Renewable Heating Virtual Article 6 Pilot

Ground source heat pumps in Khovd, Mongolia

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Introduction

Article 6 of the Paris Agreement provides the framework for a new generation of carbon markets in a context where all countries are supposed to formulate and implement ambitious Nationally Determined Contributions towards a temperature target and ratchet their contribution on a regular basis. Under this new regime, carbon market mitigation activities must account for, encourage and enable, and most importantly not be a disincentive for increased domestic climate action. With the final rules for Article 6 being an issue of ongoing negotiation, virtual pilots can help contribute to the discussion regarding rulemaking for Article 6 and inform new approaches to cooperation.

NewClimate Institute has identified the installation of ground source heat pumps (GSHPs) in Mongolia as a promising emission reduction option for a virtual Article 6 pilot. Winter temperatures in Mongolia can reach -40°C at night, with even more extremes of -58°C in severe winters on the steppe. Heating in Mongolia is almost entirely coal-based, either with stoves installed in traditional gers (also known as yurts) or through district heating grids. Together these are responsible for high levels of GHG emissions as well as severe air pollution. GSHPs are likely inaccessible; mostly due to a lack of familiarity with GSHP technology, a lack of existing on the ground technical expertise to install and maintain heat pumps, as well as significantly higher upfront costs compared to alternative heating technologies, illustrated in Figure 1.

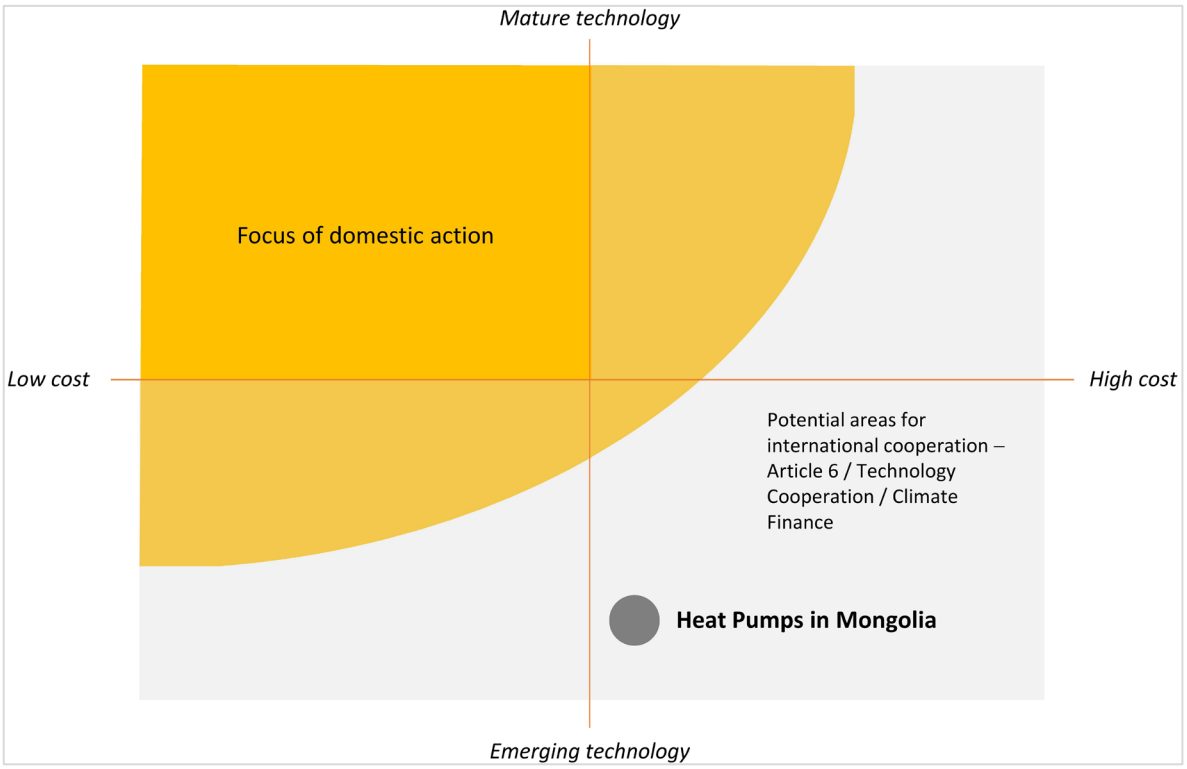

Figure 1: Heat pumps in Mongolia are classified as high-cost, emerging technology quadrant and are therefore inaccessible to the country as well as a potential area for international cooperation.

Background

Mongolia is rapidly urbanising: between 2000 and 2017 its urban population grew from 57 to 68% (World Bank, 2018b). Rural-to-urban migration is driven by both environmental and economic factors. Despite the growing migration trend to Ulaanbaatar, most of the population live outside the capital in one of the 21 *aimags* (regional administrative centres or provinces). The development of these areas would improve basic urban services and infrastructure, promote the local economy, and enable green urban planning. Such planning is lagging in most Mongolian urban centres (GGGI and Government of Mongolia, 2016a; ADB, 2017, 2018a).

Khovd *aimag* has the potential to catalyse local economic growth and relieve urbanisation pressure on Ulaanbaatar thanks to its high concentration of manufacturing industries but lagging investments in housing and infrastructures are holding back the region (ADB, 2017). Its capital, Khovd city, has a population of approximately 30,000 people. Roughly 25% of the households live in apartments, which translates to approximately 55,000 m^2 of effective area connected to heating plants. The two coal-fired heating plants in the city serving independent heating grids. One plant was built in 1986 and is due for replacement in the next years considering the boiler has already been in operation for over 30 years (GGGI and Government of Mongolia, 2016b).

The building sector is included in the Mongolian NDC, which primarily focusses on energy efficiency measures which alone are not enough to significantly reduce air pollution or GHG emissions. There is an urgent need for further measures to move towards decarbonisation of the heat supply sector. Nonetheless, Mongolia does not currently have a plan to shift away from the use of coal, nor a more general long-term strategy for decarbonisation.

Pilot implementation

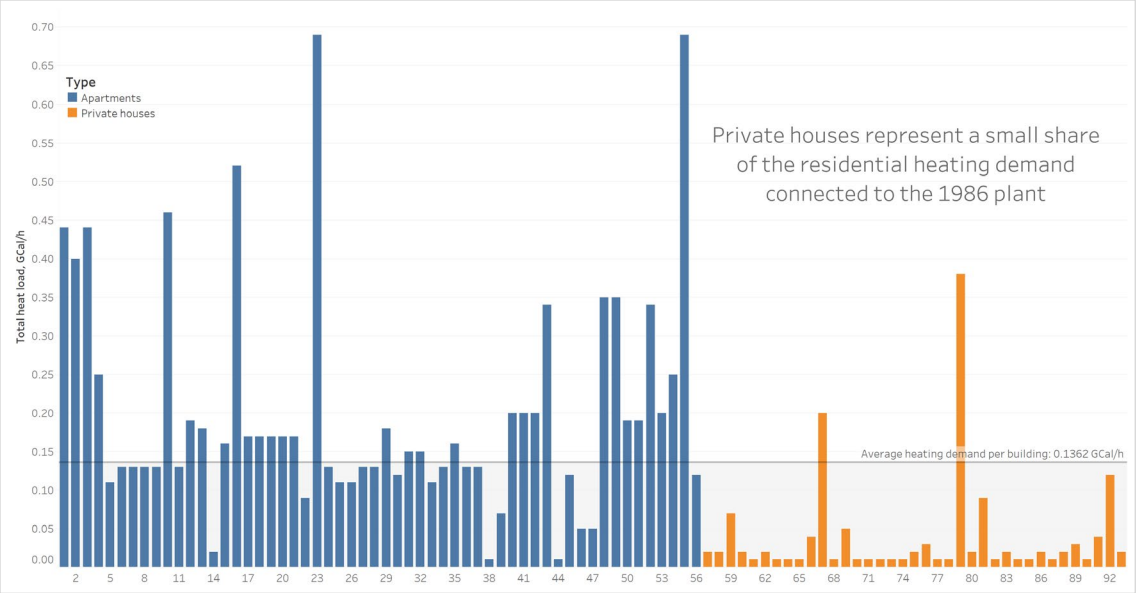

Figure 2: Total heating demand from the 93 residential private houses and apartment buildings connected to the 1986 heating plant.

A feasibility study for a GSHP system in Khovd shows that heat pumps are the most suitable technology for low emissions general heating and can be combined with a small backup system for the coldest days (ADB, 2018b). Other pilot systems in the country have been in operation for years without any performance issues (GGGI, 2018). Ground source heat pumps represent a large efficiency improvement over electrical resistance heating, could conceivably be connected to the district heating system or be decentralised, and result in emissions savings compared to heat from heating-only plants and fire stoves. For our virtual pilot, we propose to install GSHPs in apartment buildings currently connected to the coal-based district heating grid, since they require most of the heating supplied by the 1986 plant (see Figure 2).

We consider three apartment heating alternatives in Khovd. The first option is based on the continuous use of the existing plant. The second involves the replacement of the old boiler with a new circulating fluidized bed (CFB) boiler that would improve efficiency and reduce air pollution levels. The third option is replacing the heat supplied by the current coal-fired plant with heat pumps. Even though heat pumps are likely the best performing clean heating alternative in Mongolia, they still need to overcome several barriers, e.g. high upfront investment costs (see Table 1). Depending on the cost of capital however, heat pumps are likely to have lower overall total costs over their expected 20-year lifetime. The high upfront costs and low technological maturity indicate that the implementation of the project would not provide a disincentive for Mongolian domestic climate action and that Mongolia would not endanger its own NDC achievement if it were to approve the project, export mitigation outcomes, and apply a corresponding adjustment.

Table 1:Estimated upfront costs and present value of total costs in million EUR from existing plants, heat pumps, and CFB coal-fired boilers.

Costs	Existing plant	CFB boilers	Heat pumps
Upfront costs (million EUR)	-	3.8	7.0
Total costs (million EUR)	9.4	13.2	11.2
LCOH (EUR/kWh)	0.028	0.039	0.033

Although the sale of emission reductions could be used to fund the project in full, this would lead to relatively high per tonne costs for emission unit buyers. On a systemic level, ground source heat pumps represent a cost saving over their entire lifetime in comparison to CFB boilers that the Mongolian government is most likely to install in the next years, so an energy service company model is another possibility. In this case, revenue streams could come from charging residents a reduced price for heat, as well as selling emission units. As GSHPs increase electricity use, such a model could be of interest to the local electric utility (see Figure 3).

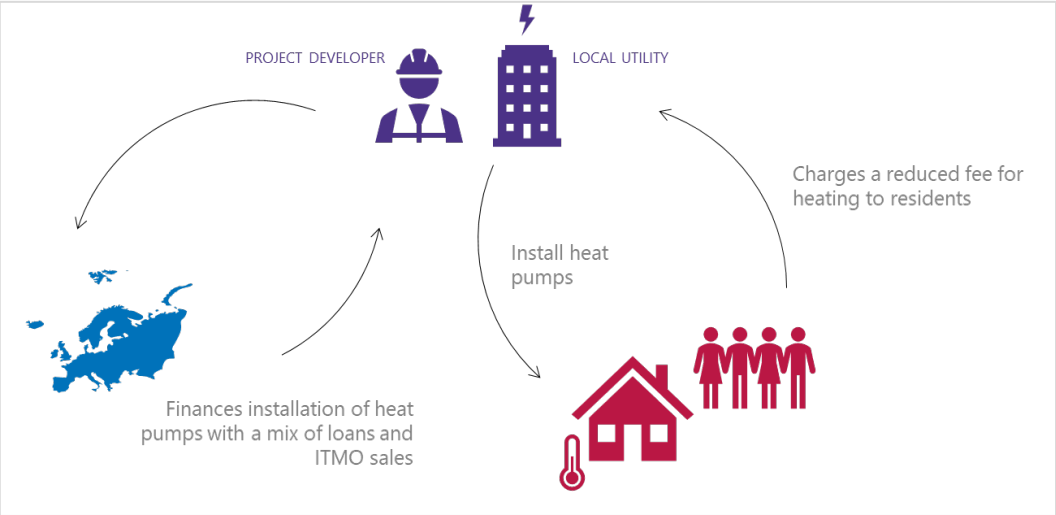

Figure 3: Potential business model for implementation of renewable heating in Mongolia

Considering the regulatory requirements, although Mongolia is host to a number of successful CDM projects, participates in the Japanese Joint Crediting Mechanism and is currently revising its NDC, it would require further support to conduct an annual GHG inventory and to comply with requirements laid out in COP24 decision 77d on transfers and corresponding adjustments. It is assumed that the current Designated National Authority (DNA) would continue to retain authority to issue host country letters of approval, but this mandate would need expanding to carry out corresponding adjustments with important implications for NDC achievement.

The successful implementation of the proposed pilot project has the potential to accelerate the retirement of the older heat plant, reduce GHG emissions, familiarise housing construction firms and residents with renewable heating technologies, and promote other important sustainable development co-benefits, notably a reduction of air pollution. The proposed pilot offers a novel alternative to current heating technologies used in Mongolia, since it can be based on clean and Paris-compatible heating supply, and has unexplored synergies with efforts to expand the availability of affordable permanent housing to the *ger* populations. We do not foresee any danger of the project becoming a stranded asset in a rapid sectoral decarbonisation scenario; GSHPs do not have direct emissions associated with their operation and can be fuelled by renewable electricity.

Potential emissions impact

We have developed an emissions baseline based on the average heating demand from apartment buildings connected to the 1986 plant and country-reported emissions factors. These estimates would need to be corroborated through sampling during project implementation. Taking into consideration targets and policies included in the Mongolian NDC, we adjust our baseline to include the Mongolian government's goal of 20% reduction in building losses by 2020 but do not include other policies that impact the buildings sector indirectly. We have also calculated the residual emissions based on CDM Methodology AMS-II.E: Energy efficiency and fuel switching measures for buildings.

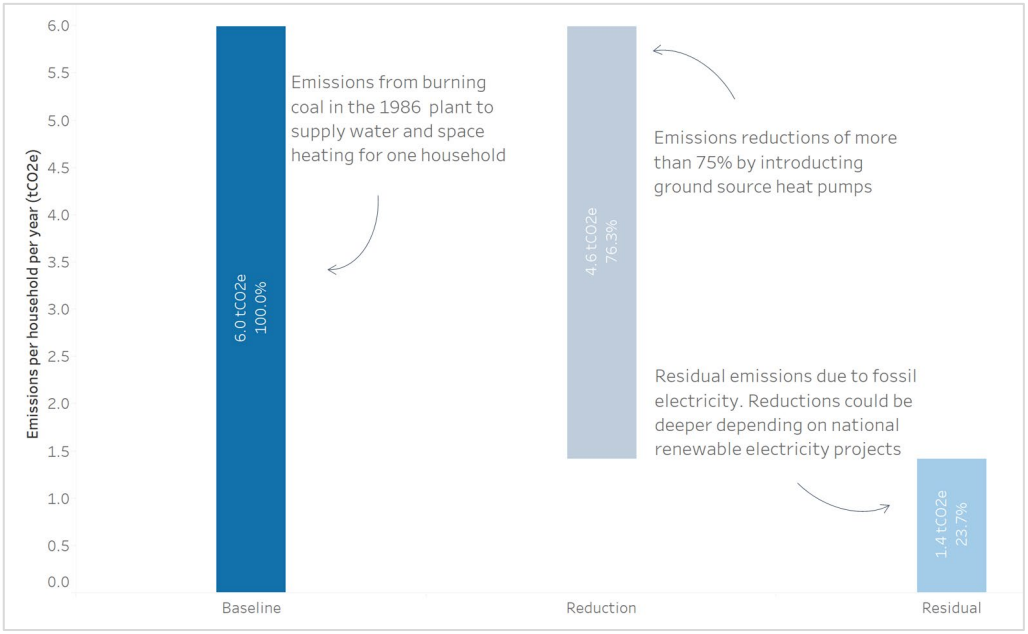

Figure 4: Household residual annual emissions compared to the baseline case which is based on coal-fired district heating in Khovd, Mongolia.

We estimate that heating an average household in a multi-unit apartment building from the local district heat grid generates emissions of 6.0 tCO_2e per year. Because GSHPs run on and would increase demand for electricity – and considering that the local grid is not completely decarbonised, we estimate residual indirect emissions of 1.4 tCO_2e per household per year. We note that many heat pumps use refrigerants that have a high global warming potential, and would propose to use natural refrigerants with low (or no) global warming potential while making provisions for professional decommissioning of the heat pumps at the end of their lifetime to avoid other emissions associated with the project. On a systemic level, upfront costs of the installation of the heat pumps are estimated to be approximately EUR 7.0 million, which the project could reduce by approximately 7,000 tonnes of CO_2 per year. For a crediting period of 10 years, this would correspond to an emissions reduction cost of approximately 100 EUR/tCO_2. It is however conceivable that the upfront installation cost could in part be financed through a soft loan. We assume an investment in both a new coal-fired boiler or GSHP to be debt-financed with a cost of capital of 8.75%[1]. This is likely a conservative estimate but corresponds to the interest rate on government bonds as of June 2019. The loan would partially be repaid by the local utility financed through the savings resulting from the lower O&M from the heat pumps adjusted to reflect the difference between the heating costs residents had previously paid and the increased electricity used to run the heat pumps. If the equivalent of what would have been the upfront investment cost of a new CFB coal-fired boiler – EUR 3.8 million – is financed through a loan, this could reduce the price per tonne of reduced emissions to approximately 46 EUR/tCO_2.

[1] BondEvalue (2019). "Mongolia (Government)". Available at: https://bondevalue.com/bond-market/Government-USY6142NAA64 (Retrieved 3 June 2019).

Disclaimer

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