KEY POINTS

• Ulaanbaatar is one of the world’s most polluted cities. Coal-burning households in the peri-urban ger areas are major contributors to air pollution. In 2019, the substitution of raw coal with briquettes led to air quality improvements, but pollution levels still exceed World Health Organization (WHO) safety standards.

• Electrification of ger area heating is the optimal solution to end the use of residential coal stoves. However, the higher costs of electricity supply, lack of additional plant capacity to produce more electricity, and the high levels of greenhouse gas emissions from Mongolia’s coal-dominated electricity grid complicate the transition.

• A systematic approach is required to accelerate energy efficiency improvements in ger areas, pilot and deploy heat pumps, and better target electricity subsidies. Carbon emissions from electricity generation can be addressed in parallel through expanding wind and solar generation, adding energy storage, and using natural gas as a transition fuel.

Improving Air Quality in Ulaanbaatar

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SUMMARY

Given Mongolia’s extreme continental climate and reliance on coal for heating, air pollution from coal combustion is a major threat to public health and quality of life in Ulaanbaatar and other urban areas. High levels of outdoor and indoor air pollution particularly affect those living in ger (traditional tent-like dwelling) or informal settlement areas of Ulaanbaatar due to inefficient coal combustion.

Previous efforts to improve air quality in Ulaanbaatar have included a switch from raw coal to coal briquettes and the rollout of improved stoves for more efficient combustion. While these measures have ameliorated some of the worst impacts, they are not sufficient to reduce pollution to acceptable levels.

An impact assessment by the Asian Development Bank (ADB) suggests a three-pronged approach: (i) replace coal stoves with electric heating in ger areas, (ii) implement energy efficiency measures in traditional dwellings and detached houses and make these measures more affordable, and (iii) subsidize electric heaters for ger households. There is also a need to strengthen ongoing plans and policies to reduce reliance on coal for electricity supply while strengthening and expanding the power system to accommodate the increased electricity loads.

The transformation to clean electric heating and energy-efficient buildings will be challenging and requires collaboration of multiple actors at national and municipal levels. In addition to reducing air pollution, Mongolia’s energy transition promises opportunities for local businesses, employment, and social development; and will contribute greatly toward meeting Mongolia’s greenhouse gas reduction targets.

Note: This brief was peer-reviewed by Sakari Oksanen, senior energy consultant, and Bold Sandagdorj, senior economics officer, Mongolia Resident Mission, Asian Development Bank. Copyediting and graphic design were provided by ADB external consultant Christian Fischer.

MAIN CHALLENGES

Ulaanbaatar’s Air Pollution Crisis

Ulaanbaatar is well-known as the world’s coldest capital and the most polluted one in wintertime. Temperatures in January and February average –20°C and can drop as low as –40°C overnight. The heating season is unusually long, running eight months from September to May, resulting in energy demand for heat load exceeding that for electricity by more than two times. Coal is the most affordable and dominant energy resource in Mongolia and accounts for more than 60% of primary energy and more than 85% of secondary energy. Mongolia’s vast coal reserves could meet the electricity demand of its East Asian neighbors, including the People’s Republic of China (PRC), the Republic of Korea, and Japan for the next 20 years. At the same time, there is no meaningful domestic petroleum or natural gas production. All refined oil is currently imported from the Russian Federation.

The result of Mongolia’s high heating demand and dominance of coal causes serious urban pollution in Ulaanbaatar during the winter season. Winter months are characterized by extremely high concentrations of outdoor particulate matter in ger areas, exceeding WHO guidelines by many multiples. While the WHO’s safe level is set to 50 micrograms per cubic meter (μg/m³), concentrations reach up to 500 μg/m³ of air in winter (Figure 1). The poor air quality has become a major public health concern aggravating diseases, pneumonia, tuberculosis, and other respiratory issues among urban residents, especially in Ulaanbaatar. A joint report by the National Center for Public Health and United Nations Children’s Fund (UNICEF) in 2018 concluded that without a significant reduction of Ulaanbaatar’s air pollution, the financial costs of health care would increase by 33% by 2025.

![Figure 1: Measured PM$_{2.5}$ Concentrations in Ulaanbaatar’s Ger Areas](image)

PM$_{2.5}$ = particulate matter 2.5 microns or less in width, μg/m³ = micrograms per cubic meter, WHO = World Health Organization.

Note: Concentrations shown are the averages across 11 air quality monitoring stations located in ger areas. Not all stations were operating for the full period.


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2 The official heating season runs from 15 September to 15 May.
4 There is a small production site producing 16,000 barrels of crude oil per day, all of which are exported to the PRC.
5 ADB. 2018. Report and Recommendation of the President to the Board of Directors: Proposed Policy-Based Loan to Mongolia for the Ulaanbaatar Air Quality Improvement Program. Sector Assessment: Energy (accessible from the list of linked documents in Appendix 2). Manila.
6 A mixture of solid and liquid particles in the air that are small enough not to settle on the Earth’s surface under the influence of gravity, classified by aerodynamic diameter.
Improving Air Quality in Ulaanbaatar

Drivers of Air Pollution

Estimates of the contribution of various sources to pollution levels in Ulaanbaatar vary widely across studies. But there is consensus about household coal-burning in ger districts being a major contributor. Figure 2 shows the estimated contribution of the different sources of particulate matter in Ulaanbaatar.

District heating and electricity supply in Ulaanbaatar are currently dependent on three large coal-fired combined heat and power plants (CHPs), a large heat-only plant, and several smaller heat-only plants. The three CHPs are all located to the west of Ulaanbaatar, where prevailing winds blow emissions away from the built-up central area (Figure 3). CHP 2 and CHP 3 have operated for more than 45 years without proper emission control devices, and the largest plant, CHP 4, has operated for more than 25 years. Generally, existing facilities for heating and electricity (power plants and distribution lines) are outdated.

Burning coal in these CHPs results in high levels of particulate matter (PM). However, due to the height of CHP stacks and their locations toward the edges of Ulaanbaatar’s built-up area, the emissions are dispersed, contributing less to population exposure to ground-level PM concentrations than individual households burning coal (Figure 2). Emissions from ground-level combustion do not disperse well and tend to get trapped in the city which lies in a valley. Figure 4 shows the dispersal of emissions from CHPs and from heat-only boilers (HOBs), which are used as a proxy for household stoves. The International Monetary Fund (IMF) estimates that human inhalation of PM$_{2.5}$ emissions is 23 times higher for ground-level sources such as household stoves than for coal burned in CHPs.$^{10}$

Ger Area Heating

Households in the peri-urban ger areas, where 850,000 of the city’s 1.6 million residents reside, rely on coal stoves for winter heating.

Ger areas comprise low-density housing$^{11}$ spilling into the valleys and hills surrounding Ulaanbaatar and are not connected to district heating networks.$^{12}$ The most common type of residential housing in the ger areas is detached houses (35% of the total heated residential space in Ulaanbaatar) followed by gers (20% of total heated space)$^{13}$ which are self-built or built and do not comply with building regulations.$^{14}$ In contrast, residential

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Figure 2: Sources of Population Exposure to PM$_{2.5}$ in Ulaanbaatar

Notes: Share of PM$_{2.5}$ concentrations attributed to each source. PM$_{2.5}$ emissions contribute 0.04% to population exposure and are too small to show on the CHP figure.


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$^{10}$ International Monetary Fund. 2014. Getting Energy Prices Right: From Principle to Practice. The accompanying database is also available (direct download).

$^{11}$ Geres. Energy renovation of fragile housing in urban areas of Ulaanbaatar. Ulaanbaatar.

$^{12}$ Several pictures illustrating ger areas and pollution are available in UNICEF. 2020. Reducing impacts of air pollution on Maternal and Child Health.

$^{13}$ Fraunhofer ISE. 2018. Energy Master Plan for Ulaanbaatar. A breakdown for ger areas only is not available.

buildings in central Ulaanbaatar consist of apartment blocks made from precast panels (20% of the heated space) and new apartment buildings (18% of the heated space), which are connected to the central heat supply systems.

A 2017 household survey found that 92% of individual ger area households used coal stoves for heating. Seven percent used low-pressure HOBs without proper emission control devices and just 0.9% used electric heaters. The reliance on coal stoves is not solely due to the unavailability of district heating, but also to concerns over the cost and reliability of alternative household-level heating supplies (a vital consideration where a loss of overnight heating is life-threatening). In the past, coal supplied to ger areas came from a variety of mines close to Ulaanbaatar. It is typically affordable low-quality coal with high levels of impurities not suitable for export. It results in increased pollution from burning it.

The poor standards for construction of many ger area buildings, such as poor insulation increasing heating needs, exacerbates pollution challenges. Indoor temperatures cannot be controlled and tend to be below or above comfort levels. The lack of materials and skills, higher costs, and the need to ventilate to avoid the buildup of dangerous gases from coal-burning inside homes are the main explanatory factors of this trend.

Figure 4: PM$_{10}$ Emissions from Combined Heat and Power Plants Dispersed from Residential Areas, Unlike Emissions from Ground-Level Heat-Only Boilers

CHPs

HOBs

PM$_{10}$ CONCENTRATIONS CHPs - 2008.06.01–2009.06.01

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PM$_{10}$ CONCENTRATIONS HOBs - 2008.06.01–2009.06.01

<table>
<thead>
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<th>Range</th>
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<tbody>
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<td>16–20</td>
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<tr>
<td>Greater than 20</td>
<td>Brown</td>
</tr>
</tbody>
</table>

CHP = combined heat and power plant, HOB = heat-only boiler, PM$_{10}$ = particulate matter of 10 microns in width.

Note: HOBs are used as a proxy for household stoves in ger areas as a dispersal figure is not available for these.

The reliance on coal stoves results in dangerous levels of indoor air pollution in ger areas. A recent study estimated that indoor air quality standards were breached 39% of the time during the heating season.\textsuperscript{16} Compared to WHO guidelines, indoor PM\textsubscript{2.5} concentrations were over 10 times greater, PM\textsubscript{10} concentrations were over 4 times greater, and sulfur dioxide concentrations up to three times greater. The high levels of indoor PM arise from both indoor sources and from inflows of outside PM. This means that reducing indoor air pollution in an individual household is insufficient to reduce indoor PM to safe levels. High levels of outdoor PM can increase indoor PM\textsubscript{2.5} and PM\textsubscript{10} concentrations by up to 39.5% (footnote 13).

**PREVIOUS AND ONGOING ACTIONS**

**Establishment of the National Program**

During the early 2000s, the Government of Mongolia actively pursued measures to reduce air pollution in Ulaanbaatar. These included the distribution of improved stoves, encouragement for ger area households to switch to electric heating, and the renovation and conversion of low-pressure heat-only boilers, under the Clean Air Fund (CAF). However, these activities largely ceased from 2014 onward, initially due to the closure of CAF as well as concerns over its misuse and of other special funds, amid an economic slowdown.\textsuperscript{17} In 2017, the government relaunched its campaign to reduce environmental and air pollution with the re-establishment of the National Committee on Air and Environmental Pollution Reduction. The committee plays a coordinating role across government and civil society to implement the National Program for Reducing Air and Environmental Pollution. It is chaired by the Minister for Environment and Tourism and is supported by a dedicated secretariat. The national committee developed a national program on reduction of air and environmental pollution together with an implementation action plan that was approved by the government.\textsuperscript{18}

**Improved Stoves**

Previous attempts to reduce the pollution from household stoves in Ulaanbaatar have mainly focused on replacing traditional stoves with more efficient improved stoves. Large-scale conversion programs were previously implemented by both the World Bank and the Millennium Challenge Corporation (MCC),\textsuperscript{19} with 144,000 improved stoves distributed.\textsuperscript{20} An impact evaluation of the MCC program found coal consumption did not change significantly,\textsuperscript{21} which was attributed to incorrect use of the stoves.\textsuperscript{22} A 2017 household survey found that 15% of households had previously used improved stoves but returned to traditional stoves because the improved stoves were considered broken or not working properly. However, more positive results were reported for the World Bank program which saw greater acceptance of the improved stoves, but also found that as many as 40% of the subsidized stoves distributed may have been resold outside of Ulaanbaatar by recipient households.\textsuperscript{23} The experience of the programs highlights the importance of effective community engagement to support the deployment of new technologies and of ensuring that subsidies are well-targeted and not transferable.

**Introduction of Coal Briquettes**

Most significantly, the national program has supported the establishment of briquetting plants at the state-owned Tavan Tolgoi coal mine and the development of an accompanying storage and distribution network. With this, in May 2019, the use of “raw” (unprocessed) coal by ger area and other households in Ulaanbaatar was banned and replaced by subsidized higher quality coal briquettes to avoid an increase in costs to households.\textsuperscript{24} The national program also includes funding for filters for coal-fired heating boilers in public buildings.\textsuperscript{25}

**Electrification Efforts**

While ger areas are connected to the electricity grid, there has been little switching to electric heating. This is despite incentives, such as free night-time electricity supplies in winter.\textsuperscript{26} Deterrents include the high upfront cost of conversion and unreliable electricity supplies due to the low capacity of the electricity network in ger areas.

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\textsuperscript{17} AARC Consultancy. 2019. *Air Pollution in Mongolia: Opportunities for Further Actions. Report for United Nations Development Programme (UNDP).*

\textsuperscript{18} Expenditures from the Clean Air Fund fell by 60% from 2013 to 2014, prior to its closure in 2015.


\textsuperscript{23} Traditional Mongolian stoves are fed from the top and are kept continuously burning. The improved stoves are fed from the bottom and need to be allowed to burn out and then cleared before relighting. Households were reluctant to let their stoves burn out in winter in case they were unable to relight them.


\textsuperscript{25} Government Resolution #62 of 2018.

\textsuperscript{26} National Committee on Air and Environmental Pollution Reduction. 2021 Implementation Action Plan.

The subsidies are funded by government payments to the Ulaanbaatar Electricity Distribution Network company (UBEDN). (Government Resolution #199 of 2017), Ulaanbaatar.
The Asian Development Bank (ADB) has been actively supporting Mongolia in reducing air pollution through two policy-based loans (PBLs) for air quality improvement, $130 million in 2018 and $160 million in 2019. Under PBLs, funding tranches are released for the achievement of defined policies, which help provide impetus to the implementation of key policies, such as the raw coal ban, by linking these to new funding. These PBLs have also been used to support measures to strengthen policy implementation, such as requiring effective community engagement on the raw coal ban and the formalization of the National Committee’s Secretariat as preconditions to releasing funds. The piloting of charcoal briquettes was a key first step in assessing the feasibility of banning the burning of raw coal.

Since 2020, the World Bank has implemented a program to install 1,000 modern electric heaters, but as of April 2021, only 15 households had installed heaters and 94 had signed contracts. Among the causes for this slow deployment were the coronavirus disease (COVID-19) pandemic disruptions, the need for households to pay upfront for installations, and discounts on coal and electricity tariffs, which led to preferences for coal stoves and older, less efficient heaters.

Another barrier is the limit of heaters to 4 kilowatt (kW) capacity due to the weak electricity distribution network in ger areas. This is only sufficient to heat houses up to 30–40 square meters (m²), too small for many households. While this would be adequate for gers, they were ruled out due to administrative barriers, such as their mobile nature and frequent lack of permanent residency and clear land rights, making electricity billing and collection of payments for heater installation difficult. The national program is making some investments in upgrading the capacity of the electricity distribution network in ger areas, but these are limited in scope.

FUTURE POLICY APPROACHES

Clean Heat Strategy Overview

The Clean Heat Strategy (CHS), developed with ADB’s assistance, is central to the long-term reduction of air pollution from ger areas. The starting point for the CHS is the successful implementation of the raw coal ban and its replacement by briquettes. The higher quality of the briquettes has led to a substantial fall in PM emissions and carbon monoxide (CO).

Other Activities

Alongside the national program are various other activities that contribute to reducing air pollution from ger areas. The Municipality of Ulaanbaatar (MUB) is finalizing its Master Plan 2040, which will guide the city’s future development. This includes the replacement of current ger area housing stock with “green” apartments organized around new community centers and their connection to the district heating network. It also includes the expansion of renewable energy supplies, with the potential use of geothermal and solar energy for electricity and heating. The Ministry for Construction and Urban Development (MCUD) is developing updated building regulations which replace the current regulations of the former Soviet Union adapted from Russian models, and which place much greater emphasis on enhancing energy efficiency in new buildings. Mongolia’s implementation action plan, along with needed budget support for air quality improvement, led the ADB engagement in policy dialogue with the government and development partners to identify priorities for the reforms. A summary of ADB’s assistance is provided in Box 1.

Box 1: Asian Development Bank Support to Air Quality Improvement in Ulaanbaatar

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A recent study determined a mean 48-hour CO concentrations in coal-briquette households at 6.1 parts per million (ppm) (range 1.5–35.8 ppm) with no significant differences by household, stove, or venting factors.30 Particulate matter has also substantially decreased following the ban of raw coal.

During the 2019–2020 winter, the maximum PM$_{2.5}$ concentration was reduced to 46% and PM$_{10}$ concentration to 55%, compared to the mean maximum values of the previous 5 years.31 While CO and PM levels were significantly lower in coal-briquette compared to raw coal households, concentrations remain higher than acceptable and further reductions are needed. The switch from raw coal to briquettes is also estimated to have had little effect on overall carbon emissions and Mongolia’s delivery of its national determined contribution (NDC) under the Paris Agreement.32

Clean heating options considered in the CHS included expansion of the district heating network, electrification of heating, use of biomass briquettes to replace coal briquettes, introduction of solar thermal heating, and use of propane heating. Biomass, solar thermal, and propane were ruled out because of supply reliability concerns, high costs, and safety concerns. Instead, the CHS emphasizes the need for continued expansion of district heating where feasible and, for other households, the rapid electrification of heating.

Key components of the CHS are as follows:

(i) Rapid electrification of ger area heating to foster early improvements in air quality in Ulaanbaatar, yielding major health benefits, following strengthened electricity distribution networks and pilots for the use of heat pumps for electrification.33

(ii) Ensuring affordability by a large-scale energy efficiency program in ger areas supported by tariff and subsidy reforms.

(iii) Accelerating current efforts to decarbonize electricity supply to reduce the resulting impacts on greenhouse gas (GHG) emissions and to continue to move forward on Mongolia’s NDC.

(iv) A phased transition to clean heating for ger areas, e.g., reduce pollution concentrations while decarbonizing the electricity grid (Figure 5).

**Electrification of Ger Area Heating**

Central to the CHS is the rapid electrification of heating in ger area buildings to replace coal stoves. The rollout of direct electric heating to ger areas and detached houses (combined 55% of Ulaanbaatar’s heated area) will require about 1.6 gigawatts additional power plant capacity for heating. When direct electric heating is installed in buildings with energy efficiency measures the required power plant capacity is reduced.

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**Figure 5: Timeline of Planned Reduction in Carbon Dioxide and Particulate Matter Emissions in Ulaanbaatar**

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<th>Particulate Matter Emissions</th>
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<td><strong>2021–2022</strong> Preparation and Piloting</td>
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<tr>
<td>• Upgrade ger area electricity distribution networks</td>
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<tr>
<td>• Large-scale pilot of heat pumps to test performance and community acceptance</td>
<td></td>
</tr>
<tr>
<td><strong>2023–2026</strong> Electrification of heating</td>
<td></td>
</tr>
<tr>
<td>• Roll-out electric heat pumps and heaters to replace coal stoves</td>
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</tr>
<tr>
<td>• Large-scale energy efficiency programme to reduce household consumption and bills</td>
<td></td>
</tr>
<tr>
<td><strong>2027 onward</strong> Decarbonization of electricity</td>
<td></td>
</tr>
<tr>
<td>• Further increases wind and solar generation</td>
<td></td>
</tr>
<tr>
<td>• Continuing improvements in system flexibility to manage variable renewable energy</td>
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</tbody>
</table>

Box 2: Heat Pump Potential in Ulaanbaatar

Air source heat pumps are essentially reversed air conditioners, which draw heat from a cooler external source and raise the temperature using electricity. As the heat released is drawn from the ambient environment rather than from the electricity consumed, they are more efficient than electric heaters. This greater efficiency is measured by the coefficient of performance (COP), which gives the ratio of heat supplied to electricity consumption. A COP of 3, for example, would mean that the heating energy transferred is three times the electric energy consumed.

A major concern with respect to the widespread deployment of heat pumps in Ulaanbaatar is that the COP declines as the difference in temperatures between the external heat source and the heating systems’ temperature increases. Given the extremely cold winter air temperatures in Mongolia, the performance of heat pumps drops precipitously. The COP is estimated to drop to 1 (i.e., heat supplied equals electricity consumed) at temperatures of –20°C. Experiences from the People's Republic of China suggest that if heat pumps were to be adopted, then the reduction would be about 350 megawatts (MW). Adopting air source heat pumps instead of direct electric heating would reduce requirements by 320 MW. If more efficient, but most costly, ground-source heat pumps were to be adopted, then the reduction would be 620 MW.

By lowering system load, the use of heat pumps can also reduce the need for investments in strengthening electricity distribution networks in ger areas to accommodate the additional heating demand. At present, ger area household connections are generally limited to 4 kW which is insufficient to supply both electric space heating and cooking.

There are questions as to how well heat pumps can function in Mongolia’s extreme winter temperatures. While small-scale pilots have been promising and there is experience in the northeast region of the PRC, further assessments are needed to understand performance at scale. If heat pumps do prove viable, they do offer substantial potential to reduce energy consumption for electric heating and, therefore, household heating bills.

Protecting Affordability

A major concern with respect to electrification is the cost implications for households. Higher costs for heaters (direct) and for tariffs (indirect) are required to recover investments that help increase electricity generating capacity and electricity distribution networks. If too high, these costs will deter conversion and encourage continued illicit use of coal for heating.

Two main measures are proposed to help address affordability concerns:

(i) improve energy efficiency in ger area buildings to lower energy use and increase prices, while keeping overall household energy expenditure constant; and

(ii) reform the current electricity tariff subsidies to make these more sustainable, while protecting low-income households and making the switch to electric heating affordable.

Accelerating Decarbonization of Electricity Generation

Mongolia’s electricity industry is currently dominated by coal CHPs. In 2020, 80.7% of electricity was generated domestically (73.4% by CHPs and 7.3% from solar, wind, and hydro). The remaining 19.3% were imported. The government is committed to expanding the share of renewable energy, with the current National Energy Strategy targeting a renewable energy share of 30% in installed capacity by 2030. The New Revival Policy, approved by the Mongolian Parliament in December 2021, places an emphasis on expanding natural gas and renewable energy capacity, although without specific targets.

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35 Government Resolution #106 of 2021.
In the short term, it will be difficult to reduce the share of coal power. The Government of Mongolia’s 2020–2024 Action Plan foresees further expansion of the existing CHPs and the construction of two coal power plants with a combined capacity of 850 MW along with 170 MW of solar and wind plants.36 At a March 2022 investment forum, the Minister for Energy identified the urgent need to build a new 300 MW coal power plant and expand an existing coal-fired heating plant to meet demand growth, stating that Mongolia was already exceeding its cap on electricity imports.37

Gas-fired CHPs could meet heating and electricity demand at much lower levels of emissions. Given the potential role of gas as a transition fuel, these are likely to attract international financing more easily than coal plants. While Mongolia does not have a domestic natural gas production, the planned Power of Siberia 2 pipeline from the Russian Federation to the PRC would cross its territory and supply for Mongolia as well.38 An initial feasibility study was completed in April 2021, but the commissioning date is unknown, as is whether the impacts of the Russian invasion of Ukraine and sanctions on the Russian Federation will delay or accelerate the project.39 Mongolia is also exploring use of domestic coal-bed methane as an alternative to imported gas.40

Mongolia has abundant solar and wind resources. However, the ability to reach higher penetration levels is constrained by several factors: the need to run coal CHPs in winter to supply heat, funding, lack of energy storage and smart infrastructure for daytime solar generation to meet night-time demand, and a lack of noncoal-powered flexible supply sources to manage fluctuations in renewables output.41

A major scaling-up of storage capacity would result in greater use of solar and wind generation to meet night-time heating demands reliably. ADB currently helps fund a large-scale new battery storage system under construction, which marks a first step in this process.42 The government is also exploring the potential for developing a pumped storage project, which would provide flexibility to support significant capacity additions of wind and solar. Strengthening electricity interconnections with the Russian Federation and building new electricity interconnections with the PRC would provide a mechanism to manage mismatches between energy generation and demand by using the interconnected systems as giant batteries. Additionally, innovative technologies may also reach maturity—for example, small modular nuclear reactors (SMRs) could provide a scalable and emissions-free source of power generation by the early 2030s.43

Main Stakeholders
Implementing the strategy requires close cooperation across ministries and agencies. The National Committee’s coordinating role will continue to be essential. Planning and delivering on the necessary investments to ensure adequate electricity supplies and their decarbonization will be led by the Ministry of Energy (MOE) working through the various power sector state-owned enterprises. The Energy Regulatory Commission will be responsible for tariff reforms, working together with the MOE and the Ministry of Finance on future subsidy provision. The rollout of heat pumps and energy efficiency measures will fall under MUB. Meanwhile, MCUD will be responsible for building regulations and the development of a supporting energy efficiency industry.

Mongolia’s Commitments to Mitigate Climate Change
To facilitate cooperation and coordination among government agencies, private business entities, and local civil society organizations, the Climate Change Research and Cooperation Center was established under the Ministry of Environment and Tourism in 2020. Its mandate is to ensure implementation of Mongolia’s climate policies and its NDC commitments under the Paris Agreement.

The energy sector is Mongolia’s largest contributor to GHG emissions, accounting for about two-thirds of the total. Mongolia’s current NDC targets a reduction in GHG by 23% from business-as-usual levels by 2030.44 This will inevitably require a transition away from the current dependence on coal for electricity generation and heating. Financial resources are less available for coal-fired CHP development and expansion projects because of their substantial GHG contributions. Additionally, international institutions and Mongolia’s key energy sector partners in the PRC, the Republic of Korea, and Japan are shifting away from investments in coal power, which further emphasizes the need to rapidly identify and deploy alternatives to new coal power plants in Mongolia.

36 Resolution of the State Great Khural (Mongolian Parliament) #24 of 2020.
38 D. Pallardy. 2020. Power of Siberia 2’s new route makes Russian gas supplies to China more feasible. ICIS. The article includes a map of the proposed route.
41 There are pilots being carried out in Mongolia to address these, including an ADB-funded establishment of a 80–MW/200–MWh battery energy storage system.
43 SMRs are nuclear reactors of less than 300 MW capacity, which can be delivered as modules for installation on-site and which, thereby, are expected to be quicker and lower cost to deploy than conventional large nuclear reactors. As of late-2020, the International Atomic Energy Agency listed over 70 designs under development with the first commercial SMR (a 70 MW floating SMR in the Russian Federation) commissioning in May 2020.
44 Government of Mongolia. 2020. Updated Nationally Determined Contribution. The target is to reduce emissions by 16.9 million tons of carbon dioxide equivalent (MtCO2e) relative to BAU levels by 2030, with 8.3 MtCO2e of this coming from the power sector.
LESSONS LEARNED

Mongolia’s experience in managing air pollution in Ulaanbaatar offers ample lessons for other low- and middle-income countries to reduce air pollution, improve heating, and transition their energy supply.

(i) Even the seemingly lowest hanging fruits of replacing conventional coal stoves with more efficient alternatives or by directly electrifying households’ heating systems must go hand in hand with educating recipients about the relevance and functionality of the new systems. Otherwise, there is a risk that new stoves, for example, are not actually taken up, abandoned because minimal maintenance cannot be performed, or are sold for profit.

(ii) Targeted government assistance is key to facilitate the uptake of clean heating systems. Pro-poor tariffs and subsidized grid connection charges are pivotal but should be accompanied by programs to improve energy efficiency and reduce bills. Support is not limited to financial assistance but includes awareness raising and assistance with streamlining (e.g., permitting for retrofitting buildings).

(iii) A meaningful transition toward a greener economy should be pursued concurrently to the electrification of heating systems. Transitioning energy supply requires substantial investment in a portfolio of renewable energy sources and the development of storage infrastructure. Such investment takes time and, in the interim, pollution and health damages can be reduced by electrifying, even if using fossil fuels, while clean energy deployment continues to expand.

WAY FORWARD: POLICY RECOMMENDATIONS

Improving air quality in Ulaanbaatar is a multifaceted challenge. Electrification of heating is required to end the use of household coal stoves, responsible for much of the pollution in Ulaanbaatar and other urban areas. This faces challenges of cost and affordability for ger area households as upfront investment is needed and subsidies are to be reformed. Additionally, increasing electricity demand in a coal-dominated system complicates achieving Mongolia’s climate change commitments. The following set of policy recommendations addresses each of these aspects:

(i) **Rolling out electric heating in ger areas.** Household stoves in peri-urban ger areas burning raw coal have been a major contributor to Ulaanbaatar’s air quality crisis. 2019 saw a significant improvement with the ban of raw coal and substitution with coal briquettes. However, air pollution levels still exceed WHO standards. Large-scale and sustained reductions in pollution require the electrification of heating in ger areas.

(ii) **Strengthening ger area distribution networks.** Currently, electricity distribution networks in ger areas are too weak to accommodate widespread use of electric heating. Strengthening and upgrading is needed to support electrification of heat.

(iii) **Investing in energy efficiency.** Improved energy efficiency is key to reduce electricity consumption for heating and, thereby, improving affordability and reducing environmental impacts. This includes both the retrofitting of existing buildings and the improvement and enforcement of standards for new buildings. Ecotechnologies and smarter urban planning should also be among the options explored. The volume of work required has the potential to grow a large domestic supply chain and workforce which will also support the transition away from coal by providing an alternative source of energy sector employment.

(iv) **Large-scale piloting of heat pumps.** Widespread adoption of heat pumps can further reduce electricity consumption for a given heating level and, thereby, lower investment costs and bills and enhance affordability. However, there is too little evidence on how well they perform in Mongolia’s extreme climate. The needed rollouts will depend on the results of larger-scale pilots.

(v) **Reforming electricity tariffs and subsidies.** Existing electric heating subsidies, delivered through electricity tariffs, can be redesigned to strengthen incentives for switching to electric heating for ger area households by linking subsidy eligibility and proof of conversion. Adjusting subsidies to recognize that households can be expected to pay a higher share of income for electric heating, given its greater comfort and convenience can help keep overall subsidy costs acceptable.

(vi) **Enabling low-carbon electricity.** Ensuring that electrification of heating does not hinder Mongolia’s commitments to reduce GHG emissions requires accelerating the decarbonization of the power sector. The country’s combined wind and solar power potential is estimated to be equivalent to 2,600 gigawatts of installed capacity, enough to theoretically meet the country’s energy demand, given a suitable transmission and storage infrastructure. Measures include major investment in wind and solar generation and the introduction of energy storage; and strengthened interconnections to manage intermittency and variability in generation. Potentially, natural gas might also be deployed as a transition fuel to speed up retirement of coal-fired CHPs, if the planned Power of Siberia 2 pipeline transiting Mongolia is realized.

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