The cover features a collage of images: a large wind turbine on the left, a solar panel in the center, and a statue of a warrior on a horse on the right. The bottom half of the cover is overlaid with a teal geometric pattern.

Development of Green Energy Systems and Energy Efficiency in Mongolia

December 2020



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Case Studies based on GGGI's Activities

December 2020

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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 Institute |
| 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 efficiency².

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.

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 Russia 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;
- Reduction in 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 assessment⁵ 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 CO₂e. 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.

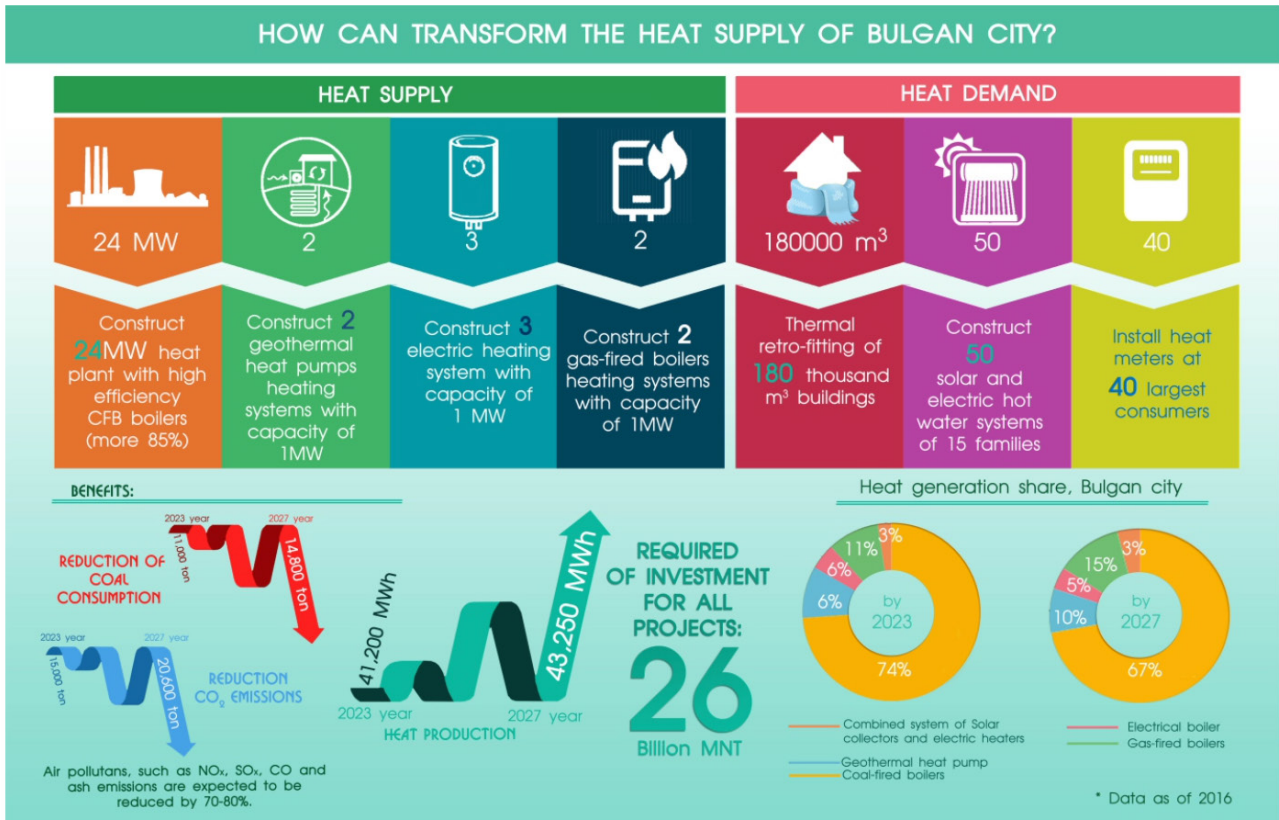


Figure 2: Bulgan city, 28 January 2016.

Photo by GGGI Consultant

These measures will achieve in GHG reduction of 15,000 CO₂e by 2023 and 20,600 CO₂e 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, soil 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. Songinokhairkhan district is known for heavy air pollution and dense population, mostly migrants from rural areas.
- School operates in three shifts to enroll 2015⁶ 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.

Technological assessment recommended a ground source heat pump (GSHP) system as an optimum alternative taking into account of its baseline performance, heat generation capacity and simple and reliable operation. Increased thermal comfort and avoidance of handling raw coal and ash emission will be also achieved.

As a result of regular consultation and engagement with the Ministry of Environment and Tourism (MET), the business case study was piloted and commissioned in 2019. Under the framework of NAPRAEP, total allocated state budget for the pilot project was MNT 720 million (US\$250 thousand).



Figure 5: Installation of Ground Source Heat Pump of 122nd Public School of Ulaanbaatar city, October 5, 2019.
Photo credit goes to Green Solar Energy LLC

Application of GSHP for space heating resulted in reducing GHG emissions by 133 tons CO₂eq and 42 tons of air pollutants. Monthly heating costs of the school was reduced MNT 3 to 7 mln after installing the GSHP. The school does not have to buy and combust raw coal anymore. Instead, the school has to pay only for power they use to operate the GSHP and personnel who operate and maintain the new heating system.

Accelerating Energy Efficiency in Green Public Infrastructure

Energy Efficiency in precast multi-family residential buildings

In support to the 2016-2020 Action Programme of the Government of Mongolia to improve energy efficiency and to reduce the building heat loss by 20 percent by 2020 and 30 percent by 2030. More than 40- 50 percent of heat and power energy co-generated at the CHPs is used for space heating of multi-family residential and office buildings.

The capital city has the largest building stock in the country. There are 1077 precast residential building blocks in Ulaanbaatar city that were constructed during 1965-2000. In order to reduce GHG emissions from energy consumed in residential buildings, the Mayor's office has designed and implemented number of preparatory sub-programs and projects. These include development of TTR blueprints with the Construction Development Center, pilot investment-grade energy audits to selected 3 pre-cast residential buildings with GGGI and carrying out city-wide earthquake resilience tests.

One of GGGI work on Sustainable Energy in Mongolia focuses on reducing heat loss of building sector. In 2017, GGGI carried out investment -grade energy audits to 3 selected precast residential buildings that demonstrated great potential for monetized energy savings and GHG emissions reduction. In addition to the audits, GGGI installed all three buildings with heat meters. Building up on this work, GGGI has developed a business model with Standard Offer Approach to initiate green innovative financing mechanisms for thermal retrofitting of multi-family residential buildings – in partnership of the Ulaanbaatar Municipality Office, and ICLEI East Asia.



Figure 6: Common Multi-Family Apartment Block, 2019.
Photo by GGGI Mongolia

GGGI is currently seeking to attract financing for the implementation of Thermo-Technical Retrofitting (TTR) of the residential buildings in UB city from Nationally Adapted Mitigation Actions Facility (NAMA). Concept note for “Mongolia – Energy Performance Contracting for Residential Retrofitting in Ulaanbaatar City” was selected for the phase of detailed project proposal development by NAMA in 2019. The proposal will be completed and submitted to the NAMA in 2021. It will be addressing main challenges in country such as availability of financial resources, capacity gaps in private sector and stakeholders and increasing public awareness on benefits of TTR. Also, it will be using NAMA funds as a leverage to mobilize additional

financial resources, project beneficiaries and private sector to improve market conditions for energy performance contracting and trigger the government to review its heating sector subsidy scheme.

The expected benefits of retrofitting 375 buildings blocks over 5 years is to be at least 91,073 tCO₂eq emissions annually, with a 10-year cumulative savings of 775,128 tCO₂eq.

Green building

Introduction of green building principles to educational facilities has multiple benefits. It will be improving health and well-beings of children, reducing operational and maintenance costs relevant to the space heating and domestic hot water and cutting GHG emission reductions. In general, public schools and kindergartens spend majority of their funds for personnel salary, but 75 percent of the remaining expenditure is spent on space heating only. At larger scale of roll-out, costs saved from improved energy consumption behavior can help the GoM to achieve budget savings. Most importantly, it will enable the GoM to fulfill its obligation to create an opportunity for every child to access pre-school education and optimize the use of limited public funds and other resources.

In 2015, the GoM requested GGGI to design a green kindergarten blueprint. GGGI partnered with the Green Technology Center of Korea (GTC-K) on an initial assessment and designed blueprint for green public kindergarten with total enrollment capacity of 125 children for a specific site selected in Songinokhairkhan district of Ulaanbaatar city. Technology solutions for green kindergarten building have been further elaborated (i) resource efficiency; (ii) technology friendliness from both education users and environment perspectives; (iii) cost effectiveness and (iv) overall green building principles, including indoor air quality, comfort level, use of renewable energy that has implications to overall climate change mitigation, safety and other requirements for outdoor environment and (v) social inclusiveness.

Selected site for the Pilot Green Kindergarten with capacity of 125 students is low-income peri-urban area of Songinokhairkhan district in Ulaanbaatar. According to the Cost-Benefit Analysis (CBA) of the green kindergarten analysis, upfront investment for green kindergarten construction is 26 percent higher than ordinary kindergarten. However, in long run, operation and maintenance costs are lower by 50 percent in heating, 95 percent in electricity, 16.6 percent in water, and 99.5 percent in wastewater, respectively. In addition, the green kindergarten prevents of burning at least 68-89 tons of coal per year that will result in reduction 91.8-120.15 tCO₂ eq per year.

The kindergarten will be constructed with ADB Funding of total estimated investment of US\$766,308⁷ - as part of the US\$50 loan package to finance growing demand for education buildings, under five-year project titled “Sustaining Access to and Quality of Education During Economic Difficulties Project” signed between GoM and the ADB.

⁷ <https://www.adb.org/sites/default/files/project-documents/50091/50091-002-pp-en.pdf>

Accelerating Energy Efficiency and ESCO Market development

Energy efficiency market development

Accelerating energy efficiency and ESCO market development is one of GGGI core activities in Mongolia. Various financial modalities, such as Energy Service Companies, energy performance contracts and upfront financing in energy efficiency market has been explored and activated. GGGI not only works in the project development but also supports the ERC to set up enabling regulatory and institutional tools and incentive mechanisms to stimulate the market development.

In December 2016, first batch of so-called “Designated Entities” were announced by the Government whose consumption of heat and/or electricity exceeded the Government threshold. In 2017, GGGI in partnership with Pricewaterhouse Coopers (PwC), carried out first kind of investment-grade energy efficiency audit at selected 15 DEs. It estimated the market per sector, gap analysis of Mongolia’s policy, regulatory, and financial framework, and developed a pipeline of pilot energy efficiency projects. Possible annual electricity savings of these 15 companies would equal to annual electricity production of Darkhan Power Plant, 10 per cent saving in a year calculated to save electricity of 259 million kWh and additional 701 thousand GCal of heat energy. The project implementers estimated that investment of MNT 50,819 million per year (equal to US\$19 mln, as of 2017) will be required for realization of electricity savings in Mongolia and the investment will be recovered only in three years. The electricity savings would reduce carbon dioxide emissions by 620 thousand tons CO₂eq per year.

As of November 2019, the country has 299 designated entities with total energy consumption of 4,590 million kWh. Mining sector alone consumes 55 percent of the total energy (8,308,3 million kWh) supplied to 685,237 energy consumers in the country (ERC, 2019).

GGGI supports MoU signing between China and Mongolia to promote collaboration of two countries in fields of energy efficiency

Within the framework of the implementation of the Law on Energy Conservation and other relevant legal acts, the ERC is aiming to develop cooperation between Mongolia and China on energy conservation and efficiency, including possible investment to be made at the benefit of energy conservation and identify potential other areas of collaboration.

GGGI has facilitated the signing of a bilateral Memorandum of Understanding (MoU) between the ERC of Mongolia, and the Chinese National Institute of Standardization (CNIS) and the National Energy Conservation Center (NECC) of the People’s Republic of China. Two countries will collaborate in several areas, particularly joint project implementation, harmonizing of relevant energy efficiency standards for electric appliances and equipment, explore possibilities for the setting up of a joint testing laboratory, and knowledge and experience exchange for the capacity building.

ERC has successfully hold initial discussions about the foundations of a structured cooperation with the NECC, the CNIS and the Energy Management Companies Association (EMCA). Scope of the discussions are:

- Identify collaboration areas in Energy Efficiency between the Government Organizations of China and Mongolia;
- Identify potential investments and collaboration between energy companies of China and Mongolia in reducing electricity distribution network losses (for instance, Smart metering and Transformer Applications of Amorphous Alloys in Power Distribution Systems); and
- Capacity building and knowledge sharing between the Chinese and Mongolian energy management companies.

Development of the National Green Financial Vehicle

As a National Financing Vehicle, GGGI has developed the Mongolia Green Finance Corporation (MGFC), which secured USD 10 million in equity from the Green Climate Fund (GCF) in 2018 to enable access to green finance and investment and approved its funding of USD 50 mln in 2020. It is also seen as the most important project to facilitate green PPP as well as first example of climate finance in the country.

The MGFC will be a public, private, IO partnership between line ministries, the MSFA and the GCF, where Government ensures policy alignment and leverages on the contribution of the private sector to finance its green growth and climate ambitions, where private sector ensures sound independent, professional management and IOs bring the necessary level of capacity building and technical expertise. In terms of green financing, the MGFC's Business Plan targeted markets such as:

- Cleaner Alternative Heating Solutions for the Ger Segment
- Energy Efficiency Products for Large Energy Consumers
- Affordable Green Housing and Mortgage Schemes.

The MGFC could facilitate the delivery of a cut of more than 3.7M tons CO₂eq and will come as a tool to displace the barriers identified above. Total number of direct beneficiaries is 80,000.

Key Findings

The following are key lessons of GGGI's efforts in improving energy efficiency and promoting green energy systems in Mongolia:

- **Alignment with National Objectives and Priorities Promotes Strong Government Ownership**

GoM has made a strong political commitment towards green development, adoption of renewable energy and improving of energy efficiency. Last decade from 2009 to 2019 has been critical for Mongolia to design and adopt key policy documents that aligns with the Paris Agreement and Sustainable Development Goals. It includes the Sustainable Development Vision 2030, Renewable Energy Law with its Amendments, Energy Conservation Law, the National Green Development Policy, and the NEEAP. Moreover, during the same period, Mongolia approved its first INDC in 2015 and revised accordingly in 2019 by increasing its commitments to reduce GHG emissions from 14.0 percent to 22.7 percent. Mongolia has the ambitious target of increasing installed capacity of the renewable electricity to 20 percent by 2023, and to further increase this to 30 percent by 2030.

GGGI has established a strong partnership with national institutions, such as Ministry of Environment and Tourism, Ministry of Energy, Ministry of Construction and Urban Development, Energy Regulatory Commission, and the Municipality of Ulaanbaatar city and acts as trusted advisor in supporting national efforts in clean energy development, planning and implementation. This helped into achievement of realistic outcomes in the joint GoM and GGGI initiatives, such as NGDP and its Outcome Indicators, Green Development Strategic Plans of Khovd, Bulgan and Khentii, demonstration of green kindergarten and small-scale green heating systems, designing and implementation of the NEEAP, ESCO market development and energy efficient standards and methodologies.

GGGI supports GoM commitments to achieve Sustainable Development Goals and fulfill its obligation under the Paris Agreement. Strategic Objectives of the GoM has been reflected in 2015-2020 Country planning Framework of GGGI in Mongolia with core operation areas of Sustainable Energy and Green Cities.

- **Adopting Systematic Approach in Policy Introduction: Assessment, Planning and Implementation (Evidence-based)**

GGGI work in green energy development started with assessment and long-term planning of energy systems in Mongolia which supported energy sector plans within the NDGP and its Action Plan of Implementation.

Further heating system assessment in Arkhangai, Bulgan and Khovd provinces and proposed recommendation on transforming the heating systems in the Provincial centers is catalyzed in the Provincial Green Development Strategic Plans. Annually the Provincial Government commits their human and budgetary resources for implementation of the Strategies and Plans.

- **Strong Analysis Facilitates Good Policy Decision-Making**

In formulation of the Strategies for Development of Green Systems in Mongolia, LEAP tool was used by employing a broad range of socio-economic, environmental and energy sector data for use in bottom-up techno-economic analysis of energy and GHG-reduction scenarios. Use of good quantitative data and solid analysis and evidence-based assessment facilitated GoM's policy decision making, formulation and planning processes.

Assessment of alternative heating systems in Arkhangai, Bulgan and Khovd provinces used assessment of available technology options along with LEAP tool, which provide recommendations of systematic planning and design of heating system transformation and its investment requirements.

In demonstration of green kindergarten, with support of GTC-K, the model options were developed used environmental, economic and technology analyses. The options were further advanced by local green building advisory companies to reflect available technology options in Mongolia. With request from the Government, cost benefit analysis was conducted to demonstrate long-term benefits of green public infrastructure for investment decision making by the Government and potential investors.

Collaboration with the National Academia, the Mongolian University of Science and Technology, in various level of technical projects related to the space heating contributed to successful engagement with the key stakeholders.

- **Focusing from National to Provincial and Sectoral Green Energy Development**

GGGI's work in energy sector started at the national level - designing long-term energy systems scenarios for Mongolia and continued in promoting energy efficiency policies, planning and implementation, including improvement of energy efficient norms, standards, labeling and auditing.

From the national level, the focus was expanded into supporting regional and provincial government, collaborating with the Provincial Governments of Arkhangai, Bulgan and Khovd in helping to transform their energy systems.

Further, the demonstration of green kindergarten project aims to improve energy efficiency in public infrastructure with an initial focus of education sector. There is a growing need to construct hundreds of kindergarten facilities in Mongolia, as there are about 60,000 preschool children who have no access to pre-school education due to shortage of kindergarten buildings and facilities.

- **Continuity and Building on Results**

The Strategies for Development of Green Systems in Mongolia, Alternative Heating Systems in the Provincial Centers, Demonstration of Green Kindergarten, Energy Efficiency Pilot Audits, Low Carbon Alternative Heating Solution for Public Educational Facility provided comprehensive analysis and recommendations on necessary policies, measures, technology options and financial requirements, including necessary investments.

For example, the green kindergarten demonstration project has been highly emphasized by GoM, as it can be replicated in construction of hundreds of public infrastructures, such as kindergartens, schools, hospitals and government offices. GoM will start construction of the green kindergarten with US\$0.6 million funding support from ADB in 2020.

The business case study on low carbon space heating for the Public School #122 in Ulaanbaatar city was implemented with the State budget to replace old coal boiler with the GSHP successfully in 2019. It was one of other alternatives of electric and gas heating piloted in the country for the first to mitigate air pollution in Ulaanbaatar city.

GGGI collaborates closely with the Mongolian Renewables Industries Association in supporting renewable energy development in the country. GGGI supports organization of the National Renewable Energy Forums and the International New Energy Summit since 2015. In average, these events attract attendance of at least 600 representatives from academia, civil society organizations, government, private sector, and development partners.

Finally, but not the least, role of the national financial vehicles such as the MGFC is designed to enable and support transformation of energy systems and energy efficiency measures prioritized for the country. This will also help policy makers, development organizations and investors in their decision-making and facilitate in design of bankable projects.

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ABOUT GLOBAL GREEN GROWTH INSTITUTE

The Global Green Growth Institute was founded to support and promote a model of economic growth known as “green growth”, which targets key aspects of economic performance such as poverty reduction, job creation, social inclusion and environmental sustainability.

Headquartered in Seoul, Republic of Korea, GGGI also has representation in a number of partner countries.