



Engineering Informed by Anthropology: Decarbonization Efforts through Clean Energy Devices in Mongolia

Project Overview

How can we support an affordable clean energy transition for communities in Ulaanbaatar, Mongolia, one of the world’s coldest and polluted capital cities?



Manduhai Buyandelger

This team, led by MIT Professors Manduhai Buyandelger (Anthropology) and Michael Short (Nuclear Science and Engineering), as well as Research Scientist Lauren Bonilla, worked on low-cost thermal energy storage banks or alternative briquettes (compressed blocks of coal dust or any other flammable biomass), with the goal of combatting climate change, significantly improving household air quality to alleviate respiratory illness, and increasing households’ freedom and agency amidst an increasingly energy- and policy-constrained society. The team’s field site was Ulaanbaatar, Mongolia, the world’s coldest capital city and one of the most polluted due to coal as the main energy source.

The researchers’ immediate objective was to improve and facilitate the usage of their low-cost thermal energy storage prototypes. The technical efficacy of these prototypes has been demonstrated in their previous studies, but the social acceptance and effects on all stakeholders had yet to be fully identified. The team explored the continually evolving larger context of geopolitics, policymaking, business development, infrastructure, and lifestyles to integrate the prototype into these shifting contexts and to facilitate new support structures at the household and community levels. The team also explored whether expanding options for heating sources will enhance individual autonomy, and measurably

foster a more open, free, and democratic society, where citizens are demonstrably empowered to shape their collective future.



Pictured left: Students and faculty from MIT and National University of Mongolia on their first meeting (in Mongolia) with GerHub, a mission-driven organization that seeks to find innovative and creative solutions to the most pressing issues in the ger areas of Mongolia. Photo by Jiyoo Jye.

This research was tied into an MIT undergraduate class entitled *Anthro-Engineering: Decarbonization at the Million-Person Scale*, which is followed by an immersive, ethnographic research expedition to Mongolia. The final goal of the research was educational: to train the next generation of transdisciplinary scholars and innovators who will promote human-centered and socially and culturally viable engineering. In this context, this type of *anthro-engineering* combines rigorous design and physical prototyping, finite element modeling, and field testing in Mongolia (as an example) on heat-saving substances with engineering prototyping of a heating device. By bringing engineering innovation together with anthropological methods and knowledge, this project aimed to bring innovation, helpful service for diverse groups of people, and develop economically viable, socio-culturally acceptable, and scalable energy storage banks.



Pictured left: Faculty and students from the National University of Mongolia came together to organize a welcoming event for the MIT team during their visit to Mongolia, inviting everyone to join them inside a traditional ger dwelling for a khorkhog cookout. Photo by Jiyoo Jye.



The project aligns closely with the MCSC's Social Dimensions pathway.

Findings & Outcomes

The team's deliverables included an improved heat bank, a shift towards a more democratic and free society in Mongolia, and publications that present their research.

- **Improved heat bank.** The researchers aim to make clean energy heat storing system coupled with an operation and logistics system, both of which will lead to Ulaanbaatar's decreased air pollution, better public health, and a more democratic society that is less dependent on the government.

- **Student education.** An equally important outcome was successive cohorts of MIT students trained in Anthro-Engineering: a new, transdisciplinary, human-centered branch of engineering.
- **Publications.** The team is working on publications (articles, papers, and a book) on the Co-PIs' experience of collaboration. These publications will detail attempts to expand our disciplinary boundaries, pedagogical experiments, and students' experiences between MIT and Mongolia and between the lab and people.

Presentations

Lauren Bonilla, Research Scientist who supported this project, presented: *Anthro-Engineering Decarbonization: An Interdisciplinary Approach and Design Practice* at the Society for Applied Anthropology Annual Meeting in Sante Fe, New Mexico; and *What is Anthro-Engineering? Anthropological Approaches to Air Pollution and Decarbonization in Ulaanbaatar* at the National University of Mongolia's Conference in Ulaanbaatar, Mongolia.

Student & Alumni Contributions

Iselle Barrios, MIT undergraduate student, was a table leader at the MCSC's 2024 Annual Symposium for the roundtable session. She led a conversation on *Putting People and Places First in Engineering*. She also authored [a paper](#) on this topic as part of the MCSC Climate and Sustainability Scholars Program.

Arina Khotimsky, an MIT alumna who came on the 2024 trip to Mongolia, spoke at the 2024 World Energy Outlook event, drawing on her observations about energy autonomy in Mongolia to reflect on energy futures under a Trump administration.

Opportunities for Implementation

- With the adoption of new technologies, a large-scale transformation within communities must be overseen and curated, and a holistic approach to implementation is necessary. Heat storage batteries would need a transportation and dissemination infrastructure, and energy companies will need to enhance their local and global collaborations and work with scholars, communities, and engineers.
- Moving forward, there is an opportunity to identify the ways in which Mongolia (and similarly disadvantaged places) can engage in trade without paying large tariffs from the Chinese (and other bigger) governments. This might prompt local companies to work towards discussing global trade with international entities and banks (e.g. the World Bank, the Asian Development Bank).
- Another opportunity is to situate local companies within the new context and market by identifying solutions that local stakeholders can produce, while also offering products that are not yet available. It would also be productive to build flexibility strategies within local companies in relation to different products in cases of uncertain shifts in different geographical areas.