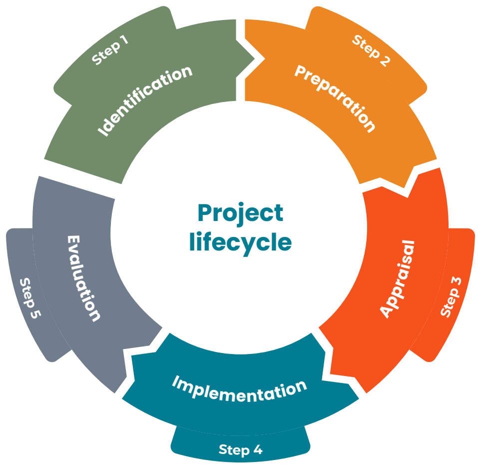
Enhancing Air Quality Outcomes in Energy Efficiency Projects: A Case Study from Ulaanbaatar

The Air Quality Toolkit for Development Finance Institutions (DFIs) guides DFI Project Officers to include air quality considerations into their sectoral development projects, and track the associated air quality co-benefits by identifying meaningful monitoring indicators. The case study is framed around the core project lifecycle steps from Identification to Evaluation. At the concept *Identification* stage, it is important to establish if the project will have an air quality positive impact. During *Preparation* and *Appraisal*, the potential impact of a project on air quality is assessed, opportunities identified to enhance air quality benefits and indicators selected to be used in evaluation. *Implementation* and *Evaluation* involves ensuring that planned air quality benefits are realised during project delivery, collecting relevant data to track progress against indicators, and assessing the actual air quality outcomes after project completion.

OPPORTUNITIES TO MAINSTREAM AIR QUALITY THROUGHOUT A PROJECT LIFECYCLE



Project factsheet

Name

Energy Performance Contracting for Residential Retrofitting in Ulaanbaatar City (RePaRe)

Date

2022 - 2027

Location

Ulaanbaatar City, Mongolia

Sector(s)

Domestic, Energy

Funders

Mitigation Action Facility (MAF) on behalf of the German Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety and the UK Department for Energy Security and Net Zero

Partner Contributions

Government of Mongolia (Ministry of Urban Development, Construction and Housing), Municipality of Ulaanbaatar, Implemented by: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Value

MAF: €18 million

Partner Contributions: €14.5 million

Main objectives

To transform Mongolia's residential building sector by significantly improving energy efficiency, improving living conditions and reducing greenhouse gas emissions:

1. Provide funding for retrofitting of 200 private apartment buildings and enable large scale investments from private sector into energy efficient buildings.
2. Establish a flexible financing mechanism to cover upfront costs of retrofitting.
3. Reduce heating consumption demand of residential panel buildings to reduce carbon dioxide (CO_2) emissions.

Project site

www.mitigation-action.org/projects/mongolia-energy-performance-building-retrofitting/

www.repare.mn

Background and context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This case study looks at how the existing Energy Performance Contracting for Residential Retrofitting in Ulaanbaatar City (RePaRe) project, implemented by GIZ, incorporated air quality considerations and explores where the *Air Quality Toolkit for DFIs* could have supported enhanced inclusion of air quality as an explicit co-benefit.

Ulaanbaatar experiences extreme winters that drive high heating demand. During the cold season, 80% of the city's air pollution is caused by residential household stoves, compared to 10% by road transport, and 6% by power plants. Approximately 20% of Ulaanbaatar's residents live in prefabricated apartment blocks; these buildings suffer from poor insulation, outdated heating systems, and structural deficiencies, leading to significant heat loss, high energy consumption, and deteriorating living conditions. Mongolia's reliance on coal for heating further contributes to its status as one of the highest per-capita greenhouse gas (GHG) emitters among comparable economies, despite recent policies such as transitioning Ulaanbaatar's ger districts to improved compressed fuel.

Improving energy efficiency in residential buildings is central to Mongolia's climate commitments. However, retrofitting efforts have been constrained by systemic barriers: limited access to affordable financing; high commercial loan rates; and a tariff system that reduces incentives for households. The RePaRe project addresses some of these challenges by providing initial funds to retrofit approximately 200 apartment blocks and introducing revolving (flexible) financing mechanisms to scale-up its interventions to all panel buildings in Ulaanbaatar. The retrofitting work includes insulation of walls and roofs, as well as the installation of heat meters and automated controls to improve energy performance. This initiative aims to reduce CO_2 emissions, improve living standards, and create sustainable market conditions for large-scale energy efficiency investments.

Identification of opportunities to improve air quality

While the RePaRe project is mainly targeted at improving energy efficiency and climate mitigation through the retrofitting process, its interventions are likely to provide co-benefits for air quality improvement in Ulaanbaatar which could be further drawn out with help from the guidance in the *Air Quality Toolkit for DFIs*.

The primary air quality benefit from this project would arise from improvements in energy efficiency throughout the 200 apartment blocks, which will have a quantifiable reduction in fuel consumption. In Mongolia, where coal remains the dominant fuel source, lower fuel use will help reduce both GHG emissions and emissions of key air pollutants such as oxides of nitrogen (NO_x) and particulate matter (PM_{10} and $PM_{2.5}$). The RePaRe project therefore has the potential to impact ambient air quality levels across the city. Furthermore, as the project addresses sources of heating inside the home, improvements in indoor air quality would also be expected, which can have significant health benefits.

This project could also introduce additional measures to address indoor air quality if not yet considered. Poorly insulated buildings can be susceptible to infiltration of outdoor polluted air. With improved insulation and airtightness, the buildings will already have reduced uncontrolled infiltration, lowering indoor concentrations of $PM_{2.5}$ and other pollutants (e.g., Volatile Organic Compounds (VOCs)). However, energy-inefficient buildings often rely on opening windows for ventilation, which introduces outdoor pollution. Efficiency upgrades should also include controlled ventilation systems to ensure improved indoor air quality improvements while maintaining energy savings.

Preparation and appraisal

One way of quantifying improvements to air quality as a result of project implementation is through direct measurements. Ulaanbaatar already has a monitoring network which could be used to establish a baseline and then used to quantify changes in ambient air quality across the city. As the RePaRe project is targeting 200 apartment blocks across the city and the contribution of air pollution from the residential sector is high, significant changes may be observed from the ambient pollution measurements. Another option for the project could be to undertake indoor air quality monitoring within the apartment blocks, for example using low-cost sensors. This would support quantification of improvements in indoor air pollution exposure.

In addition to monitoring changes in air quality, the reduction in emissions of key pollutants due to reduction in coal consumption as a result of improved energy performance of the apartment blocks could be estimated. Using quantified or estimated fuel savings, emissions reductions of key pollutants, such as PM_{10} and $PM_{2.5}$, NO_x, SO_x, heavy metals and polycyclic aromatic hydrocarbons (PAHs), can be approximated using emissions factors from handbooks such as the Atmospheric Brown Clouds Manual, EMEP-EEA Guidebook, or US-EPA AP42. More detail on these types of assessments can be found in Section 2.2.4 of the *Air Quality Toolkit for DFIs*.

The Toolkit also describes further steps that could have been considered using population/exposure data, health impact functions, and economic valuation methods to estimate the potential health and economic benefits arising from air quality improvements. The Air Quality Toolbox "Assessing potential impacts of projects" provides examples of tools that can assist with this, such as Air Quality through Urban Actions (AQUA) (C40) or The Long-range Energy Alternatives Planning – Integrated Benefits Calculator (LEAP-IBC) (Stockholm Environment Institute). This is particularly relevant for the RePaRe project, as a way to help contextualise the expected improvements in indoor air pollution.

Implementation and evaluation

As discussed above, ambient air quality monitoring is unlikely to demonstrate the full extent of the RePaRe project's impact on air quality. However, explicit air quality co-benefits can also be tracked using other relevant data. Within the *Air Quality Toolkit for DFIs*, Appendix 2 provides example indicators for tracking air quality outcomes. The table below highlights indicators from the RePaRe project's monitoring framework which can be related to air quality, and recommends further examples to help track air quality co-benefits.

RePaRe project indicators which can be related to air quality	Recommendations for indicators to track air quality co-benefits
• % of building energy demand reduced → a proxy indicator for reduced coal use, reduced GHG and air pollutant emissions. • GHG emissions reduced → a proxy indicator for reduced coal use which also reduces air pollutant emissions. • People benefitting from the project → a proxy for reduced human exposure to indoor air pollutants from inefficient heating. • Number of co-benefits achieved → air quality improvement can be considered as one of these co-benefits.	• Improvement in indoor air pollution before and after retrofit → measures direct air quality improvements. • Change in total fuel (coal) use as a result of energy efficiency measures → decrease in amount of coal burnt could be used to estimate reduction in emissions of air pollutants such as NO_x, PM, VOCs, etc.

This case study demonstrates how explicit air quality co-benefits were identified from a domestic sector energy efficiency project, and explores how air quality improvements resulting from the project could be tracked more effectively using proxy indicators and indoor air quality monitoring. For more information on how these concepts can be applied to other development projects, please see the *Air Quality Toolkit for DFIs*.

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