaching bus information and information from multiple bus operators on one screen. This is expected to improve convenience during transfers. Additionally, it enables the consolidation and confirmation of bus operation information and announcements from multiple operators, as well as the dissemination of various information such as municipal and tourist information, improving the bus waiting environment and potentially generating advertising revenue. It is a system that can advance the transportation management of buses and other vehicles by using ICT and other technologies at transportation hubs such as bus terminals.

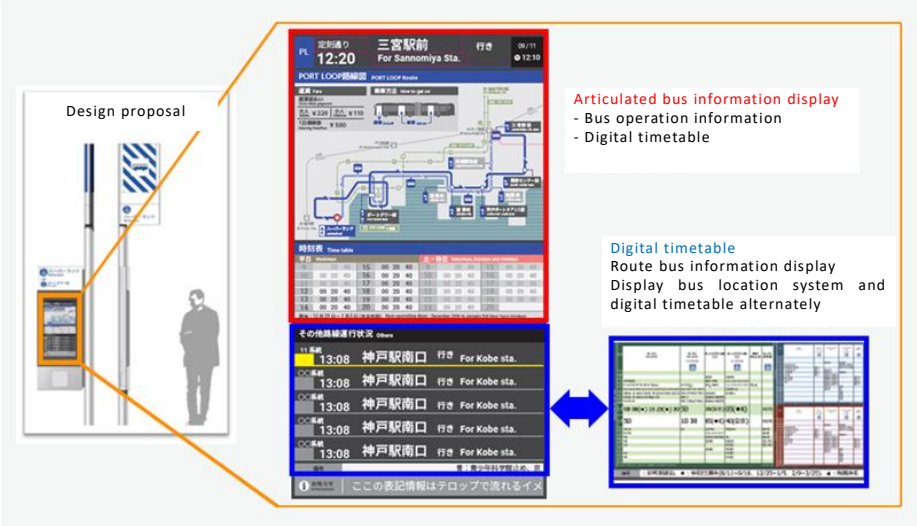


Figure 4-16 Smart Bus Stops

Source: YE Digital Website

Figure 4-17 Installation of Smart Bus Stops in Cold Regions

Source: Tokachi Bus Website

3） Automation of Bus Control within Terminals

Vehicle recognition functions installed in buses are used to automate the opening and closing of entry gates to the bus terminal, allowing only authorized buses to pass through, and sensors installed

at each disembarking area within the terminal allow for real-time understanding of bus stopping conditions, realizing centralized management. In Japan, the vehicle authentication function of ETC onboard units is used, and DSRC roadside antennas are installed at each disembarking area within the terminal for management.

Figure 4-18 Automation of Bus Control by Automatic Gate Opening and Closing

Source: Guidelines for Strengthening the Function of Transportation Hubs (Ministry of Land, Infrastructure, Transport and Tourism)

4） AI-based Collection of Bus Boarding and Alighting Data

The number of passengers boarding and alighting the bus is measured by analyzing images from cameras installed at bus bays using AI. The AI has a learning function that only measures the number of people getting on the bus, tracking the movement of people during boarding and alighting. The number of passengers measured using this system is published on the Website.

Figure 4-19 Automation of Bus Passenger Count Measurement

Source: Guidelines for Strengthening the Function of Transportation Hubs (Ministry of Land, Infrastructure, Transport and Tourism)

5） AI Demand-Responsive Transport

AI demand-responsive transport is a system that performs optimal vehicle dispatch in real-time to user reservations through efficient dispatch using AI. Such an AI dispatch system enables efficient dispatching of multiple reservations in real-time while assuming carpooling.

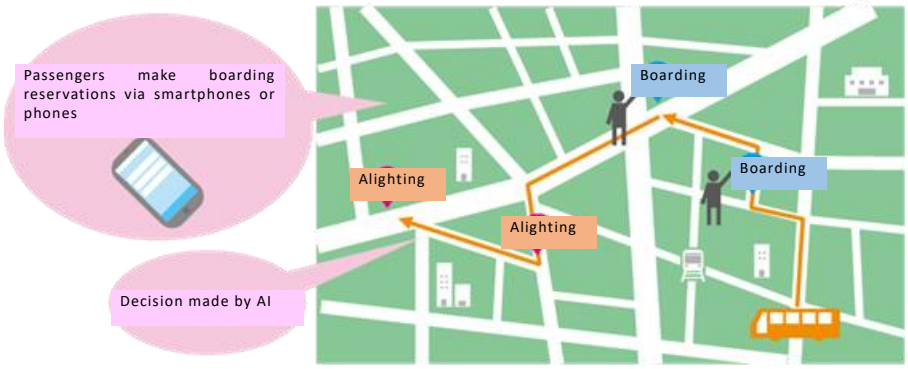


Figure 4-20 Image of AI Demand Operation

Source: General Policy Bureau of the Ministry of Land, Infrastructure, Transport and Tourism Website

（5） Issues for the Next Fiscal Year

At the first workshop held in August, an opportunity was created to gain a common understanding of the efforts and challenges related to traffic improvements for decarbonization, including case presentations from Sapporo and other locations in Japan, with the city of Ulaanbaatar. However, afterwards, there were significant personnel changes in the Ulaanbaatar City Transportation Bureau, and the system was not organized, preventing the opportunity for discussion, and the transportation needs of Ulaanbaatar City were not understood. Based on the initiatives in Ulaanbaatar City and others surveyed this fiscal year, it is necessary to propose priority measures and technologies to be implemented.

4.3 Needs of Ulaanbaatar City Companies

4.3.1 Needs Survey

Hearings were conducted with several major private companies in Ulaanbaatar City regarding their efforts related to decarbonization. The awareness of decarbonization among major private companies is high, and they are planning to undertake such initiatives in the future. These local private companies were encouraged to understand the support provided by the Joint Crediting Mechanism (JCM). Furthermore, they are considering the use of JCM and are planning to confirm their intentions with these companies. The table below lists the decarbonization plans of the companies surveyed.

Table 4-8 Decarbonization Efforts of Mongolian Private Companies

Company / Sector	Decarbonization Efforts
Telecommunications Company	- Intends to introduce renewable energy of 3.5kW or less at 1,600 base station sites across Mongolia to advance decarbonization. - Wants to make the base stations that introduce renewable energy passive houses. - Is also working on introducing renewable energy for data centers and would like to incorporate control functions that show the amount of power generated by renewable energy. - Has already introduced renewable energy at several data centers at its own expense.
Beverage Company	- Considering a plan to replace 94 delivery vehicles with electric vehicles (EVs), each truck being 15 tons. Initially, a few EVs will be introduced to check running conditions. The budget is not yet finalized. - Wants to introduce renewable energy in the beverage factory and cover electricity needs with renewable energy. The factory uses 1 million kW per year. Plans to visit factories that have introduced renewable energy to consider how to proceed. - 1,000 people work at the factory.
Food Company	- Considering updating two boilers in the food factory. The current boilers use coal, which causes air pollution and ash waste problems. Wants to switch to boilers that use LP gas. - The hot water heated by the boilers is mainly used for heating the food factory (2400 ㎡). The boilers operate for 20 hours from October to May, consuming 1,500 kg of processed coal per day. - The factory makes rice balls and lunch boxes, and 200 people work there. - For product distribution, the company delivers to 375 stores in UB city twice a day by truck and wants to reduce CO2 emissions by switching to EVs.
Mining Company	- Wants to produce green hydrogen near the mine. Provided own funds to the local national university to conduct basic research on green hydrogen. - Wants to help the villages near the mine become cities and is looking for available support to use for that purpose.
Bank	- Has set a goal to make all lending cases carbon-free by 2050. Is working on sustainable finance initiatives. - Can provide information on potential JCM projects for client companies.

Source: Created by the survey team

4.4 Decarbonization Products and Technologies of Sapporo/Hokkaido Companies

4.4.1 Sapporo/Hokkaido Companies' Seeds Survey

Information collection was conducted on domestic companies that can provide environmental equipment and technology and may contribute to Mongolia's decarbonization. The survey targeted companies in Hokkaido, centering on Sapporo City, as described below.

（1） Survey Method

The survey targeted private companies listed in the documents below, collecting information from the companies' websites regarding energy-saving and renewable energy technologies. Companies with business offices (including branches and sales offices) in the vicinity of Sapporo City were selected for the initial screening. Further selection was made based on criteria such as "having a head office in Hokkaido."

Table 4-9 Sapporo/Hokkaido Companies Survey Materials

Document	Description
Success Cases of Sapporo City's Manufacturing Support Projects	Examples of successful support projects for new technology and product development and human resource development of companies in Sapporo City.
List of Companies Registered with the Sapporo Zero Carbon Promotion Network	A dedicated site launched by the Sapporo Chamber of Commerce and Industry with the aim of promoting initiatives related to renewable energy, energy-saving, and new energy in Sapporo and connecting those who want to work on decarbonization with those who handle related products.
Sapporo Manufacturing Database	A search site for "manufacturing-related companies" that exist in large numbers in Hokkaido, centered on Sapporo City, launched by the Sapporo Chamber of Commerce and Industry.
Hokkaido Environmental Company Data BOOK 2017	Compiled by the Hokkaido Bureau of Economy, Trade, and Industry, containing information on environmental companies in Hokkaido.
Subsidy for Product Development and Sales Expansion for Small Businesses - List of Grant Recipients	A subsidy project to support the development of new products and technologies with high commercialization potential for small manufacturing businesses within the area of the "Sapporo Central Urban Area," as well as market development and expansion of new products developed or improved by the companies themselves.
Business EXPO 2023 Exhibiting Companies	Hokkaido's largest exhibition aimed at creating new business opportunities and revitalizing the economy and industry of Hokkaido, held by the Hokkaido Technology & Business Exchange Executive Committee. Includes business matching support, job search support, and business seminars.
List of Sapporo Innovation Lab Members	A corporation established with the aim of creating opportunities for technological innovation in the regional community and disseminating the necessary technologies.
Others	Target companies from past surveys on hydrogen utilization in Hokkaido, list of recipients of Hokkaido energy-related subsidy projects (provided by Hokkaido), etc.

（2） Survey Implementation Steps

The initial screening created a list of private companies from the documents mentioned above and gathered company information (1: business location near Sapporo City, 2: technology content related to energy-saving and renewable energy), excluding companies without relevant information.

For the secondary screening, the companies from the initial results were scored based on priority criteria, selecting the top 10 companies as interview candidates. The priority criteria were energy creation technology, off-grid, and cold climate adaptation.

（3） Survey Results

1） Initial Screening

106 companies were selected from the initial screening. The list of initial screening results is shown in the supplementary material.

2） Secondary Screening

From the secondary screening, 10 companies were selected as interview candidates based on scoring.

Table 4-10 Secondary Screening Results of Private Companies (Top 10 Companies)

No.	Industry / Location	Technology Content
1	Machinery (Obihiro City)	Ice shelter (ice room), biogas plant, plant factory
2	Manufacturing (Sapporo City)	Hybrid PC tower for onshore wind power
3	Manufacturing (Sapporo City)	Floating offshore wind power generation, bio fermentation gas power generation system, solar power generation system
4	Manufacturing (Sapporo City)	Ultra-compact electric vehicle for cold climates
5	Professional & Technical Services (Sapporo City)	E3 Road System
6	Manufacturing (Iwamizawa City)	Geothermal heat utilization air conditioning and ventilation system
7	Construction (Sapporo City)	Solar power generation, sewage heat utilization, snow air conditioning
8	Construction (Sapporo City)	Promoting smart cities through the smartification of existing homes
9	Manufacturing & Services (Sapporo City)	Hydrogen supply chain demonstration project utilizing hydrogen derived from livestock manure and urine
10	Manufacturing (Sapporo City)	Small wind turbines

（4） Interview Results with Companies That May Contribute to Mongolia's Decarbonization

From the ten companies selected in the second round, three companies with decarbonization technologies and products that could foreseeably be utilized in Mongolia were interviewed and the information about their products and technologies is detailed below.

Table 4-11 Companies That May Contribute to Mongolia's Decarbonization

Industry / Location	Decarbonization Efforts, Technologies, etc.
Manufacturing & Services (Sapporo City)	This company's efforts toward carbon neutrality include hydrogen business (hydrogen production from natural gas, etc.), wood biomass, CO_2 capture business, biogas from livestock manure, CO_2 gas recycling business, wind power generation, carbon nanotubes, etc., utilizing local resources. They also operate mobile hydrogen stations. They are also building a regional, circular supply chain for the production and consumption of energy by taking biogas from livestock manure and processing it into liquid biomethane, which is an alternative to liquefied natural gas.
Machinery (Obihiro City)	This company has biomass technology that can be utilized in ice shelters and at temperatures below freezing. Ice shelters are storage and air-conditioning facilities that utilize the winter's cold as a resource to make a low-temperature and high-humidity environment utilizing water and ice. This decarbonized thermal energy utilization system is well suited to cold climates. In Mongolia, large-scale farmers have large refrigeration facilities, which use large amounts of electricity, so there appears to be utility for this technology. Additionally, biogas is well suited be used in cold climates, and is in fact used in Hokkaido in minus 20-degree (C) temperatures. Using this company's machinery, renewable biogas is generated from animal manure at biogas plants, which is used to produce electricity and heat energy. This reduces the environmental cost of animal husbandry, and over 80% of the renewable produced is effectively utilized to reduce use of fossil fuels and contribute to CO_2 reduction The slurry leftover after processing makes a good fertilizer, enabling circular agriculture. 
Construction (Sapporo)	They are engaged in decarbonization measures utilizing hydrogen energy, solar power generation, snow cooling, and wastewater heat. Sewage heat involves laying heat-collecting pipes in the sewage pipes, circulating a heat-absorbing antifreeze solution, and utilizing it for road heating by using a heat pump. With enough heat-collecting pipe length, it can also be used for air conditioning. Due to the need to install heat-collecting pipes in sewage pipes, coordination with public sector organizations is required.

4.4.2 Matching Needs and Seeds

The interviews with major local private companies in Ulaanbaatar revealed the high potential presence of companies with a strong consciousness for decarbonization. In the future, the Energy Council at the Mongolia Chamber of Commerce and Industry, which includes local private companies working on decarbonization, will be approached to promote understanding of their decarbonization initiatives and the JCM facility subsidy projects. Subsequently, activities will be conducted on the potential for collaboration between Mongolian private companies and Sapporo/Hokkaido companies.

4.5 Meeting and Workshop in Ulaanbaatar City

Three workshops and meetings were held to share the policies and initiatives of Sapporo City

and Ulaanbaatar City. The results of the workshops are shown below. The materials of the workshops are attached as an appendix.

Table 4-12 Results of Workshops and Courses

Contents	Date
1st: Meeting/Workshop	28 August 2023
2nd: Workshop	14 December 2023
3rd: Meeting	31 January 2024

4.5.1 1st: Meeting/ Workshop

（1） Purpose

- To share the objective of the project and activities of this fiscal year
- Explanation and sharing of current status of JCM projects in progress and to be implemented in the future

（2） Outcome

- The objective, goals, processes, etc. of this year's project were explained, and the cooperation of Ulaanbaatar City was confirmed.
- Ulaanbaatar City confirmed information and intentions on the city's plan to realize a zero-carbon society, such as transportation to reduce carbon dioxide emissions.

（3） Overview of Event

Date: 13:00–14:30 (JST 14:00–15:30), Monday, 28 August 2023

Venue: Ulaanbaatar City Hall

Participants: From Mongolia: Ulaanbaatar City Hall, Urban Development Department of the Capital City

From Japan: Sapporo City (online), Oriental Consultants (OC), Asian Gateway (AG)

（4） Agenda

Time in Mongolia (Time in Japan)	Contents	Presenter
13:00～13:05 (14:00～14:05)	Opening: Opening Remarks by Ulaanbaatar City Opening Remarks by Sapporo City	Ulaanbaatar City Sapporo City
13:05～13:10 (14:05～14:10)	Participant Introductions	
13:10～13:20 (14:10～14:20)	Description of the 2023 Project (Objectives, Goals, Processes, etc.)	Ulaanbaatar City Sapporo City
13:20～13:30 (14:20～14:30)	Introduction of case studies on the City of Sapporo's efforts in hydrogen	
13:30～13:45 (14:30～14:45)	JCM projects in progress and future JCM projects development	OC
13:45～14:05 (14:45～15:05)	- Explanation of the concept of the transportation sector - Introduction of the initiatives and case studies of decarbonization through transportation improvement in Japan.	Sapporo City

Time in Mongolia (Time in Japan)	Contents	Presenter
14:05～14:15 (14:05～15:15)	Explanation of the current status of geothermal heat pump project	AG
14:15～14:25 (15:15～15:25)	Discussion and Question and Answer Session Information sharing from Ulaanbaatar	AG OC
14:25～14:30 (15:25～15:30)	Closing: Closing Remarks by Ulaanbaatar City Closing Remarks by Sapporo City Group Photo	Ulaanbaatar City

4.5.2 2nd: Workshop

（1） Purpose

- To share Ulaanbaatar city's decarbonization initiatives and future projects
- To share Sapporo City's initiatives related to decarbonization
- To enhance understanding of JCM projects and share the current status

（2） Outcome

- Sapporo's decarbonization efforts were shared with Ulaanbaatar.
- The first step of collaboration between JICA, Ulaanbaatar, and Sapporo in the city-to-city Collaboration is achieved

（3） Overview of Event

Date: 10:00-11:30 (JST11:00-12:30), Thursday, 14th December 2023

Venue: Khangardi palace, Ulaanbaatar City Hall

Participants: From Mongolia: Capital City Governor's Office, Capital City Environment Agency, Capital City Air and Environmental Pollution Control Agency

From Japan: Sapporo City, JICA Mongolia Office, Oriental Consultants

（4） Agenda

Mongolian Time (JST)	Title	Presenter
10:00～10:05 (11:00～11:05)	Opening Remarks: Objective of the workshop and explanation of JCM (5 mins)	Oriental Consultants
10:05～10:10 (11:05～11:10)	Introduction of participants (5mins) Photo session	
10:10～10:18 (11:10～11:18)	The challenges related to decarbonization in UB City, and the necessary efforts, technologies, and facilities for future decarbonization (8mins)	Capital City Environment Agency
10:18～10:25 (11:18～11:25)	The challenges related to decarbonization and efforts to reduce air and soil pollution or environmental issues (8mins)	Capital City Air and Environmental Pollution Control Agency

Mongolian Time (JST)	Title	Presenter
10:25～10:40 （11:25～11:40）	Efforts for Decarbonization in Sapporo City (15mins)	Sapporo City
10:40～11:00 （11:40～12:00）	JICA's efforts in Mongolia related to decarbonization and the environment (20mins)	JICA Mongolia Office
11:00～11:05 （12:00～12:05）	Discussion and Question and Answer Session (5mins)	Oriental Consultants
12:05～12:15 （12:05～12:15）	Closing Remarks：from Ulaanbaatar City from Sapporo City	

4.5.3 3rd: Meeting

（1） Purpose

- To share Ulaanbaatar City's decarbonization initiatives and future projects
- To share Sapporo City's initiatives related to decarbonization
- Through the above 1) and 2), discuss the formation of JCM projects, support through City-to-City collaboration, and share the activity policy for the next year.

（2） Outcome

- Ulaanbaatar City, Sapporo City and OC shared their thoughts on the initiatives and plans for decarbonization.

（3） Overview of Event

Date: 10:00-11:10 (JST11:00-12:10), Wednesday, 31st January 2024

Venue: Capital City Governor’s Office

Participants: From Mongolia: Capital City Governor's Office’ Development Policy and Planning Department, UB City Mayor’s office’ City Engineering Infrastructure Department, Governor's implementing agency for Housing Policy

From Japan: Sapporo City (online), Oriental Consultants

（4） Agenda

Mongolian Time (JST)	Title	Presenter
10:00～10:05 （11:00～11:05）	Opening Remarks: from Ulaanbaatar City (5 mins)	Deputy Governor of Capital City in charge of Social Sector, Green Development, Air and Environmental Pollution
10:05～10:10 （11:05～11:10）	Introduction of participants (3 mins) Photo session	
10:10～10:30 （11:10～11:30）	Objective of the workshop and explanation of JCM, and Exchange of Opinions on the C2C Collaboration for	Oriental Consultants

Mongolian Time (JST)	Title	Presenter
	next fiscal year (20 mins)	
10:30～10:45 （11:30～11:45）	Issues related to decarbonization and energy in Ulaanbaatar, and future initiatives (15 mins)	Capital City Governor's Office
10:45～11:00 （11:45～12:00）	Introduction of case studies of Sapporo's GX investment efforts (15 mins) <Tentative>	Sapporo City (online)
11:00～11:10 （12:00～12:10）	Question and Answer Session (10 mins)	Oriental Consultants
11:10～11:15 （12:10～12:15）	Closing (5 mins)	Capital City Governor's Office

Chapter 5　Study of JCM Project Development

This chapter will document the projects that have been identified in this fiscal year's survey as having the potential for future JCM project formation.

5.1 Consideration for a Large-Scale Solar Power Project

（1） Survey Overview

This project is the second phase of the construction of a solar power plant intended for supplying power to the grid, involving an expansion by adding 15MW of generation capacity. As the first phase, 15MW was introduced at the same project site in 2022, and after confirming the stability of the energy network, this project is planned as a second phase of additional construction.

Similar to the first phase, the electricity generated in the second phase will also be connected to the Central Electricity System (CES) through a substation. The use of renewable energy-generated power will reduce GHG emissions.

（2） Background Issues

Due to recent sustained economic growth, Mongolia has seen an increase in electricity demand. The improvement in the living standards of urban residents is also a factor driving up electricity demand. The mining sector, which consumes a large amount of electricity, accounts for a high percentage of power consumption. This project will contribute to policies aimed at reducing dependence on imported power by providing clean renewable energy to the grid.

（3） Overview of the Equipment and Technology to be Introduced

The solar modules will utilize JA Solar's JAM72D30-550MB from China. The conversion efficiency of this equipment is 21.3%. As of 2022, JA Solar has a cumulative delivery record of 103GW, making it one of the world's largest solar panel manufacturers.

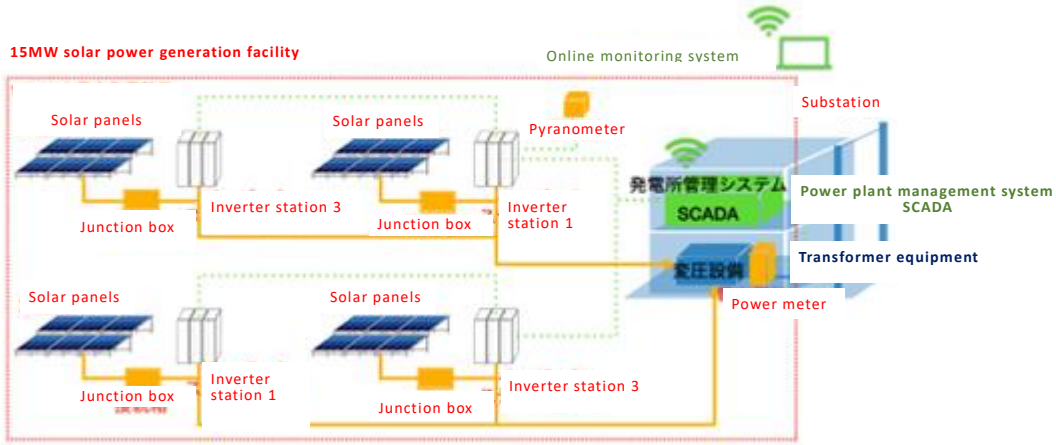


Figure 5-1 System diagram of the project

（4） Candidate Site

The project will be implemented in the Erdene soum area of Dornogovi province, located 590km

southeast of Ulaanbaatar. It is the same project site as the first phase. Dornogovi province, where mining and heavy industry are concentrated, needs to meet the rapidly increasing electricity demand in the southeastern part. The solar power generated at this project site will be directly connected to a nearby substation for the purpose of selling electricity, located 20m away.

（5） Implementation Structure

AG Corporation will act as the lead operator, forming an international consortium with Bayasaltugs LLC (BSTS), which has a record in Mongolia for the construction and operation of distribution and transmission networks and substations, and Solar Power Mongolia LLC (SPM). BSTS has been entrusted by the Mongolian government to manage projects involving the maintenance of substations and high-voltage grid networks (totaling 9,000km) and the development and engineering of diesel power generation. BSTS established SPM in 2016 to conduct business operations, including signing power purchase agreements, obtaining approval for environmental impact assessments, and securing permits for this project's construction. Additionally, BSTS has acquired 84.75ha of land in the Erdene soum area of Dornogovi province for the project implementation site. AG Corporation and BSTS have implemented the first phase of the 15MW solar power project and will continue to promote the second phase of the 15MW solar power project.

As the lead operator, AG Corporation will be responsible for creating and reporting MRV reports. The operation and maintenance of the installed equipment will be carried out by SPM. Local companies with experience in installing solar power generation facilities will be employed as the EPC contractors for this project.

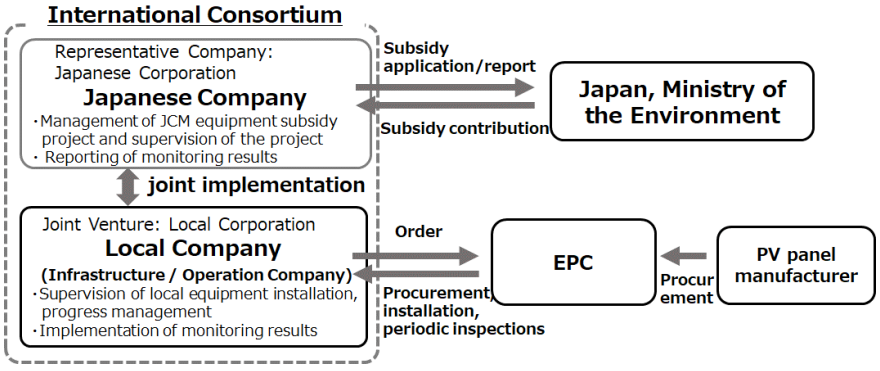


Figure 5-2 Implementation Structure Proposal

（6） Project Feasibility Assessment (GHG Emission Reduction, Cost-Effectiveness)

The CO2 reduction effect of the solar power system is calculated based on the amount of electricity supplied by the system to the grid electricity, using the grid electricity as a reference. The following formula is applied:

CO2 reduction by the solar power system = (Electricity generated by the solar power system) x (Emission factor)

Reference CO2 emissions - Project CO2 emissions
= 19,337 tCO2/year

Reference CO2 emissions
= Project generation amount 24,263 [MWh/year] x Emission factor 0.797 [tCO2/MWh]
Project CO2 emissions
= 0 [tCO2/year]

（7） Schedule

The second phase is planned to apply in September 2024. In Mongolia, December to March is the winter season, during which temperatures can drop below minus 30 degrees Celsius, affecting installation work. Considering the seasonal factors in Mongolia, installation work will be carried out excluding the December to March period.

Table 5-1 Schedule Proposal 1

Monthe	1	2	3	4	5	6	7	8	9	10	11	12
Application	Application											
Installation							Setup					
Operation										Operation		

（8） Remaining Issues and Future Response/Policy

Currently, the final inspection and completion report for the first phase are being prepared. For the implementation of the second phase, fundraising efforts will continue.

5.2 Consideration on Updating Boilers at the Food Processing Factory

（1） Investigation Summary

By introducing LPG boilers at a food processing factory located in the outskirts of Ulaanbaatar city, we aim to reduce GHG emissions and contribute to mitigating serious air pollution. We plan to stop using the existing coal-fired boilers and introduce new high-efficiency boilers, saving energy as well as reducing the emission of air pollutants.

（2） Underlying Issues

Boilers that use coal emit a large number of atmospheric pollutants such as dust when burned, causing serious air pollution. The factory has two coal-fired boilers that consume a significant amount of coal, contributing to air pollution and emitting a large amount of GHGs. They also have a negative impact on the health of the employees who handle them.

Figure 5-3 Existing Coal-Fired Boiler

Table 5-2 Existing Coal Boiler Specifications

Item	Specification
Output	600,000kcal/h
Ignition Method	Manual ignition
Water Volume	2200L
Boiler Operating Pressure	1 kg/cm2

（3） Overview of Facilities and Technologies to be Introduced

Converting the fuel from coal to LPG can improve the combustion efficiency of the boilers, increasing the calorific value per weight of the fuel, and reducing CO2 emissions. Moreover, since LPG does not contain sulfur or ash, it can virtually eliminate the emissions of sulfur oxides and dust.

The candidate for introduction, a through-flow boiler, is a type of water tube boiler. Compared to fire tube boilers and water tube boilers, it has less water content per unit of heat transfer area, which allows for a shorter time to generate the required steam from startup. Being comprised only of a tube system, without the need for a steam or water drum, it has a lower water content per unit of heat transfer area, making it compact and lightweight, enabling effective use of the boiler room. Not only does it save energy, but it also has low NOx characteristics, reducing the emission of atmospheric pollutants.

（4） Candidate Site

A food factory located about 10 km away from the urban area of Ulaanbaatar. The new boiler will be installed in the location where the current coal boilers are situated.

Figure 5-4 Existing Coal-Fired Boiler Installation Location

（5） Implementation Structure

The implementation structure proposal is described below.

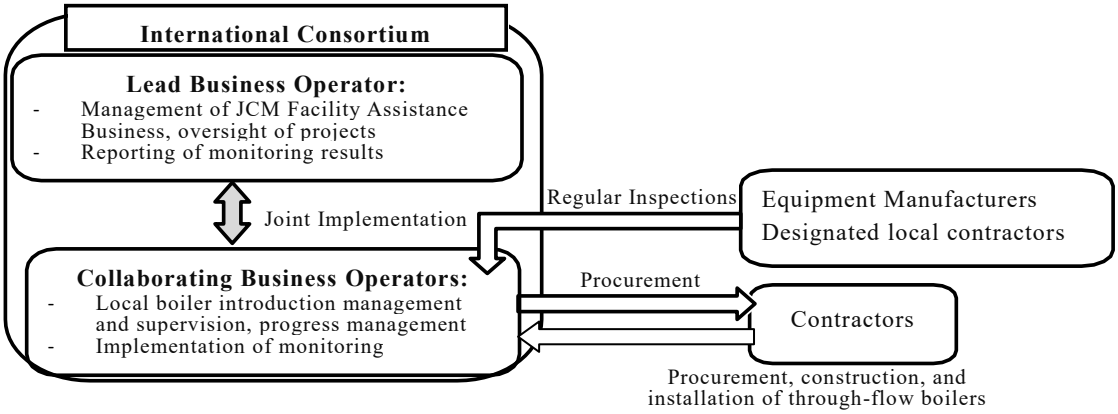


Figure 5-5 Implementation Structure Proposal

（6） Project Evaluation (GHG Emission Reductions, Cost-effectiveness)

Approximately 600-800 tCO2/y

= Reference CO2 emissions (Ry) [tCO2/y]

− Project CO2 emissions (Py) [tCO2/y]

Ry = Reference fuel consumption (RQfy) [t/y]

× Fuel emission factor (furf) [tCO2/t]

+ Reference electricity consumption (RQey) [MWh/y]

× Grid emission factor (gef) [tCO2/MWh]

Py = Project fuel consumption (PQfy) [t/y]

× Fuel emission factor (fupf) [tCO2/t]

+ Project electricity consumption (PQey) [MWh/y]

× Grid emission factor (gef) [tCO2/MWh]

（7） Schedule

The schedule proposal is described below.

Table 5-3 Schedule Proposal 2

Month	1	2	3	4	5	6	7	8	9	10	11	12
Local Survey	Boiler Selection Detailed Design											
Design			Formation of JCM International Consortium, Creation of PIN									
Introduction										Introduction of New Boiler		
Month												COD

（8） Future Responses and Policies

Plans are in place to finalize the selection of the boiler to be installed and to select the representative operator.

5.3 Examination of the Introduction of Solar Power Generation and Power Controllers to Communication Base Stations

（1） Survey Overview

The goal is to provide mobile phone base stations in Mongolia with a stable communication environment for extended periods by efficiently utilizing electricity generated by renewable energy (renewable energy) and the surplus power stored in batteries. By introducing renewable energy power and visualizing the data from renewable energy generation, we aim to reduce greenhouse gas emissions caused by base station power consumption.

（2） Background Issues

In Mongolia, the rapid proliferation of mobile phones has led to a surge in the number of base stations. On the other hand, there are many base stations that cannot use electricity due to their remote location or are prone to power outages, and the fuel consumption of diesel generators installed at base stations has become an economic and environmental burden.

（3） Overview of the Facilities and Technology to be Introduced

- Solar Power Generation: Install solar power systems on the poles of communication base stations and in surrounding areas.
- Wind Power Generation: Utilize small wind turbines to enable continuous supply of renewable energy power even at night.
- Controllers: Directly supply power to communication equipment through renewable energy power and visualize renewable energy generation data to enable rapid maintenance response.
- Batteries: Use batteries to allow stable power supply as an independent power source.
- As stable power supply is required for communication base stations, the aim is to supply power by combining the optimal ratio of renewable and conventional power.

（4） Candidate Sites

Select appropriate base stations from the many in Mongolia as JCM (Joint Crediting Mechanism) projects.

（5） Implementation System

An international consortium will be formed by the local telecommunications company and a Japanese corporation to purchase the equipment.

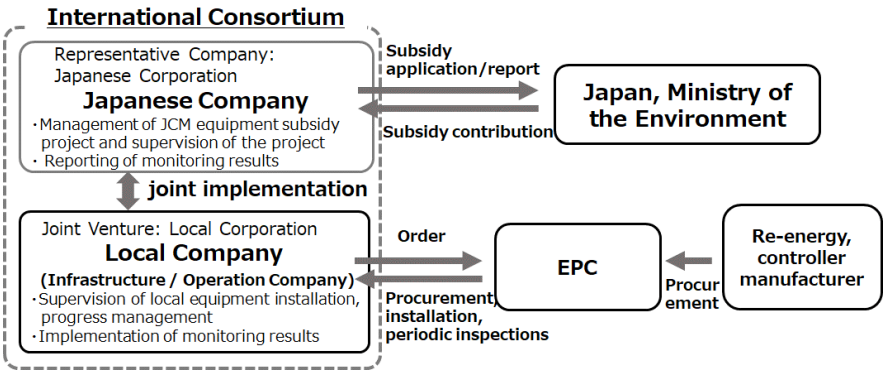


Figure 5-6 Implementation Structure Proposal

（6） Schedule

The proposed schedule is outlined below.

Table 5-4 Proposed Schedule 3

Month	1	2	3	4	5	6	7	8	9	10	～	18
Local Survey	Detailed Design											
Design			Formation of JCM International Consortium, Creation of PIN									
Introduction and Operation											Equipment Introduction → Sequential Operation	

（7） Remaining Issues and Future Response/Policy

Select the installation locations for the equipment assistance project and design optimally according to the installation location.

5.4 Consideration of Projects Related to the Deployment of System Connection Facilitation Battery Storage Systems and System Development

（1） Project Overview

A system-connected battery storage system will be deployed in the suburbs of Ulaanbaatar, directly connected to the power grid (system) at a substation and co-located with a solar power generation system. During the day, the newly installed solar power generates electricity that is charged to the battery storage system. At night, electricity derived from existing wind power

generation is orderly charged to the storage system, and this renewable energy is then discharged to the system as an adjustment power source.

（2） Underlying Challenges

In Ulaanbaatar city, due to economic growth and improvements in residents' living standards, there is an increasing demand for electricity, and there is a shortage of power during peak hours, from 5 to 10 pm. This project will enable system stabilization, load shifting, and secure backup power by charging surplus renewable energy during the day and discharging it during peak times. It will contribute to the stability of the CES power grid and the reduction of GHG emissions.

（3） Overview of the Equipment and Technology to be Introduced

The introduction of a system-connected Battery Energy Storage System (BESS) and an Energy Management System (EMS), integrated with solar power generation facilities, is under consideration as a package system. The introduction of NAS batteries (Vanadium Redox Flow Battery) is being considered for the system storage batteries. The assumed model for the BESS installation capacity is 10MW/42MWh.

（4） Candidate Sites

From the following candidate locations, an appropriate first site will be selected, and thereafter, the project will be implemented sequentially at the candidate locations.

Project Name BESS Size / PV Capacity	Location
Yesunbulag project 10MW/42MWh BESS	Yesunbulag soum, Gobi-Almai province
VAAR 10MW/42MWh BESS+1.5 MW PV	Songinohairkhan district, UB city
Choir 100MW BESS+PV-4.9x4= 19.6 MW PV	Sumber soum, Gobi-Sumber province

（5） Implementation System

The lead business operator will be responsible for overall management, while the joint proposers will handle the practical development of the local project. Companies that are candidate participants in JCM are expected to participate as EPC (Engineering Procurement Construction) contractors. Moreover, actual construction and procurement of materials are expected to be entrusted to local companies with experience in implementing local PV and BESS projects.

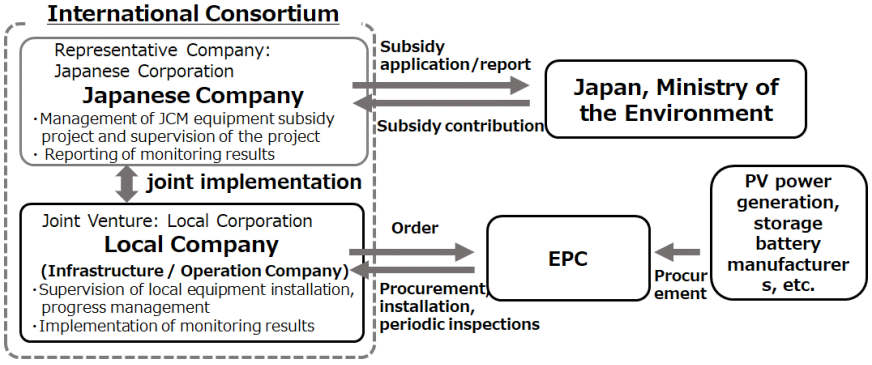


Figure 5-7 Implementation Structure Proposal

（6） Business Evaluation (GHG Emission Reduction, Cost-Effectiveness, Payback Period)

The installation of a BESS with a capacity of 10MW/42MWh (Chinese-made ternary lithium battery) is assumed. The project cost is estimated at 13.5 million US dollars. The distribution capacity is 15,299 kWh, and negotiations for a PPA (Power Purchase Agreement) are underway with a selling price of 0.156 USD/kWh and a buying price of 0.020 USD/kWh.

（7） GHG Emission Reduction

The assumptions for the expected GHG reductions through this project are: 1. CO2 emission reductions from the grid emission factor due to the new installation of the PV system, 2. additional CO2 emission reductions due to the nighttime supply of surplus electricity generated by the PV system through the battery storage, and 3. additional CO2 emission reductions during off-peak times through the storage of surplus renewable energy (such as wind power) connected to the grid.

The GHG emission reduction at the candidate VAAR substation will be as follows:

1: Emission reduction effect due to the new installation of PV: 33,243 tCO2/y

2: Stabilization effect of PV by battery storage: 30,062 tCO2/y

3: Effect of energy storage from the grid by renewable energy: 178,866 tCO2/y

From the estimates, the GHG emission reduction at the VAAR substation is expected to be 242,171 tCO2/year.

（8） Schedule

Progress is being made on the conceptual design of the storage facility, the optimal layout plan, etc. A JCM international consortium will be formed, and a PIN will be created. Selection of BESS will be completed, and EPC will commence.

Table 5-5 Schedule Proposal 4

Month	1	2	3	4	5	6	7	8～	14	15
Local Survey	Detailed Design									
Design		PIN Creation								
Construction Operation								BESS Selection EPC Commencement		COD

（9） Remaining Issues and Future Response Policy

- Select the optimal technology and manufacturer for the system storage battery. Clarify the detailed specifications and performance records from the manufacturers, obtain detailed quotations, and confirm warranty conditions, etc.
- Organize requirements definition and solutions aimed at improving system stabilization and adjustment capabilities.
- Proceed with PPA price negotiations, calculate project profitability based on the PPA price, and refine the business model.

5.5 Pumped Storage Power Project Review

（1） Survey Overview

In the suburbs of Ulaanbaatar, a pumped storage power station will be installed to store surplus renewable energy generated during the day from sources such as wind power and provide electricity during the evening peak load times and in emergencies. Currently, during peak times, electricity is imported from neighboring countries, where power generation is mostly coal-fired, so this project could contribute to the reduction of greenhouse gases (GHG).

（2） Background Issues

In Ulaanbaatar, there is a shortage of electricity during the peak demand hours of 5 to 10 p.m. On the other hand, the amount of renewable energy, such as solar and wind power, generated during the day is increasing, but the lack of flexible adjustment of the power system has become an obstacle to the introduction of more renewable energy. By charging surplus renewable energy during the day at the pumped storage power station and discharging it during peak times, the project aims to promote the use of renewable energy by supplying electricity to neighboring households and factories.

（3） Overview of Facilities & Technology to be Introduced

Water at a maximum usage rate of 27.94 m³/sec is moved from an upper to a lower adjustment pond using a drop of 68 meters to generate electricity. Two Francis turbines of 55 MW each will be installed. The Francis turbines planned for this project use the velocity and pressure of water to rotate the runner. The water that falls enters a spiral casing and contacts the runner after passing through adjustable vanes in a rotating inward flow, turning the turbine. Francis turbines can be used in a wide range of head drops, from 10 to 300 meters.

Table 5-6 Details of the Planned Pumped Storage Power Generation

Capacity (pump turbine) 2×55 MW	110MW
Annual production electricity	310,000Mwh
Dam crest length	580 m
Maximum dam height	68 m
Dab reservoir volume	1875 Million. m³
Upper reservoir max/min working level	1490/1470 M
Minimum/operational water level of the lower storage reservoir	1245/1242 m
Rated head	H = 245 m
Unit number	2 set
Francic type reversible vertical pump/turbine	54.5/67.5 MW
Water discharge	Q = 27.94 m³/sec
Daily working time (T)	8.5 h
Working head max min	H = 224/249.3 m H = 209/219.3 m

（4） Candidate Sites

The installation is planned next to a new sewage treatment plant in the Songino Khairkhan district. The drop between the upper and lower adjustment ponds is 68 meters.

Figure 5-8 Pumped Storage Power Station Diagram

Figure 5-9 Planned Location for Pumped Storage Power Construction

（5） Implementation System

A local infrastructure and operating company have been established for this project.

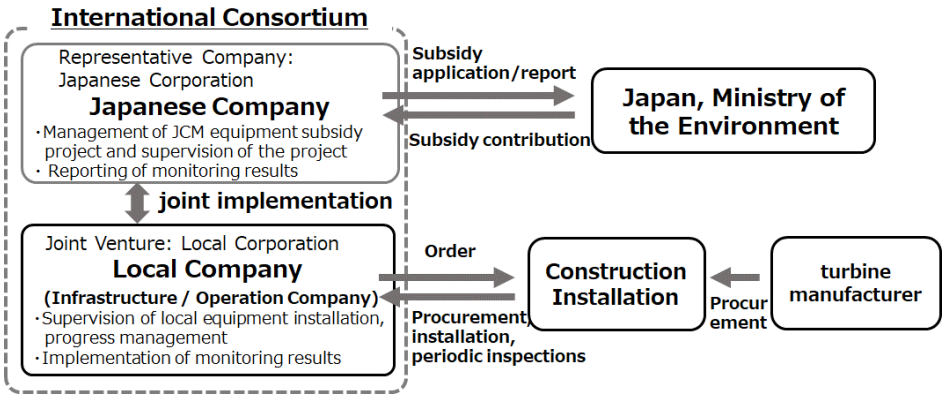


Figure 5-10 Implementation Structure Proposal

（6） Remaining Issues and Future Response & Policy

The total investment required for this project is estimated at approximately 175 million US dollars. The construction period is scheduled to be completed within 3 years. The local

infrastructure and operating company are advancing fundraising and will continue to look for investors.