MOEJ

Final Report

City to City
Collaboration for
Zero-carbon Society in FY2020

Zero Carbon Society Development in
Ulaanbaatar City and Tuv Aimag

March 2021

Oriental Consultants Co., Ltd.

Sapporo City

Table of Contents

List of Figures and Tables

Abbreviations

Abbreviation	Formal name
EPS	Expanded Poly-Styrene
GDP	Gross Domestic Product
GHG	Greenhouse Gas
JCM	Joint Crediting Mechanism
ME	Ministry of Energy
MET	Ministry of Environment and Tourism
MoCUD	Ministry of Construction and Urban Development
MoMHI	Ministry of Food, Agriculture and Light Industry
UB	Ulaanbaatar
ZEB	Zero Emission Buildings
ZEH-M	Net-Zero Energy Housing-M

Chapter 1. Project Overview

1.1. Project Purpose

The Paris Agreement came into force in November 2016 and entered into practice in 2020. As indicated by the Paris Agreement, which encourages not only national governments but also sub-national governments, including local and city authorities, to step up climate change mitigation efforts, local and city governments are expected to take a key role in formulating and implementing regional climate change programs and projects. Moreover, as it has been noted that the global transition to a zero-carbon society requires accelerated efforts to create, at first, low-carbon societies and then, sustainable, zero-carbon societies, especially in rapidly developing Asian economies, the international community has stepped up efforts to assist city governments in creating a low- or zero-carbon city to facilitate socioeconomic development.

In this project, a study was conducted to examine how, in collaboration with Japanese city governments that have the experience and know-how to create a low- or zero-carbon society, Japanese research institutions, universities, and private companies could support the efforts of overseas local authorities to introduce solutions and technologies that would facilitate their shit to a low- or zero-carbon society.

1.2. Project Outline

Project title:	City to City Collaboration for Zero-Carbon Society in FY2020 (Consignment Programme): Zero Carbon Society Development in Ulaanbaatar City and Tuv Aimag
Duration:	From November 2020 to March 10, 2021
Consigner:	General Director of the Global Environment Bureau, the Ministry of the Environment
Consignee:	Oriental Consultants Co., Ltd.

1.3. Project Activities

1.3.1 Project Components

(1) Review existing energy-saving housing and building infrastructure in cold climates

1) Review and propose zero-carbon housing projects
2) Showcase advanced energy-saving technologies and advise on their applicability to building design
3) Explain the Comprehensive Assessment System for Built Environment Efficiency and advise on its applicability
4) Map out JCM Model Projects and financing schemes for next fiscal year and onwards
5) Interview companies from Sapporo, Hokkaido to gauge their interest

(2) Analyze the applicability of renewable and alternative energy sources in Ulaanbaatar

1) Summarize and showcase cold-weather technologies and know-how used in Sapporo, Hokkaido

(3) Support the capacity development of the Ulaanbaatar City Government

1) Summarize and showcase cold-weather measures taken by the Sapporo City Government

1.3.2 Project Activities

(1) Review existing energy-saving housing and building infrastructure in cold climates

1) Review and propose zero-carbon housing projects

The project team analyzed the applicability of zero-carbon technologies (switching from coal to alternative fuels) to cold-weather housing in a satellite city near the New Ulaanbaatar International Airport (Aerocity). The project team also analyzed the feasibility of constructing or renovating government and private office buildings with zero-carbon technologies in Ulaanbaatar.

2) Showcase advanced energy-saving technologies and advise on their applicability to building design

The project team showcased Japan's advanced energy-saving technologies and analyzed their applicability to building design in Mongolia.

3) Explain the Comprehensive Assessment System for Built Environment Efficiency and advise on its applicability

The project team explained the Comprehensive Assessment System for Built Environment Efficiency of Sapporo (CASBEE Sapporo) and analyzed its applicability to Ulaanbaatar in Mongolia.

4) Map out JCM Model Projects and financing schemes for next fiscal year and onwards

The project team planned how to use the JCM Model Project and financing schemes to introduce zero-carbon technologies (switch from coal to alternative fuels) in cold-weather housing in a satellite city near the New Ulaanbaatar International Airport (Aerocity).

5) Interview companies from Sapporo, Hokkaido to gauge their interest

The project team interviewed companies from relevant industries (e.g. building design, insulation, and window frame industries) in Sapporo, Hokkaido to gauge their interest in participating in this project.

(2) Analyze the applicability of renewable and alternative energy sources in Ulaanbaatar

1) Showcase cold-weather technologies and know-how used in Sapporo, Hokkaido

The project team showcased regional heating and cooling systems and geothermal, snow and ice cryogenic and other renewable energy technologies and know-how used in Sapporo.

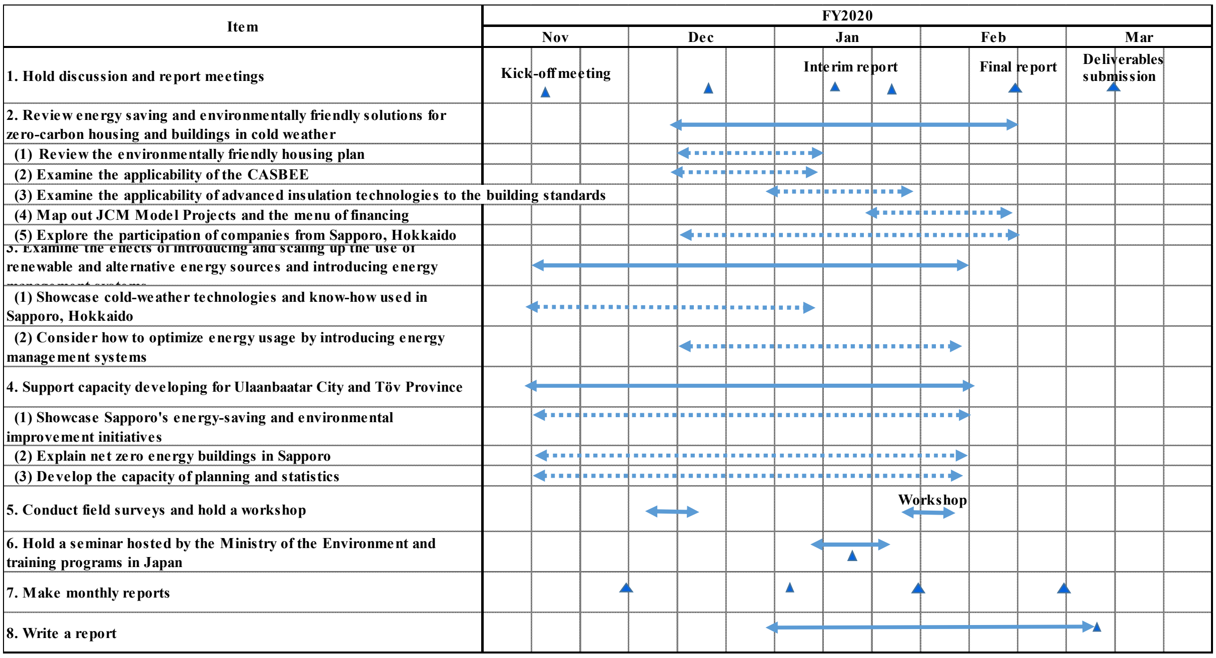
(3) Support the capacity development of the Ulaanbaatar City Government

1) Showcase energy-saving and environmental improvement measures taken by the Sapporo City Government

The project team explained energy-saving and environmental improvement measures put in place in cold weather in Sapporo and shared relevant knowledge and experiences with Ulaanbaatar Municipal officers.

1.4. Operation Schedule

This project was carried out in accordance with the following operation schedule.



1.5. Project Implementation Structure

The organizational structure of the project team is planned as follows.

Project Team Plan

Role	Candidate Name	Organization & Position	Tasks
Expert Leader	Masanori Fujii	Assistant Senior Manager, Overseas Division	- Supervise project operations - Support capacity development - Coordinate stakeholders
Expert	1) Motofumi Suzuki	Senior Advisor, Overseas Division	- Assist in supervising project operations
	2) Masahiro Tsuzuki	Assistant Senior Manager, Overseas Division	- Investigate and collect information - Assist in formulating energy saving plans for the housing and building sector - Write a report
	3) Yuji Sato	Assistant Senior Manager, Overseas Division	- Map out JCM Model Projects - Develop MRV methods - Write a report
	4) Mai Suzuki	Engineering Manager, Overseas Division	- Investigate and collect information - Coordinate project operations - Write a report

1.6. Operational Challenges and Countermeasures

(1) Implications of COVID-19

Because commercial flights to and from Mongolia had been suspended since March 2020 due to the COVID-19 pandemic, the project team was not allowed to enter Mongolia. In addition, the project activities were restricted in Ulaanbaatar due to a one-month lockdown in November 2020 and another lockdown in February 2021 in the city. Therefore, the field survey was conducted online with support from the Mongolia-Japan Center in Mongolia.

(2) Administrative changes in Mongolia

When a new mayor was elected in Ulaanbaatar in October 2020, the municipal officers in charge of this project were replaced by new appointees, with whom the project team needed to reestablish a collaborative relationship. In addition, the project team lost contact with the responsible municipal officers of Ulaanbaatar for several days after the Cabinet resigned suddenly in January 2021. With support from the Sapporo City Government and local staff of the Mongolia-Japan Center, the project team contacted the Deputy Mayor of Ulaanbaatar City (in charge of construction projects) to reestablish contact with responsible officers.

Chapter 2. Ulaanbaatar City Profile and Its Building Sector

2.1. Ulaanbaatar City Profile and Its Climate Change Mitigation Efforts

2.1.1 Ulaanbaatar City Profile

(1) Overview of Ulaanbaatar

After the collapse of communism in the 1990s, Mongolia went through a transition from a centrally planned to a market economy, and many of the public support and stock farming promotion schemes established during the communist regime were scrapped. This was followed by the collapse of rural economies, the spread of a monetary economy, and the surge of resource prices, which increased the gap between the rich and poor. Due to the deterioration of public services and the lack of employment opportunities in rural areas as well as snow disasters occurring every few years, many nomads moved from rural areas to Ulaanbaatar. This movement was further fueled by the enforcement of the Land Privatization Law, which allowed people to choose where to live in accordance with the more democratic 1992 Constitution.

As immigrants to Ulaanbaatar built tent houses called “gers” without permission from the local authorities, informal settlements called Ger areas were formed randomly. Thus, the large inflow of poor migrants in the 2000s caused a construction boom in Ulaanbaatar, while there was no urban development plan in place. The Ger areas are inhibited by 60% of the city’s population, which increased 2.5 times from 650 thousand in 1998 to 1,530 thousand in 2019. Now, a half of the country’s population is concentrated in Ulaanbaatar.

Ulaanbaatar is one of the coldest capitals in the world, with the daytime temperature down to -15 to -30 degrees Celsius, sometimes even to -40 degrees Celsius, in December and January. Home heating is needed for many months of the year (eight months), from mid-September to mid-May. Because most of the population is concentrated in the city, there is a serious lack of urban infrastructure, and the resulting high consumption of coal for home heating has caused one of the most serious air pollution problems in the world.

Table 2-1. Monthly Average Temperature (Degrees Celsius) and Humidity (Percent) in Ulaanbaatar

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	-24.6	-21.1	-8.2	2.4	10.7	16.4	18.2	16.3	9.1	0.5	-11.0	-20.8
Humidity	71	69	60	46	45	52	60	60	59	64	72	73

Mongolia is also one of the largest coal producers and consumers in the world. In addition, most houses in Ger areas do not have heating systems and use coal- or waste wood-fired stoves. To make matters worse, Ulaanbaatar is prone to heavy smog not only because it is cold in winter but also because it is located in a natural basin surrounded by mountains. Air pollution in Ulaanbaatar is mainly attributable to smoke emitted from coal-fired stoves and has become a serious urban environmental problem and a threat to human health by causing pneumonia and other respiratory diseases.

(2) Outline of Ulaanbaatar

Administratively speaking, Ulaanbaatar is categorized as a provincial municipality and enjoys the same status as a province (aimag). The city is divided into nine municipal districts (düüregs) including three satellite districts (Nalaikh, Baganuur, and Bagakhangai). It has an area of 4,704 km^2, 13% of which is residential.

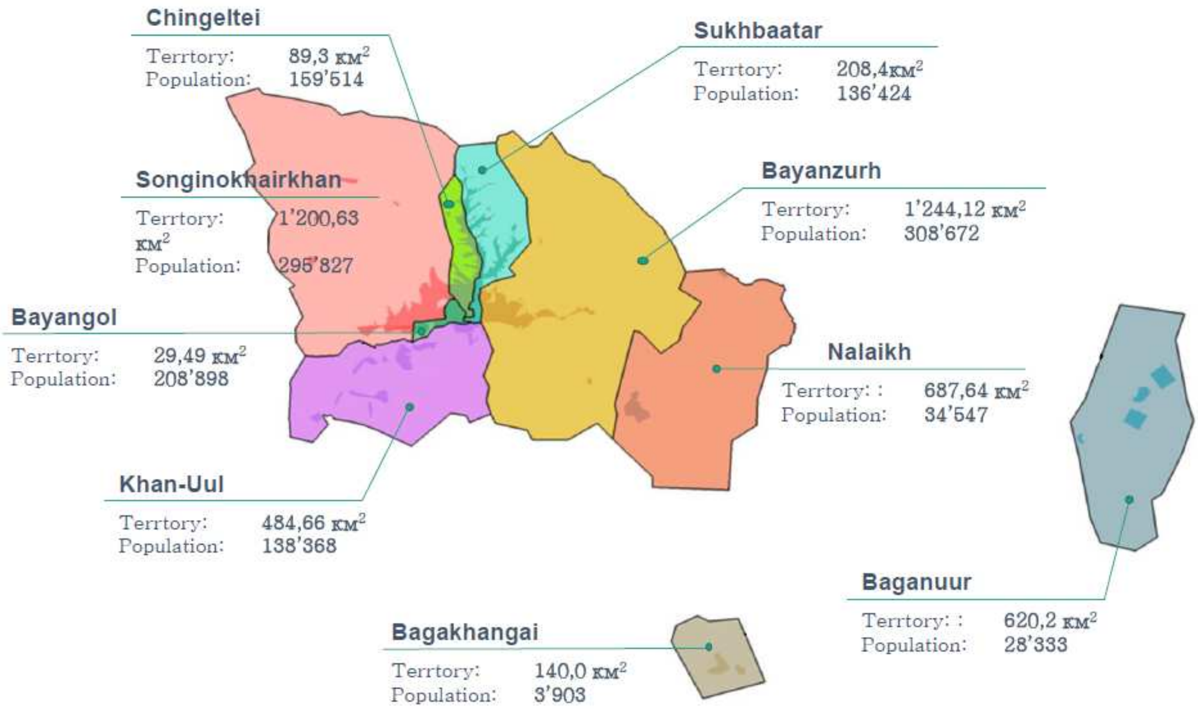


Figure 2-1. Municipal Districts of Ulaanbaatar

(3) A New City

A new airport city (Aerocity) is planned to be developed adjacent to the new airport at Khöshigt Valley in Sergelen District, Tuv Province. In January 2019, the New Ulaanbaatar International Airport Satellite City Master Plan (Aerocity Master Plan) was formulated and adopted by the Cabinet. According to this Master Plan, a satellite city is planned to be built, along with airport logistics, tourist, and other facilities, near the new airport, which is located 50km from the center of Ulaanbaatar. This Master Plan also includes the development of electricity, water supply, sewage, and other utility infrastructure systems as well as residential areas, a logistics center, and a special economic zone. Still, there is much work to do to realize the Aerocity Master Plan, such as making action plans and determining responsible organizations. However, this new satellite city is expected to solve urbanization problems caused by the excess concentration of population in Ulaanbaatar and facilitate the further economic development of Mongolia. The development project will start in the near future.

Although Aerocity is located in Tuv Province, the Aerocity Master Plan suggests that it should be developed by expanding Ulaanbaatar City. The Tuv Provincial Government considers that the development of outskirts of Aerocity should be controlled by managing the privatization of land and its urban development plan should be harmonized with that of Ulaanbaatar to maximize the spillover effect of the new airport development on the development of Tuv Province. Thus, it is important to establish collaboration between Ulaanbaatar and Tuv.

2.1.2 Ulaanbaatar City's Climate Change Mitigation Efforts

(1) Green Development Policy

The United Nations Conference on Sustainable Development in 2012 reasserted the importance of green economy to bring together environmental protection and economic growth to achieve the Sustainable Development Goals. In response, the Government of Mongolia adopted the Green Development Policy in 2014 and set strategic objectives, including promoting a sustainable consumption and production pattern with efficient use of natural resources, low GHG emissions and reduced waste. This Policy also sets GHG emissions reduction targets for 2030, including reducing building heat losses by 20% and 40% by 2020 and 2030, respectively, and increasing the share of renewable energy in total energy production (from 7.62% in 2014) to 20% and 30% by 2020 and 2030, respectively.

(2) National Program for Reducing Air and Environmental Pollution

The National Program for Reducing Air and Environmental Pollution (NPRAEP) adopted by the Cabinet in March 2017 aims to reduce air pollutants by 80% by 2025 and sets targets and action plans for the Government of Mongolia to reduce air pollution in Mongolia. The NPRAEP also aims to implement an effective policy for urban planning in the capital and urban areas and improve the quality of infrastructure to ensure a healthy and safe living environment for citizens, reduce pollution sources, and establish healthy living practices among citizens to reduce air and environmental pollution and develop a healthy and safe living environment. In addition, the Action Plan on Program Implementation has been developed, including measures to improve urban planning, enhance infrastructure development capacity and accessibility, reduce raw coal consumption, advance rural development, and promote decentralization.

The NPRAEP Action Plan for the housing and building sector is described below.

Table 2-2. NPRAEP Action Plan for the Housing and Building Sector

No.	Activity	Output	Indicator	Responsible organization	Partner	Time line
Objective 1. To implement an effective policy for urban planning, construction, and infrastructure development and promote decentralization through rural development to improve air and environment quality in the capital and urban areas						
Action Plan 7. Promote infrastructure and housing development in Ger areas for development of individual detached houses and provide long-term, low-interest loans to youth and low-income families as part of the Affordable Housing Program						
1.7.1	Continue the apartment renting program	Apartment renting fund for 20,000 families	20,000 families are provided with rental apartments	MoCUD	Rental housing companies	2017-2021
1.7.2	Promote housing development in Ger areas and provide long-term, low-interest loans to middle-income families	Long-term, low-interest housing loans for low- and middle-income families	Housing development and long-term, low-interest loan financing are promoted for residents in Ger areas	MoCUD, BoM	MoF	2017-2025
1.7.3	Implement the green housing model projects step by step	Green housing that meets the international standards	Pilot projects are implemented	MoCUD, city governments	ME	2018-2020
1.7.4	Incorporate gas supply and water engineering systems in the design of new housing and put it into practice	Buildings with gas supply pipes	In accordance with design, buildings with gas supply pipes are constructed to ensure gas supply for residents	MoCUD, ME	Mayors, Provincial Governors, MoMHI	2018-2025
		Buildings with greywater pipes	In accordance with design, buildings with greywater pipes are constructed to enable the domestic use of greywater	MCUD	MET, provincial governors, mayors	2018-2025

Source: JICA 2017

The NPRAEP Action Plan for the renewable energy sector is described below.

Table 2-3. NPRAEP Action Plan for the Renewable Energy Sector

No.	Activity	Output	Indicator	Responsible organization	Partner	Time line
Objective 1. To implement an effective policy for urban planning, construction, and infrastructure development and promote decentralization through rural development to improve air and environment quality in the capital and urban areas						
Action Plan 8. Provide access to regional engineering systems to residents without access to central heating systems in urban centers, build subcenters, and introduce renewable energy technologies						
1.8.1	Build engineering systems step by step in Bayankhoshyy and Selbe subcenters within Ulaanbaatar	Engineering systems, pipelines, and heating systems developed in Bayankhoshyy and Selbe subcenters	Engineering systems are built step by step in Bayankhoshyy and Selbe subcenters within Ulaanbaatar	City governments, MCUD		2017-2021
1.8.2	Select Ger areas in Ulaanbaatar with serious air pollution and build micro-subcenters	Micro-subcenters with home heating for residents	Micro-subcenters are built to provide regional engineering services to 200-300 families and improve the environment of Ger areas	MCUD	City governments, ME	2017-2025
1.8.4	Promote the generation of solar, wind, geothermal, and other renewable energy	Renewable energy projects with a capacity of 10-50MW	The generation and use of renewable energy are promoted	ME, ERC	MET, city governments, private companies	2017-2020
1.8.5	Support and encourage individuals and private companies to introduce and use renewable energy sources	Small-scale projects to introduce and use clean and renewable energy sources	A mechanism is established to support the introduction of renewable energy sources and enable the government to purchase surplus renewable energy from individuals and private companies	ME, ERC	MET, city governments, private companies	2019-2025
1.8.6	Use gas-fired heating boilers to supply heat to residents in the outskirts of Ulaanbaatar without access to central heating systems	Regional gas-fired heating systems	The number of buildings that use gas-fired heaters, instead of raw coal-fired stoves, is increased	ME, ERC		2018-2023

Source: JICA 2017

Renewable energy is given priority in Mongolia. The Ulaanbaatar City Government started replacing coal-fired heaters with electric or gas heaters in 2016 and allocated three fourths of the budget for fiscal year 2016-2017 to electricity subsidiaries to promote the use of electricity at night.

(3) Ulaanbaatar City Urban Development Master Plan 2020 and Development Directions 2030

The Ulaanbaatar City Urban Development Master Plan 2020 and Development Directions 2030 (UBMP2020) was developed by the Ulaanbaatar City Government, with support from JICA, to ensure orderly urban development and adopted by Parliament in May 2013. The UBMP2020 consists of five projects: redeveloping urban areas to meet the urban development requirements, replacing gers with apartments in Ger areas, rezoning Ger areas, renovating old apartments, and redeveloping public land. In addition, the UBMP2020 suggests restricting the sprawl of urban areas and turning them into high-density compact cities. It is planned to develop subcenters with a population of 130,000 to 200,000 in Ulaanbaatar and new satellite cities with a population of 500,000 to 600,000, instead of concentrating all functions into the center of Ulaanbaatar. Through these projects, the UBMP2020 aims to promote the orderly use and development of land.

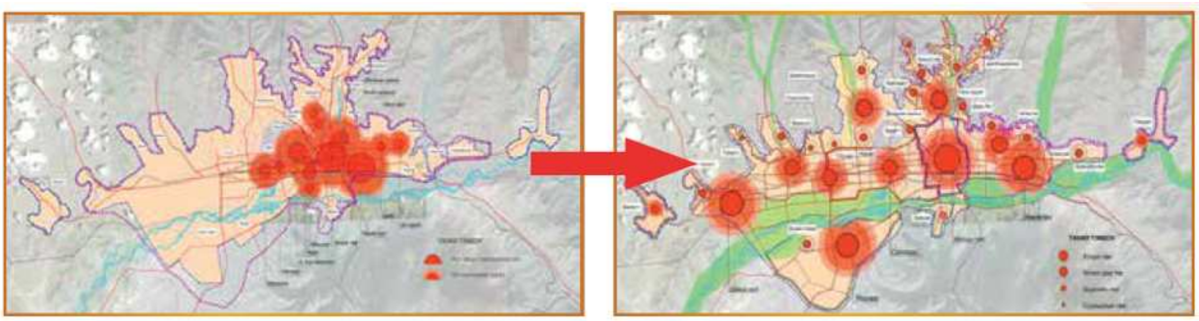
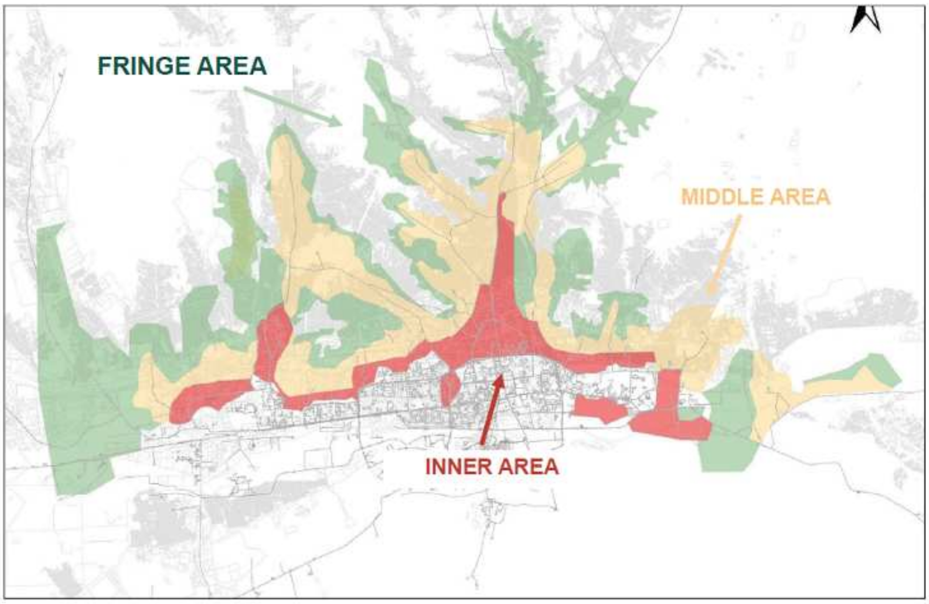


Figure 2-2. Decentralization Plan in UBMP2020

The UBMP2020 categorizes the Ger areas into inner, middle, and fringe areas, depending on their distance from the city center, and formulates different development plans for different categories. The inner areas, which account for approximately 24% of all Ger areas, are planned to be connected to existing infrastructure in the city center and redeveloped by replacing gers with apartments. The middle areas, which account for approximately 29% of all Ger areas, are planned to be redeveloped by constructing regional infrastructure and low- and middle-story apartments within the areas because it is technically and financially difficult to connect these areas to existing infrastructure. The fringe areas, which account for the largest share at 47%, are planned to be redeveloped by building new detached houses with standalone utilities.



Source: UBMP2020

Figure 2-3. Ulaanbaatar Ger Area Development Project

The Ulaanbaatar City Government is planning to raise the share of public apartments to 80% of the total housing in the city as well as increase the average floor area of apartments to 13.5 m^2 per person by 2030.

Table 2-4. Housing Stock Projection

Provider		2011-2016	2017-2020	2021-2030
Private company		67,900	31,700	52,480
	Annual average	11,317	7,925	5,248
Owner-occupied house		2,500	7,700	55,000
	Annual average	417	1,925	13,750
Government	Rental house	1,000	2,000	5,000
	Affordable house		2,500	9,500
Total		71,400	43,900	121,980
Annual average		11,900	10,975	12,198

Source: UBMP2020

Moreover, Ulaanbaatar's electricity demand is increasing with a population inflow, estimated to reach 5.8 billion kWh by 2030. The UBMP2030 suggests increasing the use of renewable energy sources for power generation to supply electricity to streetlights in Ger areas as well as houses and public facilities in Ulaanbaatar and its satellite cities.

Table 2-5. Electricity Demand Projection

	2010		2020		2030	
	Supply (Thousand kW)	Demand (Hundred kWh)	Supply (Thousand kW)	Demand (Hundred kWh)	Supply (Thousand kW)	Demand (Hundred kWh)
Ulaanbaatar	246	1,408	652	3,932	1,064	5,886
Satellite cities	36	203	189	568	280	963
Total	282	1,611	841	5,679	1,344	6,849

Source: UBMP2020

The Ulaanbaatar City Government was required to develop an action plan to promote the implementation of the UBMP2020. In February 2018, the City Council of Ulaanbaatar approved the Capital City Housing and Infrastructure Development Subprogram, including the city's medium-term urban development plan. This Subprogram sets a five-year action plan from 2018 to 2022 and targets, including providing housing to low- and middle-income families, supplying rental housing, developing residential areas, promoting urban development, and expanding heating, electricity, water supply, and sewage networks.

2.2. Current Situation and Challenges of the Housing Sector in Ulaanbaatar

2.2.1 Current Situation of the Housing Sector

(1) Overview

The residential areas in Ulaanbaatar, the capital of Mongolia, are divided into two areas: apartment areas in urban centers and Ger areas in the eastern, western, and northern outskirts of the city. As of 2015, Ulaanbaatar has 380,000 households, among which 220,000 households (almost 60%) live in Ger areas. Approximately 30% of the households reside in traditional nomadic tent houses in Ger areas, 30% in basic houses without access to water supply, sewage, or regional heating systems in Ger areas, and the remaining 40% in apartments with access to electricity, water supply, sewage, or regional heating systems in apartment areas.

Table 2-6 Number of Households by Type of Housing Unit

Year	Total households	Apartment area		Ger area			No house
		Apartment	Detached house	Ger	Basic house	Detached house	
2005	215,727 100%	87,539 40.6%	1,122 0.5%	56,701 26.3%	66,901 31.0%	1,083 0.5%	2,381 1.1%
2010	294,416 100%	116,249 39.5%	878 0.3%	76,497 26.0%	97,854 33.2%	2,299 0.8%	639 0.2%
2015	376,419 100%	156,199 41.5%	1,515 0.4%	105,962 28.2%	110,707 29.4%	1,782 0.5%	254 0.1%

Source: Statistical Yearbook of Ulaanbaatar

(2) Examples of Houses in Ulaanbaatar

1) Brick Apartments

Brick apartments are typical dwellings in Mongolia. They are usually connected to regional heating systems. Until around 2010, most brick apartments had double-glazed wooden-sash windows and often became drafty, especially when they were old and not properly maintained, as window frames were deformed due to water leaks. Later, vacuum double-glazed plastic-sash windows have become mainstream in Ulaanbaatar, though they are poor in quality, and there are still many drafty apartments. Most apartments have wooden doors without glass and uninsulated roofs.

2) Precast Concrete Apartments

In Mongolia, precast concrete apartments are as typical as brick apartments, and they are also connected to regional heating systems. The exterior walls are made of 20cm-thick precast concrete blocks, and the interior walls are not insulated but covered with lime or cement mortar. The window frames and doors of precast concrete apartments are the same as those of brick apartments, and the roofs are not insulated either.

3) Basic houses

Wooden or brick detached houses are another typical type of dwelling in Mongolia. Many of them are built by owners due to financial reasons, the lack of builders, and the habit of doing it yourself. Wooden houses are most common, but some wooden, earthen-walled houses are retrofitted and insulated by building exterior brick walls and putting insulation between the wooden interior and brick exterior walls after money is saved up. Many basic houses are roofed with wood. Due to the lack of insulation knowledge, the roofs, ceilings, and floors are rarely insulated and allow cold air to penetrate the rooms. Inside these houses, coal- or wood-fired stoves are used not only for heating but also for cooking.

2.2.2 Housing Challenges

(1) Dwellings Not Well-designed for Cold Weather

With a rapid population growth, houses were built randomly in Ulaanbaatar, especially in Ger areas. These houses are not energy efficient or suitable to cold weather, although Mongolia is one of the coldest countries where home heating is needed for many months of the year and accounts for 60% of domestic energy consumption. Home heating is essential to protect lives in winter in cold climates, but the increase in the number of houses with low energy efficiency has raised energy consumption for heating.

In Ulaanbaatar, there are mainly two types of home heating: regional heating systems and coal-fired stoves. Apartment and commercial buildings in city centers are connected to regional heating systems using hot water from coal-fired power plants. However, the population is growing faster than regional heating systems are being built. In particular, residents in the Ger areas and outskirts of Ulaanbaatar have limited access to regional heating systems and use coal-fired stoves in their homes. Due to the heavy reliance on coal for home heating and a large number of buildings with low energy efficiency, Mongolia's coal consumption is growing, which is increasing GHG emissions and deteriorating air pollution from coal soot and smoke. Some reports attribute 90% of air pollution to home heating in Ger areas.

Meanwhile, the Ulaanbaatar City Government has announced apartment development projects for residents in Ger areas. Given its cold weather, the housing sector of Ulaanbaatar is considered to have high potential for energy conservation.

2.3. Organizations Concerned with This Study in Ulaanbaatar

The organizations concerned with this Study are described below, including the Urban Development Department of the Capital City and the Capital City Housing Corporation, which are boxed in red.

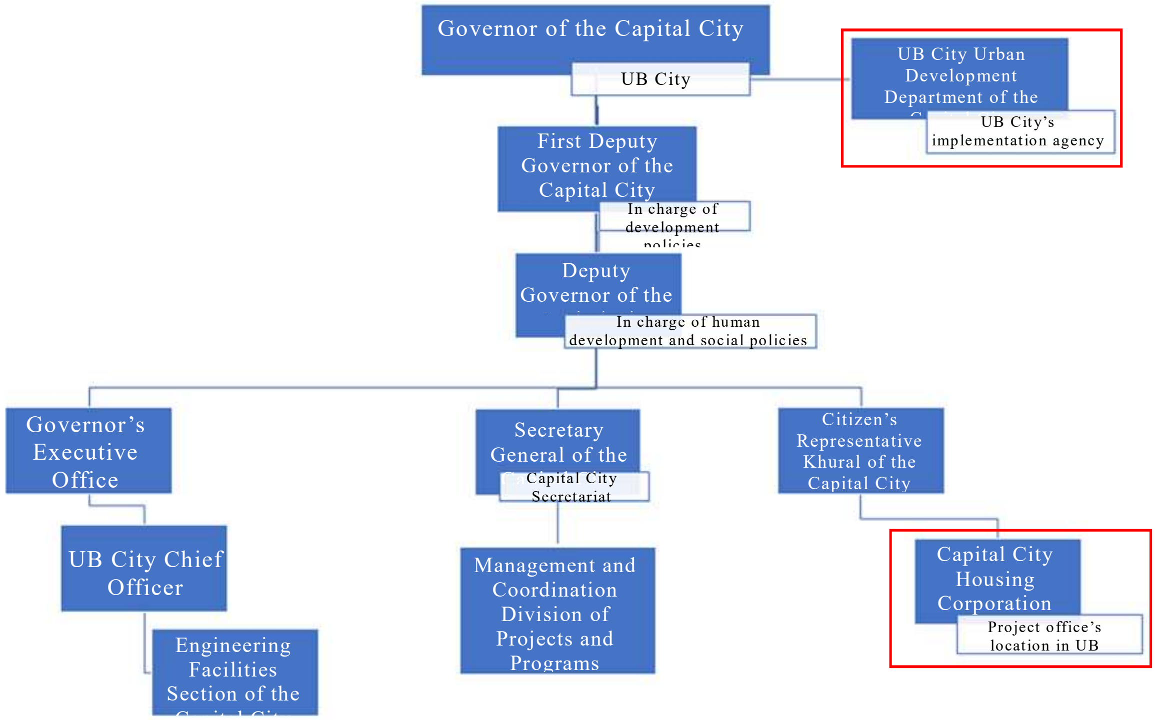


Figure 2-4. Organization Chart of the Ulaanbaatar City Government

(1) Urban Development Department of the Capital City, Ulaanbaatar City

The Urban Development Department of the Capital City is responsible for urban development, land spatial planning, and inspections for construction permits in Ulaanbaatar. The Chief Architect's Division is in charge of constructing buildings in the capital city to execute its rights and responsibilities, regional development in Ulaanbaatar, and regulation management in accordance with the Urban Development Law and the Capital City Charter. The Urban Development Information Division is responsible for continuing urban development in the capital city, developing and updating the joint urban development database, providing information on urban development to citizens and legal institutions, making topographic maps, and managing information. The Construction Quality and Safety Management Division is responsible for issuing permits for construction, renovations, and demolition of buildings in line with the city's master plan and redevelopment projects, conducting seismic and other structural evaluations for permits, and giving instructions to demolish or retrofit buildings when necessary. The Infrastructure Engineering and Planning Division is responsible for conducting structural evaluations and quality assessments for infrastructure, monitoring infrastructure development projects, consulting and making decisions on technical matters, and checking and finalizing drawings and designs.

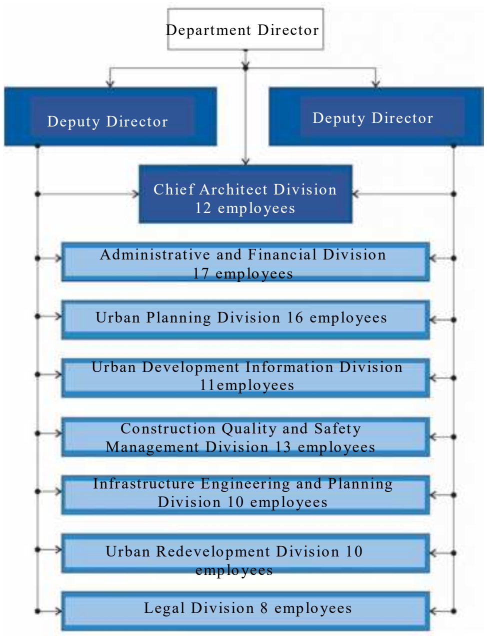


Figure 2-5. Organization Chart of the Urban Development Agency of Capital City

(2) Capital City Housing Corporation, Ulaanbaatar City

The Capital City Housing Corporation of Ulaanbaatar City is responsible for developing a legal framework for housing development in the capital city, formulating and proposing housing policies and project plans, financing residential and apartment area development programs, and building housing. In collaboration with financial institutions, the Corporation brings new financial products to markets inside and outside Mongolia and secures financial resources through multifaceted financing. The Corporation is also responsible for setting conditions for soft housing loans, subsidies, and incentives, issuing mortgage-backed securities, establishing a rental housing fund, and managing revenues from rents. In addition, the Corporation is responsible for introducing environmentally friendly technologies and materials for housing and building construction, pursuing policies to reduce the construction costs incurred by the Construction Division and increase the return on investment, and supporting private sector-led housing development.

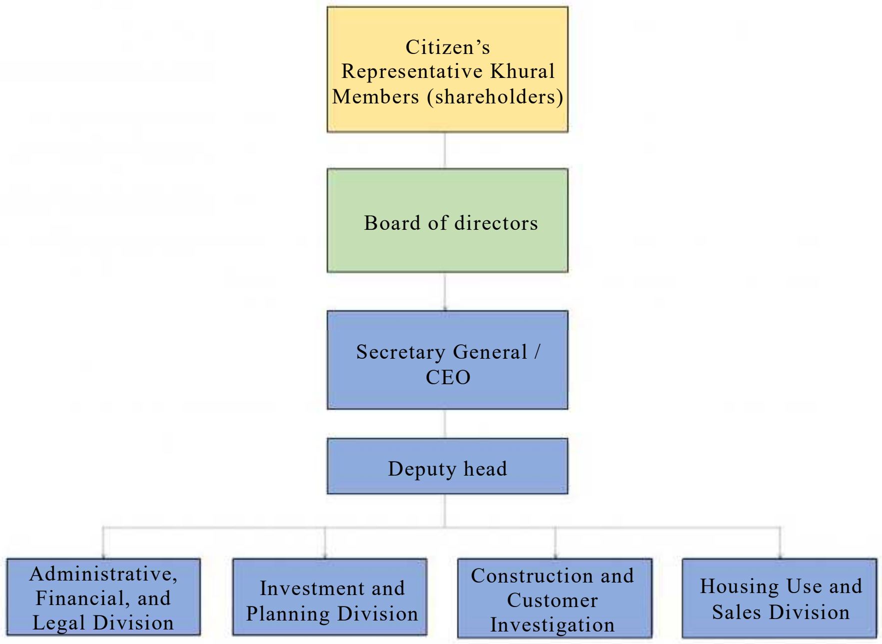


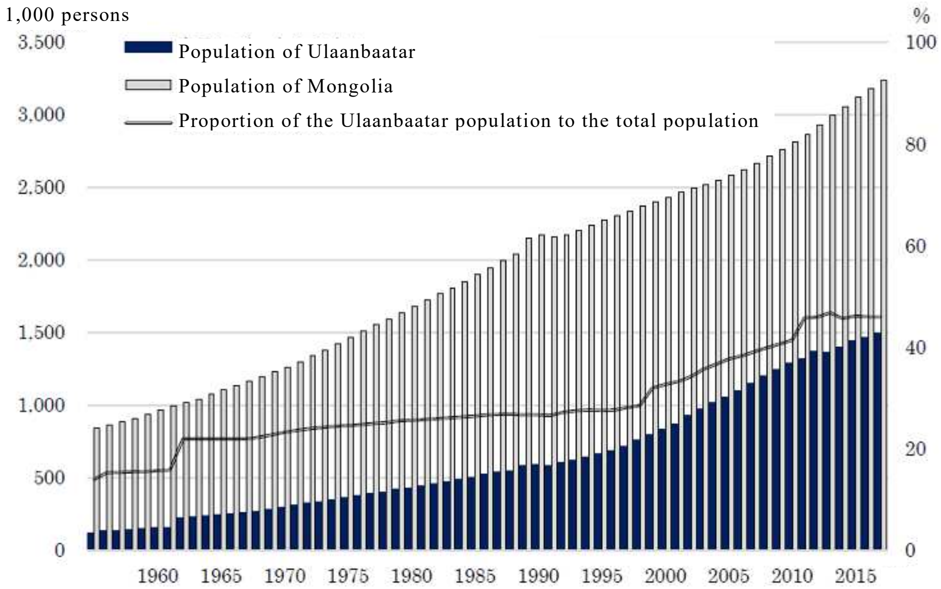
Figure 2-6. Organization Chart of the Capital City Housing Corporation

Chapter 3. Feasibility of JCM Project in the Building Sector

3.1. Status survey/analysis of the architectural field

3.1.1 Changing population and the current GHG emission in Mongolia

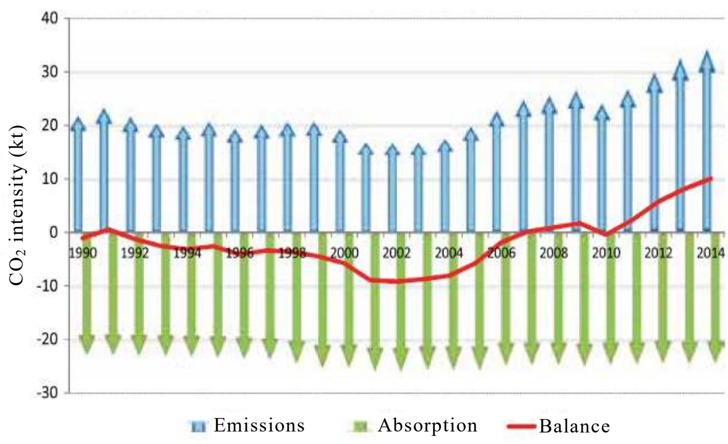
Having developed economically, despite a backdrop of soaring resource prices, the population in Mongolia has increased sharply, from about 2.4 million in 2000 to 3.06 million in 2016. In addition, the regional population has been flowing into Ulaanbaatar due to stalled social reform, which saw its population virtually double in just fifteen years, from around 0.7 million in 2000 to 1.39 million in 2016.



Source: Yuko Matsumiya, “Formation and Foundation of Ger Areas in Ulaanbaatar – Epistemological Change from Problematic Area to Living Space –”

Figure 3-1. Changing population in Mongolia and Ulaanbaatar

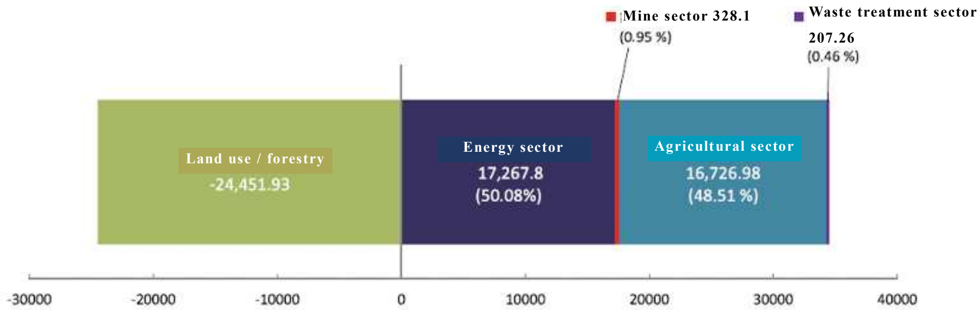
The main fuel used to supply energy in Mongolia is coal, which is inexpensive and comprises more than 90% of all fuels consumed for power generation, heating and cooking in Mongolia. As shown in the following table, GHG emissions in Mongolia have been increasing since 2000. In case measures to curb such emissions, such as saving energy and introducing renewable energy, fail to progress, GHG emissions are expected to increase, due to population growth and other relevant factors.



Source: MET 2018

Figure 3-2. Changing GHG emissions and absorption (from 1900 to 2016, Unit: $MtCO_2e$)

In Mongolia, the energy sector generates around half of all GHG emissions. Accordingly, moves to save energy and introduce solar and wind powers and other renewable energies in households and businesses are expected to cut emissions significantly.



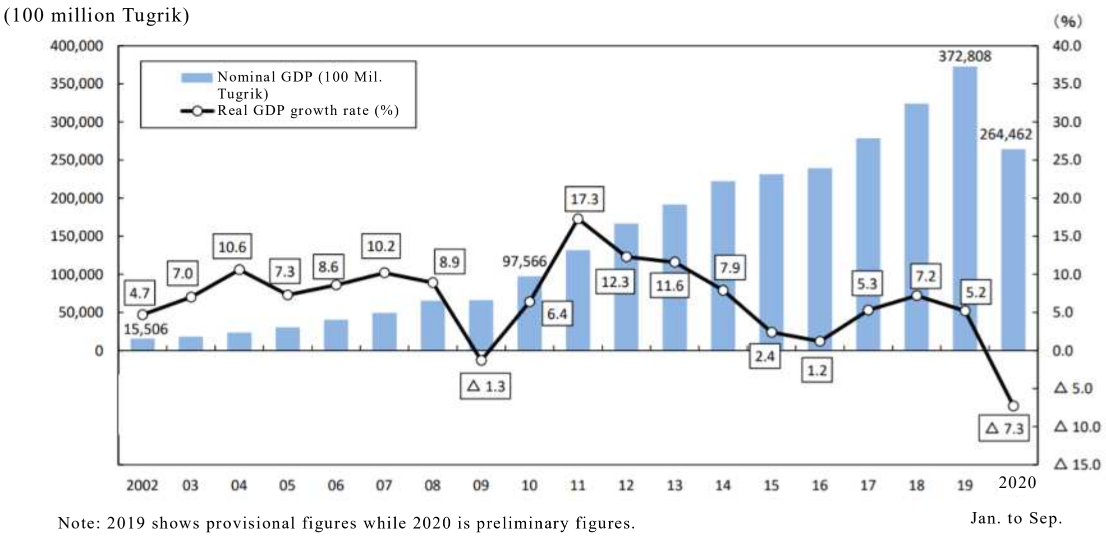
Source: MET 2018

Figure 3-3. Composition of GHG emissions in Mongolia (2014)

3.1.2 The construction market and building and energy-efficiency standards in Mongolia

(1) Economic trends in Mongolia

The Mongolian economy has soared, triggered by direct foreign investment into large-scale mine development such as Oyu Tolgoi. In 2011, the real GDP growth rate exceeded 17%, but subsequently declined due to a fall in mine resource prices; dropping substantially from 7.9% in 2014 to 2.4% in 2015, according to the announcement by the National Statistical Office of Mongolia. Sluggish direct investment, declining mine sector resource prices and decreasing exports due to the economic recession in China, acknowledged as the largest export destination, are recognized as the major factors behind the decline in the rate. Despite a recovery trend emerging since 2016, negative growth was recorded in 2020 due to the global COVID-19 pandemic.



(From 1900 to 2016, Unit: $MtCO_2e$) Source: MET 2018

Figure 3-4. Change in GHG emissions and absorption in Mongolia

(2) Construction sector in Mongolia

Given the significant increase in housing construction investment against a backdrop of rapid population growth since 2000, construction investment and construction material production in Mongolia showed an upward trend by 2014. In 2015, however, public investment decreased due to sluggish foreign direct investment, declining mine sector resource prices and decreasing exports due to the economic recession in China, whereupon construction investment in 2015 decreased to approximately 16.5 billion yen (447,166 million MNT).

Table 3-1. Construction investment and trend in major construction materials in Mongolia

The amount of investment, products produced, etc.	Unit	Production			
		2012	2013	2014	2015
Domestic construction investment	1 million MNT	1,307,864	1,102,839	1,146,557	447,166
Housing construction	Same as above	389,418	856,903	1,430,863	N.A.
New apartment building	No. of households	11,413	18,012	22,546	N.A.
Addition of housing stocks	1,000 m²	531	906	1,604	N.A.
Cement	1,000 t	349.4	258.8	411.3	410.1
Concrete and mortar	1,000 m³	176.2	317.8	432.6	129.0
Clay-like bricks	1 million bricks	44.5	66.5	58.9	41.5
Timber	1,000 m³	14.2	9.8	16.4	15.2
Wooden door/window	1,000 m²	7.6	12.4	14.6	7.8
Construction material imported	1 million US$	279	336	330	N.A.

Source: A Guide for Business Environment in Mongolia 2017

In 2015, the Mongolian parliament approved the Urban Redevelopment Law which justifies converting property rights in development projects and has subsequently considered development project in the ger area and new housing policy for low-income groups. Increasing demands to improve the living environment and thus ensure that no air pollutants nor any domestic wastewater contaminate the soil, are against the backdrop. In a new department store, constructed during an apartmentization project in the ger area, residents have access to water and sewerage services and hot water and heating systems, improving their living environment. Moreover, thanks to Aero City, Maidar Eco-City and other satellite cities being developed under a foothold city policy, infrastructural development and housing construction are expected to be promoted in future, as is done for construction investment.

New apartment buildings constructed during an apartmentization project in the ger area
(The UB Seventh District in September 2016)

Meanwhile, urban infrastructure facilities, such as water and heating supply equipment, have yet to be developed in many ger areas, compelling residents to use coal as their main source of fuel for heating and cooking, sparking air pollution in Ulaanbaatar City and impacting on global warming.

(3) Building and energy-efficiency standards in Mongolia

① Building standards

The framework for legal systems on buildings in Mongolia is prescribed based on the Construction Law 2016, which comprises the following chapters:

Table 3-2. Structure of the Construction Law 2016

Chapter	Title	Article
1	General Provisions	1-8
2	Construction and Construction Categories	9-10
3	Basic Requirements for Construction Activities	11-17
4	Construction Operating Licenses and Construction Work Permit * A construction permit must be granted before constructing new buildings.	18-30
5	Construction Sector Management and Regulation	31-35
6	Participants in Construction Activity	36-46
7	Technical State Control	47
8	Construction Certificate * A construction certificate must be granted before completing the work.	48-49
9	Other Provisions	50

Based on this Construction Law, the Ministry of Construction and Urban Development prepares the Mongolian construction standards which comprise the Construction Codes of Mongolia, Construction 3 Regulations and Other Guidance Documents and Administrative Documents and encompass a total of around 450 documents. Relevant standards are prescribed by 674 Mongolian Standards.

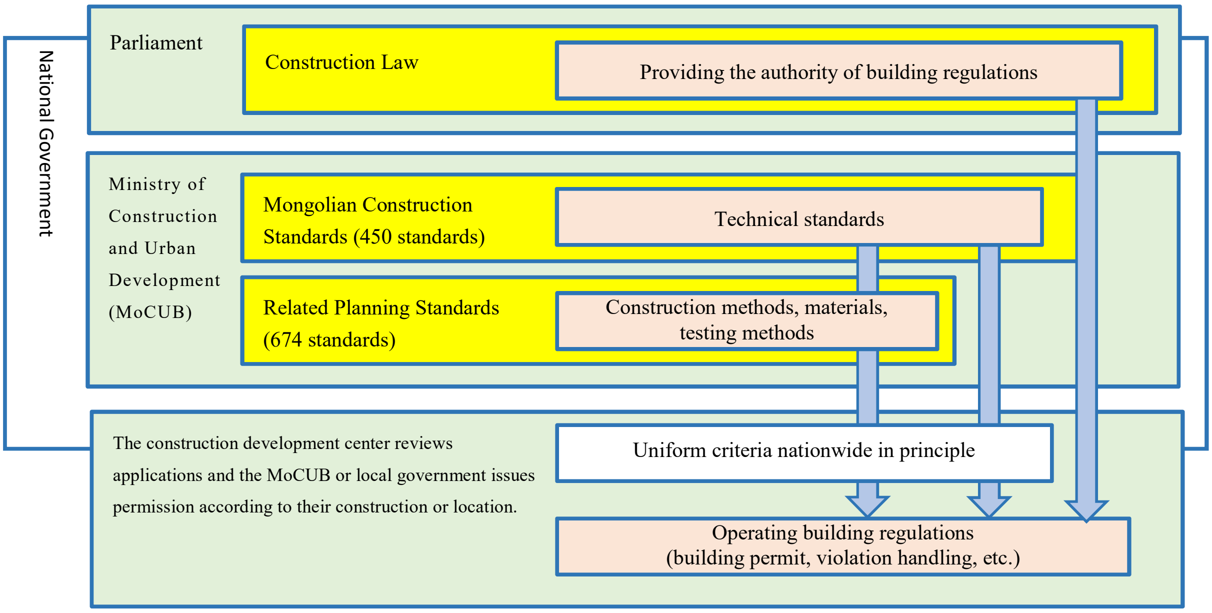


Figure 3-5. Institutional flow in the Mongolian building sector

Current standards in Mongolia remain unchanged from those enacted in the former Soviet Union era between the 1960s and 70s, rendering them incompatible with modern approaches and very complicated. Around one third of those standards were written in Russian and a further third was directly translated from Russian into Mongolian. The remainder were adjusted to Mongolian conditions to some extent and have been published in Mongolian language. The reality is that those standards do not practically function as those aged 30 years or under in Mongolia do not read Russian.

Moreover, although the Construction Law of Mongolia sets out the procedures to be followed in building construction and underlines the need to "fulfil the requirements and instructions issued by the authorities for the construction phase", it does not cite technical matters. While technical standards are set forth to complement the Law, they only show construction standards like standard specifications. Accordingly, it is expected that actual insulation performance will differ considerably according to the buildings involved.

In Mongolia, strict paperwork is required; construction permits should be applied with construction drawings and 144 permits should be obtained prior to starting construction work. Despite such strict procedures, however, no mechanism exists to check the execution of works and it is not unusual to see design drawings and the specifications of the completed building diverge. Accordingly, it is deemed impossible to verify whether insulation technology designated by design was actually constructed given such an insufficient check system. To ensure that construction works are executed as specified in design drawings, matters to establish and ensure a means of checking the construction quality plus improving the legal system are key.

② Heat insulation standards

In Mongolia, standards for thermal technology in building envelope structures are set forth in BCNS23-02-2009 (BCNS) while energy-efficiency requirements are referenced in those standards mainly established during the former Soviet Union era. Comparing the thermal performance standards of Mongolia and the Czech Republic (former Soviet Union) for reference purposes reveals very similar building insulation requirements.

Table 3-3. Comparison of thermal standards between Mongolia and Czech (the former Soviet Union)

Item	Czech Republic $U_N(R_N)$[W/(m²K)]	Mongolia $U_N(R_N)$[W/(m²K)]
Exterior wall	0.30 (3.16)	0.26 (3.70)
Roof	0.24 (4.03)	0.20 (5.00)
Ceiling above non-heating space	0.60 (1.33)	-
Floor	0.45 (2.05)	-
Window	1.50 (0.50)	0.30 (3.16)
Door	1.70 (0.42)	-

Source: BCNS23-02-2009 Building Thermal Performance (Mongolian standards) and CSN730 0540-2 Building Thermal protection (Czech national standards)

③ Energy-efficiency standards

In Mongolia, summers are cool and winters are icy. Regional heating systems are commonplace in urban areas and connecting to the system is mandatory. In 2009, the Building Thermal Performance (CCM 23-02-09) was issued as a set of standards requiring new buildings should be designed to ensure that primary energy is below a certain criterion (Table 3-4), measured after the building comes into operation and checking the results obtained. Classes A, B and C are set according to the design phase of a new or renovated building while Classes D and E are set to check the repair work sequence of those buildings constructed in 2000 or earlier.

Table 3-4. Classification of building energy efficiency in Mongolia

Class	Classification of energy efficiency	Measured value (q^{des}_h) of heat energy consumption rate of building heating system and variable range from the baseline (%)	National governmental measures for the facility
Newly or renovated building			
A	Very high	Lower than -51	Subsidy
B	High	Between -10 and -50	Subsidy
C	Normal	Between +5 and -9	-
Building constructed			
D	Low	Between +6 and +75	Repair of building
E	Very low	Higher than 76	Heat insulation measures must be taken shortly/

It is unclear whether private houses and other common buildings are designed and constructed in conformity with these criteria. For insulation and equipment installed with energy efficiency in mind, however, highly efficient Japanese and other foreign products are used in part of the capital city. However, even if quality Japanese materials are applied under current circumstances, they may not be utilized by the construction engineering in Mongolia, given the technical capacity needed to construct buildings sufficiently airtight to allow energy efficiency. To use Japanese materials and products and promote energy efficiency in

Mongolia properly in future, efforts to introduce technology and insights in packaged form, over and above products alone, will be effective and can be leveraged to improve infrastructure and operations and help develop the city in Mongolia.

(4) Building specifications and their issues in Mongolia

① Fittings

By around 2010 in Mongolia, many collective buildings with wooden double-glazed windows were not being properly maintained and managed, even in Ulaanbaatar City. Windowpanes were simply fitted in wooden frames or fixed by nails alone in some cases. Given the preponderance of distorted glass, the outside air infiltrating the building from such openings severely hampered efforts to secure the indoor environment.

In response, each household fills the glass edges with kneaded flour. However, rainwater still permeates through a gap in the window, resulting in humidity. When the materials later dry, this process generates repeated expansion and contraction, causing the wooden frame to crack and leading to a gap generated by the distorted frame distortion, making it difficult to secure the airtightness.

Since around 2005, lower-priced resin sash has been imported from China. Since frame materials have been imported and sash-processing factories constructed in Mongolia, resin sash materials were chosen to open parts of new buildings, while old buildings were also renovated with resin sash, which is currently the main material used in Ulaanbaatar City. In line with this trend, glass and double-glazing sash are also used, but their performance is insufficient, given the condensation generated inside the materials in winter. Except for a portion of those sash and glazing products imported or domestically processed, those product qualities are not guaranteed.

Currently, the major type of resin sash method used in Mongolia is the two-action type, featuring a tilt and turn with a single lever. However, the quality is not guaranteed and the airtightness imperfect; prone to failure or distortion. Accordingly, airtightness is not secured, even then using resin sash or double-glazing sash.

Since around 2000, with crime prevention in mind, conventional wooden double doors have been replaced with Chinese steel products, which are now commonly used for fittings linked to the outside, such as those used in entrances. Although gaps between fittings and frames are filled in using urethane foam, the construction technique involved largely depends on each craftsman and the insulation performance is not necessarily secured.

② Insulation

By around 2005, insulation had been regulated by the thickness of a brick-built wall. Subsequently, the scope of the specifications was extended to constructing a wall surface with concrete blocks, inserting insulation materials into the central part of the masonry structure and using Styrofoam for external/internal insulation.

In standard specifications for construction work in Mongolia, insulation is specified by БНБД31-08-05 (BNBD31-08-05). However, they have not been updated since 2005, rendering them unsuitable for current conditions. Moreover, whether such insulation criteria would be applicable to actual construction works remains in doubt.

The Russian standards saw insulation materials of coal ash laid out and asphalt waterproofing applied for school and other low-rise buildings constructed during the socialist period. Such construction materials deteriorated faster due to the severe climatic conditions of Mongolia, with leakage from the roof observed in several cases. Accordingly, the insulation performance of coal ash having deteriorated due to moisture is difficult to measure.

③ Airtightness associated with exterior wall deterioration

The annual temperature difference in Mongolia is nearly 70°C, causing construction materials to deteriorate significantly with the expansion and contraction caused by alternating dry and wet conditions and temperature differences. Steel-frame buildings are rare in Mongolia and the basic structural core of many collective housings is made of reinforced concrete (hereinafter, "RC").

The major structure of many collective housings is constructed by RC, while most exterior walls are constructed with concrete block masonry. Since the opening parts are liable to be cracked and damaged as building stress is concentrated, finishing materials like mortar are used for such parts. However, opening part reinforcement and the installation of contraction joints are often omitted. Although parts around the opening are sealed, a single-component cartridge is often used for sealing without any backup material, which often results in the sealing breaking. Since fittings and the area around them are often unsealed, the outside air and rainwater flowing in adversely affects the airtightness and building performance.

Moreover, insufficient insulation processing and sash performance around the opening parts leads to indoor condensation. When moisture repeatedly melts and freezes around the window frames, this exacerbates deterioration of the frame, both externally and internally and hampers efforts to maintain airtightness.

④ Airtightness and ventilation

Mongolia has standard specifications for ventilation, which require air-vent installation. Meanwhile, "natural air supply/ventilation" and "natural air supply and mechanical ventilation system" are commonly applied in Mongolia. In some cases, air vents are closed to prevent outside air from flowing inside the building in winter, where the average temperature is -25 degrees. Energy recovery ventilation systems are seldom used in general collective housings and private housing. In many such buildings, the ventilation system does not work and polluted air is sealed in. Accordingly, securing airtightness and maintaining a comfortable indoor temperature while ensuring ventilation is key.

Many mobile tent houses remain in ger areas, where airtightness is difficult to ensure. Their opening part is located in the ceiling and a chimney should be installed. As well as constructing the entrance only with a wooden door, a padded "futon" type mattress is attached to those parts to secure airtightness but fails to achieve sufficient insulation and airtightness.

⑤ Heating system

Collective housings and office buildings in Ulaanbaatar City use a heating system utilizing steam generated from thermal power plants as the heat source and distributing heat to each building via plumbing installed city wide. Each building circulates heat, which is distributed to the top floor, to radiators in each floor via the plumbing, meaning the temperature varies by area and floor, even within the same building. New apartment houses install radiator with a flow regulator, which is expected to solve temperature differences among floors. However, supply stoppages, no supply at the beginning of autumn and unstable indoor temperatures, even when the heat source is supplied normally to buildings, remain acknowledged issues with the heat supply system. In such cases, the boiler must be installed individually.

(5) Issue of building construction in Mongolia

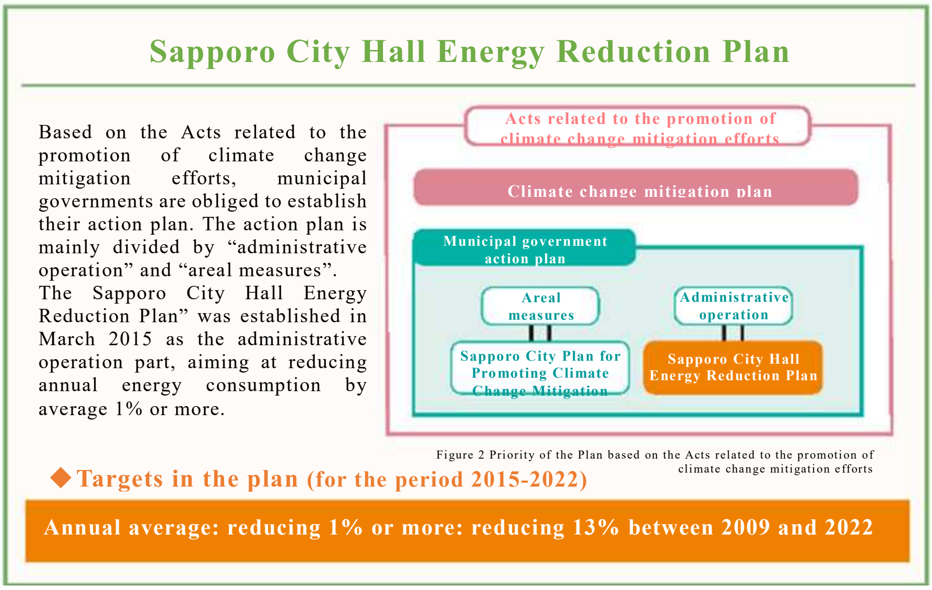
In Mongolia, few domestic products are used in sectors like construction and manufacturing, in which steadily accumulated technology, establishing supply chains and introducing ISO and other standards all become important. Accordingly, Mongolian production technology remains behind that of Japan. In the Mongolian construction industry, meanwhile, insufficient construction engineering and a limited choice of materials makes it difficult to regularly supply a certain quality of materials. Construction quality must be improved with ISO and other standards and an administrative monitoring system.

Considering the political instability in Mongolia, the government-led prototype often varies from the initial arrangement and contract due to the regime transition and official financial situation. Accordingly, there is a need to approach the administration side to develop laws and establish ordinances by getting private developers and construction companies to collaborate.

3.1.3 Energy-efficiency efforts, system and technology of Sapporo City

(1) Energy-efficiency target and GHG emissions of Sapporo City

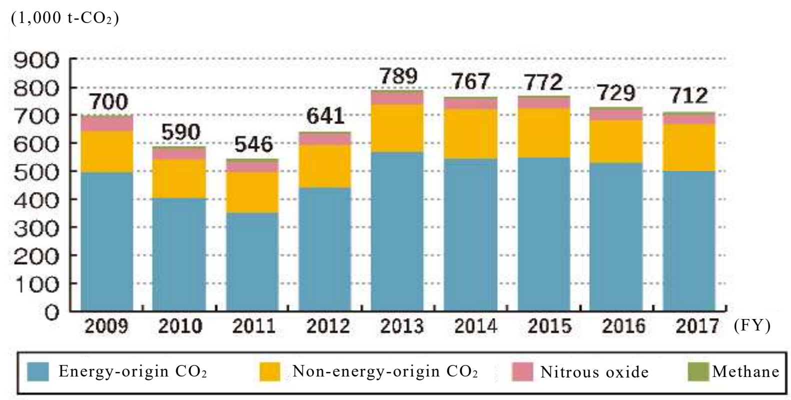
Sapporo City is the largest energy supplier city wide and strives to reduce energy consumption and GHG emissions by setting an example for lead citizens and business operators. In particular, the City optimally exploits energy-efficiency technology and renewable energy reflecting its snowy and cold setting and strives to steadily reduce energy consumption and GHG emissions consumed during administrative operations in the Sapporo City office. In addition, it also taps into individual ability and harnesses the collective efforts of citizens, businesses and the administration to develop a low-carbon city.



Source: Sapporo City Environmental Management Report 2019

Figure 3-6. Energy reduction target of Sapporo City Office

In Sapporo City, CO_2 emissions of energy origin associated with the use of power and fuels comprise around 70% of all GHG emissions. GHG emissions for FY 2017 amounted to around 712,000 t-CO_2, which was a decrease of around 2.3% from the previous fiscal year, reflecting the effect of efforts made to save energy and introduce renewable energy in the city.



Source: Sapporo City Environmental Management Report 2019

Figure 3-7. Change in GHG emission

(2) Energy-efficiency system of Sapporo City

Sapporo City implements systems and initiatives to reduce GHG emissions in its civic and business activities.

① Environmental conservation action plan / vehicle use management plan

Under the Ordinance on Securing Living Environment in Sapporo City, businesses of a certain scale or larger establish and implement their own plan for mitigating environmental loads, including reducing CO_2 emissions according to their business activity or type, aiming to continuously reduce environmental loads generated by their business activity. Their progress should be reported under this system.

② Sapporo City Comprehensive Assessment System for Building Environmental Efficiency (CASBEE Sapporo)

The Sapporo City Comprehensive Assessment System for Building Environmental Efficiency (CASBEE Sapporo) is a mandatory system prescribed by the ordinance to assess environmental matters of newly constructed, extended and renovated buildings covering an area of 2,000 m² or more by their construction client and submit the assessment result (in the form of a building environmental efficiency plan) to Sapporo City, aiming to disseminate and promote environmentally efficient buildings. This system comprehensively assesses building environmental efficiency efforts (92 items), ranks them by five grades (S to C) and distributes a label clearly showing the result to the builder. Moreover, the contents of the building environmental efficiency plan submitted are published to citizens via the Sapporo City website to help raise environmental awareness among citizens and businesses.

Source: CASBEE Sapporo leaflet

Figure 3-8. CASBEE Sapporo assessment label

Table 3-5. Change in the number of CASBEE Sapporo notifications

Rating	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
S (Excellent)	1	1	2	1	1	0	0	0	0	2
A (Very good)	8	10	14	22	15	22	9	24	34	22
B+ (Good)	31	18	26	47	46	45	35	42	38	38
B- (Slightly worse)	7	3	22	12	24	19	13	18	19	21
C (Worse)	0	0	2	1	1	1	1	0	0	2
Total	47	32	66	83	87	87	58	84	91	85

(No. of notifications)

Source: Sapporo Environmental Management Report 2019

③ Seminars/lectures on energy efficiency and publishing technical information

Sapporo City regularly hosts seminars by engineers with energy-efficiency expertise and giving practical lectures at city-owned business facilities. These seminars and lectures give participants useful insights into the energy-efficiency efforts made by each business by providing insights into their energy and power consumption, heavy oil and gas consumption and actual energy-efficiency cases of Sapporo City in city-owned and private facilities. These efforts extend the effect of the energy-efficiency policy and promote businesses' energy-efficiency activities as well as bringing engineers up to speed with the knowledge and technology needed to promote energy efficiency.

Moreover, Sapporo City has standardized highly effective energy-efficiency technologies which were obtained by upgrading the equipment in city-owned facilities, as well as publishing case studies of operational improvement technology on its website, complied as "Sapporo Energy Efficiency Technology" unique to the snowy cold region, a "Notebook of Sapporo Energy Efficiency Technology" which summarizes important points in energy-efficiency cases and other useful information.

Source: Sapporo Environmental Management Report 2019

Activities in an energy-efficiency lecture

④ Standards and systems on energy-efficient houses

Sapporo City is located in a snowy cold region and consumes more heating energy than anywhere else in Japan. Given particularly high CO_2 emissions from households, promoting energy efficiency under national standards remains difficult. Accordingly, the City established a System of Standards for Sapporo Next-

Generation Houses suitable for cold regions. By disseminating this housing, Sapporo City reduces the significant heating energy consumed in households and thus cuts CO_2 emissions.

The Standards for Sapporo Next-Generation Houses sets out standards for housing with insulation and airtightness that outperform national standards. It classifies five grades for new housing and three grades for renovated housing with four indicators: the average thermal transmittance (UA value), primary energy consumptions (whole house, heating + ventilation) and corresponding gap area (C value).

Table 3-6. Standards for Sapporo Next-Generation Houses (new housing)

Grade	Average thermal transmittance (U_A value) [W/(m² · K)]	Primary energy consumption (whole house)	Primary energy consumption (heating + ventilation)	Corresponding gap area (C value) [cm²/m²]
Top runner	0.18 or less	Grade 5	35% or less	0.5 or less
High level	0.22 or less	Grade 5	45% or less	0.5 or less
Standard level	0.28 or less	Grade 5	60% or less	1 or less
Basic level	0.36 or less	Grade 5	75% or less	1 or less
Minimum level	0.46 or less	Grade 4	90% or less	1 or less

Source: Sapporo City website

⑤ Subsidy for designing Zero-Energy Buildings (ZEB) / Net-Zero Energy Housing-M (ZEH-M)

Sapporo City institutionalizes efforts to provide building owners with a subsidy ranging from 600,000 to three million yen for additional design costs needed to construct a Zero-Energy Buildings (ZEB) and Net-Zero Energy Housing-M (ZEH-M) to promote Zero-Energy buildings and reduce GHG emissions in the City.

This subsidy is aimed at building owners constructing ZEB or ZEH-M with a total floor area of 300 m² or larger in Sapporo City and those business operators paying a registered architect's office for additional design costs and meeting all the following requirements. The requirements of the building owners, conditions and the subsidy for registered architect's office are as follows:

[Requirement for building owners, etc.]

- Legal entity (except those owned by the government) or individual;
- Those who are not in arrears with their taxes; and
- Those who are not a member of or operator relevant to organized crime group (the management of which is substantially governed by an organized crime group member, or those having a close relationship with other organized crime groups or group member as provided for by Article 2.2) as provided for by Article 2.6 of the Act on Prevention of Unjust Acts by Organized Crime Group Members (1999 Law No. 77)

[Conditions of registered architect's office]

- Registered architect's office, or registered architect, designing subsidized building sets up an office in Sapporo City; and
- In case multiple registered architect's offices involved in designing subsidized building, the architect's office located in Sapporo City mush involve in the additional design cost.

ZEB (Total floor area: larger than 300 m² and smaller than 2,000 m²	ZEB (Total floor area: larger than 2,000 m²)	ZEH-M (Total floor area: larger than 300 m² and smaller than 2,000 m²	ZEH-M (Total floor area: larger than 2,000 m²)
1.5 million yen	3 million yen	600,000 yen	1 million yen

When applying subsidy for a complex building of ZEB and ZEH-M, the subsidy for corresponding parts are added up.

Source: Leaflet of ZEB/ZEH-M Design Subsidy

Figure 3-9. Requirements of building owners and conditions and the subsidy for registered architect's office

The definition of ZEB and ZEH-M and other relevant terms are shown as follows:

ZEB	The summary of the ZEB Roadmap Follow-up Committee (March 2019) of the Ministry of Economy, Trade and Industry defines ZEB. Major standards are outlined as follows: - ZEB: 100% energy efficient - Nearly ZEB: over 75% energy efficient - ZEB Ready: over 50% energy efficient - ZEB Oriented: among those buildings with the total floor area larger than 10,000 m^2, office, school and factory are over 40% energy efficient and hotel, hospital, department store, restaurant and meeting place are over 30% energy efficient.
ZEH-M	The summary of the ZEH Roadmap Examination Committee for Collective Housings (May 2018) of the Ministry of Economy, Trade and Industry defines ZEH-M. Major standards are outlined as follows: - ZEH-M: 100% energy efficient - Nearly ZEH-M: over 75% energy efficient - ZEH-M Ready: over 50% energy efficient - ZEH-M Oriented: over 20% energy efficient
BELS	The third-party assessment organization reviews the conformity with ZEB and ZEH-M standards and certifies the energy efficient performance mark.
Additional design cost	Those costs needed to consider ZEB or ZEH-M design and calculate energy efficiency as well as those charges for obtaining BELS.

Source: Leaflet of ZEB/ZEH-M Design Subsidy

Figure 3-10. Definition of the terms used in the Sapporo City ZEB/ZEH-M design support

⑥ Subsidy system for Sapporo next-generation houses (detached houses for citizens)

Under the subsidy system for Sapporo next-generation houses (detached houses for citizens), part of the cost incurred for construction and assessing conformity of insulation performance (Sapporo next-generation house conformity assessment) borne by building owners who construct a new house meeting the standards stipulated for Sapporo next-generation houses higher than the benchmark are subsidized.

Target houses, application requirements and the subsidy are as follows:

■ Houses for the subsidy

1. Those detached houses newly built in the city and a Sapporo Next-Generation housing meeting the standard or higher level of grade.
2. When the building is also used for non-residential purpose, the residential area should occupy more than a half of the total area.
3. The construction works should be completed*1 after April 2020 and the certification of the Sapporo Next-Generation Housing works are issued before the application period.

*1: The date of inspection certificate issued as set out by the Building Standard Act shall be the completion date of works

*2: a built-for-sale house is not covered by the subsidy

■ Application requirements

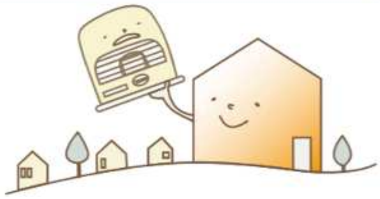
1. Those building owners newly building a subsidized house in Sapporo City to reside.
2. Those who are not in arrears with their municipal and prefectural taxes.
3. Those who are not an organized crime group member as provided for by Article 2.6 of the Act on Prevention of Unjust Acts by Organized Crime Group Member.

* Users of the subsidy system will be asked to cooperate a survey on fuel consumption for heating use for an year from April 2021.

* In case of multiple building owners, they can apply under their name.

■ Subsidy range

Grade of Target Sapporo Next-Generation House	Subsidy
Top Runner	1.6 Mil. yen
High Level	1.1 Mil. yen
Standard Level	0.5 Mil. yen



Source: Leaflet of the FY 2020 Subsidy System for Sapporo Next-Generation Houses

Figure 3-11. Target, application requirements and the subsidy under the subsidy system for Sapporo next-generation houses

(3) Energy-efficiency technology/system in Sapporo City

① High insulation/airtightness products

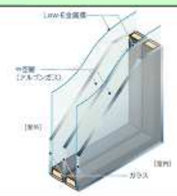
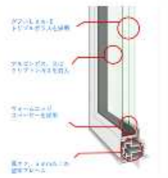
Urethane- and polystyrene-made high-performance insulation materials are used for exterior walls. According to building parts, meanwhile, double insulation materials are used for higher insulation.

For window and opening parts, Low-E triple glazing is used, which is a multi-layered material comprising three panes and two air layers. Since it has more air layers than double glazing, the insulation performance is high. On the inner surface of Low-E triple glazing, a specific metal membrane, called Low-E membrane, is coated which enhances not only insulation but also heat-shielding effects. Compared with the thermal transmittance of double glazing, the insulation and heat-shielding effects of Low-E triple glazing are more than tripled with higher energy efficiency.

Table 3-7. Products with high insulation/airtightness (1/2)

Where to use	Products with high heat insulation/airtightness	Image
Roof, etc.	**<u>Heat-insulation product</u>** - Barrier roof Gr (prevent solar radiation heat from penetrating the roof) - Nichiha Insulation Panel “Panel α” (allow to simply construct as insulation material and wood base are integrated) * BTO product - es Panel (reduce draft from the floor and boost comfortability and energy efficiency) *BTO product	
Exterior wall, etc.	**<u>Airtight product</u>** - Airtight packing for the foundation, moisture-proof airtight sheet, airtight packing for windows, water-proof around the window, airtight materials, water-proof around pipes and airtight materials	
Exterior wall, etc.	**<u>Wooden fiber insulation product</u>** - Environmentally friendly and innovative construction materials having thermal relaxation, sound-proof, fireproof and humidity control functions with high insulation performance and unique characteristics of wood.	
Exterior wall, etc.	**<u>Construction method to enhance insulation performance</u>** Double-wall unit method * factory production Thick double insulation layers ensure high insulation performance.	
Exterior wall, etc.	**<u>Products enhancing insulation performance</u>** A product jointly developed by Hoei Construction and LIXIL - Urethane insulation panel	
Exterior wall, etc.	**<u>Products enhancing insulation performance</u>** An original product of Tsuchiya Home - Original polystyrene insulation material “SE Best Board” enhances both airtightness and heat insulation	

Table 3-8. Products with high insulation/airtightness (2/2)

Where to use	Products with high heat insulation/airtightness	Image
Window and opening parts	**Products enhancing insulation performance** LOW-E triple glazing - APW 430 Achieve a high insulation performance by combining triple glazing and resin frame	
Window and opening parts	**Products enhancing insulation performance** LOW-E triple glazing - Triple Shanon A triple glazing on which inner and exterior glasses are composed by Low-E glazing (Best insulation performance in Japan)	
Window and opening parts	**Products enhancing insulation performance** LOW-E triple glazing - Thermos X A triple glazing on which inner and exterior glasses are composed by Low-E glazing (Best insulation performance in Japan)	
Window and opening parts	**Products enhancing airtightness** - External cover sash ALUMAKE A high airtightness also ensures sound-proofing effect.	

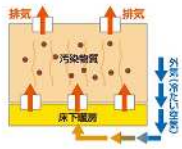
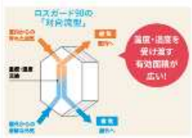
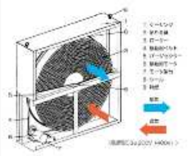
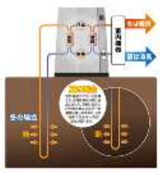
② Energy efficiency system

For the underfloor foundation, as well as using various insulation materials, an underfloor heating system is applied to streamline the process of heating during winter, while applying technology helps reduce heating energy.

For ventilation, a passive system is introduced, which ventilates all around the house with natural air flow and does not depend on machines. In particular, fresh outside air taken from air supply inlets is heated under the floor, distributed all around the house to efficiently heat the entire space and discharged from a ceiling chimney. Meanwhile, geothermal energy is used to heat up the outside air and reduce heating energy.

In addition, using geothermal heat pumps for air-conditioning systems allows a renewable source to be exploited, for energy efficiency and to reduce GHG emissions by using energy for air-conditioning.

Table 3-9. Energy efficiency system/technology
(floor heating, passive air-conditioning, geothermal heat air-conditioning)

Location	Equipment system	Outline	Image
Underfloor	Heating system by accumulating heat on the floor	[Equipment] Construct piping on the floor concrete to heat the whole indoors from the underfloor. [Energy efficiency] - The whole room is heated by heat transmitted directly from the underfloor and discharged from the floor vent. - Heating efficiently without losing heat thanks to heat insulation on the foundation. - An economical heating system using midnight power service (e time 3 plus) with a lower electricity bill.	
Underfloor	Central underfloor heating	[Equipment] Heating the whole house by circulating hot water pipes under the floor (heat source: kerosene) * introduced in 70% to 80% of housings in Hokkaido. [Energy efficiency] - Heating the whole house with underfloor vent to increase the comfortability and reduce air-conditioning load.	
Air-conditioner Heating	Passive ventilation	[Equipment] Heat the air by underground heat in the course of taking in outer air from an earth tube. [Energy efficiency] - No power consumed since passive ventilation does not use mechanical power. - Reduce air-conditioning load by passive ventilation.	
Air-conditioner Heating	Passive ventilation Underfloor heating system	[Equipment] An underfloor heating system heating the outer air by underground heat and utilizing the air rising by being heated. [Energy efficiency] - Low cost and highly efficient by combining an underfloor heating system and passive ventilation. - Reduce air-conditioning load by passive ventilation.	
Air-conditioner	Heat exchanging ventilation system “Loss Guard 90”	[Equipment] A “heat-exchanging-type” ventilating system equipped with high performance filters. [Energy efficiency] - The world’s highest energy efficiency performance with up to 90% of temperature exchange efficiency.	
Air-conditioner	Total heat exchanger	[Equipment] The total heat exchanger recovers heat exchanging the total or sensible heat from exhaust air to air supply using rotor rotation. [Energy efficiency] - The total heat exchanger reduces air-conditioning load and increases power efficiency.	
Air conditioning (underground heat)	Air conditioning system using geothermal heat pump	[Equipment] Collect underground natural energy to create heating energy. [Energy efficiency] - Increase energy efficiency by using natural energy, reduce CO_2 emissions and reduce heat island effects.	

3.2. Candidate JCM Model Projects

3.2.1 Candidate project facilities

(1) Selection perspectives

Energy-saving technologies and systems which could help address energy-saving issues of buildings in Mongolia, as described in the previous section, were examined.

Although regulations exist to govern insulation/energy-efficient in Mongolia, their operational status is unknown. Accordingly, it is considered that incentivizing the introduction of energy-saving technologies by utilizing standardized energy-efficient technology, calculating the energy-saving effects and devising subsidy schemes based on said calculation will help promote energy saving of buildings.

(2) Selection perspectives

In the early 2000s, the Mongolian government allocated a certain area of land to all citizens. Subsequently, in Ulaanbaatar, citizens built Ger houses in disorderly fashion without administrative permission and formed villages called the “Ger area”. Under the circumstances, many poor citizens flowed into Ulaanbaatar City in the 2000s, sparking a construction boom and soaring population but without urban planning. Moreover, following the opening of the New Ulaanbaatar International Airport, there are plans to develop satellite cities around the new airport and many candidate sites for this project.

Accordingly, the candidate facilities for the JCM Model Project are selected from the following perspectives:

<Selection perspectives>

- High energy consumption and high energy-saving effects.
- Scope to roll out new technology, given the infrastructural limitations.
- Renewable energy can be introduced as an replacement for existing power equipment.
- The project can provide a model case in Ulaanbaatar City and the lessons learned are expected to be applied to other similar cases.

(3) Selection result

The new collective housing to be developed denotes those facilities with high energy consumption for which new infrastructure can be introduced. For large-scale collective housing, a regional electric heat supply using renewable energy can be applied.

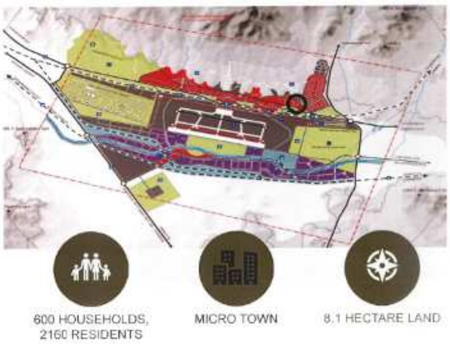
Based on the aforementioned perspectives, collective housing scheduled for construction near the new airport where infrastructure has yet to be developed is considered a preferable candidate for this JCM Model Project.

(4) Overview of the candidate project site

The candidate project site includes collective housing for airport staff and their family (600 households) in the aero-city area, one of the satellite cities planned to be developed under the multi-hub-city policy following the opening of the New Ulaanbaatar International Airport. The Aero city has become a satellite town, covering 12,000 ha and housing 34,000 residents (9,478 households) utilizing the new airport.

While infrastructure is not developed around the new airport area, the heating requirements for the 9,478 households in the Aero city collectively total 139.8 MW. If we estimate 10% of all housing construction during the initial stage after the airport goes into service, just 14 MW will be required, which is one third of the airport's supply capacity (42 MW).

The required electric power is expected to be 27.4 MW between 2020 and 2025 and 28.6 MW between 2026 and 2030. Accordingly, there are plans to construct power supply facilities for the Aero city and develop solar power generation/accumulation equipment for charging streetlights and electric vehicles (EVs). To reduce energy consumption in the Aero city as a means of making the equipment introduced more affordable and helping promote efforts to mitigate climate change, further extending energy-saving housing and an efficient energy supply using renewable energy are considered necessary.



3.2.2 Overview of model housing and building specifications

(1) Outline of buildings in the aero-city residential district

The collective housing for airport staff and their families in the aero-city residential district is outlined as follows:

Site area: 81,000 m²

Resident: 600 households, 2,160 residents

Buildings

Collective housing:	Five stories, 27 buildings
	Three stories, six buildings
School:	420 school children
Kindergarten:	360 children
Trade center with amusement facility	

Figure 3-12. The aero-city residential district (image)

(2) Overview of building specifications

Detailed specifications for the target building have not been obtained.

Referring to the existing survey results, the common specifications are expected to be as follows:

1） 1) Reinforced concrete construction in Mongolia

RC construction is applied for a lot of collective housing. Structural column, beam and slab members are constructed using reinforced concrete and aerated concrete blocks (300 mm thick) are applied for exterior walls. Bead method polystyrene foam (EPS) and other insulation materials are applied to columns, beams and exterior wall concrete blocks and a mortar coating is applied.

In many cases, exterior walls are composed as follows:

① Coating finishing + bricks (120 mm) + EPS (100 mm) + aerated CBs (380 mm) + mortar (15 mm)

② Coating finishing + mortar (15 mm) + EPS (150 mm) + aerated CBs (380mm) + mortar (15 mm)

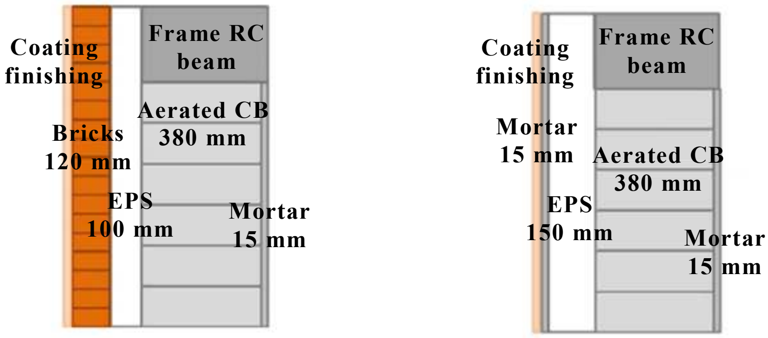


Figure 3-13. Exterior wall composition in RC construction

Table 3-10. Specifications applied in RC construction

Part		Existing house in Ulaanbaatar City
Insulation	Exterior wall	EPS (bead method polystyrene foam) 100 mm
	Roof	EPS (bead method polystyrene foam) 100 mm
	1st floor	No heat insulation
	Window	Plastic sash Standard double glazing
	Door	Standard metal door
	Thermal bridge	- Installed on each floor - Installed in parapet Insulation insufficiently reinforced.
Ventilation		Natural ventilation Ventilation volume is uncontrolled.

Prepared by referring to a report on the "Project Development Study for GHG reduction by introducing energy-efficient collective housing in the Ger areas of Ulaanbaatar, Mongolia (2014)".

2） 2) Precast concrete construction

Precast concrete construction is also commonly applied for collective housing.

The exterior wall is around 200 mm thick and only the internal surface is coated in cement/lime cement mortar. Old wooden double-glazed windows are often installed but poorly coated and sealed, resulting in leakage. The roof is flat and constructed by slabs reinforced with around 200 mm of precast concrete. No insulation materials are used.

3.2.3 Energy-saving systems and technologies to be introduced

Among the energy-saving systems in Sapporo City, those applicable to the project selected include measures and standards adopted in subsidy systems for Zero-Energy Buildings (ZEB) and Net-Zero Energy Housing-M (ZEH-M).

Since the methods of calculating the energy-saving effects of office buildings and collective housing are established in these systems, certification by level is available and the certification and subsidy system are uniformly operated, hence their introduction to Mongolia is expected to help promote energy saving of buildings.

(1) Subsidy system for ZEB and ZEH-M in Sapporo City

The City of Sapporo subsidizes building owners with an amount from 600,000 to 3 million yen to cover the additional design cost needed to construct ZEB and ZEH-M to reduce GHG emissions. With this assistance, the City promotes "zero-energy" of buildings from a long-term perspective.

The initiative targets building owners constructing ZEB and ZEH-M covering a floor area exceeding 300m² in Sapporo City. The subsidies are as follows:

Table 3-11. Subsidy systems of the City of Sapporo

ZEB (total floor area: larger than 300m² and smaller than 2,000 m²)	ZEB (total floor area: larger than 2,000 m²)	ZEH-M (total floor area: larger than 300m² and smaller than 2,000 m²)	ZEH-M (total floor area: larger than 2,000 m²)
1.5 million yen	3 million yen	600,000 yen	1 million yen

Figure 3-14. A guide for the Sapporo City Subsidy System

(2) ZEB

ZEB is a building targeting a zero-balance for its internal energy consumption. While discussions continue inside and outside Japan, the summary of the ZEB Roadmap Examination Committee (December 2015), prepared by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, defines ZEB as follows:

Definition of ZEB

> A ZEB is a building achieving considerable primary energy consumption savings each year. As much energy as possible is saved by actively utilizing natural energy. This entails reducing energy loads and applying a passive method with advanced architectural design, introducing high-efficiency equipment to maintain the quality of indoor environment and boosting energy independence as much as possible by introducing renewable energy.

As described above, the main building technologies for realizing ZEB are: (1) reducing energy load (passive method), (2) high-efficiency equipment (active method) and (3) renewable energy (energy creation).

① Passive method: Heat insulation of building envelope (high-efficiency insulation materials, high-efficiency heat insulation/shielding window), solar shielding, natural light
② Active method: high-efficiency air-conditioning, high-efficiency lighting
③ Energy creation: Solar power generation system

To achieve and disseminate buildings with zero-balance of energy consumption, Nearly ZEB, ZEB Ready and ZEB Oriented are also defined qualitatively and quantitatively in addition to ZEB.

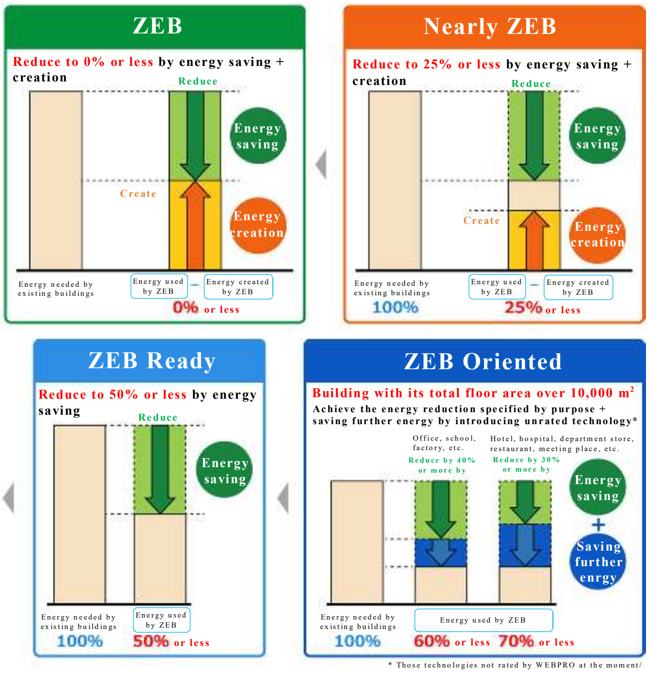


Figure 3-15. Overview of ZEB defined by four steps

Source: the Ministry of the Environment website

(3) ZEH-M

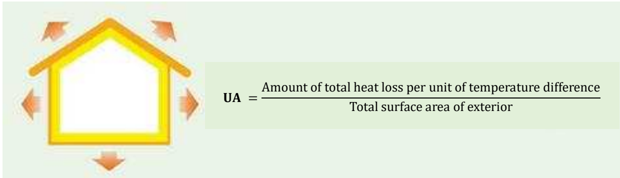
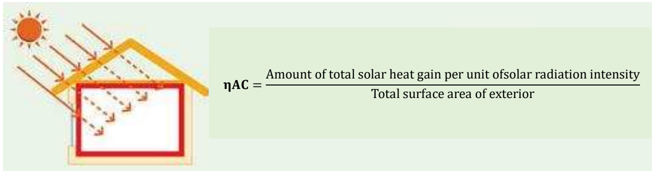
While ZEB applies to general office buildings, ZEH-M targets collective housing. The definition of ZEH-M also encompasses four levels and assessment standards to be met by residential building as follows:

Table 3-12. Assessment standards for ZEH-M

	Assessment standards			
	ZEH-M	Nearly ZEH-M	ZEH-M Ready	ZEH-M Oriented
Heat insulation of building envelope	Criteria for reinforced envelope (which all households should satisfy)			
Primary energy consumption	20% decrease except renewable energy			
	100% decrease including renewable energy	100% decrease including renewable energy	50% decrease including renewable energy	Renewable energy not specified

As shown above, at least (1) all households should satisfy the criteria for reinforced envelopes and (2) the primary energy consumption should be decreased by 20% or more to conform to ZEH-M. It is assessed in terms of the reduction volume of primary energy consumption, including renewable energy. The criteria for reducing primary energy consumption are in line with the 2016 energy efficiency standards, as shown in the Building Energy Efficiency Act.

Table 3-13. Standards for envelope performance

Standards	Baseline	Description
Average outer shell heat transmission coefficient UA[W/(㎡・K)]	0.4 or less (Hokkaido, Sapporo/Asahikawa)	The total heat loss from the exterior walls, opening parts, roof and other "outer shell" per unit of temperature difference is divided by the total surface area of the exterior. 
Average solar heat gain coefficient during cooling period ηAC	Not set for cool regions	Total solar heat gain from exterior wall, opening parts, roof and other "outer shell" per unit of solar radiation intensity is divided by total surface area of exterior. 

In ZEH-M, the levels to be achieved are set according to the number of building stories. Those with three stories or less should conform to ZEH-M or Nearly ZEH-M while those with four to five stories and six or more stories should conform to ZEH-M Ready and ZEH-M Oriented, respectively.

In this project, many residential buildings are expected to be four stories high and securing materials equivalent to those used in Japan will be difficult in Mongolia. Accordingly, the project will introduce ZEH-M Ready and ZEH-M Oriented.

(4) Energy efficiency technology to be introduced

For ZEH-M, the envelope performance and primary energy consumption amount are calculated based on the specifications of each building part. This calculation method allows the building energy efficiency in Mongolia to be quantitatively determined and showcases the performance to be achieved. Portions used to benchmark the determination are shown in the table below. Those technologies increasing energy efficiency, which will subject to subsidy when certified as ZEH-M, are also shown in the figure below.

[Common area]

Equipment	Air-conditioning
	Lighting
	Elevator

[Exclusive owned area]

Heat insulation materials	Roof
	Exterior wall
	Floor
	Boundary floor
Opening part	Window
	Door
Equipment	Air-conditioning
	Ventilation
	Lighting
	Heated water supply

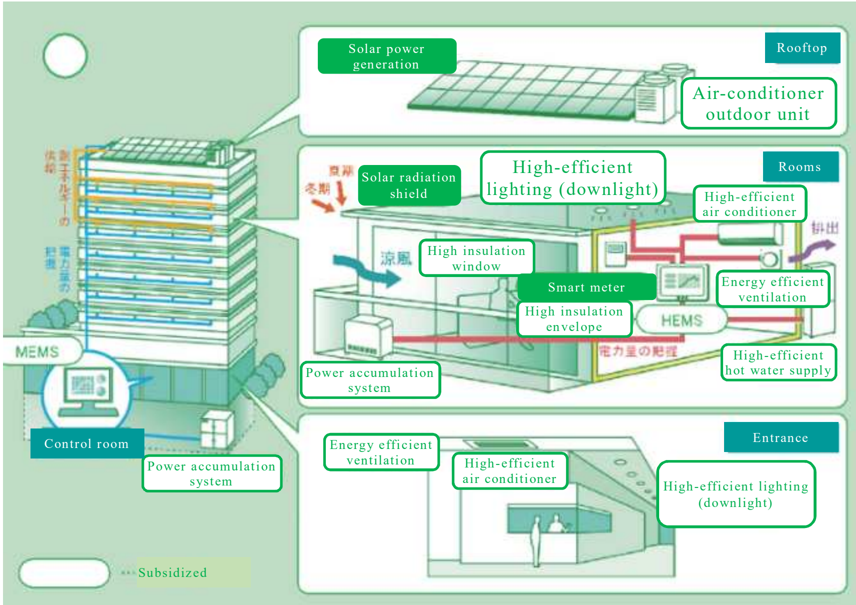


Figure 3-16. Energy efficiency technology to be subsidized

In this survey, the above calculation is carried out to estimate the primary energy consumption based on specifications adopted in Ulaanbaatar City. The same calculation is applied in line with specifications for introducing energy efficiency technology to clarify the scope of the reduction.

Since the specific ZEH-M calculation elicits different results according to the scale and shape of buildings, a detailed architectural plan needs to be formulated for the calculation.

In the ZEH Design Guidelines for Collective Housing (March 2020), the building specifications for ZEH-M Ready or ZEH-M Oriented are simulated, while presuming a model collective housing as a case study.

Since the building shape in the Aero city has yet to be specifically decided, this survey assumes that the shape of model collective housing in above-referred guidelines will constitute the actual building shape and the following specifications to achieve ZEH-M Oriented will be introduced.

[Outline of the model collective housing]

Total area	5,558.26 m²
Common area	4,640.04 m²
Average household floor area	72.5 m²
No. of households	64 households
Structure	RC construction, six stories

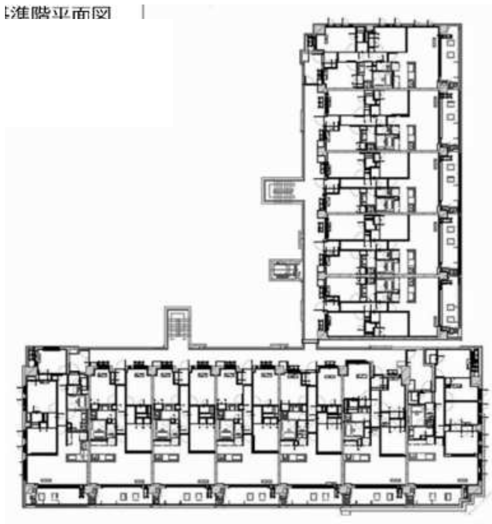
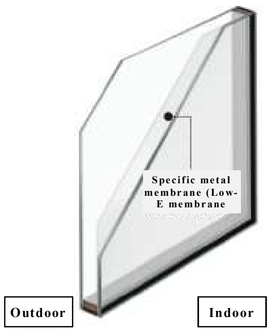
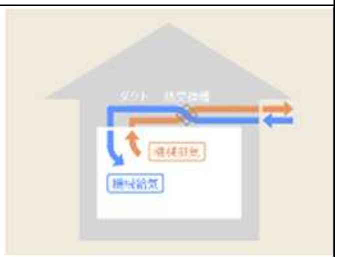


Figure 3-17. A typical floor layout of the model collective housing

Table 3-14. Specification to be introduced

Part		Introduced specifications	Overview
Heat insulation materials	Roof	Exterior heat insulation: extruded polystyrene foam insulation (Interior heat insulation: sprayed rigid urethane foam insulation)	Sheet-type form polystyrene which is hard and fire-resistant. High heat insulation performance compared with bead method polystyrene foam. Water resistance is also high and the performance does not decline as much when wet. 
	Exterior wall	Interior heat insulation: sprayed rigid urethane foam insulation	Utilizing self-adhesion, bring an undiluted solution and forming machine to the construction site. When spraying undiluted urethane solution, it forms rigid urethane form insulation. Spraying allows construction without leaving a crack. 
	Floor	Outer air and pit: exterior heat insulation: extruded polystyrene foam insulation	—
	Boundary floor	Interior heat insulation: sprayed rigid urethane foam insulation	—

Opening part	Window	Resin-metal composite fittings + Low-E multi-layered glazing acquiring solar radiation heat	As well as enhancing heat insulation, it maintains a high solar radiation heat acquisition rate and helps reduce heating energy. 
Equipment	Air-conditioning	Room air conditioner Floor heating system using heated water	In addition to a high-efficiency air conditioner, it also uses a floor heating system. The latter combines “thermal conduction”, via which heat is felt from the feet and “radiation”, via which heat is felt by far infrared rays from the floor surface, allowing an efficient and comfortable indoor environment to be maintained.
	Ventilation	Duct-type Class 1 ventilating equipment (using a duct with a larger diameter and DC motor) and total heat exchanger	Compared to ventilation without exchanging heat, it uses the air heat discharged outside to supply air at close to room temperature. This paves the way to reduce heat loss in the residence and running cost of air conditioners. 
	Lighting	LED lighting (motion detector)	Introducing LED equipment and monitoring its switch via a motion detector.
	Heated water supply	Water heater with electric heat pump Hot-water-saving faucet (kitchen faucet, bathroom shower, wash-basin faucet)	In addition to water heating equipment using high-efficiency heat pump technology, a hot-water-saving faucet is used to reduce the energy consumed in the kitchen and bathroom.

3.3. GHG reduction effect and establishing a monitoring plan

3.3.1 Concept of calculation

In line with the ZEH-M concept, this section compares the primary energy consumption figures for airport-staff housing to be constructed within the new airport premises. Project values, in which introduced specifications are often introduced and benchmark building specification values applied in Ulaanbaatar, are compared and the GHG reduction effects are calculated.

When certifying ZEH in Japan, the 2016 Energy Efficiency Standards are applied as a benchmark and the certification is determined according to the level of reduction. However, given the inability to establish a benchmark in Ulaanbaatar, this Chapter calculates the primary energy consumptions in both cases with building specifications applied across the board in Ulaanbaatar City and with introduced specifications to determine the reduction amount.

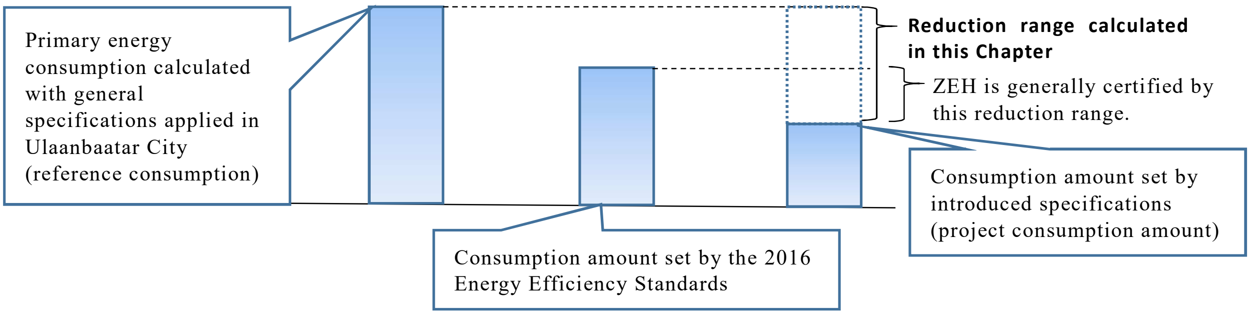


Figure 3-18. Concept of calculating the reduction amount

3.3.2 ZEH-H calculation based on detailed specifications

(1) Determination flow of ZEH-M

In determining ZEH-M, using the “energy consumption performance calculation program” and other tools to calculate the envelope performance and Building Energy Index (BEI) in accordance with the following flow.

As described in 3.3.1, this Chapter is not intended to determine ZEH-M but to calculate the energy efficiency effects of the introduced specifications compared to the Mongolian specifications. Accordingly, a model household in the area exclusively owned is set and its envelope performance and primary energy consumption are calculated.

As shown in 3.2.3 (3), the expected building scale shall be that used in a case study indicated in the ZEH Design Guidelines for Collective Housing (six stories above ground and 64 households)

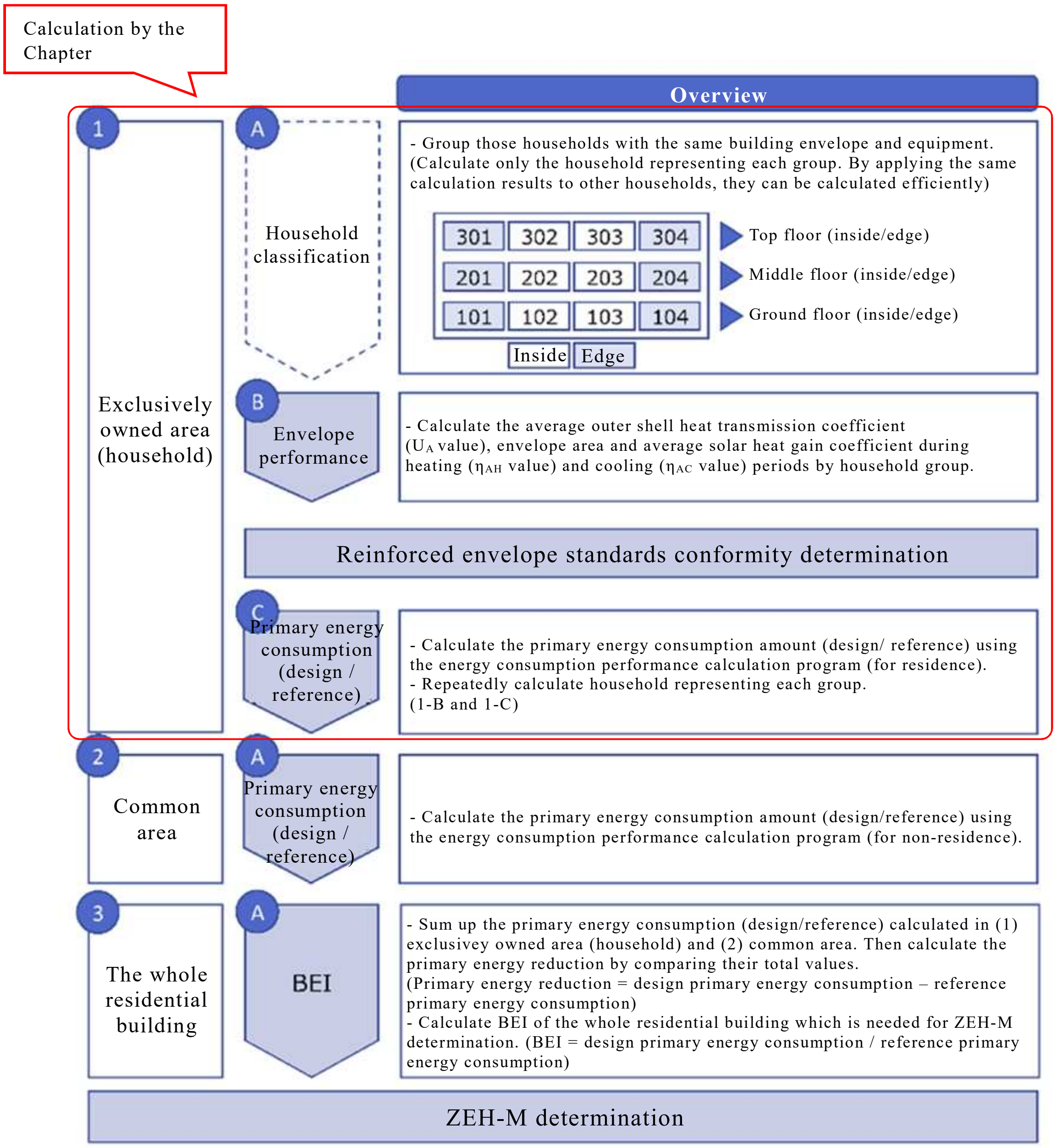
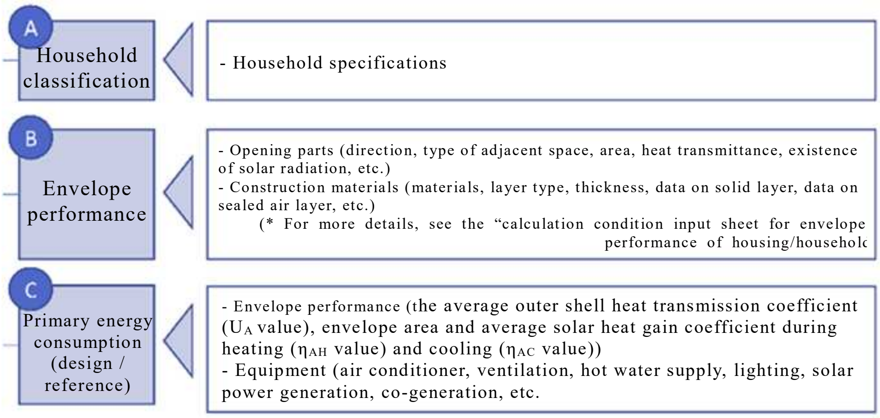


Figure 3-19. Determination flow of ZEH-M

* According to the ZEH Design Guidelines for Collective Housing. The collective housing structure is divided by exclusively owned portions (households) and common areas, including separate entrances and common space. Given the lack of programs for calculating them together, this Chapter calculates by only extracting a household portion with a larger exclusively owned area.

(2) Architectural specifications to be input

Following the ZEH-M method, the primary energy consumption in the model household as shown above is calculated by the following procedure:



Source: ZEH Design Guidelines for Collective Housing

Figure 3-20. Calculation procedures for household

The specifications for calculating the envelope performance and primary energy consumption are shown as follows. The data input for calculation are shown as hatched portions. The general specifications in Ulaanbaatar City are those confirmed by the field survey and constructed by a Japanese company on site. The reference values set under the 2016 Energy Efficiency Standards are applied for those unknown items.

Table 3-15. List of specifications applied

Item		Standard specifications in Ulaanbaatar	Specifications for introduction
Heat insulation materials	Roof	Bead method polystyrene foam 100 mm	Exterior heat insulation: extruded polystyrene foam insulation (Class 3 bA 60 mm) Interior heat insulation: sprayed rigid urethane foam insulation (Class A 1H 70 mm)
	Exterior wall	Bead method polystyrene foam 100 mm	Interior heat insulation: sprayed rigid urethane foam insulation (Class A 1H 100mm)
	Floor	None	Outer air: extruded polystyrene foam insulation (Class 3 bA 75 mm) Pit: exterior heat insulation: extruded polystyrene foam insulation (Class 3 bA 60 mm)
	Boundary floor	None	Interior heat insulation: sprayed rigid urethane foam insulation (Class A 1H 20mm)
Opening part	Window	Resin-metal composite fittings + multi-layered glazing	Resin-metal composite fittings + Low-E multi-layered glazing acquiring solar radiation heat
	Door	Honeycomb-structured metal door (U-value: 4.65)	Honeycomb-structed metal door (U-value: 4.65)
Equipment	Air conditioning	Room air conditioner	Room air conditioner Floor heating using hot water
	Ventilation	Duct-type Class 2 or duct-type Class 3 ventilation equipment	Duct-type Class 1 ventilating equipment (Energy efficiency specifications: using a duct with larger diameter, DC motor and heat exchanger)
	Lighting	Fluorescent light (except an incandescent lamp)	LED lighting (all equipment, motion detector)
	Heated water supply	Single-function heated water supply	Water heater with electric heat pump Hot water saving faucet (kitchen faucet, bathroom shower, wash-basin faucet)

3.3.3 Calculation of reduction impacts

(1) Calculation results

The reduction impacts are calculated as shown below.

A) Housing classification

A housing unit with the below area on the top floor of a 6-story collective housing building

Main living space: 25.58 m^2, other living space: 25.83 m^2, non-living space: 20.68 = 72.09 m^2 in total

Total building envelope area: 250.1 m^2

B) Envelope performance

Because the comparison of two buildings is the main purpose herein, insulation performance of the wall insulation material is compared as the envelope performance.

The overall coefficient K(W/m^2K) of the wall is calculated in the below calculation formula.

$$K = \frac{1}{\frac{1}{\alpha_i} + \sum_i \frac{L_i}{\lambda_i} + \sum_i R_i + \frac{1}{\alpha_o}}$$

αi: inside overall heat transfer coefficient 9.0W/(m^2K)

α0: outside overall heat transfer coefficient 23.0 W/(m^2・K)

Li: thickness of building material i [m] ⇒100 mm

λi: heat transfer coefficient of building material i [W/(m・K)]

⇒ specifications of each insulation material

Ri: heat transfer resistance of midair layer [(m^2・K)/W] ⇒0

(Source: Calculation method of overall coefficient of the wall, Building Research Institute)

Specifications of heat insulation materials are provided in the below table.

Table 3-16. Specifications for heat insulation materials

General specifications in Ulaanbaatar	Introduced specifications
Bead method polystyrene foam (EPS) 100 mm	Interior heat insulation: sprayed rigid urethane foam insulation Class A, 1H 100mm
Thermal conductivity: 0.037W/m^2K	Thermal conductivity: 0.026W/m^2K

The envelope performance is calculated as shown in the below table.

Table 3-17. Insulation performance assessment of exterior surface

	Ulaanbaatar Standard specifications	Introduced specifications
Average outer shell heat transmission coefficient	0.35 W/m^{2}K	0.25 W/m^{2}K

C) Primary energy consumption

The below table provides the primary energy consumption based on the Ulaanbaatar standard specifications and introduced specifications as a result of calculations with the above values in accordance with the energy consumption calculation program (for housing) Ver.2.8.1 published by Building Research Institute.

Table 3-18. Energy performance assessment

<table>
<tr><th colspan="3"></th><th>Ulaanbaatar standard specifications (MJ/year)</th><th>Introduced specifications (MJ/year)</th></tr>
<tr><td rowspan="5">Exclusive use area</td><td rowspan="2">Air-conditioning</td><td>Heating</td><td>37,141</td><td>26,491</td></tr>
<tr><td>Cooling</td><td>526</td><td>541</td></tr>
<tr><td colspan="2">Ventilation</td><td>3565</td><td>2902</td></tr>
<tr><td colspan="2">Water heating</td><td>21690</td><td>23038</td></tr>
<tr><td colspan="2">Lighting</td><td>3616</td><td>2590</td></tr>
<tr><td colspan="3">Total (GJ/year)</td><td>66.6</td><td>55.6</td></tr>
</table>

(2) Calculation formula for reference emissions and project emissions

The emissions are calculated based on the primary energy consumption obtained above and CO_2 emission coefficient.

The above is assumed to be a 64-unit collective housing building and the calculation is based on 600 units that is the scale of the building in Aero city plan.

Reference emissions
= Σ{Primary energy consumption based on Ulaanbaatar specifications (600 units) ×) 0 Ulaanbaatar emission coefficient}

Project emissions
= Σ{Primary energy consumption based on introduced specifications (600 units)×) 0 introduced emission coefficient}

CO_2 emission coefficient is as shown in the below table.

Table 3-19. CO_2 emission coefficient

Item		Value	Unit	Note	Source
Reference CO_2 emission coefficient	Coal-fired power generation	0.975	kg-CO2/kWh		Agency for Natural Resources and Energy, Study Group Report on Low Carbon Power Supply System, 2009
		0.271	t-CO2/GJ	kWh=3.6MJ	
Project CO2 Emission coefficient	Renewable energy emission coefficient (Mongolia)	0.797	Kg-CO_2/kWh		GEC, FY2020 JCM project Electric power CO2 emission factor (t-CO2 / MWh) list
		0.221	t-CO_2/GJ	kWh=3.6MJ	

(3)Summary of reduction and impacts

Based on the above, the CO_2 emissions reduction is calculated as shown below.

Table 3-20. Calculation of CO_2 emissions reduction

	① Primary energy consumption (GJ/year, per model unit)	② Primary energy consumption (GJ/year, per 600 units, per ①×)	③ CO_2 emissions (t-CO_2/year、② × emission coefficient (0.239))
Reference emissions (Ulaanbaatar specifications)	66.6	39,960	10,829
Project emissions (introduced specifications)	55.6	33,360	7,373
Reduction			3,456

The calculation results show possible annual CO_2 emissions reduction of 3,456 tons by introducing specifications proposed to the 600-unit collective housing planned in Aero city.

The cost-benefit performance is estimated based on the cost in the country because information on the cost of introduced specifications and construction cost in Mongolia has yet to be obtained.

The guidelines provide the estimated gap between construction of condominium building based on 2016 energy-efficiency standards and ZEH-M-oriented specifications as below based on the interview with makers and unit prices in catalogues.

Table 3-21. Cost comparison by specification change

	Energy efficiency standards (10,000 yen)	Additional cost (10,000 yen)	ZEH-M Oriented (10,000 yen)	Increase rate
Temporary work	9,337	136	9,473	101%
Civil engineering work	4,391	0	4,391	100%
Foundation work	5,836	0	5,836	100%
Skeleton work	32,681	0	32,681	100%
Envelope performance	41,185	2,958	44,143	107%
Electril equipment (lighting)	8,948	102	9,050	101%
Sanitary equipment (hot water)	11,561	442	12,002	104%
Air conditioning system (heating/cooling, ventilation)	2,279	1,236	3,515	154%
Elevator	1,167	0	1,167	100%
Various costs	14,895	745	15,640	105%
Total	132,280	5,618	137,899	104%

An increase of 56,180,000 yen due to the specification change provided above is for a 64-unit condominium building and it is estimated to be an increase of 526,690,000 yen (5,618×600/64) for a 600-unit building.

The subsidy ratio is assumed to be 50% and the statutory useful life for (steel-reinforced concrete or reinforced concrete) housing buildings is assumed to be 47 years.

Based on the above assumption, the cost-benefit performance is calculated as below.

(526,690,000 yen × 50%) / ((3,456t -CO_2 × 47 years) = 1,621 yen/t-CO_2

The above calculation suggests that introduction of ZEH-M-oriented building to a 600-unit collective housing proposed in the survey will enable the cost-benefit performance of the emissions reduction of 4,000 yen/t-CO_2/year or below.

3.4. Consideration of the Project Implementation System and Plan

3.4.1 System and plan to implement project

(1) Project implementation system

The project implementation system is expected to constitute the following:

Table 3-22. Expected project implementation system

Role	Name of business operators	Remarks
Destination to introduce the technology	The City of Ulaanbaatar and Tuv Provincial Government (provisional)	・ Energy-efficient design and construction are reflected in the collective housing in Aero city. ・ Establish a subsidy system referring to ZEH-M
Representative company	IWATA CHIZAKI Inc.	・ Apply for the JCM ・ Support design and construction works
System design / technical support	The City of Sapporo Hokkaido University	・ Support efforts to design a subsidy system in Mongolia ・ Support efforts to optimize via Japanese energy efficiency technology in Mongolia

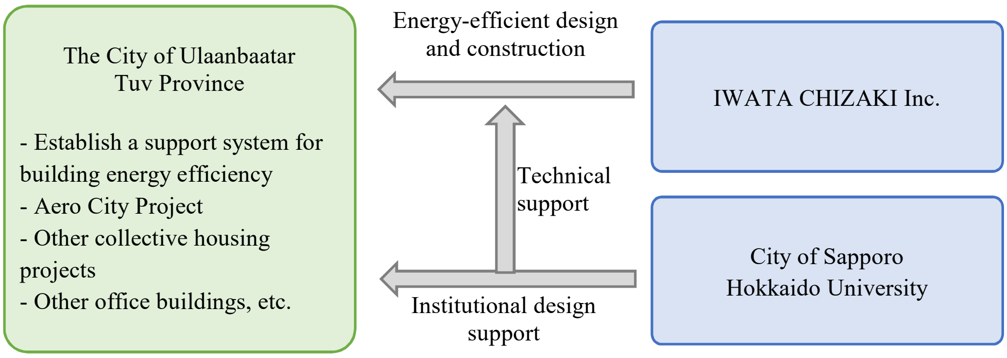


Figure 3-21. Stakeholders and their role in the project

(2) Project implementation plan

The following schedule is expected to introduce the technology. As soon as the system is determined, the project will strive to apply for the JCM Financing program at an early stage to start the implementation.

Table 3-23. Project implementation schedule

Item	FY 2021												FY 2022											
	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Consider infrastructure development with high environmental performance by increasing energy efficiency in the housing/building sector to achieve zero-carbon society in a cool region.																								
(1) Consider a JCM Model Project																								
(2) Confirm details of Mongolian building standards and systems																								
(3) Consider the participation of the City of Sapporo and businesses in Hokkaido																								
Specifically consider the expansion of introducing renewable energy and new energy in Ulaanbaatar City																								
(1) Build a consensus on a roadmap to introduce equipment																								
Capacity development support of the City of Ulaanbaatar and Tuv Provincial government																								
(1) Share knowledge of Sapporo City and consider the applicability of the knowledge to the Aero city new city concept																								
(2) Introduce efforts on the net-zero energy buildings																								
Consider infrastructure development with high environmental performance by increasing energy efficiency in the housing/building sector to achieve zero-carbon society in a cool region.																								
(1) Prepare application for the JCM financing programme																								
(2) Consider and utilize financing schemes other than the JCM																								
Specifically consider the expansion of introducing renewable energy and new energy in Ulaanbaatar City																								
(1) Advisary support for specific introduction																								
Capacity development support of the City of Ulaanbaatar and Tuv Provincial government																								
(1) Capacity development support in the field other than CO_2 reduction																								

3.5. Other Potential Projects

3.5.1 Other housing projects than Aero city residential district project

The energy efficiency calculation method and construction specifications based on the ZEH-M concept are expected to be introduced to other collective housing projects.

There is a plan of a housing efficiency improvement project in the ger area in Ulan Bator and construction of a number of collective housing has been planned. Electricity is assumed to be the main energy source of the collective housing, which is the same as Aero city. Because it is essential to improve the building energy efficiency technology, use of ZEH-M energy-saving technology is effective.

In Ulan Bator, of all residences, detached houses, collective housing and Gers account for 40%, 35% and 25%, respectively, and the ger area is expanding due to the influx of job seekers into urban areas. In proportion to the increase in housing due to the population influx, coal consumption in the ger area is also on the rise, which has been causing serious air pollution in recent years. Unregulated expansion of residential areas has resulted in a growing shortage of public land, which has escalated the severity of city planning causing such a problem as constant traffic congestion due to inability to develop roads. The Ulan Bator city government is promoting a redevelopment project of the ger area as a priority project.

When 70% of the estimated 187,000 households in the ger area are assumed to move to mid-to-high-rise apartments to be redeveloped, 130,900 will move there, which implies the potential construction demand for 1,300 100-unit apartment buildings.

Due to a rise in the income level in line with the economic development and increase in demand to move to better-quality housing, the housing market in Mongolia has been strong. Also outside the ger area, old precast concrete mid-rise collective housing buildings constructed during the socialist resume have been demolished and new housing buildings are being constructed there in the city zone, which also shows the big demand for collective housing.

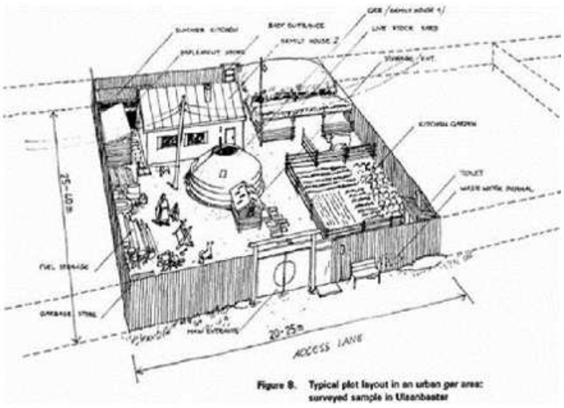


Figure 3-22. Housing unit in a ger area

Figure 3-23. Appearance of a Ger house

Source: Report on the Project Development Study for GHG reduction by introducing energy-efficient collective housing in the ger areas of Ulan Bator, Mongolia

3.5.2 Utilization of ZEB technology for other buildings than collective housing

(1) ZEB technology

The ZEB technology is expected to be utilized also for office buildings.

Because the properties of office buildings differ from those of collective housing buildings, items to be assessed also differ. While buildings with the same specifications stand next to each other in the case of collective housing, air-conditioning and water and hot-water supply are used differently from one housing unit to another and thus it is important to select high-efficiency equipment for the collective housing. Meanwhile, for office buildings, introduction of equipment systems that include energy-saving technologies for wide space, central energy-consumption control and utilization a wide variety of heat sources including daylight and ground source works effectively.

An example of an office building where the ZEB technology is introduced is shown below.

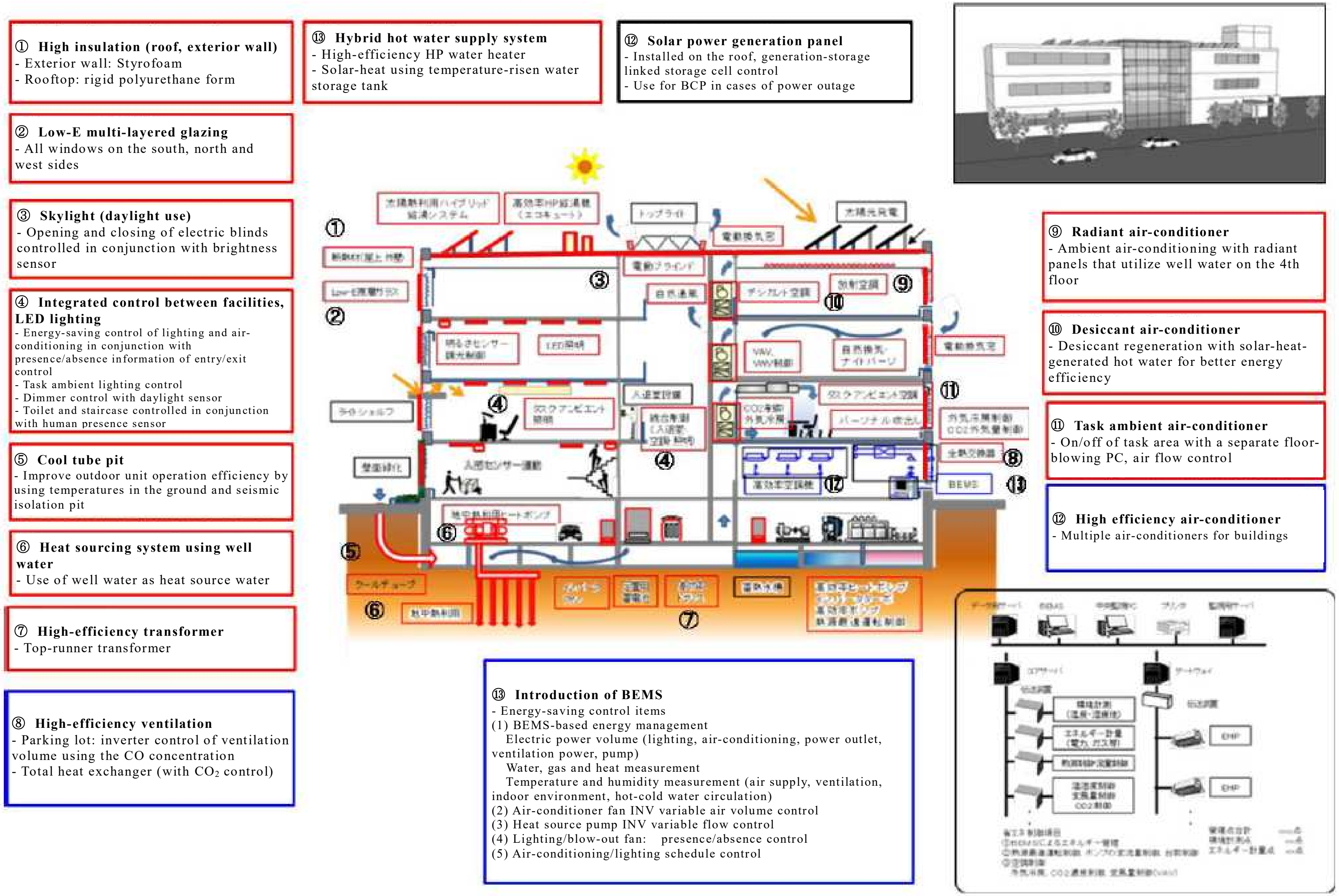


Figure 3-24. ZEB technology introduced to an office building

Energy-efficiency technologies in ZEB introduced in the above building are listed in the below table.

Table 3-24. List of energy-efficiency technologies in ZEB

Item	Energy-Efficiency Technology
① Higher insulation (roof and exterior wall)	・Exterior wall: Styrofoam ・Roof: rigid urethane foam
② Low-E multi-layered glazing	・All windows on the south, north and west sides
③ Skylight (daylight use)	・Opening and closing of electric blinds controlled in conjunction with brightness sensor
④ Integrated control between facilities, LED lighting	・Energy-saving control of lighting and air-conditioning in conjunction with presence/absence information of entry/exit control ・Task ambient lighting control ・Dimmer control with daylight sensor ・Toilet and staircase controlled in conjunction with human presence sensor
⑤ Cool tube pit	・Improve outdoor unit operation efficiency by using temperatures in the ground and seismic isolation pit
⑥ Heat source system using well water	・Use of well water as heat source water
⑦ High-efficiency transformer	・Top-runner transformer
⑧ High-efficiency ventilation	・Parking lot: inverter control of ventilation volume using CO concentration ・Total heat exchanger (with CO_2 control)
⑨ Radiant air-conditioner	・Ambient air-conditioning with radiant panels that utilize well water on the 4th floor
⑩ Desiccant air-conditioner	・Desiccant regeneration with solar-heat-generated hot water for better energy efficiency
⑪ Task ambient air-conditioner	・On/off of task area with a separate floor-blowing PC, air flow control
⑫ High efficiency air-conditioner	・Multiple air-conditioners with one outdoor unit for buildings
⑫ Solar-power generation panel	・Installed on the roof, generation-storage linked storage cell control ・Use for BCP in cases of power outage
⑬ Introduction of BEMS	・Energy-saving control items ①BEMS-based energy management Electric power volume (lighting, air-conditioning, power outlet, ventilation power, pump) Water, gas and heat measurement Temperature and humidity measurement (air supply, ventilation, indoor environment, hot-cold water circulation) ②Air-conditioner fan INV variable air volume control ③Heat source pump INV variable flow control ④Lighting/blow-out fan: presence/absence control ⑤Air-conditioning/lighting schedule control
⑬ Hybrid hot water supply system	・High-efficiency HP water heater ・Solar-heat using temperature-risen water storage tank

(2) Utilization for new TDB building construction plan


Figure 3-25. An image of a new TDB building

The Trade and Development Bank of Mongolia (TDB) based in Ulan Bator is examining a construction plan of a new headquarters building and it has shown interest in a green building.

On the other hand, the bank faces a challenge of inability to identify advantages of constructing a green building as there is no green building assessment program or certification scheme in the country.

The building is planned to be a 154.55-meter-tall 28-story building above ground with three basement floors with an approximate total floor area of 65,000 m^2. The 24,000m^2 exterior wall in total is assumed to be a glass façade built with energy-efficient materials. It is also considering the introduction of a water recycling system—recycling 33 cubic meters of water that is approximately 30% of total daily water use of 107 cubic meters for better water use.

In studying the plan, use of ZEB for calculation of energy efficiency and certification will help clarify the technology introduction and energy-saving impacts of the facility to enable examination of optimal energy-saving technology of the entire building, which is expected to promote the plan as a green building and contribution to CO_2 emissions reduction.

The clarification of energy-saving impacts is also expected to improve the corporate image users have and serve as an appealing point to investors.

(3) Potential to utilize for new emart store construction

Figure 3-26. An image of new emart building

There are three emart stores in Ulan Bator with 20,000 customers daily and it is considering the use of the JCM financing project to construct its fourth store.

It plans a large-sale 6-story supermarket with an approximate air heating volume of 145,000 m^3 in total. It aims to reduce CO_2 emissions by 30% with better energy efficiency by improving the air-conditioning system and building exterior surface. It is estimated to emit 4,569 tons of CO_2 annually and it estimates to reduce 1,370 tons of CO_2 emissions.

In the plan, it is considering installation of solar panels and introduction of high-efficiency air-conditioning and cooling system for better energy efficiency as well as introduction of BEMS and improvement of exterior surface as shown in the table below.

Table 3-25. List of energy-efficient technologies in new emart building construction plan

	Item	Outline
1	Introduction of BEMS (building energy management system)	Introduction of latest energy management system to reduce energy consumption
2	Improvement of building exterior surface performance	Introduction of highly energy-efficient specifications of glass façade, doors and windows
3	Installation of solar panels	Installation of solar-power generation system (0.5 mw) on the roof
4	Air-handling unit	Use of high-efficiency units for approx. 30 air-handling units (AHUs), two chillers and six air-conditioners and cooling compressors

Use of ZEB calculation method for the plan will enable the calculation of energy-saving impacts and study of effective technologies. Because TDB plans to provide a loan to promote the project, it is likely to be highly feasible. Use of the JCM subsidy is also considered for energy regeneration and saving facilities.

3.5.3 Utilization for green finance

Certification of eco-friendly buildings as green buildings and use for green finance to promote investment are also expected. There is no uniform definition of a green building in the world and each country certifies them based on their own certification program. ZEB and ZEH-M that provide numerical assessment regarding the eco-friendliness can be used as a certification standard for green buildings and it can lead to ESG investment.

A "green building" is a term for an eco-friendly building and there is no uniform definition. Such terms as a "sustainable building", "high performance building", "green architecture", and "natural building" are also used. Certification organizations in each country assess conformity. Below certification programs are some of major examples.

- USA: Leadership in Energy and Environmental Design (LEED)
- UK: BRE Environmental Assessment Method (BREEAM)
- China: GBAS (Green Building Assessment System)
- Japan: CASBEE

Advantages of green buildings include reduction of utility charges by using excellent materials and high-efficiency energy device, reduction of water charges by introducing water-saving equipment and water recycling systems and reduction of maintenance costs.

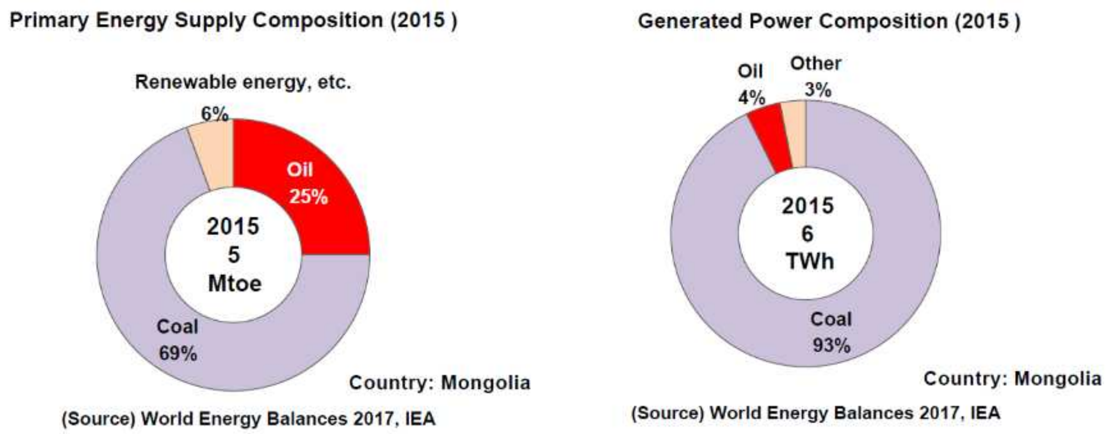
Establishment of green building certification programs listed above enables objective presentation of buildings satisfying energy-efficient specifications and being certified by a third party. It also allows building owners to appeal the value as ESG real estate to investors. It is also expected to improve the corporate image of the tenants, which will help more candidate tenants hope to rent the space in green buildings and thus raise the rent and occupancy rate.

Chapter 4. Examination of Possibility to Transfer Sapporo's Renewable Energy Technologies to Ulaanbaatar

4.1. Efforts to Introduce Renewable Energy in Ulaanbaatar

4.1.1 Energy Composition in Mongolia

Looking at Mongolia's primary energy supply composition in 2015, coal, oil and renewable energy etc. account for 69%, 25% and 6% respectively. As for the generated power composition, coal accounts for 93% and is the most widely used fuel for power generation.



Source: World Energy Balance, February 2018, The Institute of Energy Economics, Japan

Figure 4-1. Compositions of Primary Energy and Generated Power in Mongolia

In Mongolia, Tavan Tolgoi cold field in the southern part of the Gobi Desert alone has an estimated coal reserve of 6 billion tons, and there are also open-pit mines in such locations near Ulaanbaatar as Baganuur, Shivee ovoo and Shariin gol. With abundant coal resources, the country can meet hundreds of years of demand if coal is only used for its people. The country does not produce much oil or gas and depends on import for petroleum products (including LP gas). Coal prices are overwhelmingly lower than imported fuel prices, which include high transportation costs in this landlocked country.

In this situation, the city of Ulaanbaatar has centralized coal-fueled cogeneration power plants as its core power production facility and in winter it supplies power and heating heat to major locations in a distributed cogeneration system using boiler houses around the city. For detached houses and local facilities including schools, individual coal boilers have been installed to supply heated water. In the surrounding gel districts, raw coals are burned in stoves.

Therefore, air pollution concentration has recently been increasing every year. There were cases where pollution concentration exceeded the maximum value and became unmeasurable even PM2.5 measurement equipment was used in a very cold season. In this situation, in 2019, burning of raw coals in winter was banned and the use of improved fuel in the shape of of briquettes became mandatory in Ulaanbaatar. As a result, air pollution was on the decline in 2020.

On the other hand, there is a new issue of increased atmospheric carbon dioxide concentration. Mongolia's mineral resources have a high content of sulfur. When briquettes are used, concentrated sulfur turns into sulfur dioxide through the burning process. In the 2020-2021 winter season, sulfur dioxide emissions increased three times compared with the previous season.

To break such dependency on coal, introduction of renewable energy such as solar and wind power should be promoted.

4.1.2 Mongolia's Energy Policy

In 2007, for the purpose of promoting the use of renewable energy, the government of Mongolia established the Renewable Energy Law, which stipulates renewable energy power generation and supply. The law consists of Chapter 1 to Chapter 6. Chapter 3 offers detailed provisions of power generation licenses, rights and duties of transmission system operators, procedures to acquire construction and power generation licenses, contents of power purchase contracts, etc. Chapter 4 prescribes the range of electric power prices for hydraulic, wind and solar power, how to determine prices and applicable periods.

The Renewable Energy Law was amended in 2015 and 2019. The changes in 2015 included addition of 4MNT/kWh to the electricity prices as a green tariff, but there were no changes in the renewable energy prices.

Table 4-1. Renewable Energy Power Price (Tariff)

Energy source	Type	Capacity	Tariff (USD/kWh)
Solar power	Grid connection		0.150～0.180
	Independent		0.200～0.300
Wind power	Grid connection		0.080～0.095
	Independent		0.100～0.150
Hydraulic power	Grid connection	～5,000kW	0.045～0.060
	Independent	～500kW	0.080～0.100
		501～2,000kW	0.050～0.060
		2,001～5,000kW	0.045～0.050

Source: Preparation Report for the Khurmen Wind Farm Project, Mongolia, November 2015

In Mongolia, electric power and energy demands are expected to increase intermittently. According to the researches conducted by ADB and the Ministry of Energy, electric power and energy demands are expected to grow strongly till 2030 at an average annual rate of 9.3%, 9.8% and 10.5% in a slow growth, medium growth and high growth scenarios respectively. With regard to power sources, the government of Mongolia has a policy to continue promoting introduction of renewable energy.

Although renewable energy accounts for only about 6% of the total primary energy as of 2015, the country has a high potential for such renewable energy as solar, wind and small hydropower. The country is also a party to the Paris Convention, and in 2015 the Diet approved a national policy including medium-term targets for the energy sector. The policy set a target to raise the share of renewable energy in the total amount of power generation to 30% by 2030.

4.1.3 State of Introduction of Renewable Energy in the City of Ulaanbaatar, Mongolia

Ulaanbaatar is facing a serious problem of air pollution caused by coal-fired thermal power plants (cogeneration) in the city. To respond to the problem, there have been a growing number of power generation projects with renewable sources including solar power. Many of such projects have used JCM subsidy and greatly contribute to the achievement of Mongolia's greenhouse gas reduction targets.

Table 4-2. No. of Special Permissions for Construction and Capacity of Renewable Energy Generation Projects

	Energy source	No. of Special Permissions	Capacity (MW)
1	Wind power	5	502.4
2	Solar power	29	727
3	Hydraulic power	3	217.4
4	Others	2	82

Source: Bavuudorj (2018)

Source: Climate Change and Renewable Energy Use in Mongolia, ERINA REPOT PLUS NO.145, 2018

With regard to the state of introduction of renewable energy in Mongolia, the Energy Regulatory Commission has granted permissions for renewable energy power generation for 5 wind power facilities (502.4MW), 29 solar power facilities (727MW), 3 hydraulic power facilities (217.4MW) and 2 biomass facilities (82MW). Introduction of renewable energy has progressed with private investment, thanks largely to the Renewable Energy Law, established in 2007.

An example of the introduction of wind power generation with private investment is Tsetsii Wind Farm (see the photo below), constructed in Gobi Desert with abundant wind resources. The wind farm started operation in October 2017 with 25 giant wind turbines with a height of 130 meters and has a capacity to produce 50MW, about 5% of the total power demand in Mongolia. The project is run by Clean Energy Asia LLC, a joint venture between Newcom LLC, an infrastructure investment firm that has constructed and operated wind farms in Mongolia, and SB Energy Corp in SoftBank Group, which engages in renewable energy business in Japan.

(Source: JICA)

Tsetsii Wind Farm

In 2019, in partnership with Sermsang Power Corporation (headquartered in Bangkok and Tenuun Gerel Construction LLC (headquartered in Ulaanbaatar, Mongolia), engaged in renewable energy business, Sharp Energy Solution Corp constructed a solar plant in Sergelen sum, Töv province. Located about 14km southeast of the New Ulaanbaatar International Airport, the plant will supply electric power to the city and the new airport. With an annual output of 16.4MW, the plant generates about 23,134 MWh annually and the annual reduction in greenhouse gas emissions is estimated to be about 18,438 tCO2. This is Sharps' third mega solar plant in Mongolia, following a 10MW-class plant in Darkhan and a 16.5MW-class plant in Zamiin-Uud, Dornogovi province.

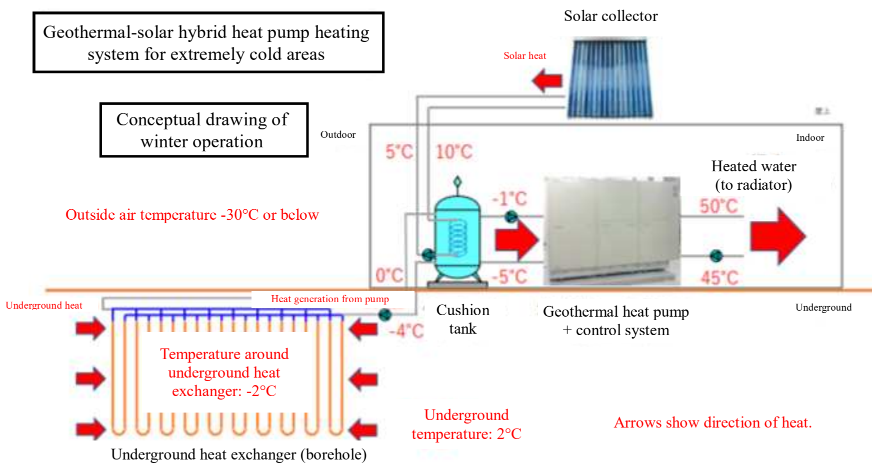
(Source: Sharp Energy Solution)

Mega Solar Plant in Khushigtiin khundii

In Mongolia, renewable energy has been introduced on a large scale, contributing to the reduction of green house gas emissions. However, due to weak transmission and distribution networks in the country, increased power generation in remote locations is suppressing system capacity.

In addition to increase of transmission line capacity, strengthening of distribution systems and use of storage batteries at the time of introduction of renewable energy, there is also a need for promoting the introduction of distributed renewable energy mainly in urban areas. One possible way to introduce distributed renewable energy in urban areas is to use underground heat for heating and cooling of public facilities and private houses. Individual heating with coal stoves in gel districts, etc. has low energy efficiency and causes air pollution. For gel district development, introduction of distributed district heat supply from renewable energy also seems to be an effective measure.

As an example of the introduction of distributed renewable energy, a hybrid geothermal-solar heat pump heating system demonstration project was planned in Mongolia. This type of system has been used in Japan for heating purpose. The project has been implemented since February 2020 as "Project to Develop and Promote Low Carbon Technologies through Co-Innovation for Developing Countries".



Source: Website of Global Environment Centre Foundation, September 10, 2021

Figure 4-2. Geothermal-Solar Hybrid Heat Pump Heating System

4.2. Renewable Energy Introduction Policy and Energy Consumption of the City of Sapporo, Hokkaido

4.2.1 Renewable Energy Introduction Policy of Hokkaido

Because Hokkaido is a snowy cold region where kerosene and other types of fuels are heavily used in winter and highly depends on cars for transportation, CO2 emissions per capita are higher than the national average.

In 2010, Hokkaido established “Hokkaido Global Warming Countermeasures Plan” to promote countermeasures against climate changes in a comprehensive and planned manner. In 2014, the CO2 reduction target included in the plan was changed to 7% reduction from 1990. To achieve this target, priority measures have been developed as shown in the figure below.

With vast land and diverse renewable energy resources, Hokkaido has the largest potential in Japan. Its potential is especially large for onshore wind power generation, 49% of the total potential in the country. It also has a great potential for solar power generation with mega solar plants where solar energy is untapped as well as offshore wind power and geothermal power generation. With future development, Hokkaido is expected to be the largest renewable energy supply base in Japan.

Priority Measures

- Taking advantage of Hokkaido's regional characteristics and strengths –

Shift to low carbon lifestyle and business style

- Encouraging residents and businesses in Hokkaido to take actions to prevent global warming
- Promotion of actions to prevent global warming through recognition of companies contributing to environmental conservation
- Promotion of emissions reduction with the use of emission-reduction credits in Japan, etc.
- Promotion of dissemination, awareness raising and activity support in cooperation with Hokkaido Global Warming Prevention Activity Promotion Center
- Promotion of human resources development for environmental conservation

Introduction of environmentally friendly energy based on the region's characteristics

- Comprehensive promotion of energy saving and new energy measures
- Promotion of the utilization of renewable energy through the effective utilization of diverse energy resources in Hokkaido including solar light, hydraulic power, snow and ice and biomass

Promotion of development and conservation of forests as carbon dioxide sinks

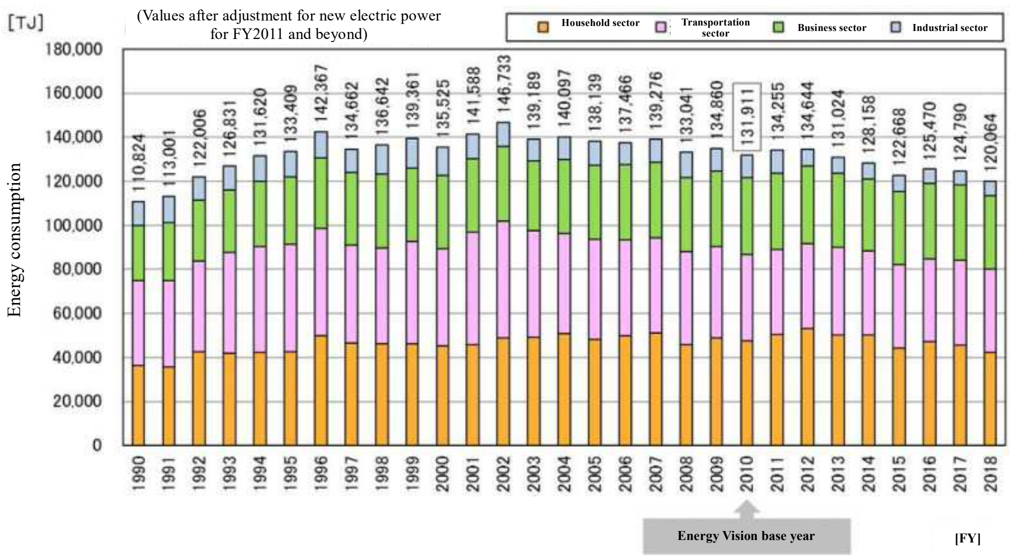
- Promotion of development and conservation of forests in a way to fulfill multiple functions including CO2 absorption and to take advantage of regional characteristics, and promotion of development of forests with the participation of residents of the prefecture
- Promotion of the utilization of wood materials and woody biomass
- Promotion of green space conservation in urban areas, etc.

Figure 4-3. Priority Measures in Hokkaido Global Warming Countermeasures Plan

4.2.2 Energy Consumption and Renewable Energy Introduction Policy of Sapporo

(1) Energy Consumption in Sapporo

Energy consumption in the city of Sapporo increased till it reached a peak in FY2002 and has been slowly declining since then. Looking at the energy consumption by sector in 2018, the transportation and industrial sectors saw decline from FY1990. In contrast, energy consumption in the household and private business sectors declined compared with FY2010 (base year for the city's energy vision) but grew about 1.2-1.3 times compared with FY1990.



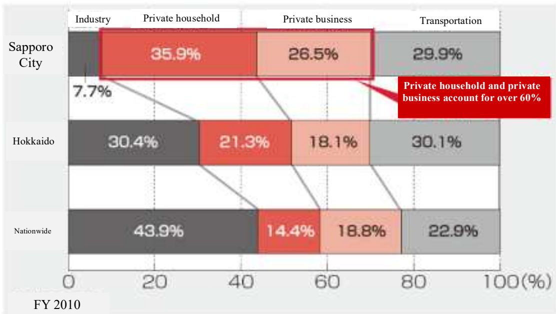
Source: Progress Control Report for the Sapporo Energy Vision Global Warming Countermeasure Promotion Plan (FY2018 Preliminary Values and FY2016 Definitive Values)

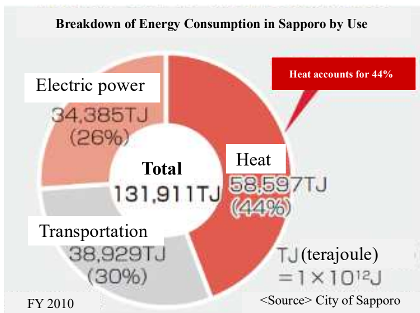
Figure 4-4. Changes in Energy Consumption in Sapporo

Looking at Sapporo's energy consumption composition by sector, compared with Japan and Hokkaido, the industrial sector has a smaller share because the city does not have many large plants and the household and private business sectors have larger shares. One characteristic of energy consumption in Sapporo is that energy consumption in the household and private business sectors accounts for over 60% of the total energy consumption.

As for the energy consumption by use (power, heat and transportation), heat accounts for 44%, nearly half. About 60% of the energy use for heat occurs in private households.

Like Ulaanbaatar, Sapporo is in a cold district and has a high energy consumption for heating of private houses.





Source: Sapporo Energy vision, 2014

Figure 4-5. Sapporo's Energy Consumption Composition by Use

(2) Sapporo's Renewable Energy Introduction Policy

Sapporo, the largest energy consumer in Hokkaido, established "Sapporo Energy Vision" in 2014. The vision shows the direction of the city's energy policy to review the traditional lifestyle, reestablish a new one to reduce energy consumption and pass down the society where people can live safely for children who will bear the future.

The city also established the Sapporo City Center Energy Master Plan in 2018, setting the principle, "Pass down a rich life and improve our city center to be trusted by the world – Continue pioneering approaches and innovative challenges". The Sapporo Global Warming Countermeasure Promotion Plan (draft) sets a mid-term target to reduce greenhouse gas emissions by 55% from 2016 to 2030 (target reduction amount 5.37 million tCO2) and a long-term target to reduce to zero (zero carbon) in 2050.

Table 4-3. Major Efforts to Achieve the 2030 Target Set in the Sapporo Global Warming Countermeasure Promotion Plan (draft)

Measure	Action	Target reduction amount
[Energy saving] Thorough energy saving measures	(1) Promotion of ZEH	Approx. 1.74 million t-CO_2
	(2) Promotion of ZEB	Approx. 1.25 million t-CO_2
	Subtotal	Approx. **2.99** million t-CO_2
[Renewable energy] Expansion of introduction of renewable energy	(1) Promotion of introduction of renewable energy for buildings, etc.	Approx. 2.18 million t-CO_2
	(2) Promotion of introduction of renewable energy in the region	
	Subtotal	Approx. **2.18** million t-CO_2
[Transportation] Decarbonization of transportation	(1) Promotion of dissemination of zero emission vehicles	Approx. 1.32 million t-CO_2
	(2) Promotion of the use of public transportation	
	(3) Promotion of compact cities	
	Subtotal	Approx. **1.32** million t-CO_2
[Resource] Resource circulation and carbon sink measures	(1) Promotion of resource saving and circulation	Approx. 70,000 t-CO_2
	(2) Promotion of conservation, creation and utilization of forests, etc.	Approx. 2,000 t-CO_2
	Subtotal	Approx. **70,000** t-CO_2
[Action] Lifestyle transformation and technological renovation	(1) Lifestyle transformation	-
	(2) Technological renovation	
Total		Approx. **6.56** million t-CO_2

Source: Sapporo Global Warming Countermeasure Promotion Plan (draft), materials for 2021 public comments

4.3. Amount of Renewable Energy Introduced and Renewable Energy Technologies in Sapporo

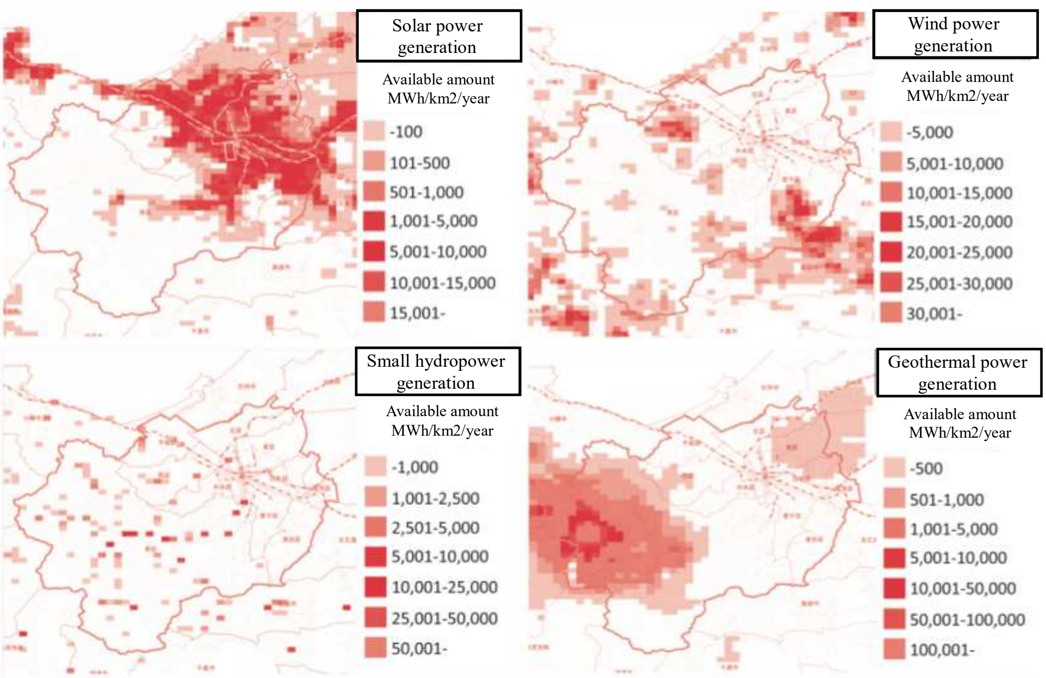
4.3.1. Amount of Renewable Energy Introduced in Sapporo

According to the research of the available amount of renewable energy conducted in 2011, the total amount of power generation from available renewable energy resources is 6.07 billion kWh (see the following table). This is equivalent to 65% of the total power consumption in FY2012 (9.40 billion kWh). As shown in the following table, in Sapporo, the renewable energy in the largest available amount is geothermal energy. However, geothermal power generation poses some challenges as it requires a long period of time from research to the start of power generation. The following table shows that Sapporo has the second largest available amount of solar energy. It is believed that promotion of solar power generation will be effective in Sapporo because it is the second largest renewable energy source as shown in the following table and it is rather easy to build equipment on building roofs and unused land.

Table 4-4. Available Amount of Renewable Energy in Sapporo and Hokkaido

	Sapporo City	**Hokkaido**
Solar power generation	**1.85 billion kWh**	**7.21 billion kWh**
Onshore wind power generation	**1.11 billion kWh**	**331.93 billion kWh**
Small hydropower generation	**0.11 billion kWh**	**2.45 billion kWh**
Geothermal power generation	**3 billion kWh**	**18.74 billion kWh**
Total	**6.07 billion kWh**	**361.33 billion kWh**

Source: Sapporo Energy Vision



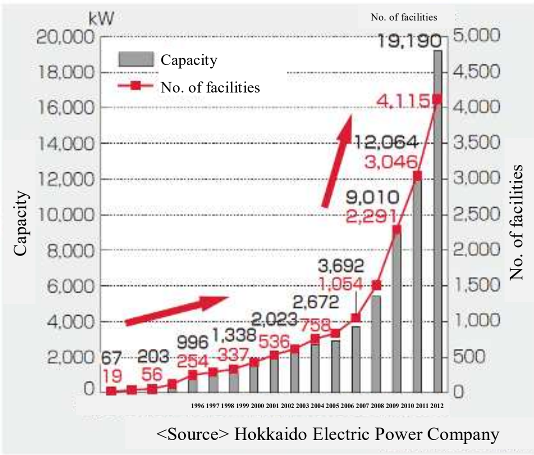
Vision

Figure 4-6. Map of Available Renewable Energy in Sapporo

4.3.2 Amount of Renewable Energy Introduced in Sapporo

Sapporo has been promoting introduction of solar power and introduced 19,000 kW solar power in FY2012, up more than tenfold from 10 years ago. In March 2013, a large-scale 2MW solar power plant was constructed. For solar power generation in the city, creative measures against snow coverage including the use of higher panel mounts and steeper panels are taken to achieve the level of annual power generation similar to that in the main island. This knowhow may be used in Ulaanbaatar, which is also in a snowy cold region. Power generation from other types of renewable energy includes small hydropower generation (400kW) at a water purification plant and waste power generation using heat from a waste incineration plant. Table 4-3-1 and Table 4-3-2 indicate that many of these power generation facilities use a feed-in tariff system.

Renewable energy has been introduced not only for power generation, but also for other purposes including the use of cold snow heat in park facilities, woody pellet boilers in elementary and junior high schools and zoos in the city and heat utilization in public facilities. An increasing number of geothermal heat pumps and woody pellet stoves have also been introduced to general dwelling houses. Cold heat of snow, woody biomass and underground heat are the types of renewable energy based on Sapporo's regional characteristics and can be used in Ulaanbaatar, which has similar climate conditions.



Source: Sapporo Energy Vision

Figure 4-7. Solar Power Generation in Sapporo

Table 4-5. Renewable Energy Introduction in Sapporo

Type	FY 2012		
	No. of facilities	Capacity	Output
Solar power generation	**4,115**	**19,190 kW**	**20.17 million kWh**
Small hydropower generation	**1**	**400 kW**	**3.22 million kWh**
Waste power generation	**3**	**39,920 kW**	**149.45 million kWh**
Total		**59,510 kW**	**172.84 million kWh**

Solar power generation output is calculated as capacity kW x 365 days x capacity factor 12%.
Actual values for small hydropower generation and waste power generation.

Source: Sapporo Energy Vision

Table 4-6. Facilities with Feed-in Tariff System in Sapporo (September 2020)

Type	Output
Solar power generation	63,919kW
Wind power generation	20kW
Small hydropower generation	400kW
Geothermal power generation	0kW
Biomass power generation	21,859kW
Total	86,189kW

Source: Public data of the Agency for Natural Resources and Energy about the adoption of the feed-in tariff system

4.3.3 Examples of Renewable Energy Introduction in Sapporo

The city of Sapporo has been introducing renewable energy in the forms of solar power generation that is easy to introduce in urban areas, power generation from waste/sludge incineration and underground heat as well as district heat supply from biomass fuels and use of snow and ice heat, based on regional characteristics. Overview of adopted technologies and examples of renewable energy introduction are given below.

(1) District Heating and Cooling System

From around 1965 to 1984, the city of Sapporo developed a wide range of geothermal heat supply facilities in the city center, Atsubetsu ward, Makomanai, etc., contributing to regional development. In recent years, in addition of aggressive use of such renewable energy sources as woody biomass, cold heat of snow and refuse-solidified fuels, there have also been efforts for efficient energy use and creation of a better environment, including introduction and networking of natural gas cogeneration at the south exit of Sapporo Station and Docho Minami Energy Center.

It is believed that distributed power sources and district heat supply can also contribute to the improvement of total area energy efficiency and reduction of carbon emissions in Ulaanbaatar, which is located in a cold region like Sapporo.

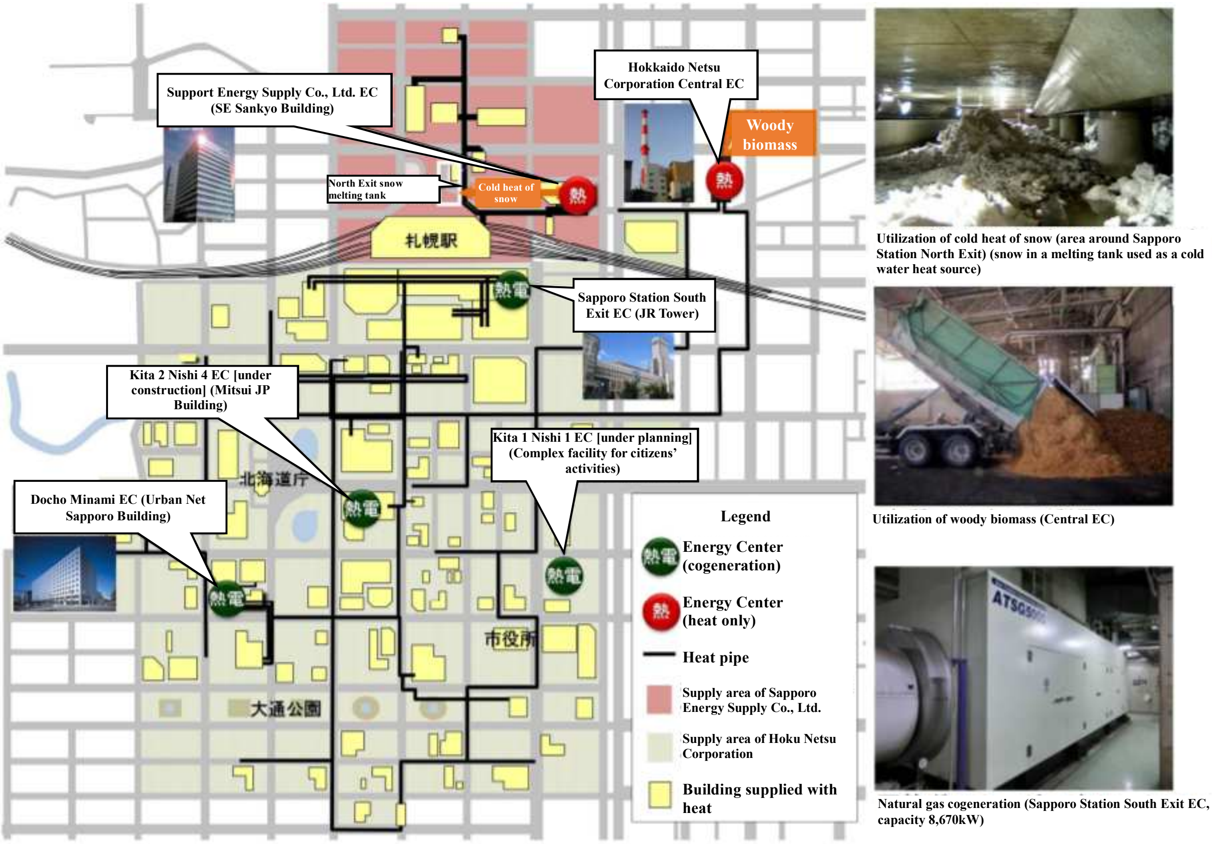


Figure 4-8. Overview of District Heat Supply at the North Exit of Sapporo Station and the City Center

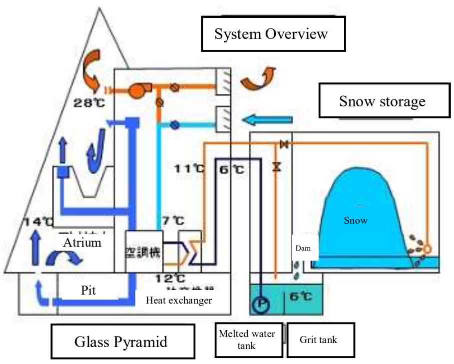
(2) Utilization of Snow and Ice Heat

Snow and ice heat utilization technology are the technology to store deposited winter snow and ice formed by cold outside air till when colling is needed and use cold air and melted as a cold heat source for such purposes as cooling of buildings and refrigeration of farm produces. Large-capacity and well-insulated snow and ice storage facilities are required to store cold heat for multiple seasons. Therefore, initial investment is necessary to construct facilities and transport snow, but fuel cost (snow) to produce cold heat is almost zero.

At Glass Pyramid of Moerenuma Park (see below) in Sapporo, snow deposited on the site is stored in a storage space. From June to September, cold water obtained from the snow is used for cooling of the glass-walled atrium space with a heat exchanging and circulating cold water system.

Glass Pyramid

Snow storage



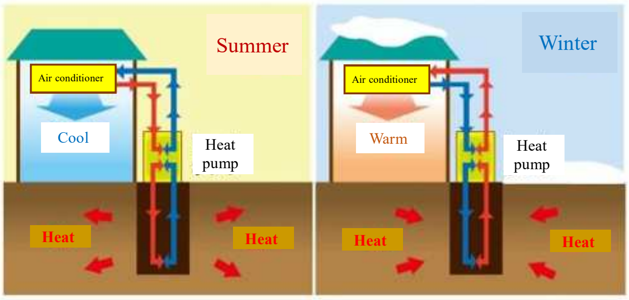
Source: Sapporo city website

Figure 4-9. Overview of the Snow and Ice Heat Utilization System in Moerenuma Park

(3) Utilization of Temperature Difference (Underground Heat)

Temperature difference utilization technologies are the technologies to utilize the energy of groundwater or river water temperature for heating, cooling and hot water supply with such devices as a heat pump. Temperature of groundwater and river water does not change much throughout the year and is colder than the air in summer and warmer in winter. The temperature difference between water and air is called temperature difference energy, with which a heat pump or a heat exchanger chills or heats water and supplies it for heating, cooling or hot water supply through a pipe.

Heat pumps and heat exchangers can obtain more heat energy than they use. Therefore, they are energy-saving devices that efficiently use not only atmospheric heat, underground heat and river water but also unused heat around us, such as waste heat from sewage from houses and plants, by raising its temperature. The technology is also used for air-conditioning, refrigerators, etc.



Source: Sapporo city website

Figure 4-10. Conceptual Drawing of Underground Heat Utilized by a Heat Pump

Shinoro Satellite Office of Sapporo city has a heat pump system utilizing underground heat about 80m below ground. Temperature does not change throughout the year at around 10m below ground. Therefore, compared with outside air, underground temperature is lower in summer and higher in winter. Using this temperature difference, efficient heating and cooling supply can be conducted. At Shinoro Satellite Office, underground heat about 80m below ground is collected and used to supply heating and cooling to the whole facility.

Geothermal heat pump heating and cooling equipment

Heat collection pipe

Geothermal Heat Pump Heating and Cooling Pipes, etc. at Shinoro Branch of North Fire Station

Source: Sapporo city website

(4) Examples of Introduction of District Heating and Cooling Systems, Utilization of Snow and Ice Heat and Utilization of Underground Heat

Examples of introduction of renewable energy in Sapporo in the forms of district heating and cooling systems, utilization of snow and ice heat and utilization of underground heat are shown below.

Table 4-7. Examples of District Heating and Cooling Systems

- A district heating and cooling system is a system to supply heating, cooling and hot water to multiple buildings in a district, such as stations, buildings, commercial facilities and hotels.
- By suppling in the whole district heating, cooling and hot water, which can have a high air-conditioning load in a cold region, the system has many advantages including stable energy supply, energy saving, economic efficiency and environmental conservation.

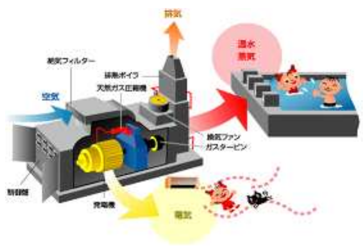
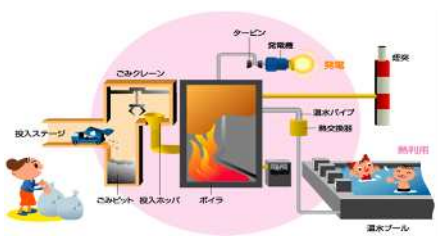
Example	Overview
[Area] Sapporo city center [Scale] Supply area 106ha [Locations of power generation] Chuo Energy Center Supporo Station South Exit Energy Center Docho Minami Energy Center Akarengamae Energy Center Sousei Energy Center [Company] Hoku Netsu Corporation	[Supply method] Cool water, hot water and electric power are supplied from multiple energy centers established in the supply area to buildings and houses in the area via high temperature water, warm water and cool water pipes with an overall length of about 45km.  [Energy sources] (Natural gas, etc. 53%, woody biomass, etc. 29% and cogeneration exhaust heat 18%) [Advantage] In natural gas cogeneration energy centers, cold heat is produced and supplied in a free cooling method, taking advantage of the weather conditions in a snowy cold region. Energy centers also operate in coordination with connected cool water pipes for further energy saving and environmental load reduction.
[Area] Kosei [Scale] 1,803 residential houses, etc. [Location of power generation] Kosei Energy Center [Company] Hoku Netsu Corporation	[Supply method] Heat is supplied from the plant to residential and business buildings in the district. In winter, 160°C hot water is supplied and used for heating and hot water supply through a heat exchanger. In summer, 140°C hot water is used for cooling and hot water supply. (Operation started on December 10, 1972 with temporary boilers. Operation with permanent boilers started on February 3, 1975. One unit each of 33GJ/h gas and kerosine-fired boilers.)  [Advantage] Environmentally friendly. Does not cause air pollution and reduces environmental load.
[Area] Makomanai Housing Complex [Scale] Heating for about 1,900 apartment units [Location of power generation] Komaoka Waste Incineration Plant [Company] Hokkaido District Heating Co., Ltd.	[Supply method] A large amount of energy generated at a waste incineration plant is used for residential heating. (Heat from Komaoka Waste Incineration Plant is used to supply heat to about 1,900 apartment units. It is also used for heating and cooling at the neighboring Recreation Center Komaoka mainly for elderly people.)  [Advantage] Energy saving through the use of unused energy and reduction of CO2 emissions

Table 4-8. Examples of Effective Utilization of Snow and Ice Heat

- For utilization of snow and ice heat, deposited snow and frozen ice are stored till when cold heat is needed. Cool air and water from the snow and ice is used as a cold heat source for such purposes as building air-conditioning and refrigeration of farm produces.
- In the past, snow removal and melting were very costly in cold regions, but now snow can be actively used as an energy source.

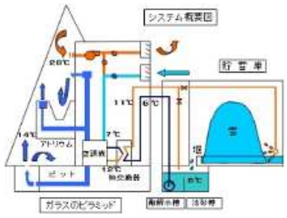
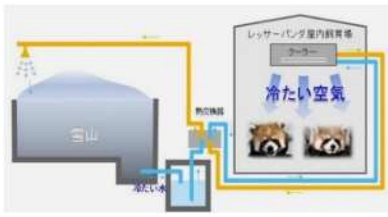
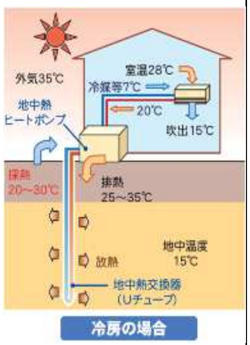
Example	Overview
[Location] Moerenuma Park (Glass Pyramid) [Scale] Snow storage: 3,160m3 (about 1,580t)	[Supply method] Snow deposited on the premise is stored in a snow storage space. From June to September, cold air from snow goes through a heat exchanger to cool air in the building. [Advantage] Taking advantage of the weather conditions in a cold region, snow is used as an abundant energy resource. 
[Location] Yamaguchi Funeral Hall [Scale] Snow storage: 5,000m3 (about 2,500t) *Largest in Japan	[Supply method] Snow is carried into snow storage and used for cooling in a heat exchanging and circulating cold water system, covering about 40% of the total cooling load of the hall. Part of melted water is stored in an irrigation water tank and used for rooftop gardens and plants on the premise. 
[Location] Maruyama Zoo (High Mountain Animal House)	[Supply method] A snow cold heat system with snow stored in a simple storage pool with insulation materials and heat reduction sheets is used to help cooling in the building from late June to early August. Cool air is supplied to the room for red pandas who normally live in the Himalayas and have low tolerance for heat. 
[Location] Area around JR Sapporo Station North Exit [Scale] Snow storage: 2,000m3 (about 1,000t)	[Supply method] Snow that is thrown at the end of the season into snow-melting tanks installed for snow removal in the city center Using snow-melting tanks installed in the city center for snow removal, snow thrown into the tanks at the end of the season is stored and used for heat supply for cooling in the area with a heat exchanging and circulating cold water system. [Advantage] Efficiency has been improved for snow removal in the city center. The method is based on the weather condition of a cold region and the resource is abundant. 

Table 4-9. Examples of Effective Utilization of Underground Heat

<table>
<tr><td colspan="2">[Utilization of underground heat]
• The technology for the utilization of underground heat is the technology to collect stable thermal energy from the ground and use it for such purposes as heating, cooling, hot water supply and snow removal. In cold weather regions, geothermal pumps are more efficient than air heat source heat pumps.
• Hokkaido is the prefecture with the largest number of locations of geothermal heat pumps.
[Heat pump system]
• Heat pump system is an energy saving technology to utilize unused heat around us, such as heat in the air and underground heat, in an efficient manner by raising its temperature with a smaller amount of energy. There are two types of heat pump systems, “closed-loop” and “open-loop”. The “closed-loop” type can be installed anywhere and has a penetration rate of more than 80%.</td></tr>
<tr><th>Example</th><th>Overview</th></tr>
<tr><td>Geothermal heat pump system
[Location] Sapporo
• Shiraishi Ward Government Offices
• Higashi Fire Station – Kitasakae Branch
• Toyohira Fire Station – Misono Branch
• West Fire Station – Heiwa Branch
• Teine Fire Station – Nishimianosawa Branch
• Hokkaido Bank Curling Stadium
• North Fire Station – Tonden Branch
• East Fire Station – Sakae Branch
• Central Fire Station – Hosui Branch
• Sapporo Art Park
• Many other locations</td><td>[Supply method] (North Fire Station – Shinoro Branch)
Shinoro Branch has introduced a heat pump system using underground heat about 80m below ground. Underground temperature is lower in summer and higher in winter than outside air temperature. Such temperature difference is used for effective heating and cooling.
[Advantage]
Energy saving with the use of unused energy and reduction of CO2 emissions

</td></tr>
<tr><td>[Example] Heat pump
• Ground source heat pump system
[Location]
• Construction of HS residence in Kitanosawa, Minami Ward, Sapporo (building heating and road heating), area 120m2, no. of boreholes 85m x 1, 65m x 1
• Construction of TU residence in Shinkawa, Kita Ward, Sapporo (heating and cooling), area 100m2, no. of boreholes 85m x 1
• Remodeling of Sapporo Branch of S Corporation in Higashi Ward, Sapporo (road heating), area 200m2, no. of boreholes 100m x 2
[Company] Nisshin Techno Co., Ltd.</td><td>[Supply method]
A borehole (100mm in diameter and 50-100m in depth) was made and a geothermal heat exchanger was installed in the borehole to use geothermal energy for such purposes as heating, cooling, hot water supply and snow melting.


[Advantage]
Energy saving (CO2 emissions reduced to less than half of those from a kerosine boiler)
[Subsidy system (Sapporo city)]
Installation of a heat pump requires boring work to make a borehole in the ground. For this initial cost, such subsidy systems as the city’s “Energy Eco Project” can be used.</td></tr>
<tr><td colspan="2">Heat pump system technologies</td></tr>
<tr><td>Low-cost vertical geothermal heat pump
[Company] Nisshin Techno Co., Ltd.</td><td>[Development and demonstration experiment of a flat-type underground heat collection system]
For the dissemination of a geothermal heat pump system superior in snowy cold regions, a new type of low-cost heat collection system (vertical and flat underground heat exchanger) was developed to cope with the issue of high installation cost, which seemed to be the largest impediment. In a demonstration experiment, cost per unit of exchanged heat (at the time of heating) was reduced by about 50%.</td></tr>
</table>

Horizontal heat collection geothermal heat pump heating and cooling system for snowy cold regions [Company] Brain	[Approval of FY2014 Program to Support Development of Energy Products in Hokkaido] Heating and cooling is conducted with a heat pump collecting heat from shallow ground in parking space or yard of a house, dug 2 meters. For installation, it requires unused land of at least 50m2.	

4.3.4 Deployment Plan to Transfer Sapporo's Renewable Energy Technologies to Ulaanbaatar

The city of Ulaanbaatar is facing the challenges of reducing greenhouse gas emissions and air pollution caused by coals used in coal-fired thermal power stations (cogeneration) and coal stoves in gel districts. To solve these issues, Mongolia has set a target to raise the share of renewable energies in the total power generation to 30% by 2030.

In Sapporo, coal was also heavily used as a major fuel from around 1955 to 1964. In winter, smoke dust from burning coals sometimes floated in the air and turned snow into black. However, as time went by, the major energy source changed from oil to LP gas. Recently, with efforts to utilize such urban renewable energies as solar and geothermal energy and to adopt district heating and cooling systems and ZEB and ZEH-m energy-saving construction designs, not only air pollution but greenhouse gas emissions has also been reduced. In February 2020, the city of Sapporo declared it would reduce "CO2 emissions virtually to zero by 2050" and would continue to promote efforts to realize a decarbonized society.

If effective utilization of urban renewable energy in Ulaanbaatar is maximized with the use of Sapporo's technologies and knowhow for renewable energy introduction, the city's renewable energy introduction rate can be increased, and reduction of greenhouse emissions and improvement of air pollution issues can be promoted.

As part of the actions to be taken in next fiscal year, the Project will provide assistance to determine the potential for renewable energy introduction, introduction targets and introduction planning based on Sapporo's renewable energy introduction cases and continue support the city of Ulaanbaatar to realize a decarbonized society. More specifically, the Project will take the following actions.

① Clarify the energy utilization status (methods and amounts) in Ulaanbaatar
② Investigate the potential of energy utilization in Ulaanbaatar
③ Select candidate renewable energy technologies from among those used in Sapporo and candidate target facilities, based on the climate conditions and status of energy utilization in Ulaanbaatar (results of a local survey)
④ Consider and propose renewable energy introduction scheme and plan

Chapter 5. Capacity Development

5.1. Support from Sapporo City

5.1.1. Background

(1) Mongolia's Participation in the JCM

In 2013, the world's first memorandum of understanding on a JCM project was signed in Ulaanbaatar. This is one of the coldest capitals in the world, and Mongolia is the only cold-weather country with which Japan has established the JCM. The Government of Mongolia is keen to implement JCM projects, as indicated by its statement made during the Ministerial Dialogue at the 19th Conference of the Parties (COP-19) of the United Nations Framework Convention on Climate Change (UNFCCC) to express its expectations for the JCM.

Meanwhile, Sapporo is the political, economic, and cultural center of Hokkaido and the largest cold-weather municipality in Japan, with an estimated population of about 1.97 million as of 2020. The city has heavy snowfalls, with an annual average snowfall of about 600 cm, and the city's energy consumption for home heating is three times as large as the national average.

In 2016, carbon dioxide accounted for 98% of the GHG emissions from Sapporo, and a sectoral breakdown shows that three sectors (domestic, business, and transport sectors) accounted for about 90% of the city's total GHG emissions. The Sapporo City Government is committed to reducing GHG emissions by 55% from 2016 levels by 2030 and creating a zero-carbon city by 2050. The city's GHG emissions reduction efforts include thorough energy saving measures, such as promoting ZEBs, and renewable energy promotion measures, such as using renewable energy sources in buildings.

The City of Sapporo joined the City-to-City Collaboration Programme with the City of Ulaanbaatar in FY2016. In the first year, they performed preliminary studies to develop three projects: an energy saving project to introduce heat supply systems that would reduce GHG emissions and air pollution from coal burning, a renewable energy project to promote the effective use of solar, wind, and other energy sources and shift to a zero-carbon economy, and a waste management project to promote waste-to-power generation.

Apart from these studies, this Project aims to develop a plan to promote the application of zero-carbon building technologies to public and other buildings in Ulaanbaatar. This is intended to share information on administrative frameworks for energy conservation and environmental policies in the housing and building sector in Sapporo as well as experiences in the application of environmentally friendly, energy-saving technologies through the City-to-City Collaboration Programme in order to formulate new projects for sustainable development in Mongolia for next fiscal year and onwards.

(2) World Winter Cities Association for Mayors

In 1998, Ulaanbaatar joined the World Winter Cities Association for Mayors (WWCAM), an international network hosted by the City of Sapporo and participated by 22 cities from nine countries around the world. The WWCAM is a network that brings together winter cities from around the world to learn from one another about cold-weather technologies and experiences as well as urban development in cold climates under the philosophy that “winter is a resource and an asset”. The first World Winter Cities Conference for Mayors (Mayors Conference) was proposed by Sapporo in 1981 and held in 1982. Since then, the mayors of winter cities have gathered every year to share information and technologies to ensure comfortable winter living and discuss how they can cooperate on global issues, including environmental issues.

In the past conferences, mayors shared knowledge and experiences on urban planning, winter transportation, snow clearing and removal, waste recycling, and winter tourism resources development and gained inspiration for urban development and cold-weather solutions.

In 2012, the 15th Mayors Conference was held in Ulaanbaatar under the main theme of “Energy Supply and Efficient Heat Consumption in Winter Cities,” which was discussed in three sessions: (1) efficient use of heat energy; (2) efficient use of electricity; and (3) air pollution and countermeasures in winter cities.

In the session on the efficient use of heat energy, the Mayor of Ulaanbaatar reported that the city faced serious air pollution in part due to its climate and geographical features and that they were planning to promote the use of solar and other renewable energy sources. In the session on the efficient use of electricity, the Mayor of Ulaanbaatar reported that the cold weather increased the city’s electricity consumption in winter and caused maintenance problems, and he projected that the city’s power consumption would increase five to eight times if electric home heating systems were installed to reduce air pollution in the Ger areas that had been seriously affected by the problem. In the session on air pollution and countermeasures in winter cities, the Mayor of Ulaanbaatar was committed to reducing air pollution by 60% through efforts such as setting up the Air Quality Department of the Capital City, introducing electric buses, shifting to renewable energy sources, constructing cogeneration power plants, and providing low-interest apartment loans to ger dwellers.

Table 5-1. WWCAM Conferences

Conference	Host city	Period	Participating cities
1st Conference	Sapporo, Japan	Feb. 7-10, 1982	30 cities from 6 countries
2nd Conference	Shenyang, China	Sep. 19-22, 1985	16 cities from 6 countries
3rd Conference	Edmonton, Canada	Feb. 13-15, 1988	20 cities from 13 countries
4th Conference	Tromso, Norway	Mar. 2-4, 1990	22 cities from 11 countries
5th Conference	Montreal, Canada	Jan. 17-21, 1992	47 cities from 12 countries
6th Conference	Anchorage, USA	Mar. 5-10, 1994	30 cities from 10 countries
7th Conference	Winnipeg, Canada	Feb. 9-12, 1996	33 cities from 9 countries
8th Conference	Harbin, China	Jan. 15-18, 1998	49 cities from 10 countries
9th Conference	Lulea/Kiruna, Sweden	Feb. 12-16, 2000	26 cities from 10 countries
10th Conference	Aomori, Japan	Feb. 7-10, 2002	28 cities from 13 countries
11th Conference	Anchorage, USA	Feb. 18-22, 2004	27 cities from 11 countries
12th Conference	Changchun, China	Jan. 15-18, 2006	29 cities from 13 countries
13th Conference	Nuuk, Greenland	Jan. 18-20, 2008	22 cities from 8 countries
14th Conference	Maardu, Estonia	Jan. 20-22, 2010	18 cities from 11 countries
15th Conference	Ulaanbaatar, Mongolia	Jan. 13-15, 2012	13 cities from 7 countries
16th Conference	Hwacheon, South Korea	Jan. 16-18, 2014	12 cities from 4 countries
17th Conference	Sapporo, Japan	Jul. 27-30, 2016	32 cities from 8 countries
18th Conference	Shenyang, China	Sep. 12-13, 2018	46 cities from 21 countries

(3) WWCAM Ulaanbaatar Declaration

The Ulaanbaatar Declaration was proposed by the City of Ulaanbaatar and the Secretariat, adopted by consensus, and signed by the Mayor of Ulaanbaatar and the Mayor of Sapporo, who also served as WWCAM President, at the 15th Mayors Conference held in Ulaanbaatar in January 2012.

The Ulaanbaatar Declaration includes the commitment of member cities to controlling GHG emissions and reducing the use of energy and the footprint of urban activities. Moreover, the Hokkaido Prefectural Government and the Mongolian Ministry of Energy signed and exchanged a memorandum of understanding on economic and technical exchanges in the energy sector in March 2015 to further promote technical cooperation between private companies from Mongolia and Hokkaido.

Ulaanbaatar Declaration 2012

The Ulaanbaatar Declaration states that the member cities are “responsible to further develop the effective use of energy and heat from what [they] learned through this conference and actively educate the citizens so that each of them recognizes the importance of saving energy.” In addition, the accompanying resolution states that the member cities should set the highest possible target values and report them at the next Mayors Conference.

Ulaanbaatar Declaration

Even now, many people are losing their lives and property and are forced to live under the severe circumstances caused by the extreme climate and natural disasters that strike many quarters of the globe. We have to keep the damage from such disasters minimal and build a safer and more secure society. The spirit of mutual assistance as well as courage and wisdom to face difficulties are the forces that move us forward.

The warm support during difficult times nurtures true friendship and peace. We, the member cities, hereby reaffirm our friendship and commitment to provide all the assistance that can be possibly given in various fields.

In addition, it is important that we strive to control the emission of greenhouse gases, which is one of the contributing factors to the current abnormal climate. The effective use of limited resources is imperative, and we are responsible to further develop the effective use of energy and heat from what we learned through this conference and actively educate the citizens so that each of them recognizes the importance of saving energy.

We, the World Winter Cities Association for Mayors, hereby declare that we renew our awareness that making actions towards energy reduction and urban activities with a low impact on the environment are the key challenges for those who live in winter cities, and that each city will make maximum efforts to address the issues.

(0) Technical Cooperation by the Waterworks Bureau of the City of Sapporo

The Waterworks Bureau of the City of Sapporo implemented the Water Transmission and Distribution System Improvement Project for Water Supply in Ulaanbaatar City through the JICA Partnership Program. This three-year technical cooperation project was launched in 2016 to improve water transmission and distribution systems in Ulaanbaatar and highly appreciated by the Ulaanbaatar City Government.

5.2. City-to-City Collaboration Seminar hosted by the Ministry of the Environment

The Seminar on City-to-City Collaboration for Creating a Zero-Carbon Society was hosted by the Ministry of the Environment on February 1, 2021. It was held online due to the COVID-19 pandemic.

Referring to the New Strategy Outline for Global Deployment of Infrastructure Systems published in 2020, the Ministry of the Environment announced the basic policy of promoting export support for infrastructure to drive zero carbon policies. This is intended to propose all possible options for reducing CO_2 emissions and support policy making for carbon-neutral transition based on the profound understanding of the needs of partner countries. In addition, it was reported that the City-to-City Collaboration Programme was renamed this fiscal year to articulate its commitment to creating a zero-carbon society. Now that the Paris Agreement has entered into force, expectations are rising for city-to-city collaboration.

This City-to-City Collaboration Seminar was held in order to:

1) Report and share the results of projects implemented in FY2020 through the City-to-City Collaboration Programme and the JCM Japan Fund in collaboration with Asian Development Bank (ADB);
2) Exchange information on networking among private companies and local authorities and their mutually complementary projects;
3) Provide and share information on the next fiscal year's government support schemes; and
4) Exchange views on global trends and changes in study methods in light of the COVID-19 pandemic.

The Seminar was attended by representatives of cities and regions from partner countries that implemented projects through the City-to-City Collaboration Programme this fiscal year, including Indonesia, Malaysia, Mongolia, Myanmar, the Philippines, Thailand, and Vietnam.

5.3. City-to-City Collaboration Workshop

(1) Workshop Summary

Because the COVID-19 pandemic prevented field visits, an online workshop was held on January 29, 2021, to share information on administrative frameworks for energy conservation and environmental policies in the housing and building sector in Sapporo as well as experiences in the application of environmentally friendly, energy-saving technologies. This workshop was attended by Deputy Mayor of Ulaanbaatar City and representatives of the Capital City Housing Corporation, the Construction Department of Ulaanbaatar City, and the Mongolia-Japan Center from Mongolia as well as representatives of the Sapporo City Government, Iwata Chizaki Inc., headquartered in Sapporo, and Oriental Consultants Co., Ltd. from Japan.

Table 5-2. Workshop Presentations

	Presentation	Speaker
1	Greetings from the City of Ulaanbaatar	Sukhbaatat, Deputy Mayor (In charge of building projects)
2	Explanation on JCM projects and this fiscal year's activities	Oriental Consultants Co., Ltd.
3	Cold-weather measures taken by the Sapporo City Government	Environmental Bureau, Sapporo City
4	Cold-climate housing design by a Japanese private company	Iwata Chizaki Inc.

A representative of the Eco-City Promotion Department, the Environmental Bureau, the City of Sapporo explained their climate change mitigation measures, especially in the building sector, as well as their GHG emissions reduction target for 2030 and their efforts towards the target, including:

- Sapporo Next Generation Housing Standards;
- Subsidy for introduction of renewable energy and energy-saving equipment;
- CASBEE Sapporo;
- ZEB, ZEH-M design support subsidy;
- Regional heat supply in city centers; and
- Sapporo's receipt of a Platinum rating through the LEED* for Cities and Communities.

A representative of Iwada Chizaki Inc. explained Japan's ZEB (ZEH and ZEH-M) technologies, including:

- Promotion of ZEBs in Japan;
- Examples of ZEBs in the cold-climate region of Hokkaido;
- ZEB items; and
- BEMS.

(2) Questions and Answers

The Deputy Mayor of Ulaanbaatar City in charge of building projects asked a question about the Sapporo City Government's rating system for environmentally friendly buildings. In answer to this question, a representative of the Sapporo City Government explained that the CASBEE Sapporo had been revised to require notification when constructing, expanding, or renovating a large building with a floor area of 2000 square meters or more. In addition, the City of Sapporo provided the City of Ulaanbaatar with detailed information about the system.

Figure 5-1. CASBEE Sapporo Brochure

A representative of the Construction Department asked questions about the Sapporo City Government's efforts to promote the ZEB system and the standards and budgets for housing support subsidies. A representative of the City of Sapporo answered that there was no penalty for a failure to meet the standards and that the subsidies were borne by the city government budget.

According to the Capital City Housing Corporation of Ulaanbaatar City, it aims to introduce two ISO standards, ISO37120 and ISO37122, in the city's building development program, as part of its efforts to achieve Sustainable Development Goal 17. These two ISO standards define 18 items of evaluation criteria and 80 items of sub-criteria. This program has been submitted to the Standard Measurement Center. The Corporation also considers introducing three ISO standards, ISO37101, ISO37100, and ISO37123, in its operations in 2021.

(3) Participants from Mongolia

The workshop participants from Mongolia are listed below. Mr. Sukhbaatar, Deputy Mayor of Ulaanbaatar City in charge of building projects, is the former president of the Capital City Housing Corporation of Ulaanbaatar City. He was involved in the Green Housing Project when working for the Corporation and is therefore particularly interested in this project.

The workshop had four participants from the Urban Development Department of the Capital City: Mr. Tulga, Director of the Administrative Department, Messrs. Battumur, Amarsanaa, and Darkhanchuluun from the Chief Architect Division.

In addition, the workshop received five participants from the Capital City Housing Corporation: Mr. S. Dorjderem, Acting Head from the Administrative Division, Mr. Undrakh from the Investment Cooperation Division, Mr. Tsevegsuren from the Construction and Customer Investigation Division, Mr. Nyamtuya, a renewable energy engineer, and Mr. D.Munkhzul, a project secretary.

The workshop was also attended by three participants form the Ministry of Construction and Urban Development: Mr. Enkh-Amgalan, Chief of the Foreign Affairs Department, Mr. Batbold, Director of the Construction Investment Department, and Mr. Bilegsaikhan, Senior Expert of the Urban Development

Department. The Ministry of Construction and Urban Development is responsible for developing basic guidelines for socioeconomic development and government action plans in the building and urban development sector of Mongolia. The Ministry of Construction and Urban Development is also responsible for coordinating international cooperation projects (In fact, it was involved in the formulation of the UBMP2020) and formulating housing and civil engineering policies and strategies.

Table 5-3. Workshop Participants from Ulaanbaatar City

Attendee	Organization	Department/Division	Position
Sukhbaatat	Ulaanbaatar City	Project Leader	Deputy Mayor
Ts. Tulga	Urban Development Department of the Capital City, Ulaanbaatar City	Administrative Division	Capital City Chief Architect, Department Director
A. Battumur		Chief Architect Division	Department Director
B. Amarsanaa		Chief Architect Division	Chief
Darkhanchuluun		Chief Architect Division	—
S. Dorjderem	Capital City Housing Corporation, Ulaanbaatar City	Administrative Division	Acting Head
O. Undrakh		Investment Cooperation Division	Department Director
J. Tsedevsuren		Construction and Customer Investigation Division	Department Director
P. Byambatuya		Project Management Section	Renewable Energy Engineer
D. Munkhzul		Project Management Section	Secretary
Enkh-Amgalan	Ministry of Construction and Urban Development	Foreign Affairs Department	Chief
Batbold	Ministry of Construction and Urban Development	Construction Investment Department	Department Director
Bilegsaikhan	Ministry of Construction and Urban Development	Urban Development Department	Senior Expert

Online Workshop