Report of the Cooperation Programme on Developing the JCM Seeds in Mongolia, Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia

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(The Overseas Environmental Corporation Center, Japan)

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Contents

I Summary

1 Institutional framework and context in project country and city

Mongolia was the first country to finalize the Joint Credit Mechanism (JCM). On April 11, 2013 (same day local time) in Ulaanbaatar, the first meeting of the Joint Committee on JCM was held which adopted the basic rules of the mechanism and decided on the rules for running the Committee.

Mongolia has some of the world's biggest coal reserves and supplies most of its own energy demand with coal. For example, a large volume of coal is used to heat the water used in urban central heating and district heating due to the freezing Mongolian winters when temperatures drop below minus 30°C. This heat and most of the electricity is reliant on Combined Heat and Power (CHP) plants and Heat Only Boilers (HOBs), all powered by coal.

For this reason, the country's per capita carbon dioxide emissions are 4.33 tons, much higher than the global average, and hence the tremendous potential for emissions reductions through more efficient use of coal fuel resources. Another urgent area for attention is the tight power supply situation resulting from the construction boom in the capital, Ulaanbaatar that began in 2000, when due to dramatic economic growth the population of the city began to increase in the absence of any clear urban planning. Moreover, air pollution is a serious issue due to coal burning and traffic jams, so a co-benefits approach that tackles all these issues at the same time would be very desirable.

2 Projects within the scope of the study

In this study, in light of the current issues facing Mongolia, we supported the generation of specific seeds by making checks on plants and other means, and attempted to select only greenhouse gas reduction projects focused on improving energy supply/demand efficiency that would help to deal with air pollution, and that had strong feasibility. We also considered a basic financing scheme in order to create the necessary platform for carrying out the projects.

3 Study methodologies

First of all, an initial study was carried out independently by the Overseas Environmental Cooperation Center, Japan (OECC) on CHP (Combined Heat and Power) and HOB (Heat Only Boiler) power plants in the energy supply sector, and energy-saving technology at other plants and factories in order to discover JCM project seeds and support the development of highly feasible and specific emissions-reducing initiatives. Next, in the second study, an investigation of applicable technologies was carried out by bringing Japanese technology specialists into the plants and factories as well as through local guidance. Following their return to Japan, the Japanese technologies and products that could be brought to Mongolia in light of its status as a developing country were narrowed down, and matching was carried out with Japanese companies in the selected applicable areas.

In the third and fourth studies, we investigated the potential for introducing the selected technologies by bringing the providers of the identified technologies to Mongolia. And in order to deepen understanding among the Mongolian parties of the technologies held by the designated providers, representatives were brought to Japan for training to learn about the technologies as well as maintenance and operations management. All of these aspects contributed to winnowing the pool of feasible Japan-made low carbon technologies and finalizing the list of seeds. In addition, as part of deliberations on the support for designing the schemes needed at the central government and city level for the projects to go ahead, we carried out an analysis of stakeholders and their roles in September including the Mongolian Ministry of Environment and Green Development, Ulaanbaatar City and donors supporting Mongolia and others. A joint seminar to explore future collaboration was also held. A scheme was considered based on this collaboration that would support small projects run by local banks and organizations mobilizing capital from the Clean Air Foundation, an environmental fund controlled by the Mongolian government, JCM and the Asian Development Bank.

4 Study results

As a result of the four studies and one training tour to Japan, we were able to identify a number of technologies as potential JCM seeds, and assess that they are capable of contributing to development in Mongolia. Inefficiencies in CHP plants were discovered as seeds that would lead to specific projects. A list of technologies to address this follows later in this report.

These seeds mesh well with Mongolia's national energy policy, and the country has high hopes that a detailed study toward a National Adaptation Programme of Action will be carried out this year. As a new JCM capital scheme, we considered a mechanism for supporting small projects and programs run by local banks and organizations mobilizing capital from the Clean Air Foundation, an environmental fund controlled by the Mongolian government, JCM and the Asian Development Bank (ADB). These projects and programs will be going ahead from next year in collaboration with

Mongolia and banks.

5 Considerations for project implementation

This initiative is targeting the energy supply sector and initiatives in power generation for example, which will require billions of yen in capital at a minimum. Therefore, as a financing scheme we based our thinking on the National Adaptation Programme of Action (ADB contribution). If we were to leverage this contribution, the first condition would be that we are entering the ADB pipeline and in relation to the identified initiatives, the technology has already been confirmed as being in the pipeline.

Given the high cost of the National Adaptation Programme of Action capital, in order to integrate cutting-edge technology into the project for the first time for an ADB project, additional costs would be contained by capital contributions from the ADB trust fund. Meanwhile, the formula for calculating the additional costs associated with integrating cutting-edge technologies is not yet known as of February 2013. Once the formula is known and the JCM part of the project cost becomes clear, the breakdown of costs for each efficiency improvement category including local surveys needs to be calculated based on the details once they are confirmed.

Therefore, the schedule will be for the projects to begin in 2015, based on details of the scheme being clarified in 2014, allowing the detailed pre-project surveys to be conducted.

II Main report

1 Institutional framework and context in project country and city

(1) The social and economic situation in the project country and city

Mongolia, the site of this project, is a landlocked northeast Asian country bordered by Russia to the north and China to the south. In 2012, its population of around 2.87 million puts it largely on par with Osaka City, but with four times the land area of Japan, it is the world's least densely populated country.

Meanwhile, looking at the distribution of the population, Ulaanbaatar, the city where this project is based (hereafter "UB") is home to around 46% of the people (some 1.32 million), or 280 people/km^2. This extreme population density is causing a wide range of problems in UB.

One of its urgent problems is the tight electricity supply. One factor is the concentration of people in the capital, but another is the economic situation in Mongolia.

Mongolia is a country blessed with rich mineral deposits, with gold, copper, coal, molybdenum and other resources accounting for nearly 90% of exports. Mongolia was a Soviet satellite and after the collapse of the Soviet Union, it moved at great pace toward democracy and market economics. The recent minerals boom has powered the country to economic growth of around 10% and demand for electricity is rising by the year.

As a result, existing domestic power generators are unable to meet electricity demand and the country is falling into reliance on its neighbour, Russia, to supplement the deficit.

		2010	2011	2012	2013	2014	2015
CENTRAL ENERGY SYSTEM							
1	Generation capacity	776	776	776	776	758	758
2	Import	120	120	120	120	120	120
3	Demand	711	768	964	1.166	1.297	1.375
4	Existing Peak load	734	782	829	896	967	1.045
5	New Potential Customer			135	272	330	330
6	Deficit of capacity		6	188	390	539	617
EASTERN ENERGY SYSTEM							
7	Generation Capacity	24	24	24	24	24	24
8	Demand	21	23	79	126	149	151
9	Existing Base load	21	23	24	26	29	31
10	New Potential Customer			55	100	120	120
11	Deficit of capacity			55	102	125	127
TOTAL DEFICIT		68	9	243	492	664	744

Figure 1. Supply and demand in Mongolia's Central and Eastern Energy Systems (unit: MW)
Source: National Dispatching Center of Power System, Mongolia

Such a situation is fatal to a nation's energy security and Mongolia is examining solutions. Specifically, there is a plan to build a new thermal power plant (Ulaanbaatar No. 5 Thermal Power Plant) to increase power supply. However, it has been delayed by site selection and cost-benefit issues and instead, the supply deficit is to be covered by expansion at the existing No. 3 and No. 4 thermal power plants.

Japan has established a financing and cooperation structure to address the city's electricity issues. Since the fall of the Soviet Union in 1989, Mongolia, which was a USSR satellite, has suffered from frequent issues such as unscheduled outages at plants as a result of the departure of Russian engineers and the end of aid from Russia. In response to requests from the Mongolian government, Japan has lent money with and without interest (grants) on many occasions, making a tremendous contribution to rescuing power plants and stability of the power supply. In recent years, improvements have been made to the power issues thanks to power plant repairs and better supply of equipment, but as noted above, the fundamental problem of lack of supply has not been solved. As such, Japan plans to continue its support.

(2) Energy consumption and greenhouse gas emissions in the project country and city

The major source of fuel in Mongolia is the coal it produces itself, making up 98% of the solid fuel consumed domestically. Greenhouse gas emissions are greatly influenced by the consumption of coal, which has a higher emission coefficient than other fossil fuels such as oil and natural gas. According to a 2006 study by the United Nations Framework Convention on Climate Change (UNFCCC) on GHG emissions by sector, the energy sector was responsible for around 60% of the total, with 30% coming from livestock methane. Of the carbon emissions from the energy sector, representing over half of the total, 96% stem from fuel consumption. The three biggest sources of these emissions are conjectured to be the coal-reliant energy supply sector, Heat Only Boilers and ger ("yurt") stoves.

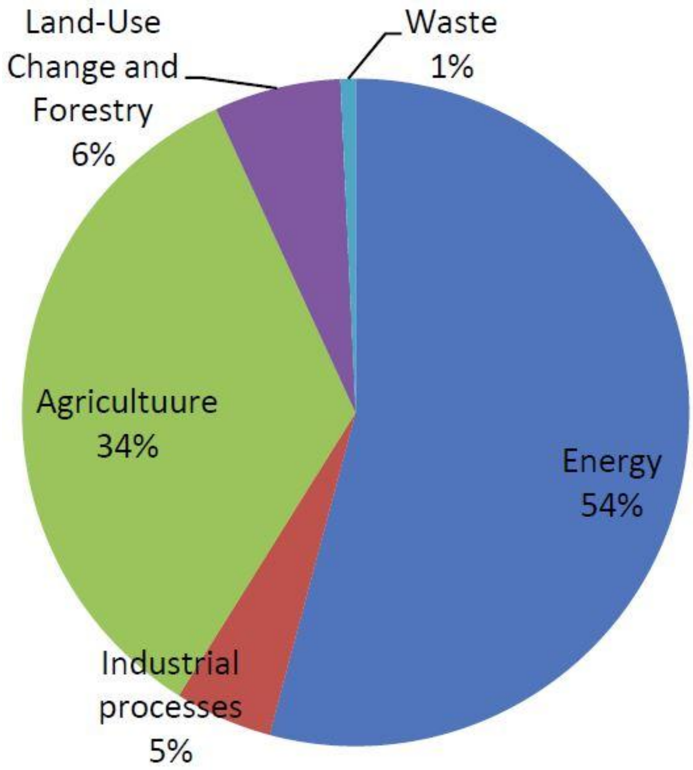


Figure 2. GHG emissions by sector in Mongolia (2006)

Source: Created from GHG emission profiles for non-Annex I Parties (UNFCCC)

Table 1　Major energy supply facilities in Mongolia (sources of energy-derived GHG emissions)

Facility type	Overview
Combined Heat Power (CHP) plant	A coal-fired thermal power plant that supplies electricity and heat to a district. Supplies chiefly power in summer and heat (steam and hot water) in winter. In UB, there are four CHP turbines at Nos. 2, 3 and 4 Power Plants.
Heat Only Boiler (HOB)	A boiler that supplies heat mostly in winter. Supplies heat to public buildings outside the centre of UB, which is supplied with heat by power stations. Major fuel is coal.
Ger stove	A small stove used for heating in households around UB not supplied with heat from power stations and gers. Fuelled by coal.

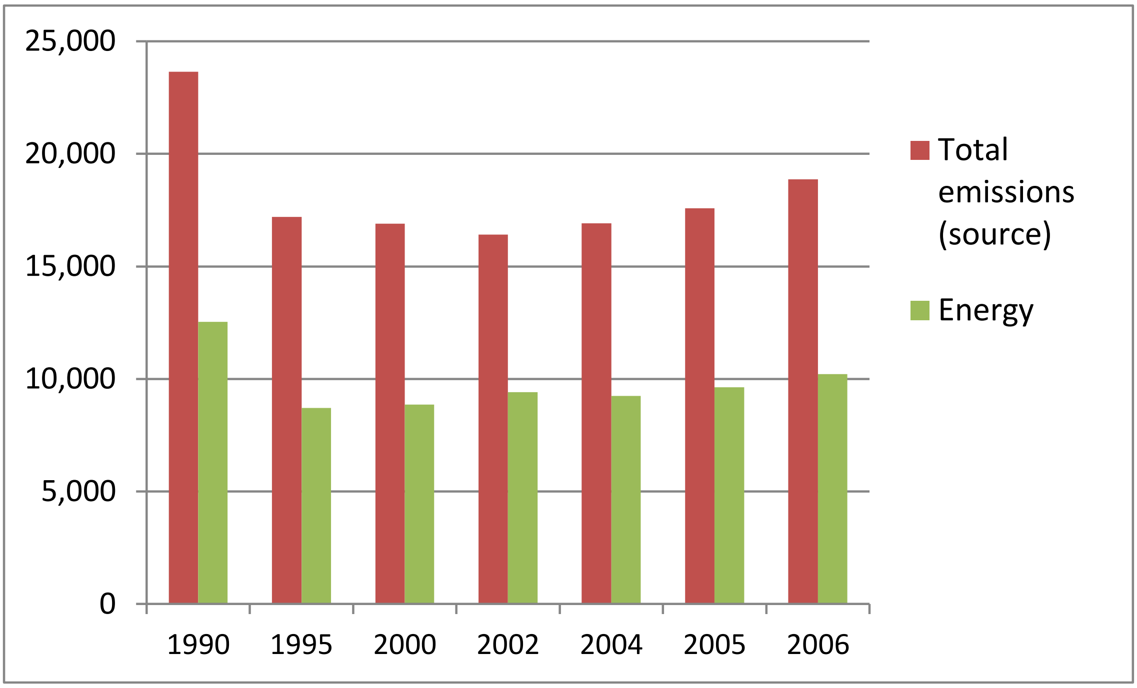


Figure 3. GHG emissions in Mongolia (total emissions and energy sector) (1990-2006) in Gg CO2-eq

Source: Mongolia Second National Communication

Table 3. 3. Greenhouse gas emissions by source (1990-2006), Gg CO2-eq

As GHG emissions trend upward in lockstep with economic growth, Mongolia is showing its willingness to cut its coal consumption and reduce its emissions. In 2010 it submitted Nationally Appropriate Mitigation Actions of Developing Country Parties (NAMAs) with its national measures against climate change that included mitigating actions such as "improving the energy efficiency of heat boilers, upgrading household stoves and improving CHP plants."

The NAMA demands efficiency improvements and GHG emissions cuts not just from the energy supply side as they are already, but also from the demand side. In particular, it requires much better energy efficiency from factories and buildings in urban and industrial areas centered on UB, where electricity demand is concentrated. In other words, for the energy sector, there is potential for GHG emissions reductions both on the energy supply and demand sides.

Meanwhile, livestock is responsible for 30% of GHG emissions and measures to reduce emissions from the sector are likely to require engagement with the national land use plan. This is due to the large scale of land dedicated to Mongolian livestock production, which is characterized by nomadic grazing. It is the basic industry of the nation and has long been its cultural basis. The form of livestock production is connected to preservation of the land and the natural environment, so it is assumed that a long-term and sustainable livestock production management plan will be needed in the sector to reduce overall national GHG emissions. Moreover, the major livestock production areas are remote from the cities, so this is not a high priority for UB, which is the focus of this project.

Based on the above, and in light of their proportion of Mongolian GHG emissions, and the potential and urgency of the issues in the capital, UB, we conclude that measures to cut GHG in the energy sector would be the most effective.

(3) Environmental burdens associated with the project (waste, air pollution, freshwater use, etc.)

Of the range of issues caused by the rapid population growth in UB, one of the most serious is the air pollution caused by coal burning in winter.

Because the city is located in a typical continental climate region, average temperatures drop below minus 30°C in the coldest part of winter. As such, heat supply is a lifeline for city residents and coal-fired power plants supplying power and hot water, mid-sized Heat Only Boilers supplying heat, small business boilers and household heating devices such as ger stoves are all in operation. The principle fuel for the power and heat supply is coal, so they are all sources of airborne particulates such as dust. Added to this, UB is located in a basin and air is trapped by an inversion layer above the city during winter, meaning that high levels of particulate matter remain in the air. As a result, air pollution in the city is worsening and damaging the health of its residents.

Table 2　Annual average airborne particulates in UB, October 2010 to September 2011

Annual (Average)	Standard MNS4585	CLEM Station ID 01	02	04	05	07	08
SO_2 (ug/m3)	10	(26)	31	(12)	53	20	18
NO_2 (ug/m3)	30	(40)	93	(49)	42	37	31
PM-10 (ug/m3)	50	(152)	189	(120)	355	209	86
PM-2.5 (ug/m3)	25		154	(49)			
Data Count Ratio							
SO_2		(40%)	90%	(45%)	97%	88%	90%
NO_2		(46%)	88%	(46%)	98%	75%	80%
PM-10		(47%)	80%	(17%)	92%	66%	89%
PM-2.5			92%	(45%)			

＊Values in () are for reference

＊SO_2, NO_2 and PM all exceeded environmental standards (MNS4585) at all measuring posts (CLEM).

Source: Hiroyuki Maeda: Introducing the Capacity Development Project for Air Pollution Control in Ulaanbaatar City, JICA Follow-up Seminar (air), mathematical programming (March 2012)

In recent years, solving air pollution has become a major issue on UB City's agenda. An air quality unit was established in its Environmental Protection Department in 2007 with the objective of monitoring air quality in the city, raising public awareness, sponsoring legislation and proposing policy. The unit was taken under the direct control of the mayor in 2009 and upgraded to Air Quality Department. Beyond the actions of UB City itself, various donors have provided technology cooperation and development studies, the National Committee for Reducing Air Pollution was established with funding from the European Bank for Reconstruction and Development (EBRD) and there is continued support from the World Bank, JICA and others.

On the other hand, the problems facing the city in tackling the issue have been clarified and they include the work jurisdictions of existing organizations in the field, lack of studies or knowledge to identify emissions sources and a weak emissions management mechanism. In Mongolia, there is little progress on developing resources other than coal and the reliance on this fuel, which is abundant and cheap, looks set to continue. Thus it is very likely that the use of coal is going to continue for the foreseeable future. The issue of air pollution needs to be addressed on the assumption of continued coal use.

Other environmental issues facing UB are solid waste, drinking water and waste water problems stemming from rapid population growth. In terms of waste, unauthorized dumping is a big issue in the Ger Districts in particular. With financial backing from JICA, the Solid Waste Master Plan of Ulaanbaatar was devised for implementation by 2020 and in 2008, grant aid was provided for purchase of necessary equipment and construction of a new landfill site at Narangiin Enger.

With backing from World Bank, a master plan for drinking water and waste water was delivered in 2006 and JICA grant aid has been applied to improving the water supply capacity of the city since then. However, per capita water use has grown as volume of water use has become differentiated by district and lifestyles change. Inadequate treatment of waste water has led to groundwater pollution and a range of other problems that need to be solved. The water supply and treatment infrastructure is in need of improvements in step with the unique characteristics and development stage of each district.

(4) State of infrastructure and plant within the scope of the project

We have already mentioned the electricity and heat supply plant in the energy sector. Of these, we will exclude ger stoves used in households from the infrastructure and plant, from the scope of this project. While we are aware that the great number of ger stoves means that action is required on them in order to cut GHG emissions and solve the air pollution crisis, purchase and management of stoves is an individual decision and their state of maintenance varies greatly across households. In a previous study, World Bank and the Mongolian Consumers Association (MCA) advocated measures on ger stoves, but solving the issues was a challenge from the perspective of upkeep and management of individual stoves. Without improving the quality of the coal fuel, it is believed that any measures would be ineffective. Therefore in this project, we have narrowed the focus to the following three types of infrastructure or plant where the state of upkeep is somewhat clear, and a GHG reduction project can feasibly be considered. An overview of their upkeep is completed.

1. CHPs (CHP3, CHP4) in UB, and CHPs of the Central Energy System
2. HOB (Heat Only Boilers)
3. Other plants and buildings where energy savings can be foreseen

1. CHPs (CHP3, CHP4) in UB, and CHPs of the Central Energy System

・Ulaanbaatar No. 4 Thermal Power Plant

Five electricity grids exist in Mongolia, and UB is located in the Central Energy

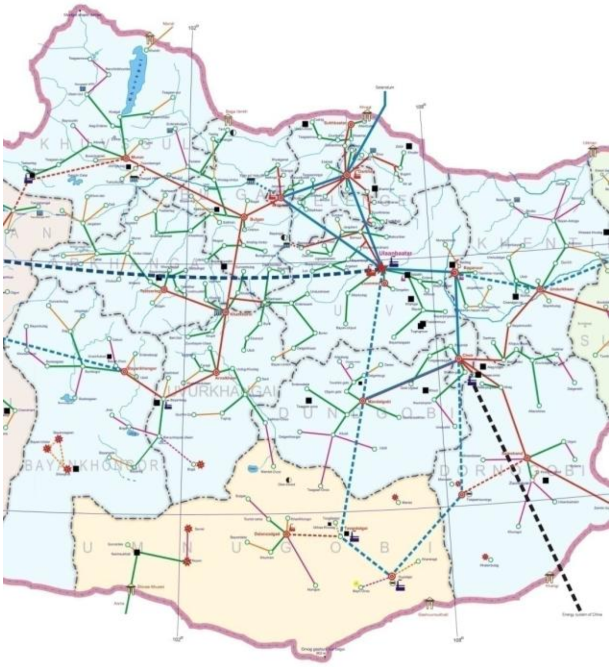
System (CES), a grid that boasts a larger output than the other systems. Equipped with a 580MW turbine, Ulaanbaatar No. 4 Thermal Power Plant (CHP4) accounts for 73% of power production (2010) and 62% of heat production in the CES. Ulaanbaatar No. 4 Thermal Power Plant (CHP4) is equipped with a 580MW turbine. The power plant was built with Soviet aid from 1983 to 1991 and started production, but the departure of Russian engineers and finance in 1991 led to the breakdown of the automatic control system and cut the electrical output of the station. Japan stepped in with aid at the request of the Mongolian government. As a result of three loans and two grants from Japan, blackouts are more or less a thing of the past and improvements are visible in all aspects, from updating of equipment to the training of engineers. However, due to inefficient operation of the distributed control system (DCS), the plant is basically run manually, leaving plenty of room for improvement. In order to meet power demand from UB, a plan to boost capacity with a 100MW turbine is due to be implemented from 2014.

・Ulaanbaatar No. 3 Thermal Power Plant

Ulaanbaatar No. 3 Thermal Power Plant (CHP3) was built in 1966 and is a 148MW turbine that produces heat and electricity. The second biggest plant after CHP4, it supplies 17% of the power for CES (2009) and 32% of its heat (2009). Consisting of a medium-pressure unit and a high-pressure unit, this power plant was the first high-pressure boiler to operate in Mongolia, going into service in 1976. The high pressures and high temperatures require a certain level of management ability from its engineers and operators, but compared to CHP4, very little support was given to CHP3 and as a result, the equipment has aged. There is a plan to add a 50MW turbine to address rising demand for electricity. As the plant is expected to continue to operate, an overhaul of the facility will be vital.

・Other CHPs in the Central Energy System

Other key CHPs in the CES zone are the Darkhan CHP (48MW) and Erdenet CHP (28.8MW). These plants are expected to continue operations but like CHP3, they are in a rundown state. Given the current reliance on Russia for electricity imports to meet demand, the capacity increases at CHP4 and CHP3 and repairs noted above will not be adequate. Measures are also needed to address the supply and demand situation across the CES as a whole.



<u>Central Energy System:</u>
Ulaanbaatar No. 2 CHP 24MW,
Ulaanbaatar No. 3 CHP 148MW,
Ulaanbaatar No. 4 CHP 580MW,
Darkhan CHP 48MW,
Erdenet CHP 28.8MW,
Total output: approx. 800MW

Figure 4 Summary of CHP in the CES zone
Source: Unidentified

2. Coal-fired Heat Only Boilers (HOB)

The districts supplied with heat by the power plants are in the central city area of UB. Surrounding districts do not have this supply, so HOBs supply heat to public facilities such as schools, hospitals and local government buildings. (Apart from these, households and gers are heated by ger stoves.) There are some 200 HOBs installed in residential areas of UB, and many have low chimneys and do not have adequate exhaust equipment. For this reason, studies and technical cooperation projects have already found that improvements to the efficiency of HOBs would make a major contribution to alleviating air pollution, and that there is plenty of room for new improvements and measures.

HOBs are built by a number of different manufacturers, and there are diverse types and sizes, but the Mongolian standard (MNS5043) specifies that a HOB is a boiler to supply heat with an output of between 0.1MW and 3.15MW. (A HOB of 0.1MW or less is considered a stove.)

When upgrading or building a new HOB in Mongolia, it is said that the product will be cheap and comparatively inefficient unless a foreign donor or other such party is funding it. Beyond the type and build of the HOB itself, the performance of the boiler also depends on how it is operated by the owner or the management company responsible, the site and the quality of the equipment used.

Japanese technology is not used in Mongolian HOBs, but according to a previous study, there is a plan to concentrate the HOBs in one place and increase their size as part of an infrastructure development plan for the Ger Districts. Should this plan to concentrate and upsize the HOBs go ahead, it would increase the likelihood of highly efficient Japanese combustion technology being deployed. Studies and technical cooperation have allowed us to grasp the role of HOBs, but in order to improve their efficiency and ensure more specific measures against air pollution, more studies and pilot tests will be needed.

Table 3　Examples of HOBs used in UB

HOB　type/maker and agent	Type and maker
CLSG/CLHG	0.11-1.05MW Made in China. Natural airflow, old Soviet technology
DZL (2.8/1.4)/Selenge Construction	2.8/1.4　MW Mobile stoker type, continuous coal feed type. Made in China, old Soviet technology
HP/Odkon	Output depends on type - fixed stoker type, batch type, old type
MUHT/Dorniin-ilch Co. Ltd.	Fixed stoker type, batch type Made in Mongolia
CARBOROBOT (150, 300) /Anu Service	0.15/0.3MW Mobile stoker type, continuous coal feed type. Made in Czech Republic

＊There are several other types of HOB in operation in addition to these

Source: March 2010 – March 2013 Ulaanbaatar City Air Pollution Measures Capacity Development Project_Detailed Planning and Policy Study Report

FY2012 Ministry of Environment Outsourced Project_FY2012 Bilateral Offset Credit Mechanism MRV Model Testing Study – Upgrading and installation of high-efficiency heat supply boilers in district heating (Mongolia)

Figure 5　Example of HOBs

3. Energy efficiency gains expected from other factories and buildings

・Textile factories

As noted, a major industry of Mongolia is mining, with minerals accounting for 87% of total exports. There are few export industries other than minerals, the main products being cashmere wool for which Mongolia has 30% of the global market share and flour (wheat), which it exports to China.

Gobi and Altai Cashmere are the two world-famous companies that represent the cashmere industry. The companies began as experimental factories set up with assistance from the United Nations and were established in 1981 with Japanese ODA. The factories have gradually been modernized following the fall of the Soviet Union and privatization, but the sheer length of time the factories have been in service means the plumbing equipment and spinning machines are very old. There is great potential for the infrastructure to be overhauled. Furthermore, due to the large number of tanneries and carpet factories, there is a certain degree of potential for upgrade of these too.

・Cement factories

Due to the population explosion and the 2011 property bubble, the apartment construction boom continues. Demand for cement in Mongolia is expected to rise, but over 50% is imported from China and costs are high. There is one state-owned cement manufacturer and one private sector manufacturer in Mongolia, and they both use wet kiln process only, a method no longer used in Japan. There is certainly space for technological improvement here.

Meanwhile, the Mongolian government has a policy of increasing domestic supply of construction materials and it has set a large objective of 100% domestic procurement of cement under the Building Materials Industry Support Program (Cabinet Order 171, 15 December 2012). Currently, a dry kiln plant is under construction, which may stimulate the Mongolian domestic cement industry in future. From the perspective of reducing the cost of production, there is likely to be demand for energy efficiency and efficiency improvement in this sector.

As market reforms continue, Mongolia's domestic industries are growing in strength and becoming less dependent on foreign capital. There is thus a need to improve profitability. In order to do so, there is likely to be strong demand not just in the above sectors but across the whole of industry to improve energy efficiency and overhaul plant.

・Energy efficiency in construction

In UB, as mentioned a number of times, unplanned housing construction is proceeding at a pace in response to rapid population growth, particularly in the Ger Districts. The result is the appearance of buildings inadequate for the cold climate and it is concerning that energy inefficient buildings continue to be erected. Inefficient buildings will lead to increased coal use and could be a factor in growth in GHG emissions and worsening air pollution. The city has been considering the construction of housing estates built to cold climate specifications in collaboration with Asahikawa City, Japan. As plans to build apartments for households living in Ger Districts continue to emerge, there is plenty of potential for energy efficiency gains in the construction sector of UB, a cold climate area.

(5) Government bodies associated with the project and their role

This project is proceeding with a number of Mongolian partners. Here we present the major government organizations involved.

・Climate Change Adaptation Department, Mongolia Ministry of Environment and Green Development

Serves as the Mongolian secretariat for the JCM. Has produced the Mongolian version of the JCM manual and is a very active partner, regularly engaging in public relations for the project, for example. It is the Mongolian counterpart for this project.

・Department of Strategic Policy and Planning, Ministry of Energy

The Ministry of Energy has jurisdiction over power plants, renewable energy and heat supply including central heating. The Department of Strategic Policy and Planning presides over national projects and other large-scale projects undertaken with foreign aid. General Director Tovuudorj Purevjav is a member of the Joint Committee on JCM.

・Ulaanbaatar

UB does not have authority over the state company-run power plants, but it is a major policymaker regarding coal-fired boilers and ger stoves. With regard to HOBs, a technical cooperation project is currently underway with financing from JICA and others to implement a boiler registration system and tackle air pollution. The second phase began in December 2013.

(6) Institutional framework related to the project

1. Energy sector policy

The policy directly related to this project is Mongolia's Updating Energy Sector Development Plan. Originally, this plan was intended to advance development of the energy sector, but with the delay in construction of CHP-5 and other problems, it is not progressing as expected. However, the sector is expected to develop according to this plan from now on. An outline of the plan is shown below.

The development plan was established on the basis of long-term energy demand forecasts. Looking at Mongolia's overall demand forecasts for heat and electricity, there are two scenarios, one for increasing heat volume by building more CHPs and by building larger HOBs, the other for electricity which envisages three scenarios for demand growth, based on economic growth rates of (1) 9.3%, (2) 9.8% and (3) 10.5%. Heat volumes and electricity are both growing. (Figure 6 shows the overall electricity demand growth forecast for Mongolia.) In addition to the overall national forecast, there are forecasts for each of the energy systems. CES, where UB is located, is expected to need more than twice as much power in 2020 as it used in 2003. (See Figure 7)

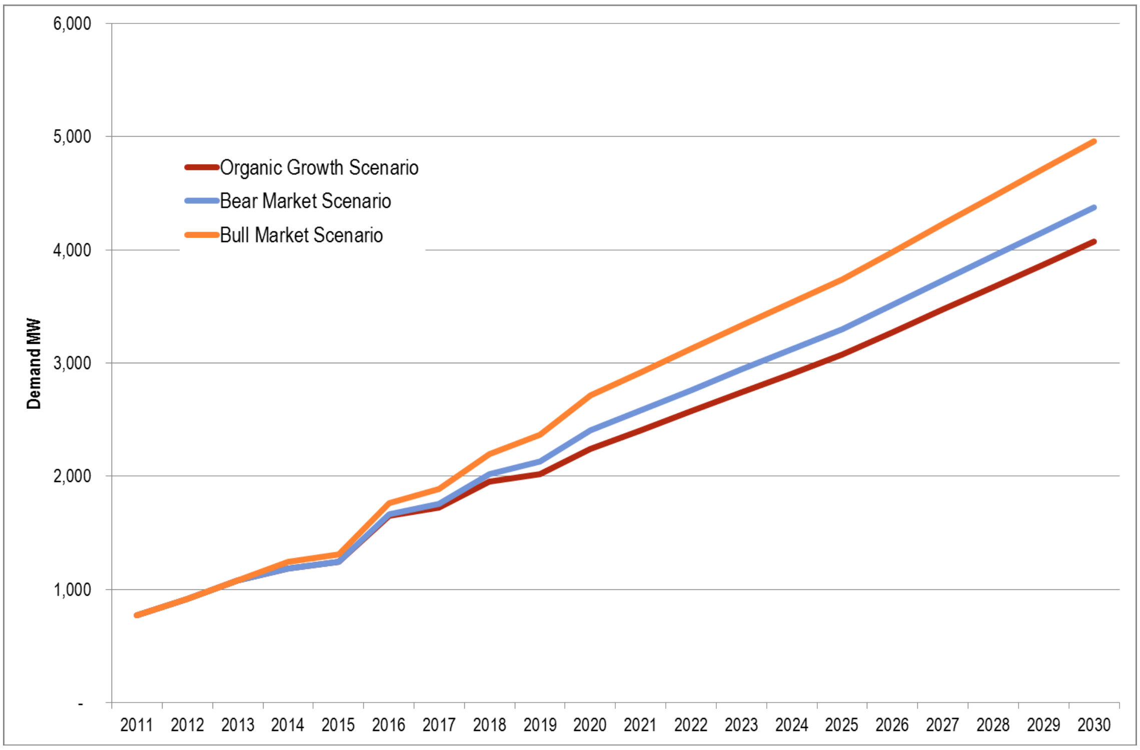


Figure 6. Forecast electricity demand in Mongolia (MW)

Source: Updating Energy Sector Development Plan (Sep 2013)

Figure 7: Electricity Demand Forecast (MW)

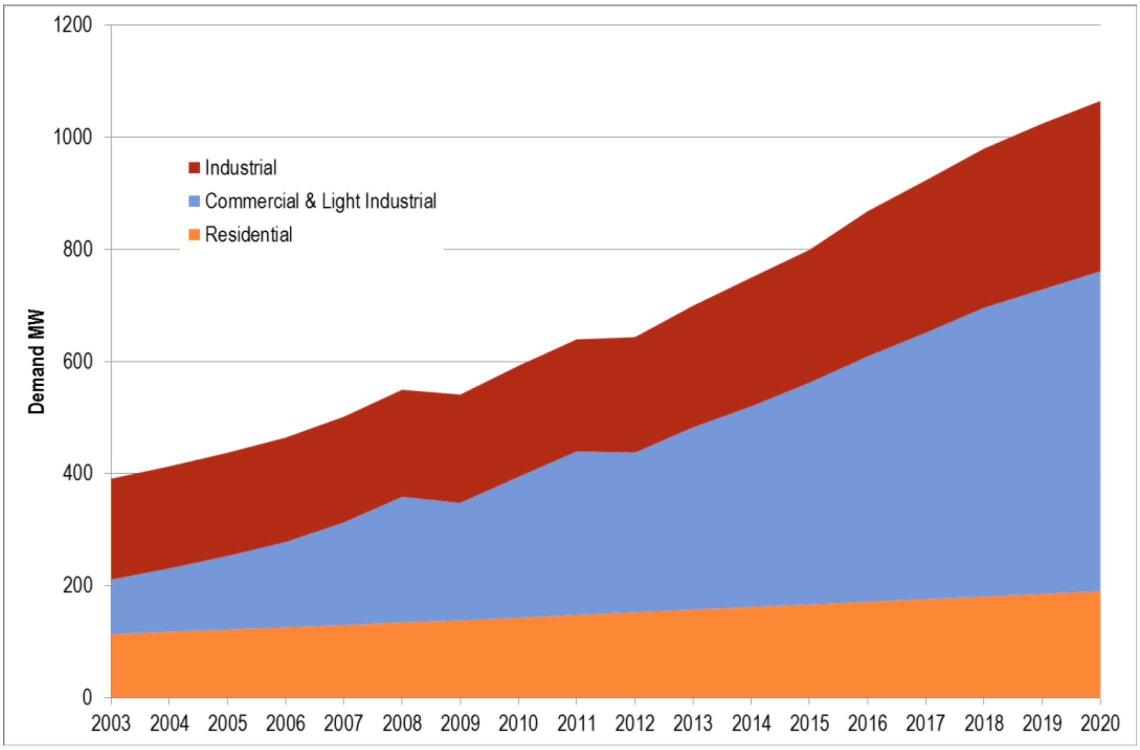


Figure 7. CES electricity demand forecast (MW)

Source: Updating Energy Sector Development Plan (Sep 2013)

Figure 9: CES Demand Forecast (MW)

According to the CES development plan based on these forecasts, expansionary upgrades will be made to CHP3, CHP4 and CHP5, and Darkhan CHP and the 50MW Newcom windfarm will be expanded. (Note: as of the time of writing, CHP5 has not been built, so upgrades are envisaged once built.) Specifically, a new 750MW CHP is to be built, along with construction of the Seuren Dam (total output 390MW, annual operating output 170MW). A coal-fired power plant enters into service in 2013 bringing 300MW, with expansion to 600MW due by 2025. Windfarms supplying 50MW will be built in 2014, with expansion to 400MW by 2025. However, the production scale assumed in the plan is based on an end use model and a low growth scenario that assumes no change to existing commerce and industry. Therefore, further development may be necessary depending on Mongolia's economic growth.

Due to the large size of the CES compared to the other energy systems, the required budget is large. The investment needed by 2025 for CES will account for 39% of overall investment in Mongolian energy systems (see Figure 8). The plan to secure the necessary investment assumes private and public sector funding for each project. (See

Figure 9)

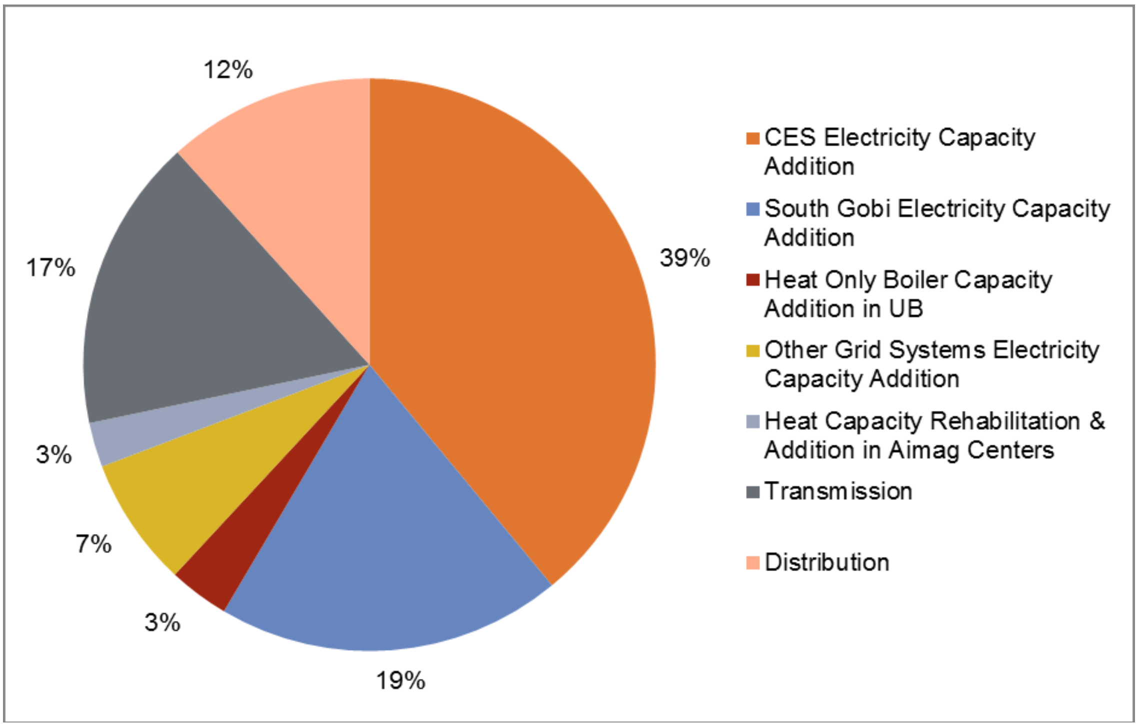


Figure 8. Estimated Investment Requirements by 2025 by %

Source: Updating Energy Sector Development Plan (Sep 2013)

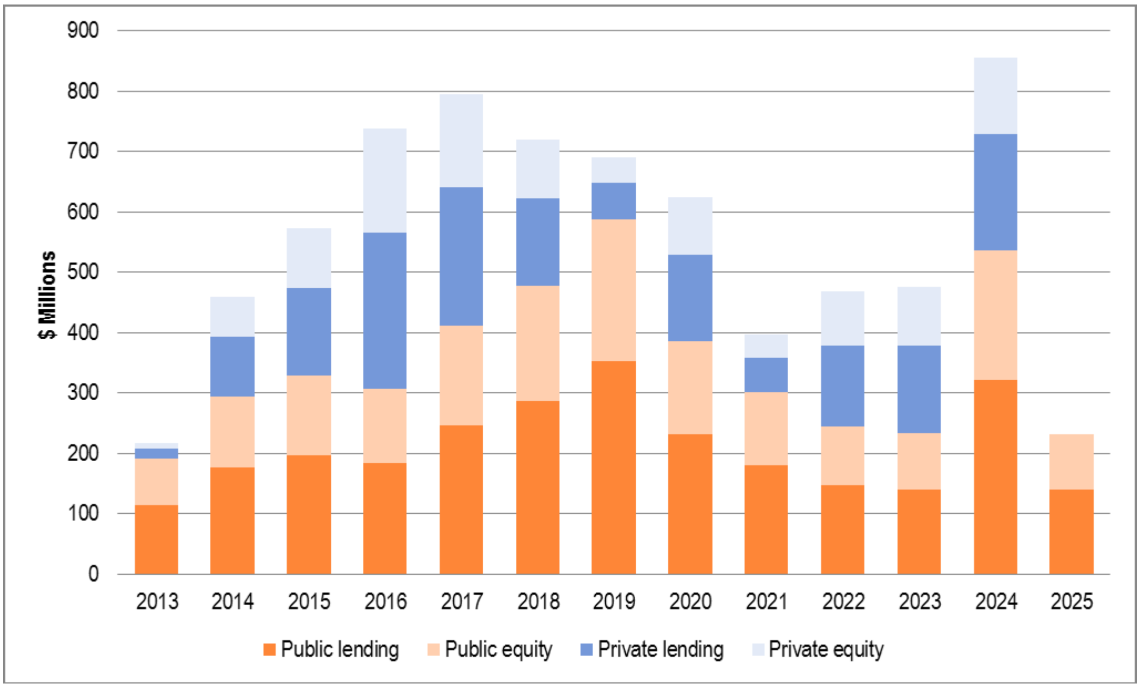


Figure 9. CES Expansion Plan by Finance Source

Source: Updating Energy Sector Development Plan (Sep 2013)

Therefore, the CES development plan which covers UB is considered the most urgent focus, even in the Mongolian electricity supply development plan. On the other hand, CES is facing many problems in meeting the demand for electricity: not only has construction of the CHP5 been delayed, but other planned CHPs have also seen lack of progress on pre-construction assessments, and hydroelectric plants have been built that have failed to deliver the planned supply due to lack of water volumes. The actual progress of electricity supply development plans will need to be watched keenly.

2. Economic support schemes

"Financial support schemes to implement the project" are one consideration of this project and are specifically addressed in Part 4 and 5 of this report. Here, we present an overview of the existing economic support schemes.

・Bond issuance

One scheme that could potentially be leveraged for this project is economic support through a bond issue. Genghis Bonds are the issuance of the Mongolian government, which issued and sold US$1.5 billion worth of Chinggis Bonds in November 2013. This was the first issuance of government dollar bonds by Mongolia. The capital raised with Genghis Bonds is intended for use in development of infrastructure such as rail, roads and power plants, as well as mining projects and other growth industries. As such, the capital could be used in the energy sector.

Yen-denominated bonds, or "samurai bonds" issued in Japan by foreign companies and organizations, were issued by the Development Bank of Mongolia in December 2013. The Japan Bank for International Cooperation (JBIC) has guaranteed the bonds in order to support capital raising for the development of Mongolian resources.

・Foundations

The Clean Air Foundation contributes to the fight against air pollution. It was established with support from the governmental National Air Pollution Reduction Committee and the European Bank for Reconstruction and Development. An Advisory Committee oversees the fund, consisting of members from the Ministry of Finance, Ministry of Energy, Ministry of Mining, the Deputy Governor of Ulaanbaatar (Bat-Erdene, in charge of ecology and green development issues), D. Battulga, Chairman of the Ulaanbaatar Citizens' Representative Khural, the Ministry of Population Development and Social Welfare and NGOs. (The Foundation is under the jurisdiction of the Minister of Environment and Green Development.) The major funding source of the Foundation is a tax on coal exports of MNT 1,000 (Mongolian togrog) per ton. According to the Foundation, it has been responsible for the following improvements:

- upgrading of ger stoves (replacing them with Turkish stoves)
- replacement of low-pressure heat only boilers (HOBs)
- adoption of hybrid LPG and diesel buses to reduce exhaust emissions from vehicles

This Foundation is funded from government revenues and as it can be used to directly combat air pollution, this is strongly anticipated as a source of financial support.

・Mongolian government and banks

One scheme offered by Mongolian and local banks is environmental financing from XacBank. XacBank considers environmental stewardship as one of its three great missions and one of its initiatives is managing a loan scheme to replace stoves in the Ger districts in cooperation with Clean Air Foundation, the environmental fund set up by the Mongolian government and Millennium Challenge Corporation (MCC), the aid agency established by the US government in 2004. The scheme is financed through kickbacks from stove companies.

XacBank also contributes financing to the environmental sector through JICA two-step loans. (Interest on these loans is kept low at around 4%.)

・Donor support

The above schemes are largely carried out by Mongolia, but besides the government there are donors offering financial support. One is the UB Clean Air Project supported by the World Bank, which directly combats air pollution.

BCAP studies and implements anti-air pollution measures in UB, its scope extending over a wide range of initiatives from Ger districts to urban greening, measures to reduce exhaust gases from power plants and feasibility studies for district heat supply. Of these, it has focused strongly in recent years on improving stoves in Ger districts and is monitoring dust, CO, CO_2, SO_2, PM10 and other environmentally polluting substances emitted by new ger stoves manufactured in Mongolia in order to promote domestic ger stove production. Between the second half of 2013 and 2014, it is carrying out several feasibility studies with World Bank funding. Other important donors engaged in other environmental initiatives are as follows.

Table 4 Support by donors in the energy and environment field

Donor	Overview of aid/investment
European Bank for Reconstruction and Development (EBRD)	Invests a lot in private sector including financing the Sharin Gol coal mine and the Sainshand Industrial Complex
Asian Development Bank (ADB)	Provides mainly pipeline public sector financing (electricity lines infrastructure, district heat supply and factory energy efficiency, etc.)
World Bank	Supports solar panels in non-electrified regions, UBCAP (noted above)

2 Projects within the scope of the study

(1) Project objectives

As noted in "1. Institutional framework and environment in project country and city," Mongolia is one of the world's leading coal producers and it supplies most of the coal it needs to meet domestic energy demand. For example, a large volume of coal is used to heat the water used in urban central heating and district heating due to the freezing Mongolian winters when temperatures drop below minus 30°C. This heat and most of the electricity is reliant on Combined Heat and Power (CHP) plants and Heat Only Boilers (HOBs), all powered by coal. For this reason, the country's per capita carbon dioxide emissions are 4.33 tons, much higher than the global average, and hence the tremendous potential for emissions reductions through more efficient use of coal fuel resources. Moreover, air pollution is a serious issue due to coal burning and traffic jams arising from the dramatic economic growth that started in the capital, Ulaanbaatar in 2000, swelling the population of the city in the absence of any clear urban planning and sparking a construction boom. A co-benefits approach that tackles all these issues at the same time would be very desirable.

Therefore, in this study, in light of the current issues facing Mongolia, we supported the generation of specific seeds by making checks on plants and other means, and attempted to select only greenhouse gas reduction projects focused on improving energy supply/demand efficiency that would help to deal with air pollution and that had strong feasibility. We also considered a basic financing scheme in order to create the necessary platform for carrying out the projects.

(2) Applicable technologies and systems

1. Technologies, strengths and weaknesses, and costs

As noted in "1. Institutional framework and environment in project country and city," the energy sector is responsible for around 60% of GHG emissions in Mongolia and as the bulk of these are from CHPs and HOBs, the focus here will be on these technologies. It is not just the energy suppliers, the demand side is also responsible for a high level of GHG emissions from factories and therefore, we also cover energy efficiency technology in factories.

Mongolia's CHP plants are run differently from Japanese power plants. First of all, there are few power plants in Japan that supply both heat and electricity. There are small-scale plants in waste disposal sites here and there, for example, but most large-scale power plants only generate electricity.

Second, in most cases in Japan, coal-fired power plants are operated with one boiler per turbine/generator. Meanwhile, Mongolia still uses header modes, for example the UB CHP4 plant has eight boilers and six turbines operating in unison. Each turbine generates a small amount of power somewhere in the range of 100MW, and the boilers are the same.

Supercritical and ultracritical pressure coal-fired power plant boiler/turbine units, for which Japanese technology is considered to lead the world, generate a minimum 500MW and anything below this figure is seen as impractical from a cost-benefit or technological perspective. It can thus be inferred that Japan's supercritical and ultracritical pressure coal thermal power technology is not currently a viable option for Mongolia given the economic scale and population of the country.

Moreover, Japan imports coal for its thermal power plants of a grade of around 6,000 kcal/kg from Australia and Indonesia, and this is subject to cleaning before importation and use. Meanwhile, Mongolia's brown coal generates around 3,000 kcal/kg of heat and is burnt without adequate cleaning. It would therefore be difficult to use Japanese coal crushers, mills or pulverized coal boilers as they are in Mongolia. And it would also be difficult to produce any cost advantage in 100MW equipment, as the cost performance of Japanese development and manufacture would likely against it. Thus, it is important to study the feasibility of adopting Japanese technology not in terms of Japanese boilers, turbines or other hardware, but of control systems, operating management and maintenance.

Next are coal-fired Heat Only Boiler: in Japan, coal-fired boilers are used only in electricity generation, while heat supplying boilers are mainly powered by natural gas or oil – coal boilers having been phased out around 40 years ago. Meanwhile, still with solid fuels, the development and production of biomass boilers is booming as a feed-in tariff system and other factors boost demand. There are cases of technologies in these areas being applied to Mongolia's coal boilers.

Moreover, as coal-fired HOBs do not generate power due to cost, they are not required to withstand high heat or pressure and as such, low-spec parts can be used. On the other hand, Mongolia currently exports its high-grade coal and uses its relatively good low-grade coal to produce power. As a result, inferior coal is often used in HOBs, causing breakdowns and many other problems.

In order to solve these problems, rather than supplying the HOBs themselves, it would probably be feasible to supply Japanese-made parts to prevent HOB breakdowns. To change the technology used in the operation and maintenance of boilers, it would likely be useful to establish a business model for maintenance targeting Japanese companies wishing to invest in Mongolia.

Finally, with regard to factory energy efficiency, Mongolia has plants producing minerals, cement, textiles, wheat milling and food and beverages. Most are operating with old equipment and in many cases, there are inadequate energy efficiency measures in place or a lack of knowledge to implement them. So there is much potential for the adoption of Japanese technology, but on the other hand, there is little benefit seen in energy efficiency measures to save power or reduce coal consumption due to the extremely low cost of coal. Another major point of difference is the high cost of water in Mongolia. As the cost of tap water is higher than Japan, reductions in water use have a large effect on cost-benefit equations. Therefore, the potential for factory energy efficiency in Mongolia needs to be explored, not on the same cost basis as Japan, but in the context of the unique Mongolian situation.

2. Japanese technology and systems versus foreign technology and systems

Here we will compare the technology and systems of coal-fired CHPs, coal-fired HOBs, and factory energy efficiency.

Firstly, CHP plants: there are few such plants producing power and heat in Japan, as noted above. But countries in the West and China operate a lot of coal-fired plants producing both heat and power. Secondly, there are power plants operating with header modes in Japan, but they are mainly in the form of on-site generators at paper factories and steelworks and represent a very small percentage of power plants overall. It is a similar situation in the West and China, in that it is difficult to make technological comparisons of header mode use because CHPs are not mainstream. Meanwhile, at a scale of boiler of around 500t/h and turbines of around 100MW of output, it is not viable to adopt Japanese supercritical or ultracritical pressure boilers or turbines in Mongolia, and it may be difficult to distinguish it technologically from other countries.

Next is the technology used in HOBs: Firstly, boilers are used to supply heat in very cold regions, so there are very few countries that build and use them. Southeast Asian coal producing countries have a warm climate and do not make them, while the developed Western nations are equipped with central heating and therefore have no demand for boilers, so its models are not available on the Mongolian market at all. The only imported boilers on the market come from countries such as those of Eastern Europe, China, South Korea and Russia. Naturally Japan does not make boilers either, so any comparison of boiler technology is difficult.

Finally, a few basic points on comparing systems. It seems difficult to compare Japan's electricity generation systems to those of the West, let alone developing countries because they are so strictly governed. Operations continue daily under strict rules, from pre-construction assessments of power plants to construction, operation and maintenance. For example, Mongolia faces an air pollution problem as noted in "1. Institutional framework and environment in project country and city." One factor in this pollution is that electrostatic dust collectors are only installed at UB's CHP4 plant, and equipment to remove NO_2 and SO_2 is not installed in any CHP. This is one of the reasons that air pollution-related emissions standards can only be set at a very low level for power plants. There is a need to contribute to Mongolia, for example, by applying emissions standards and other systems to the developing country and bringing in strong Japanese environmental technology not only to reduce GHG emissions, but to cut polluting substances.

3 Study methods

(1) Study challenges

As noted above, this study, in light of the current issues facing Mongolia, supported the generation of specific seeds by making checks on plants and other means, selecting only highly feasible GHG reduction projects focused on improving efficiency both on the energy supply and demand sides that would help to deal with air pollution.

The first challenge is, "Is there potential for adoption of technology made in Japan?" While Mongolia has plenty of potential for emissions cuts due to the operation of a large number of coal-based plant and equipment, its cold climate and high altitude mean that in many cases Japanese technology cannot be readily applied. Moreover, a population of under 3 million people cannot be expected to generate much domestic demand and therefore few Japanese companies are present. It will be necessary to find new markets using JCM.

The second challenge is funding. Mongolia has achieved average growth of over 10% in the past three years, but direct transactions between Mongolian businesses and Japanese businesses are not easy. A limited number of local banks are able to issue letters of credit and Japanese banks cannot easily provide finance either. This is as far as we will discuss the issue here, as there is a specific explanation of financing schemes and financing plans below.

(2) Study partners

The study was carried out with the following partners.

OECC (The Overseas Environmental Cooperation Center, Japan)

- **MEGD (Ministry of Environment and Green Development)**
〔 Focal Point in Mongolia 〕
- **Tenpes** **(Thermal and Nuclear Power Engineering Society, Japan)**
〔Energy efficiency diagnosis and mitigation potential identification〕
- **JCI (Japan Consulting Institute)**
(Finding corresponding technologies suitable to Mongolia, assessment of mitigation effect and planning operation)
- **SMBC** 〔Elaborating financial schemes for JCM projects〕
- **GEC (Global Environment Centre Foundation)**
(Technical advices toward developing feasibility studies, and MRV demonstration project)

(3) Studies

An initial study was carried out independently by the Overseas Environmental Cooperation Center, Japan (OECC) on CHP (Combined Heat and Power) and HOB (Heat Only Boiler) power plants in the energy supply sector and energy-saving technology at other plants and factories in order to discover JCM project seeds, and support the development of specific and highly feasible emissions-reducing initiatives.

Next, in the second study, an investigation of applicable technologies was carried out dispatching Japanese technology specialists to the plants and factories as well as through local guidance. Following their return to Japan, the Japanese technologies and products that could be brought to Mongolia in light of its status as a developing country were narrowed down, and matching carried out with Japanese companies in the selected applicable areas.

In the third and fourth studies, we investigated the potential for adoption of the selected technologies by bringing the providers of the identified technologies to Mongolia. And in order to deepen understanding among the Mongolian parties of the technologies held by the designated providers, representatives were brought to Japan for training to learn about the technologies as well as maintenance and operations management. All of these aspects contributed to winnowing the pool of feasible Japan-made low carbon technologies and finalizing the list of initiatives.

In addition, as part of deliberations on the support for designing the schemes needed at the central government and city level for the projects to go ahead, we carried out an analysis of stakeholders and their roles in September including the Mongolian Ministry of Environment and Green Development, Ulaanbaatar City and donors supporting Mongolia and others. A joint seminar to explore future collaboration was also held. A funding scheme for small-scale projects run by local banks and organizations mobilizing capital from the Clean Air Foundation, the environmental fund controlled by the Mongolian government, JCM and the Asian Development Bank was devised as a way of assisting the design of a supportive policy framework at the national and city level.

As part of seed development, we came up with a basic financing scheme in order to supplement the existing JCM financing scheme and to expand the applicable scope of JCM projects in the future. This would allow Mongolian parties to assess the benefits of using the candidate initiatives suggested by this study project.

4 Study results

(1) Study activities and results

As a result of the four studies and one training tour to Japan, we were able to identify a number of technologies as potential JCM seeds and assess that they are capable of contributing to development in Mongolia. These technologies are listed as follows.

1. Efficiency improvements in coal-fired CHP plants

Task	Period	Details
(a) Optimization of power plant output and loads, adoption of distributed control systems	Approx. 2 years	There is more potential for energy efficiency improvement in Mongolia, where rather than the Japanese style of unit where there is one boiler for each turbine, multiple units are connected and the header mode system allows for different numbers of boilers and turbines. This offers more options for power production load management.
(b) Equipping Induced Draft Fans (IDFs) and boiler Forced Draft Fans (FDFs) with inverters and improving	Around 1 year	Most power plants and on-site boilers are not equipped with these fans yet, so one successful case could open up multiple seeds in future. All inverters use Russian

synchronicity by linking with the system in (a)		technology, so it would be easy to scale up
(c) Dismantling and replacing existing units with integrated Circulating Fluidized Bed Boilers (CFBs), or adding new such units	Approx. 5 years	Circulating Fluidized Bed Boilers are best for burning Mongolia's low-grade 3000kcal/kg coal efficiently. And with Japanese technology, NOx and SOx emissions can be minimized.
(d) Adoption of oil-immersed transformers that do not use toxic insulation oil	Approx. 2 years	Co-benefits are expected because some oil-immersed transformers in Mongolia still use PCBs.
(e) Improve the performance of turbine rotors and turbine cylinders, or replace them	Approx. 3 years	The turbine rotors in some power plants are often very old, and upgrading them would clearly be very effective.
(f) Equipping water pumps (for cold water, hot water, deep wells, ash slurry, cooling tower, make-up water, etc.) with inverters and improving synchronicity by linking with the system in (a)	Around 1 year	There is potential for energy efficiency gains here because in Mongolia, water is pumped from deep wells that can be dozens of kilometers distant and this takes up a lot of power, unlike Japan. The same can be said about ash, which is made into a slurry and pumped to ash dumps that can be many kilometres away.
(g) Upgrade existing pulverized coal boilers to Circulating Fluidized Bed Boilers	Approx. 5 years	For burning Mongolia's low-grade 3000kcal/kg coal efficiently, CFBs are best. With Japanese technology, NOx and SOx emissions can be minimized as has been the case in other developing countries that use low-grade coal.
(h) Adoption of hot water air heaters to stabilize the boiler inlet temperature	Approx. 2 years	During winter, the temperature of the boiler room drops, the source of air for the boiler. By adopting a hot water air heater to control this temperature, boiler inlet temperature is stabilized, resulting in increased efficiency.
(i) Conversion of wet slurry ash disposal to dry disposal	Approx. 3 years	In Mongolia, ash slurry is pumped to disposal sites that can be kilometers away. Energy would be saved by using a dry ash process.

(j) Replacing condensers to improve vacuum	Approx. 2 years	There is often variability in the degree of vacuum of cooling towers in Mongolia during summer due to the big temperature difference between summer and winter. Upgrading the condensers would improve efficiency.
(k) Cleaning of gas air heaters	Around 1 year	There may be efficiency gains from adoption of jet cleaning equipment due to the difficulty of cleaning gas air heaters in Mongolia. There would also be savings from reducing the amount of water used in cleaning, as it is often pumped from deep wells dozens of kilometres away, using a lot of electricity.
(l) Adopting battery storage for effective use of excess power generation	Approx. 2 years	By ensuring excess power generated can be put to effective use, stable power plant operation can be achieved.
(m) Reducing electricity volumes in power plant complex through rooftop solar installation	Around 1 year	Install solar panels on roofs of power stations in order to reduce volume of electricity in power plant complex.
(n) Adopting heat pumps that harness cooling towers	Approx. 2 years	Achieve improved efficiency in power plants with heat pumps to make effective use of cooling towers.

2. Improvements to coal-fired HOBs

Task	Period	Details
(o) Adopting Japanese technology and equipment in HOBs in order to help reduce air pollution	Approx. 2 years	Supplying Japanese technology and equipment to local firms, build HOBs with reduced GHG and pollution emissions that are also cost effective.

3. Factory energy efficiency

Task	Period	Details
(p) Increasing efficiency of motors and generators at flour mills	Approx. 2 years	Replacement of motors used in flour milling and adoption of highly efficient power generators in mills

(q) Adopting highly efficient dryers needed for milling of wheat during summer rains	Approx. 2 years	Recently, summers in Mongolia have been getting wetter. In the past it was possible to mill flour without managing humidity, but cases where a drying process is needed are increasing.
(r) Equipping processing and water treatment plants with inverters at mines	Around 1 year	Install inverters in crushers, mills, pumps and separation and refining processing.
(s) Adopting highly efficient motors in water treatment plants and mine processing	Approx. 2 years	Install highly efficient motors in large mills, pumps and kilns.
(t) Equipping effluent treatment plants with highly efficient blowers	Approx. 2 years	Replace old Russian blowers with cutting-edge Japanese blowers.
(u) Raising efficiency of coking coal processing facilities and upgrading exhaust systems	Approx. 3 years	Upgrade exhaust systems at coking coal processing facilities and adopt energy efficient equipment.
(v) Adopting highly efficient plant for producing DME from coal	Approx. 4 years	Opening an energy efficient plant for producing dimethyl ether (DME) and other chemical substances from coal
(w) Replacing the existing transformers and cables used in the grid network with highly efficient transformers and highly reliable insulated cables	Approx. 5 years	Replace existing silicon cores used in electric network transformers with amorphous materials and cables with highly reliable insulated cables.

(2) GHG emissions reductions

For the seeds on the selected technology list, as detailed below, we based our thinking on the National Adaptation Programme of Action (ADB contribution) as the financing scheme. If we were to leverage this fund, it would be on the condition that the technology is in the Asian Development Bank pipeline, but for the following GHG emissions reductions, the technology is confirmed as being in the pipeline already. Moreover, given that this is a JCM, only GHGs derived from energy sources are calculated.

1. Efficiency improvements in coal-fired CHP plants

GHG emissions reduction: 152,200 t-CO2/year

Conditions: Approximate GHG reduction using the National Adaptation Programme of Action (ADB contribution) capital to implement the above tasks 1(a), (b), (c) and (f) at CHP3

2. Improvements to coal-fired HOBs

GHG emissions reduction: 26,000 t-CO2/year

Condition: Approximate GHG reduction if the above task 2(o) is implemented and some 200 HOBs operating in UB are replaced, with an average boiler efficiency improvement of 10%.

3. Improved grid infrastructure

GHG emissions reduction: 84,000 t-CO2/year

Condition: Approximate GHG reduction if as in 3(w), the existing transformers and cables used in the UB grid network are replaced with highly efficient transformers and highly reliable insulated cables.

(3) Co-benefits beyond GHG reductions

1. Co-benefits of the tasks noted in the technology list are as follows.

(a) Optimization of power plant output and loads, adoption of distributed control systems
○ Stabilization of supply voltage through matching of supply and demand balance ○ Reduced NOx, SOx and soot due to improved generation efficiency ○ Reduced outages due to improved precision of output control ○ Improved operator handling (reduction of operating burden)

(b) Equipping Induced Draft Fans (IDFs) and boiler Forced Draft Fans (FDFs) with inverters and improving synchronicity by linking with the system in (a)
○ Less noise ○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex

(c) Dismantling and replacing existing units with integrated Circulating Fluidized Bed Boilers (CFBs), or adding new such units
○ Reduced NOx, SOx and soot due to adoption of CFBs

(d) Adoption of oil-immersed transformers that do not use toxic insulation oil
○ End use of toxic insulation oil ○ Reduced NOx, SOx and soot due to improved efficiency

(e) Improving the performance of turbine rotors and turbine cylinders, or replacing them
○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex

(f) Equipping water pumps (for cold water, hot water, deep wells, ash slurry, cooling tower, make-up water, etc.) with inverters and improving synchronicity by linking with the system in (a)
○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex

(g) Upgrading existing pulverized coal boilers to Circulating Fluidized Bed Boilers
○ Heavily reduced NOx, SOx and soot due to improved generation efficiency ○ Fewer outages due to simplification of ancillary equipment (no milling)

(h) Adoption of hot water air heaters to stabilize the boiler inlet temperature
○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex

(i) Conversion of wet slurry ash disposal to dry disposal
○ Effective use of coal ash ○ Reduced air pollution, soil pollution and water pollution ○ Reduced water consumption

(j) Replacing condensers to improve vacuum
○ Reduced NOx, SOx and soot due to improved generation efficiency ○ Much improved generation efficiency and operation in summer due to increase vacuum

(k) Cleaning of gas air heaters
○ Reduced NOx, SOx and soot due to improved generation efficiency

(l) Adoption of battery storage for effective use of excess power generation

○ Stabilization of power generation levels in CES
○ Effective utilization of excess power generation

(m) Reduction of electricity volumes in power plant complex through rooftop solar installation

○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex

(n) Adoption of heat pumps that harness cooling towers

○ Reduced NOx, SOx and soot due to effective utilization of heat in power plant complex

(o) Adoption of Japanese technology and equipment in HOBs in order to help reduce air pollution

○ Reduced NOx, SOx and soot due to improved efficiency and better performance of electrostatic dust collectors, etc.

(p) Increased efficiency of motors and generators at flour mills

○ Reduced NOx, SOx and soot due to lower power volumes

(q) Adoption of highly efficient dryers needed for milling of wheat during summer rains

○ Reduced NOx, SOx and soot due to lower power volumes in power plant complex
○ Improved productivity for wheat growers

(r) Equipping processing and water treatment plants with inverters at mines

○ Reduced NOx, SOx and soot due to lower power volumes

(s) Adoption of highly efficient motors in water treatment plants and mine processing

○ Reduced NOx, SOx and soot due to lower power volumes

(t) Equipping effluent treatment plants with highly efficient blowers

○ Reduced NOx, SOx and soot due to lower power volumes
○ Improved wastewater treatment processes

(u) Raising efficiency of coking coal processing facilities and upgrading exhaust systems
○ Reduced NOx, SOx and soot due to improved coal quality

(v) Adoption of highly efficient plant for producing DME from coal
○ If DME is used to potential once produced and sold, it does not produce SOx or soot when burned, and can greatly reduce NOx emissions compared to other fossil fuels

(w) Replacing the existing transformers and cables used in the grid network with highly efficient transformers and highly reliable insulated cables
○ Reduced NOx, SOx and other emissions due to improved efficiency ○ Increased supply capacity available to power plants (to the extent that electricity leakage is reduced) ○ Increased equilibrium stability of energy system

(4) Overall project costs

As a result of investigating the overall costs associated with (2) above, we have found that implementing the projects will require the financial resources below. However, given the high cost of accessing the National Adaptation Programme of Action capital, in order to integrate the cutting-edge technology into the project for the first time for an ADB project, additional costs would be contained by capital contributions from the ADB trust fund. Meanwhile, the formula for calculating the additional costs associated with integrating cutting-edge technologies is not yet known as of February 2013. Once the formula is known and the JCM part of the project cost becomes clear, the breakdown of costs for each efficiency improvement task including local surveys needs to be calculated based on the details once they are confirmed. As such, if it is not possible to calculate the JCM portion of the project regarding cost-benefits either, no request can be made and therefore, this will be studied after February 2013 once the formula is known.

1. Efficiency improvements in coal-fired CHP plants

Cost: 10 billion yen

Condition: Approximate project cost using the National Adaptation Programme of Action (ADB contribution) capital to implement the above tasks 1(a), (b), (c) and (f) at CHP3

2. Improvements to coal-fired HOBs

Cost: 2 billion yen

Condition: Approximate project cost if the above task 2(o) is implemented at some 200 HOBs operating in UB

3. Improved grid infrastructure

Cost: 6 billion yen

Condition: Approximate project cost if as in 3(w), the existing transformers and cables used in the UB grid network are replaced with highly efficient transformers and highly reliable insulated cables.

(5) Achieved/unachieved tasks and reasons

Tasks achieved under the plan are as follows. All tasks have been achieved.

1. Discovery of JCM project seeds, support for the development of highly feasible and specific emissions-reducing initiatives

As stated in 4.(1), specific emissions-reducing projects were discovered as highly feasible seeds.

2. Selection of highly feasible low carbon technologies made in Japan and listing of seeds

As stated in 4.(2) and 4.(3), the merits and demerits of each seed were studied and compiled into a list.

3. Deliberations on the support for designing the schemes needed at central government and city level for the projects to go ahead

As part of deliberations on the support for designing the schemes needed at central government and city level for the projects to go ahead, a joint seminar was held with all stakeholders in September including the Mongolian Ministry of Environment and Green Development, Ulaanbaatar City and donors supporting Mongolia. The potential for future collaboration was explored, and the situation and role of each organization was clarified. A funding scheme for small-scale projects run by local banks and organizations mobilizing capital from the Clean Air Foundation, the environmental fund controlled by the Mongolian government, JCM and the Asian Development Bank was considered as a way of assisting the design of a supportive policy framework at the national and city level.

4. Consideration of financial schemes

This is abridged as there is a specific explanation of financing schemes and plans below.

5 Considerations for project implementation

(1) Scenarios for implementation/JCM

This project is targeting the energy supply sector and initiatives in power generation for example, which will require billions of yen in capital at a minimum. Therefore, as a financing scheme we based our deliberations on accessing the National Adaptation Programme of Action (ADB contribution) fund.

If we were to leverage this fund, the first condition would be that we are entering the ADB pipeline and in relation to seeds identified, the technology would be confirmed as being in the pipeline already.

As noted above, given the high cost of accessing the National Adaptation Programme of Action capital, in order to integrate the cutting-edge technology into the project for the first time for an ADB project, additional costs would be contained by capital contributions from the ADB trust fund. Meanwhile, the formula for calculating the additional costs associated with integrating cutting-edge technologies is not yet known as of February 2013. Once the formula is known and the JCM part of the project cost becomes clear, the breakdown of costs for each efficiency improvement task including local surveys needs to be calculated based on the details once they are confirmed.

Therefore, the schedule will be for the projects to begin in 2015, based on details of the scheme being clarified in 2014, allowing the detailed pre-project surveys to be conducted.

Moreover, for small-scale projects such as the HOB initiative which would require management at a number of sites, managing the project from the Japanese side would present many obstacles. Therefore, a scheme to support small-scale projects and programs run by local banks and organizations mobilizing capital from the Clean Air Foundation (the environmental fund controlled by the Mongolian government), JCM and the Asian Development Bank was considered.

(2) MRV methodology, monitoring framework

While building an MRV methodology and monitoring framework is outside the scope of this project study, implementation will progress as follows on efficiency improvements to CHP plants.

1. Through optimization of the operation of boilers, turbines and other equipment, automation, and improved synchronicity by installation of inverters, it is assumed that ultimately, consumption of coal per ton of steam generated will be reduced.

2. Reference scenario: Three year average consumption of coal per ton of steam generated prior to upgrade (calculated for each boiler)

Due to the large variance between seasons, the year will be split into two seasons and averages recorded as reference data for each.

○Summer (off-peak): April to September

○Winter (peak): October to March

Reference: Operating mode at UB CHP4 plant

Summer: 4-5 boilers in operation, 1:00AM-6:00AM all boilers run at 60% load

Winter: 6-7 boilers in operation, 1:00AM-6:00AM 5-6 boilers run at 60% / 1-2 boilers run at 70%

3. Monitoring parameters

Monitoring will be conducted at power stations with daily measurement of the following:

○ Volume of steam generated by each boiler (tons)

○ Volume of coal consumed by each boiler (tons)

4. Calculation of emissions cuts

Using data obtained from the reference scenario (tons coal/tons steam), volume of coal consumed will be calculated from the volume of steam generated over the monitoring period. By comparing this data with the running total of coal consumed, the reduction in coal consumption and thereby the size of the emissions reduction will be calculated. Calculation of the size of the emissions reductions will be made using the analysis value of coal at the power plant and the default value (IPCC).

(3) Project implementation framework

The framework for implementing these projects is assumed to be the National Adaptation Programme of Action (ADB fund), which can be classified into two main categories. One category is projects in the power generation field, where the initiatives require billions of yen at a minimum. The other category is small-scale individual projects such as that concerning HOBs. For these projects, we have devised a small and medium-sized project and program seed implementation framework where local Mongolian organizations would be managing multiple sites.

1. Project implementation framework for projects costing in excess of 1 billion yen

With regard to improving the efficiency of CHP plants, we have come up with the following framework.

(a) Japanese implementers

○Manufacturers

Role: Production of equipment for adoption after consultation with Mongolian partners and local support consultants mentioned below, and determination of specifications.

○Local support consultants

Role: As local engineers are not familiar with Japanese technologies, these consultants will provide appropriate support to decisions on specifications and installation methods, fulfilling the role of communication between suppliers and Mongolian partners. Specifically, these would be power companies, power company subsidiaries, and power wholesaling companies.

○ Prime contractors, logistics operators

Role: Japanese manufacturers have little experience of contractual procedures in Mongolia. Neither do they possess much logistics know-how. Specifically, these are likely to be prime contractors and trading companies in charge of logistics.

○ Specialists in GHG calculations, MRV

Role: In order to fulfill the requirements of JCM, specialists will likely be needed to build the MRV methodology for GHGs and develop the local implementation framework. Experts involved in developing the framework this year have been identified.

○Method of calculating the added cost of adopting cutting-edge technologies, etc.

Role: As noted above, as of February 2013, the method of calculating the added cost of adopting cutting-edge technologies is an unknown factor for this fund. Once this becomes clear next year, it is likely that experts in the technologies already identified will be brought in to prepare for project implementation.

(b) Mongolian implementers

○ Local project implementers

Chiefly the Ministry of Energy and public power utilities. The Ministry of Energy has overall control of the project, while the public project implementing unit (PIU) is in charge of specific project implementation.

○ Local works supervisor

Assisting the PIU and the Japanese support consultants would be a works supervisor. Specifically, an expert has been identified for this role with experience on projects for World Bank, JICA and others.

○Local works contractor

Would carry out work under PIU and the Japanese support consultant. A local contractor with a track record in Mongolia has already been identified.

○ Parties carrying out GHG calculations and MRV

This will be the responsibility of the CES control center, which compiles and oversees the PIU and the daily reporting of power stations and reports to the Ministry of Energy and the Energy Regulation Committee. Specialists in JCM MRV would be sent in as required. The Climate Change Adaptation Department of the Ministry of Environment and Green Development, as secretariat, would be in charge of JCM procedures.

2. Project implementation framework for small and medium-scale project and program seeds

It is assumed that small-scale projects such as those deals with HOBs would be run locally in Mongolia, as supervision of multiple sites is required.

(a) Japanese implementers

○Manufacturers

Role: It is assumed that the Japanese suppliers already identified would provide equipment and technology to Mongolian contractors in order to manufacture locally, although the Japanese suppliers would need to be prompt in their dealings with Mongolia and demonstrate good cost performance. Mongolian contractors would be in charge not just of manufacturing, but of operation and maintenance support.

○Financing scheme support

Role: This fund, as noted below under "Financing plans," would leverage capital from the Clean Air Foundation, JCM and ADB, and local banks would operate the loan and grant schemes for the project and procurement of equipment. These schemes would be supported by Japanese specialists.

○ Specialists in GHG calculations, MRV
Role: In the case of support taking the form of programmatic funding, a locally-led MRV implementation framework will be needed. Japanese specialists would support organizations that have already been engaged in developing the framework.

○ Method of calculating the added cost of adopting cutting-edge technologies
Role: As noted above this fund does not, as of February 2013, have a formula for calculating the added cost of cutting-edge technologies. Once this becomes clear next year, it is likely that experts in the technologies already identified will be brought in to prepare for project implementation.

(b) Mongolian implementers
○ Local manufacturers
Local firms already identified would be responsible for manufacturing, based on a supply of equipment and technology from Japanese suppliers. They would also be in charge of maintenance and operational management. They would work in conjunction with boiler management firms and others, depending on the location of the project and the specifications of the equipment used.

○ Financing scheme operation
Role: As noted specifically in "5. (4) Financing plans," capital would come from the Clean Air Foundation environmental fund controlled by the Mongolian government, JCM and ADB, and local banks would manage it. Three local banks have already been identified with experience in two-step loans from donors and management of the national environmental fund, for example. They would manage schemes appropriate to the project, its location and the equipment required among other factors.

○ Parties carrying out GHG calculations and MRV
Role: It is envisaged that organizations that have carried out JCM feasibility studies before and that have deep understanding of MRV would carry out GHG calculations and MRV for each project.

(4) Financing plans

As in 5. (3), financing plans fall into two principal categories: (a) those for projects costing in excess of 1 billion yen and (b) those for small to medium-size projects and programs.

1. Potential for harnessing Mongolian financial support schemes

(a) Projects costing in excess of 1 billion yen

Mongolia has recently started to issue Genghis Bonds. The capital raised has already been used for power generation and grid upgrades in the energy sector and is being utilized aggressively by the Ministry of Economic Development and the Ministry of Energy. It may be possible to implement efficiency improvement projects with a combination of bond issuance funding and JCM capital, once an arrangement has been agreed.

(b) Small to medium-size projects and programs

Meeting with the Minister for Environment and Green Development in December 2013, the major principal of the Clean Air Foundation environmental fund run by the Mongolian government, we agreed to develop a small and medium-size project and program financing scheme that would include JCM and ADB funding. This was at the direct request of the Minister in order to boost the collaboration between this fund and the JCM fund. Schemes devised this year together with the Ministry of Environment and Green Development, the Ministry of Energy, ADB and private banks are collated in reference documents as "Financing scheme materials."

2. Potential for harnessing Ministry of Environment (Japan) schemes (JICA, ADB, 50% Subsidy)

The National Adaptation Programme of Action (ADB fund) is envisaged as the source of capital for both (a) Projects costing in excess of 1 billion yen and (b) Small to medium-size projects and programs. If we were to leverage this fund, the first condition would be that we are entering the ADB pipeline and in relation to the identified initiatives, the technology has already been confirmed as being in the pipeline. In February 2014 the Mongolian government and ADB met and agreed to provide financial support to the energy sector.

(5) Ideas to promote adoption of Japanese technology

1. Establishing a procurement structure for the adoption of Japanese technology in Mongolia

As the National Adaptation Programme of Action (ADB fund) is envisaged as the source of capital for these projects, an international tender process would be required. In terms of the technologies identified for these projects, the equipment specifications, capacity, maintenance and assessment methods are already included in the tender specifications, and as such our studies have confirmed that procurement would progress with ease.

2. Addressing the regulatory environment in Mongolia

As the method outlined in 5.(5)(1) above is wholly adequate for this initiative, there is probably no need to address the regulatory environment immediately. On the other hand, Germany has already given advice to Mongolia on energy efficiency legislation. It would be useful for Mongolia to adopt Japan's superb top runner program.

3. Harnessing co-benefits beyond GHG reductions in project implementation

As the method outlined in 5.(5)(1) above is wholly adequate for this initiative, there is probably no need to address the regulatory environment immediately. On the other hand, there would be great value in Mongolia adopting new laws. For example, Japan has some of the world's most stringent environmental and emissions standards and if these were applied in Mongolia, it would cut not only GHG emissions but contribute to reducing NOx, SOx and soot as well. We hope to contribute to the establishment of procurement method based on co-benefits once we have observed the procurement and financing situation in Mongolia over time.

(6) Challenges, hopes and solutions toward implementation

Given the high cost of accessing National Adaptation Programme of Action capital, in order to integrate cutting-edge technology into the project for the first time for an ADB project, additional costs would be contained by capital contributions from the ADB trust fund. Meanwhile, the formula for calculating the additional costs associated with integrating cutting-edge technologies is not yet known as of February 2013. Once the formula is known and the JCM part of the project cost becomes clear, the breakdown of costs for each efficiency improvement task including local surveys needs to be calculated based on the details once they are confirmed.

We would also like to utilize a two-step loan scheme managed locally in Mongolia as studied in this report, but the necessary procedures for this remain unclear. Therefore, once the form of the support scheme is made public next year, we hope to look in detail at the shape of such a scheme on this basis, adapt it and put it into practice.

(7) The way forward and specific schedule

The full study could not be completed due to the fact that the details of this year's National Adaptation Programme of Action have not been finalized. The framework will be activated in FY2014 and we will then carry out a detailed study. The next election in Mongolia is in 2016 and therefore the government and other partners need to get results by the end of 2015, so we are receiving their cooperation. Therefore, we have mutual agreement on implementing the initiatives in FY2015. However, even if the JCM procedures are completed, the Mongolian government and ADB still need to finish their loan negotiations and other processes. As such, we will compile all our studies next year as we work to fit into their schedules.

We have also confirmed that the technologies identified in this study such as optimization of output and load in power plants and distributed control systems are needed by power generators all around Mongolia, not just in UB. Therefore we will extend the project to other cities next year. Moreover, these technologies can also be applied to power plants in other countries, so there is the possibility of a big scale-up to other countries in Asia. We hope to have a proposal for expansion to Viet Nam and Indonesia ready next year.