Development of Green Energy Systems and Energy Efficiency in Mongolia

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Case Studies based on GGGI's Activities

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FOREWORD

The energy sector is not only a pillar of the country's development, but also plays an essential role in creating opportunities for the people to learn, develop and thrive.

In 2015, the State Great Khural (Parliament) of Mongolia approved the State Policy on Energy for 2015-2030. The Policy aims to improve the legal environment, management and organizational structure of the energy sector; manage energy resources including mining of primary energy resources, maintenance of fuel reserves, generation of electricity and heat and supply operations; and to develop public-private partnerships in the energy sector to accelerate the transition to a competitive market system and strengthen human resources.

The Global Green Growth Institute (GGGI) has been providing technical and financial support to Mongolia's energy sector, particularly in the areas of energy efficiency and conservation, renewable energy development and capacity building of the government. In 2014, the Government of Mongolia and GGGI collaborated with the Stockholm Environment Institute (SEI) to develop a "Green Energy System Development Strategy for Mongolia" to assess Mongolia's energy production resources, capacity and greenhouse gas emissions by 2035 using the LEAP (Low Emissions Analysis Platform) tools.

The Energy Regulatory Commission (ERC) and the GGGI have been working closely together since signing a Memorandum of Understanding in 2017. As the main implementing agency of the Energy Conservation Law, the Energy Regulatory Commission in cooperation with the GGGI have carried out a number of important initiatives including: standards and labeling for energy efficiency in industry, construction and energy sectors; construction of energy-efficient buildings and facilities, and creating of energy efficiency incentive mechanisms to promote more energy-efficient behaviors and enhance energy savings.

Due to the unique climatic conditions of our country, the reliability of heat supply to consumers is very important during the long winter. Considering the lack of significant investment in heat supply in recent years, it is time to address the issue of heat supply in local cities and town comprehensively.

The GGGI has also been actively working to identify solutions to the heating challenges in Mongolia. The GGGI conducted an assessment to update the heat supply equipment and technologies in Arkhangai, Bulgan and Khovd aimag centers. Identifying economically feasible, low-carbon solutions such as ground-source heat pumps, solar collectors and electric boilers and estimated the required investment amount.

In 2019, the GGGI also carried out a pre-feasibility study on replacing the coal stove at School No. 122 in Songinokhairkhan District, Ulaanbaatar with a ground-source heat pump in collaboration with the Mongolian University of Science and Technology. This was successfully piloted with the Ministry of Environment. As a result, the school's GHG emissions were reduced by 133 tons of CO2eq, ash generation was reduced by 42 tons and the heating cost decreased by MNT 7 million compared to the previous period.

Currently, we are also working together with the GGGI to insulate a large number of prefabricated apartment buildings in Ulaanbaatar (1077 blocks) to reduce heat loss. The aim is to attract grant financing from the NAMA Facility and other sources to make a significant contribution to energy conservation.

We are confident that our cooperation will continue to transform Mongolia's energy sector into a green energy sector that produces efficient, economical and clean energy.

Dr.A.Tleikhan Chairman and Chief Commissioner of Energy
Regulatory Commission of Mongolia

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Acronyms

ADB	Asian Development Bank
BAU	Business As Usual
CES	Central Energy System
CHP	Combined Heat and Power
CNIS	Chinese National Institute of Standardization
CSO	Civil Society Organizations
DE	Designated Entities
DFI	Development Finance Institution
EMCA	Energy Management Companies Association of China
ERC	Energy Regulatory Commission
FiT	Feed-in Tariff
Gcal	Giga calories
GDP	Gross Domestic Product
GGGI	Global Green Growth Insitute
GHG	Greenhouse Gas
GoM	Government of Mongolia
GTC-K	Green Technology Centre of Korea
GWh	Gigawatt Hours
HOB	Heat only boilers
ICLEI	ICLEI- Local Governments for Sustainability
LEAP	Low Emissions Alternative Platform
MCUD	Ministry of Construction and Urban Development
MEPS	Minimum Energy Performance Standard
MET	Ministry of Environment and Tourism
MGFC	Mongolian Green Finance Corporation
MOE	Ministry of Energy
MRIA	Mongolian Renewables Industries Association
NAMA	Nationally Appropriate Mitigation Actions
NGDP	National Green Development Policy
NECC	National Energy Conservation Centre of China
NDC	Nationally Determined Contribution
PM	Particulate Matter
PPA	Power Purchase Agreement
SEI	Stockholm Environment Institute
SMEs	Small and Medium-sized Enterprises
SDG	Sustainable Development Goal
UNDP	United Nations Development Programme
WHO	World Health Organization

Executive Summary

Mongolia has been perceived to the outside world as a land of horse riders and of pristine nature. Its vast landscape and nomadic lifestyle practiced by herder people throughout centuries is a common image to picture Mongolia. However, the impact of globalization, urbanization and climate change is changing Mongolia's environment and socio-economic life significantly. There has been dramatic increase of rural migration in the cities mainly due to the socio-economic reasons. Many herders lost their animals during natural disasters and cannot find alternative income sources in rural areas. Traditional livestock-based economy has been gradually taken over by mining industry, given the country's rich mineral resources.

Mongolia has sufficient reserves of coal that 40 percent of which is exported as raw. Energy system of Mongolia is mainly based on coal. The country's heating and power infrastructure was constructed over 60 years ago and there is a huge room for efficiency improvement. Growing heating demand in residential and commercial areas are met with energy generated at the Central Heating Plants (CHPs), Heat only boilers (HOBs) and raw coal burning in sub-urban areas. As of 2018, the heating demand of central Ulaanbaatar city was 3540.3 GCal, and 2020.4 GCal (57%) out which is supplied from CHPs and Amgalan thermal power plant. In addition to that, over 210 thousand households in off-grid areas rely on fossil fuel, refined coal briquets for space heating. This contributes to heavy air pollution in urban centers, especially in capital Ulaanbaatar, where PM levels exceeds 7-35 times of the WHO level.[1]

Due to growing population and mining-centered economic growth, total installed capacity of Mongolian energy system has more than doubled from 538MW in 2001 to 1239.8MW in 2018. An average annual increase of the energy consumption over past 10 years is 5 percent. Currently, Mongolia imports 20 percent of its energy consumption, which require further need in investment and development of new renewable energy resources and improve energy efficiency[2].

Heat and power supply over the long and cold winter period is essential for every Mongolian and its socio-economic prosperity. The average annual temperature is 0.2°C and average winter temperature ranges between -10°C and -30°C. The country uses more than 90 percent of generated energy for heating purposes only, and approximately 57 percent of the total heat generated is used for space heating and water heating in residential buildings only.

The Government of Mongolia (GoM) has made a strong political commitment towards green development and adoption of renewable energy. In 2012, the GoM announced that green development as the new economic development strategy and adopted the National Green Development Policy (NGDP) and Sustainable Development Vision-2030, Vision 2050 in following years. Mongolia has the ambitious targets of increasing installed capacity of renewable electricity generation from current 18.1 percent to 20 percent by 2023, and to 30 percent by 2030 in its Nationally Determined Contribution (NDC) plan to utilize its abundant resources of renewable energy sources in hydropower, solar and wind.[3]

Since 2013, Global Green Growth Institute (GGGI) has been actively supporting Mongolia's energy sector, particularly in energy efficiency, technical analysis, and development of alternative energy resources. It built on GGGI support to adoption of the NGDP, its Action plan and 38 Outcome Indicators in 2015-2017. Mongolian Green Growth Outcome indicators in economic, social and environmental groups include specific indicators on energy intensity, share of renewable energy in installed capacity and reduction of building heat loss. To increase absorption of renewable energy, GGGI has also supported the GOM in improving power purchase agreements for battery storage systems.

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1 *Pollution levels in the central Ulaanbaatar and sub-urban districts greatly differ. World Bank study on effects on air pollution on human health indicated PM levels in Ulaanbaatar city centers are 7-15 times greater than the WHO standards, whereas in sub-urban district the PM levels are 17-35 times higher than the WHO standards.*

2 *National Energy Efficiency Action Programme (2018-2022)*

3 *Mongolia: Renewable Energy Readiness Assessment, IRENA, March 2016*

GGGI collaborated with the GoM and the Stockholm Environment Institute (SEI)-US in formulation of the Strategies for Development of Green Systems in Mongolia, which forecasted and analyzed four different scenarios forecasting Mongolia's energy supply and demand within the industry, transport, buildings, and agriculture sectors. These scenarios helped in developing policy and planning targets in energy and other sectors for the NGDP and its Action Plan.

GGGI's work in Mongolia also focuses on sustainable heat supply and reducing heat loss to reduce dependency on coal and improve air quality. The heating energy assessment was conducted to i) support implementation of the long-term strategy of Mongolia for greener energy sources with a focus on comprehensive heat planning alternatives; ii) data collection and update to measure NGDP targets on green energy and energy efficient buildings; and iii) build institutional capacity for effective energy management and planning and assessing the environmental, social and economic impacts of heating systems.

In 2016, GGGI with the Ministry of Environment and Tourism (MET) and the Ministry of Energy (MoE), analyzed the heating systems in Arkhangai, Bulgan and Khovd aimag centers to identify long-term solutions for transforming heating systems and reducing air and environment pollution in rural settlements. The assessment results were integrated in the Green Development Plans of Arkhangai, Bulgan and Khovd aimags, in which necessary political and financial commitments were undertaken. In addition to support the GoM's immediate agenda to reduce urban air pollution sourced from raw coal combustion for heating purposes, GGGI developed a business case study to identify Low-Carbon Small Scale Heating solutions for off-grid buildings in peri-urban areas.

Energy Efficiency is another important pathway to the development of low carbon heating system. GGGI assisted the GoM and Energy Regulatory Commission (ERC) in design and implementation of the National Energy Efficiency Action Programme (NEEAP) 2018-2022, with objectives to improve energy efficiency coordination and management, introduce innovations in energy efficient technologies, and support energy auditing mechanisms.

Moreover, GGGI, with the partnership of GoM and the Mongolian Sustainable Finance Association pioneered the establishment of Mongolia Green Finance Corporation (MGFC) as a National Green Financing Vehicle in September 2017. The MGFC aims to encourage local green financing, built institutional capacity and mobilize the private sector investments..

Sectors in Focus	Green Growth, Sustainable Energy
Key Challenges	High-energy intensity, outdated technology, low efficiency in energy production and transition, high-energy loss in buildings, limited knowledge and capacity in energy efficient policy and technology, limited financial resources for green infrastructure development
Impacts	**Environmental:** 717,347 tCO2eq reduction is estimated to be achieved from energy audits conducted at 15 Designated Entities, energy saving measures in multi-family residential buildings, low carbon space heating of public school, and the green kindergarten **Social:** Improved air quality and health benefits to over 2500 kindergarten and school children in Songinorkhairkhan district of Ulaanbaatar city; improved air quality in Tsetserleg, Khovd and Bulgan cities, increased thermal comfort in 375 pre-cast residential building blocks in Ulaanbaatar city **Economic:** By 2023, reduction of fuel use per electricity production from 312.5g/kWh to 305.5g/kWh, reduction of fuel use per heat production from 175.9kg/Gcal to 170kg/Gcal (NEEAP), reduced housing heat loss by 40 percent
Keywords	sustainable energy, energy efficiency, minimum energy performance standard, green financing
Geographic Coverage	Mongolia

Country context

In Mongolia, heat and power are generated from coal-fired Combined Heat and Power Plants (CHPs) that were built over 60 years ago. The energy sector witnesses number of challenges –to meet its continuously growing energy demand and to increase efficiency on both demand and supply side, including its high energy loss in transmission and distribution network, and industrial and building sectors. Over the past 10 years, energy demand in the country increased twofold with about 5 percent at average per year.

The energy system of Mongolia is divided into 4 systems that are not interconnected. It includes Central, Eastern, Western and Altai-Uliastai Integrated Systems. Total installed capacity of Mongolian power energy sector is 1130 MW. Power is supplied from the energy systems through 41,726 km long power transmission network. There are 330 soums in Mongolia and 319 out of these soums are connected to the power supply. One soum has access to power generating renewable energy source and other 10 soums are connected to power systems in Russa and China.

Approximately 77 percent of total consumed power energy is generated at the CHPs, and less than 1 percent is generated from diesel-fueled stations and hydro power plants. Approximately, 5.2 percent is generated from wind parks. Share of energy generation from solar and hydro power plants in the total energy generation was 2.2 percent by end of 2019. In order to meet growing demand and manage peak load in power sector, the country imports over 20 percent of its total energy needs from two neighboring countries –China and Russia. Power imported from China is mainly used for mining operations.

In cold weather with an annual average temperature of 0.2OC, being warm is everything for Mongolians to survive winter and maintain socio-economical life. There is a local saying that warmth equals to 1000 golden bars. Majority of urban commercial and residential buildings are heated from district heating system that are connected to the CHPs. Still, some of rural and peri-urban areas of larger cities rely on coal-fired HOBs for space heating and hot water. Yet, very few villages have diesel-fueled power. This badly results in air and environment pollution.

Solar and wind power are widely available across the country, and Mongolia enjoys more than 250 days of sunshine. The country has significant potential for development of different types of renewable energy, including solar, wind, and some hydroelectric resources. In 2013, the first utility-scale Salkhit Wind Park of 50 MW was operationalized.

Rapid growth in renewable energy sector was triggered by the feed-in tariff of the Renewable Energy Law that was approved in 2007. The Law applied feed-in-tariff for on-grid solar of $0.15/kWh-$0.18/kWh and wind of $0.08/kWh-$0.095/kWh. Within a short period of 6 years from 2013 to 2019, 7 individual power producers were connected to the Central Energy system (CES) - 3 wind farms of 152MW capacity and 4 Solar Power Plants with 45MW capacity. Total installed capacity of renewable energy reached 18.1 percent. This puts Mongolia on track to reach its intended target of NGDP of 20 percent by 2020, and 30 percent by 2030.

Recent Amendment to the Renewable Energy Law (2019) introduced competitive procurement mechanism with upper cap of tariff for power generation for wind and solar resources. According the Amendment, tariff for renewable energy plants that will be connected to the CES has been changed to up to $0.085/kWh for wind and $0.12/kWh for solar energy. It is still considerably high comparing to average production cost of coal-fired power plants and subsidized by end-users.[4]

Despite of the recent increase in clean energy installed capacity, coal-fired power plants will be still dominant in Mongolia. The country's abundance in raw coal and existing energy co-generation facilities and subsidized energy tariff maintain the energy production costs at lower level than its actual market costs.

[4] *Renewable Energy Law of Mongolia, 2007 (amended in 2015 and 2019): https://www.legalinfo.mn/law/details/465*

GGGI in Mongolia

Sustainable energy development has been one of the key priorities in GGGI's work based on belief that energy powers economic growth and social development. GGGI's activities focus on energy transition, energy system planning, and scaling-up investment in clean and energy efficient infrastructure in its member countries. GGGI acknowledges multi-benefits of energy efficiency that has significant impact in reducing GHG emissions and improving air quality, health and well-being of the communities.

In Mongolia, GGGI delivers policy advisory and technical assistance in supporting Mongolia's transition from brown to green and sustainable energy and improving energy efficiency. Within this framework, GGGI pursued series of approaches: i) policy and planning support to Mongolia's transition to green energy systems (including green financing mechanisms such as PPP and MGFC); ii) technical analysis on alternative energy systems for peri-urban areas of Ulaanbaatar and aimag centers with focus on energy demand side; iii) design and development of energy efficient projects for public education buildings; and iv) development guidelines, methodologies and pipeline projects for planning and designing energy efficiency measures.

Defining Long-term Strategies for Transition to Green Energy Systems

GGGI in partnership with the GoM and the SEI-US formulated "The Strategies for Development of Green Energy Systems in Mongolia" in 2014. It involved exploring Mongolia's energy potentials and GHG emissions through 2035 by employing a bottom-up techno-economic analysis of energy and GHG-reduction scenarios.

The study used The Long-range Energy Alternatives Planning system (LEAP), the software tool developed by SEI for energy policy analysis and climate change mitigation assessment. The study presented four broad scenarios of how energy supply and demand could evolve in Mongolia through 2035 by using the same economic and demographic growth forecasts to determine the needs for energy services - particularly steady growth of Mongolia's economy, in mining and industrial sectors, and related effects like increasing demand for freight and personal transportation.

The Strategies for Development of Green Energy Systems in Mongolia for period of 2016-2035 analyzed four different scenarios on Mongolia's energy supply and demand within the industry, transport, buildings, and agriculture sectors and forecasted projections to assist the country in long-term planning and policy development for energy and other sectors.

(1) The reference scenario forecasts a Mongolia that continues to rely on mineral extraction for its primary source of energy, both for export and domestic consumption. This scenario sees total energy demand more than doubling in Mongolia between 2010 and 2035, with demand for electricity and petroleum products growing especially fast. Coal-fired plants continue to be the primary source of energy to meet this demand, with renewable energy contributing less than 5 percent to the production of electricity. In the reference scenario, overall GHG emissions rise to approximately 56 million tons of CO2 by 2035 from a benchmark of just over 15 million tons in 2010.

(2) The recent plans scenario describes the potential impact to energy supply and demand in Mongolia as a result of the successful implementation of renewable energy and increased energy efficiency plans, such as the retrofitting of residential buildings to reduce energy demands by 6 percent, and the expansion of hydroelectricity, and wind power, to increase the contribution of renewable energy to total electricity production by 15 percent. The recent plans scenario would see total GHG emissions rise to about 46 million tons of CO2 by 2035.

(3) In the expanded green energy scenario, Mongolia makes a stronger transition to renewable energy and implements extensive energy efficiency measures across its economy. These initiatives help reduce energy demand by 32 percent when compared to the reference scenario, while the realization of multiple hydro, solar PV and wind power projects, increase the contribution of renewable energy to electricity production to more than 40 percent. Reductions in energy demands coupled with increases in renewable energy production

provides Mongolia with the option to phase out aging coal-fired power plants, and possibly avoid new plants altogether. As a result, GHG emissions would be half, or 28 million tons, of those forecast in the reference scenario.

(4) The shifts in energy export scenario realizes the same reduction in energy demand as the expanded green energy scenario and differs only in that Mongolia has divested itself from mineral-based energy exports, in favor of renewable energy exports. Rapidly investing in and developing its solar PV and wind resources, would allow Mongolia to install almost 12 GW of renewables by 2031, which could displace a large fraction – perhaps even all – of the value of expected coal exports noted in the reference scenario. The shift scenario would increase Mongolia's "low-carbon competitiveness" within a global market where demand for fossil fuels has declined due to increasing concerns over climate change.

Supporting Energy Efficiency Policy Framework

Mongolia identified Energy Efficiency as one of key measures to achieve sustainable development. Key policy documents, such as NDC, NGDP, State Policy on Energy (2015), and Mid-Term Energy Strategy (2019) has specific outcome indicators to improve energy efficiency by 2030. This includes:

- Reduction of building heat loss by 20 percent by 2020 and by 40 percent by 2030 compared to 2014 levels;
- Increasing renewable electricity capacity from 7.63 percent in 2014 to 20 percent by 2020 and 30 percent by 2030 as a share of total electricity generation capacity;
- Reductin electricity transmission losses from 13.7 percent in 2014 to 10.8 percent by 2020 and 7.8 percent by 2030;
- Reduce own-use energy of Combined Heat and Power Plants from 14.4 percent in 2014 to 11.2 percent by 2020.

The Energy Regulatory Commission (ERC) is the government regulatory agency with a mandate to implement the Energy Conservation Law at the national level. In March 2016, the Energy Efficiency and Conservation Division (EECD) was established to enable energy efficiency regulatory framework related to the implementation of the Energy Conservation Law. In addition to the Energy Efficiency responsibility, the ERC is responsible for licensing of enterprises in electricity and district heating markets, setting and supervising and tariffs for electricity and heat, and for formulating coal price methodology and developing tariff price index.

The ERC and GGGI signed Memorandum of Understanding (MoU) of Collaboration in March 2017. As part of the support, GGGI is providing policy advisory and technical assistance on implementation of the Energy Conservation Law and the country's first National Energy Efficiency Action Programme (NEEAP).

The NEEAP for the period of 2018-2023 was adopted in September 2017 - with support of GGGI. Objectives of NEEAP is to reduce GHG emissions, mitigate climate change through integrated management of conservation and efficient use of the energy resources, and to introduce and promote use of advanced energy efficient technique and technologies. It sets out specific measures to carry out at the national and sectoral level, mainly for industrial, transport, public, construction and energy sectors. The NEEAP promotes development of energy efficiency standards and norms, classification, monitoring, labeling, construction of energy efficient houses, creation of incentive mechanisms for energy saving users, facilitated mechanism for energy efficiency public procurement, establishment of energy efficiency online database, capacity building of energy efficiency auditors, planners, managers and technicians, creation of tax and customs tariff incentives, facilitated loan mechanisms and support for energy efficient technology uses, approval of the National Energy Balance Accounting methodology, national mechanism of GHG emission monitoring, reporting and verification (MRV), advocacy and dissemination of benefits of energy savings and introduction of educational programs in the school curriculum.

In terms of introducing energy efficiency in public infrastructures, the NEEAP mandates assessment of cost and benefits of public procurement against its operational costs and savings in public procurement, replacement of energy efficient lights on street lighting, promotion of innovation and new technologies in reducing heat and water consumption in energy production facilities, introduction of thermostats and heat regulators in apartment units in major cities, change of users' behavior through energy tariff measures, development of energy calculation and use methodologies for different type of buildings, introduction of green mortgage mechanism and naturalization of MNS ISO 50001:2014 energy management standard.

Achievement on the policy targets and commitment to mitigate GHG emissions related to the Energy Efficiency, however, largely depends on how existing challenges of the country such as lack of financial resources, subsidized heat and power tariff, limited capacity and awareness of stakeholders, including consumers and uncertainty risks in investing energy efficiency projects will be mitigated.

Effective Standards and Labeling (S&L) regulation and enforcement through the Energy Efficiency Incentive Mechanism will offer multiple benefits for Mongolian citizens and for the environment. Restricting the most energy inefficient and polluting appliances from entering the market saves energy, reduces GHG emissions & local pollutants, saves consumers money, and reduces the need to invest in additional energy generation assets.

In support to the implementation of the NEEAP, GGGI carried out technical assessment[5] in 2018. The study revealed that with introduction of Minimum Energy Performance Standards (MEPS) and mandatory energy labelling can save over 1,000 GWh of electricity annually by 2040 and reduce 1,3 million tCO2 of GHG emissions. The MEPS also activates demand for efficient products and creates a framework to structure eligibility for green financing. Pursuant to the Law on Energy Conservation (Article 12.1) and the NEEAP(Article 4.1) , the country is in process of development of the Energy Efficiency Incentive Mechanism to promote energy conservation practices.

Examining Alternative Heating Systems in Ulaanbaatar and Secondary Cities (Provincial Centers)

Green energy situational analysis in selected aimags

Sustainable solutions for low-carbon heating systems in provincial centers is critical for the country's socio-economic growth. GGGI supported the GoM in undertaking a Situation Analysis of heating systems in Arkhangai, Bulgan and Khovd aimag centers in 2016. The study identified and prioritized the interventions required for improvement of the heating systems to reduce air pollution.

The Situational Analysis examined planning and development for alternative heating systems through i) desktop review of heating systems and methodology for measuring policy targets; ii) situation analysis and capacity assessment of heating systems for selected three aimag centers; iii) guidebook development on heating systems planning tools; iv) capacity building on heating systems planning; v) investment analysis and prioritization for heating systems; and iv) multi-stakeholder communications and outreach.

The study investigated baseline performance and main technical aspects of the local context, including climate conditions and socio-economic characteristics. Alternatives recommended to transform current heating systems in three (3) cities is expected to reduce GHG emissions by 49.9tCO2eq by 2023 and 67.1tCO2eq by 2027 with total investment of US$45.5mln.

[5] *Market Scoping, Program Design, and Impact Assessment for a Mongolian Standards & Labeling (S&L) Program, IIEC, 2017*

Figure 1: Administrative Map of Mongolia by GGGI Consultant

Bulgan city in Bulgan aimag is located in 330 km from Ulaanbaatar city. The city is home for 12,400 people. Annual consumption of coal for district heating system is 10,200 tons, with GHG emission of 14,500 CO2eq. Current heating system includes 6 medium-sized HOBs and 130 low-pressure HOBs and privately-owned heating network system. Total existing heat load of Bulgan city was 13.6 MW in 2015. A district heating power plant of 28MW, constructed in 2014, has not been commissioned yet due to absence of thermal substation, and water circuit, in addition to uncertainties around the ownership and management.

Recommended low-carbon heating system for Bulgan city is 24MW heat plant and highly efficient (85 percent) CFB boilers, 2 geothermal heat pumps, 3 electric heating system, 2 gas-fired boilers heating system with capacity of 1MW each. It requires thermal retrofitting of 180 thousand cubic meter buildings, and installing 50 solar and water heating systems and 40 heat meters for largest energy consumers.

Green Heating Infographic

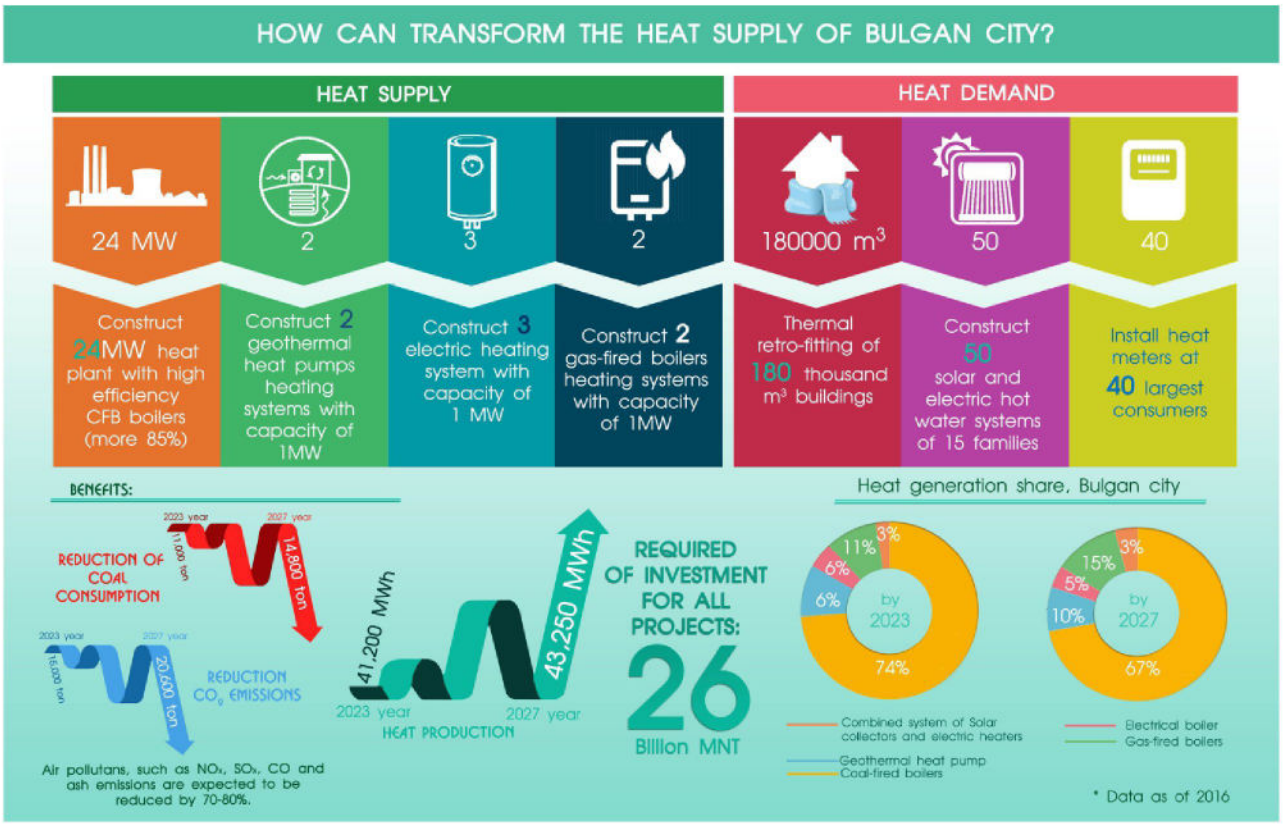

Figure 2: Bulgan city, 28 January 2016.
Photo by GGGI Consultant

These measures will achieve in GHG reduction of 15,000 CO2eq by 2023 and 20,600 CO2eq by 2027. Total estimated investment for transformation of the heating system in Bulgan city is MNT26 billion (US$ 13.1mln).

Figure 3: Tsetserleg city, 26 January 2016

Tsetserleg city in Arkhangai aimag is home for 21,000 people. The heating system is consisted of coal-fired 10 boilers, with very low efficiency of 55-60 percent, 40 low pressure HOBs, and privately owned heating network that provide space heating only. Hot water is supplied from household electric water boilers mainly. Total existing heat load of Tsetserleg city was 10.34 MW in 2015. Its annual coal consumption of the district heating system is 11,500 tons that emits GHG emissions of 16,000 CO2 eq.

Recommended low-carbon heating system for Tsetserleg city is 25MW heat plant and highly efficient (85 percent) CFB boilers, 3 geothermal heat pumps, 2 electric heating system, 5 gas-fired boilers heating system with capacity of 1MW each. In addition, it requires thermal retrofitting of 203 thousand cubic meter buildings, and installing 50 solar and water heating systems and 40 heat meters for largest energy consumers. These measures will result in reduction of GHG emissions of 16,900 CO2eq by 2023 and 26,500 CO2eq by 2027. Total estimated investment for transformation of heating system in Tsetserleg city is MNT 34 billion (US$ 17.2mln).

Khovd city in Khovd aimag is center of the western region in Mongolia, with population of 27,500 people. Two medium capacity power stations generate energy for space heating and hot water the city residents, with interruptions from May to September. Total existing heat load of Khovd city was 24.3 MW in 2016. Its annual coal consumption heating system is 13,680 tons, and for sub-urban residential district is 29,000 tons, with total GHG emission of 59,470 CO2eq.

The Situational Analysis recommends to replace current coal-fired HOBs with highly efficient (85 percent) CFB boilers, and installation of 5 geothermal heat pumps, 2 electric heating system, 5 gas-fired boilers heating system with capacity of 1MW each. In addition, it requires thermal retrofitting of 270 thousand cubic meter buildings, and installing 50 solar and water heating systems and 50 heat meters for largest energy consumers. These measures will result in reduction of GHG emissions by 18,000 CO2eq by 2023 and 20,000 CO2eq by 2027. Total estimated investment for heating system transformation in Khovd city is MNT 30 billion (US$ 15.2mln).

Green Energy Plans were integrated into the Green Development Strategies of the respective Provinces respectfully in 2016. Based on the analysis of potential green heating technologies, the local Governments analyzed the investment costs and prioritized spending on heating systems of their city.

Low carbon heating solution for Public School in peri-urban area of Ulaanbaatar city

The Action Plan of the Government of Mongolia (GoM) for 2016-2020 has set solid commitments on comprehensive measures to reduce air pollution with objective "to reduce air, water and soil pollution and implement appropriate waste management in cities and other urban areas". According to the National Action Program for Reducing Air and Environmental Pollution (NAPRAEP), household coal stoves (210 thousand) and 3200 Heat Only Boilers (HOB) in ger districts of Ulaanbaatar city account for 80 percent of the urban air pollution. Approximately 400,000 vehicles emit about 10 percent of the urban air pollution and power plants are responsible for other 6 percent. About 4 percent of the urban pollution comes from dust, waste, soild and other sources.

Figure 4: Air pollution in Ulaanbaatar

Total coal consumption used for cooking and heating purposes of the country is approximately 2.84 million tons. To mitigate urban air pollution in the immediate future, the NAPRAEP sets out number of specific actions, including demolishing certain number of heat-only boilers through shifting users to centralized heating systems and promoting electric and other alternative space heating at household levels. However, due to weak economic incentives, and lack of strong technical knowledge, use of the renewable energy in heating sector is underdeveloped in the country. Continental cold climate of the country is another contributing factor to limited use of renewables in larger scale.

There are 65 public kindergartens and schools in Ulaanbaatar city that are not connected to the district heating systems due to the remoteness. For space heating purposes, off-grid public schools and kindergartens have HOBs that are fueled with raw coal. At average, annual heating costs per school range between MNT 55 to 65 million (US$23,300) depending on size of the school and terms and agreements signed with heat supplier.

In 2018, GGGI developed a business case study on low-carbon space heating for public schools with intention to pilot and scale up to other regions. The Mongolian University of Science and Technology (MUST) was selected and carried out the business case study for the 122nd Public School in Takhiltiin am, 22nd khoroo, Songinokhairkhan district of Ulaanbaatar city.

The school was selected with following criteria:

- The building is not connected to the district heating system because of its remote location from the city center. No future plans to do so as well.
- The school building has better thermal performance than other schools in peri-urban areas. It was constructed with the Japan International Cooperation Agency (JICA), Japanese Grant Aid Project "The Project for Improvement of Primary Education Facilities (Phase IV)" in 2013. It is one of five schools (118, 120, 121, 122 and 123) that were constructed with same building design.
- Songinokhairkhan district is has the highest number of pro-poor communities in Ulaanbaatar city. Songinokharikhan district is known for heavy air pollution and dense population, mostly migrants from rural areas.
- School operates in three shifts to enroll 2015[6] children from 8AM to 8PM. However, the school was designed to enroll 640 children.

[6] *At the request of the GoM, the UN-PAGE program developed a green building design for its extension building and in 2017. The extension building is being constructed with the ADB funding.*