

Life Cycle Analysis of a Renovation Project for Old Housing in Tashkent to Reduce Greenhouse Gas Emissions

Elyor Makhmudov¹, Anna Zavaleeva^{2}, Ilya Zavaleev², and Akmal Berdimurodov³*

¹Diplomat University, Tashkent, Uzbekistan

²HPBS, Tashkent, Uzbekistan

³"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University, Tashkent, Uzbekistan

Abstract. The shift towards economic decarbonization through the reduction of carbon dioxide emissions has led to a focus on renovating and modernizing the existing buildings rather than constructing new ones. This research emphasizes the critical differences between the construction of new buildings and the modernization of the existing structures, specifically in the context of Uzbekistan. The country lacks a comprehensive methodology for accounting for the embodied carbon of building materials used in modernization projects. This research aims to bridge this gap by conducting a life cycle analysis (LCA) of a project focused on enhancing the thermal performance of the enclosing structures of a three to five-story multifamily residential building, commonly referred to as “Khrushchevka”. The analysis found that retrofitting buildings reduced greenhouse gas emissions by 13.5% through improved energy efficiency, despite the increase in initial emissions associated with the production and installation of insulation materials. The total reduction in carbon emissions over the entire life cycle of the reconstructed building was 24% (or 43.2 tons of CO₂), including emissions associated with the production of insulation. The payback period for emissions, which offsets the initial emissions during reconstruction, is 17 years.

Key Words: Energy efficiency; Carbon emissions; Retrofitting old housing.

1 Introduction

In the context of the global fight against climate change and the desire to decarbonize the economy, reducing the carbon footprint of construction and operation of buildings is becoming critical.

Renovation of existing buildings seems especially significant in Uzbekistan, where a significant part of the housing stock was built during the Soviet period and does not meet

* Corresponding author: anya.zavaleeva@gmail.com

modern energy efficiency standards. Given that the construction of new energy-efficient buildings requires significant resources, the renovation of existing structures using modern materials and technologies can be a more sustainable and economically feasible approach.

Therefore, our study is focused on the development of a methodology for accounting for carbon in building materials and assessing their environmental impact throughout the life cycle of a building. This is especially important for Uzbekistan, which is actively striving to fulfill its obligations under the Paris Agreement and move faster to a green economy. The results of this study can serve as a basis for developing a strategy for sustainable construction and renovation of buildings.

1.1 Research goals and tasks

The objective of this study is to conduct a comprehensive life cycle analysis of a multi-storey residential building renovation project to assess its environmental impact, including accounting for the embodied carbon in building materials and determining the carbon payback period.

To achieve the stated goal, the following research objectives have been identified: to examine the drivers behind the decarbonization efforts in Uzbekistan's economy, specifically regarding the enhancement of energy efficiency in existing buildings and structures; to analyze international approaches and experiences in accounting for embodied carbon dioxide to glean insights applicable to the Uzbek context; to gather and assess data pertaining to thermal efficiency and energy consumption in the target structures; to calculate the emissions of carbon dioxide per unit of heat energy consumed within the Tashkent area; to conduct a comprehensive life cycle analysis of the project to evaluate its environmental impact and carbon footprint.

1.2 Contribution of Uzbekistan to reducing greenhouse gas emissions

Uzbekistan ratified the Paris Agreement (Paris, 12 December 2015) in October 2018 [1]. To ensure the implementation of the Paris Agreement commitments and the transition of the Republic of Uzbekistan to a green economy, two fundamental Presidential resolutions have been passed during 2019-2022 [2, 3].

Uzbekistan is poised to achieve a carbon-neutral electricity sector by 2050, backed by both technical feasibility and economic viability. With an investment requirement of less than 2% of annual GDP between 2030 and 2050, the benefits of this transition far outweigh the costs. This roadmap not only preserves domestic gas reserves but also opens avenues for new manufacturing chains and supports the burgeoning hydrogen economy. To realize this vision, significant technical and regulatory reforms are imperative, bolstered by unwavering political commitment.

Uzbekistan faces the imperative to shift its electricity generation mix away from coal and gas toward cleaner alternatives to meet growing energy demands and reduce greenhouse gas emissions as per its Paris Agreement commitments. Diversifying energy sources, enhancing regional electricity trade, and promoting energy efficiency are vital strategies. With support from EBRD and Japan, a roadmap aligning with Uzbekistan's Paris Agreement goals outlines steps to prioritize renewables and low-carbon technologies, aiming for carbon neutrality by 2050. This plan not only aligns with national emissions targets but also attracts green investments in line with international lending policies [4, 12].

In 2019, Uzbekistan's Total Final Consumption (TFC) amounted to 30.9 Mtoe. Analysis reveals that natural gas dominated consumption, comprising approximately 60% of the TFC (Fig. 1). Electricity and heat accounted for 15% and 10% respectively. Petroleum products, including gasoline and diesel, constituted about 12.6% of total consumption. Among sectors,

households were the largest consumers (34.8%), followed by industry (23.0%) and transport (19.7%) [5].

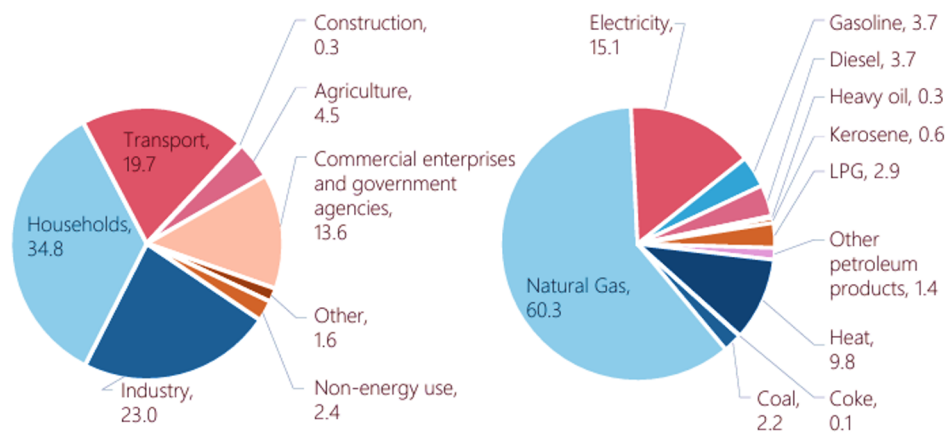


Fig. 1. Total final consumption per fuel and by sectors in 2019, %.

Over the past period, Uzbekistan witnessed notable demographic and infrastructural shifts: a 17.6% rise in permanent population, accompanied by a 25.5% increase in residential building stock, while Total Final Consumption (TFC) in households dropped by 37.4%. Consequently, specific energy consumption halved from 466 kWh/m² in 2010 to 233 kWh/m² in 2019 (Fig. 2). The graph shows that despite the significant increase in the volume of housing stock, expressed in the growth of the number and area of residential buildings, there was a noticeable decrease in specific energy consumption per square meter. This decrease in specific energy consumption indicates an increase in the energy efficiency of the existing housing stock. This achievement is attributed to targeted policy interventions, including state energy-saving programs, tariff adjustments, and revisions to building codes, alongside heightened public awareness of cost-effective energy efficiency measures [13-17].

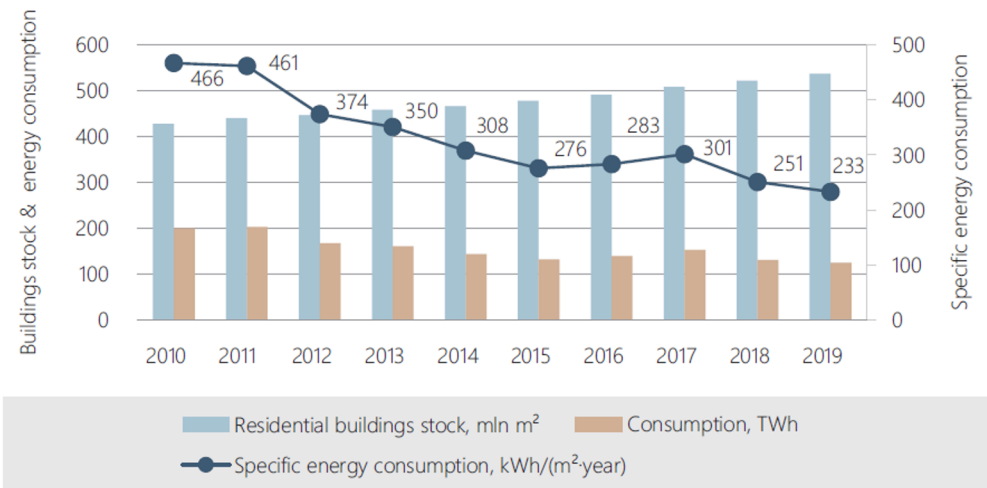


Fig. 2. Residential buildings stock, total and specific energy consumption.

Natural gas emerges as the predominant fuel for buildings, constituting 70.5% and 54.2% of consumption in residential and tertiary sectors respectively, in 2019. Heat energy, accounting for 28.5% in public and commercial buildings, contrasts sharply with its lower share of 11.0% in residential settings, largely due to the prevalence of centralized heating systems in public buildings versus individual gas boilers in rural residential areas. Electricity's role remains consistent across both sectors, comprising approximately 10.2% and 10.8% of energy consumption in tertiary and residential sectors respectively [5].

1.3 Contribution of 3-5 stores Khrushovka series buildings to greenhouse gas emissions in Tashkent

The Khrushchevka series is the most prevalent type of three to five-story residential buildings in Tashkent, as noted on the age.tashkent.uz website. These buildings are found in substantial quantities across almost all districts of Tashkent. Constructed rapidly following the 1966 earthquake, the Khrushchevka buildings became the dominant housing series until the 1980s, contributing to approximately 30-40% of Tashkent’s building stock [6].

Khrushchevkas are three to five-story residential buildings characterized by compact apartments with small kitchens and bathrooms. These buildings are not equipped with elevators and garbage chutes, which is one of their main features.

Structural features include brick or panel frames with external walls made of brick or reinforced concrete panels [10]. The floors in the buildings are made of precast concrete, and the roofs can be flat or pitched, often with additional thermal insulation.

Engineering systems of such houses include centralized heating and water supply. However, the electrical wiring in these buildings is often outdated and requires modernization.

Thermal insulation and sound insulation in Khrushchevkas leave much to be desired: poor thermal insulation leads to high heating costs, and the average level of sound insulation between floors and apartments does not always meet modern requirements.

The advantages and disadvantages of these buildings are also obvious. The advantages include fast and inexpensive construction, the ability to easily redesign apartments, and high demand for such housing due to its relative affordability. The disadvantages include low comfort levels, high operating costs, small room sizes, and low ceilings.

Historically, Khrushchevkas symbolized mass housing construction in the USSR, providing affordable housing for millions of people. Despite their age, these buildings are still in demand due to their affordability and rapid occupancy. However, their modernization is a key step to improve energy efficiency and living conditions.

Although Khrushchevka buildings have higher resistance to heat transfer compared to other panel buildings from the USSR era, they fall significantly short of current building code requirements and recommendations for energy efficiency. Comparative data from different standards illustrate this gap (Table 1).

Table 1. R-values of resistance to heat transfer of enclosing structures from different standards.

Enclosure Type	SNIP II-A.7-62 (m ² ·°C/W)	Current Code (m ² ·°C/W)
Exterior Walls	0.95	1.82
Roof	1.35	2.44
Windows	0.38	0.53

The degradation of the resistance coefficient due to the violation of the integrity of the enclosing structures exacerbates the problem, resulting in higher greenhouse gas emissions due to increased heating requirements. This situation presents a significant challenge to Uzbekistan’s plans to reduce greenhouse gas emissions.

To align with emission reduction goals, substantial interventions are required. The options include:

1. **Reconstruction with Enhanced Energy Efficiency.** This involves retrofitting existing buildings with modern insulation and energy-efficient materials to improve thermal performance.

2. **Complete Renovation.** This option would replace the old housing stock with new buildings that meet current energy efficiency standards.

Given the potential to preserve historical and cultural heritage while enhancing sustainability, the authors advocate for the reconstruction option. This approach aims to significantly increase the energy efficiency of Khrushchevka buildings, thereby reducing their greenhouse gas emissions and contributing to Uzbekistan's broader environmental objectives.

2 Materials and Methods

2.1 Information on the studied objects

For a detailed study, 33 Khrushchевka series buildings located in the massive Labzak of Tashkent were selected. The average values for these objects were used to calculate the required amount of insulation and conduct thermal calculations of enclosing structures. The initial data for heat calculation included factors such as construction site, humidity zone, duration of the heating period, and design temperatures (Fig. 3).

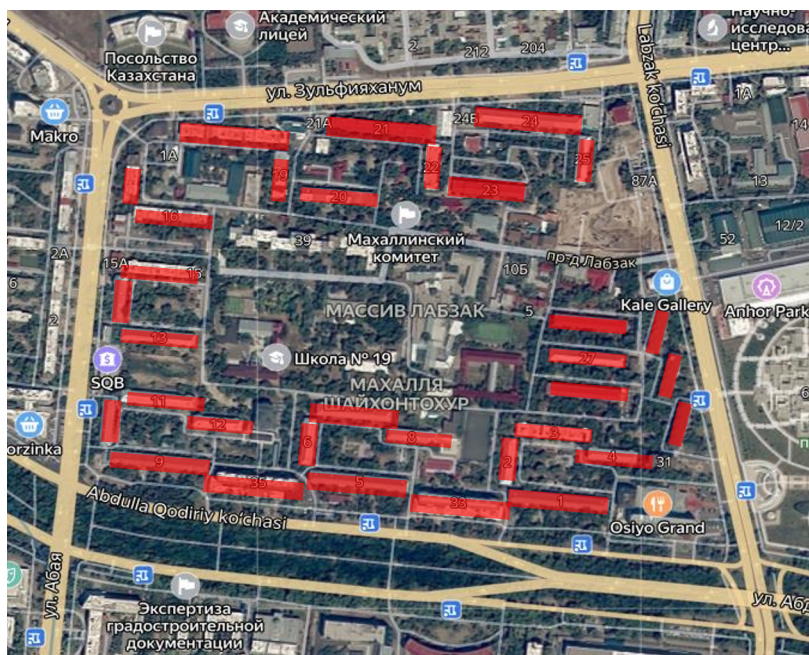


Fig. 3. Map of the massive Labzak of Tashkent.

Note: Buildings under study are highlighted in red.

Fig. 4 is a heat map of Tashkent. This heat map visualizes temperature data showing the distribution of heat across different areas of the city. The map allows identifying areas with

higher or lower temperatures, which may be due to various factors, including types of development, population density, the presence of green spaces, and heating infrastructure.

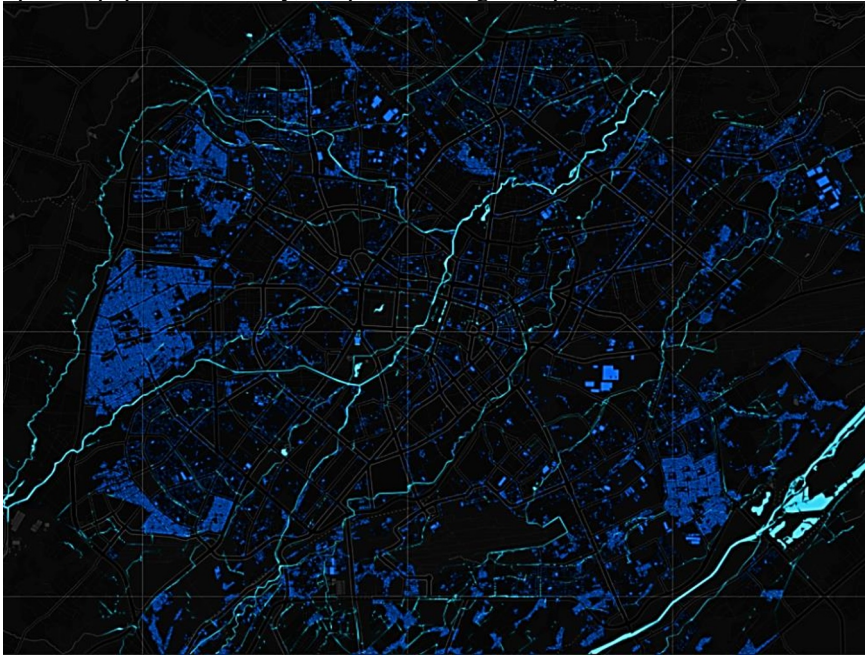


Fig. 4. Heat map of Tashkent city.

The authors employ the average values for the objects under study to calculate the required amount of insulation. The following Thermal calculations of enclosing structures are carried out.

Initial data for heat calculation:

- Construction site – Tashkent;
- Humidity zone – Dry;
- Duration of the heating period $z_{ht} = 148$ days;
- Average design temperature of the heating period $t_{ht} = +2,8^{\circ}\text{C}$;
- Temperature of a cold five-day week $t_{ext} = -16^{\circ}\text{C}$;
- Internal air temperature $t_{int} = +21^{\circ}\text{C}$;
- Indoor air humidity $\varphi = 55\%$;
- Room humidity mode – normal.

2.2 Calculation of the amount of insulation. Calculation of the number of greenhouse gases emitted into the environment during the project life cycle

The authors employed building life cycle analysis to estimate greenhouse gas emissions from a Khrushchevka series building renovation, following ISO 14040/44 and standard practices. The service life after reconstruction is assumed to be 60 years, with insulation replacement every 30 years.

2.3 Reconstruction stage

At the reconstruction stage, the primary contributor to greenhouse gas emissions is the production of building materials. In particular, the authors have utilized the ISOVER Facade insulation, for which there is a verified EPD (Environmental Product Declaration).

EPD calculates greenhouse gas emissions and other environmental footprint indicators, expressed in various units of measurement per unit of production. For the insulation ISOVER Facade for the indicator of greenhouse gas emissions, CO₂ is used in kg per 1 m³ of product.

Following the EPD declaration for ISOVER Facade products, carbon dioxide emissions for producing a 0.05 m³ sample are 1.55 kg CO₂e.

Next, the authors calculate the required amount of insulation required to bring the building to the current level of energy efficiency standards.

Table 2 demonstrates the calculation results for the required insulation thickness.

Table 3 depicts the results of calculating the required insulation volume.

Table 4 illustrates the calculation results for greenhouse gases emitted into the environment.

Table 2. Calculation results of the required insulation thickness.

Insulation type	Thermal conductivity λБ, W/(m*0C)	Required insulation thickness δ, in mm	Actual resistance to heat transfer of the building envelope R m2 * °C / W
Exterior walls			
ISOVER Facade	0.041	200	5.47
Slabs above the basement, Attic			
ISOVER Facade	0.041	250	7.14

Source: Compiled by the authors.

Table 3. Calculation results of the required insulation volume.

Enclosing structure type	Insulation thickness, in mm.	Insulation area, in m ²	Insulation volume, in m ³
Exterior walls	200	1,881.6	376.32
Attic	250	864	216
Slabs above the basement	250	864	216

Source: Compiled by the authors.

Table 4. Calculation results of greenhouse gases emitted into the environment.

Enclosing structure type	Carbon dioxide emission of a sample with a volume of 0.05 m3, in kg	Carbon dioxide emission, taking into consideration the required insulation volume, in kg
Exterior walls	1.55	11,666
Attic		6,696
Slabs above the basement		6,696
Total:		25,058

Source: Compiled by the authors.

In total, the building’s reconstruction stage will involve approximately 25 tons of CO₂e embodied in greenhouse gas emissions, which have been spent on insulation production. Besides, the authors take into account that the service life of the insulation will be 30 years, and this factor means that after this period, a complete replacement of the insulation will be carried out.

2.4 Calculation of greenhouse gas emissions during the stage of building operation before and after the reconstruction

Greenhouse gas emissions occur from primary energy sources, which are generated for heating. In particular, for Tashkent, thermal energy is generated centrally at combined heat and power plants. To comprehend the amount of greenhouse gas emissions carried out for heating, the authors analyze the existing typical heating scheme for Tashkent buildings, with natural gas being the primary fuel.

2.5 Calculation of greenhouse gas emissions at the Tashkent thermal power plant from the combustion of conventional fuel to generate heat for heating one primary building

The specific consumption of equivalent fuel for the supply of heat energy (kg/Gcal) has been calculated based on the Heat supply scheme for the city of Tashkent. The primary fuel used at the thermal power plant in Tashkent is natural gas. Emissions are calculated based on GHG methodology .

As a result, the average estimated value of emissions from 2020 to 2023 has been taken after calculating the percentage of heat losses during transportation through the pipeline, taken as the average calculated value of losses for the period from 2020 to 2023, according to the Heat supply scheme for the city of Tashkent. The authors determine that 1 Gcal of thermal energy from Tashkent CHPP produces 387.8 kg of CO₂.

2.6 Calculation of annual greenhouse gas emissions before the reconstruction

The standard of heat consumption for heating in the Tashkent Region is contained in the Order of the Department for Tariffs of the Tashkent Region.

From this data, one can perceive that the energy spent on heating in one typical residential building for one heating season equals 11,685.38 kg of carbon dioxide emissions per year.

2.7 Calculation of the reduction of thermal energy losses through the enclosing structures after the insulation installation

The percentage and amount of losses through the enclosing structures under study are known from the energy passport.

Since the authors assume the thickness of the building envelope according to the recommendations of the Practical guide to improving the energy efficiency of apartment buildings during major renovations, the authors are familiar with the percentage reduction in losses for each envelope type. Table 5 demonstrates the results. The obtained results are close to other research results and are taken for further calculation [9].

Table 5. Losses of thermal energy through enclosing structures after the insulation installation.

	Basic level of losses through the enclosing structure, in %	Loss of Gcal/year without insulation	Decrease in the level of losses through the enclosing structure, in %	Loss of Gcal/year with insulation
Slab above the basement	12	4.73	6.57	4.42
External walls	41	16.16	20.73	12.81
Attic	16	6.31	6.57	5.89

Source: Compiled by the authors.

2.8 Calculation of annual greenhouse gas emissions after the reconstruction

From the calculation results, it is evident that the improvement of energy efficiency allows one to achieve savings in heat energy spent on heating in the amount of 4.07 Gcal per year, which in turn is equivalent to 1,580.11 kg of greenhouse gases (CO₂e), which can be released into the environment during the generation of this heat energy at thermal power plants.

Annual emissions of greenhouse gases for heating after the reconstruction will amount to 10.1 tons of CO₂e per year, and it is 13.5% lower than without the reconstruction.

3 Results

Following the international practice requirements for assessing the life cycle of a building, one assumes the service life to be 60 years. The service life of mineral wool is assumed to be 30 years. During the life cycle of the building, mineral wool will be replaced two times. First of all – during the initial reconstruction, then – after 30 years. By the time of 60 years, the authors believe that the building will be entirely demolished.

Table 6 presents a comparative table of the implementation of the two scenarios. In the first case, the calculation has been performed for a building without improving the thermal properties, and in the second case, the reconstruction has been performed. The diagram (Fig. 5) compares scenarios by using cumulative total numbers from Table 6.

Table 6. Carbon dioxide emissions for two scenarios throughout the life cycle of a building.

Years	Without reconstruction, t CO ₂			With reconstruction, t CO ₂		
	Material	Heating	Cumulative total	Material	Heating	Cumulative total
1	0	11.69	11.69	25	11.69	36.69
2	0	11.69	23.38	0	10.11	46.8
3	0	11.69	35.07	0	10.11	56.91
...						
30	0	11.69	350.7	25	10.11	354.88
31	0	11.69	362.39	0	10.11	364.99
...						
60	0	11.69	701.4	0	10.11	658.18

Source: Compiled by the authors.

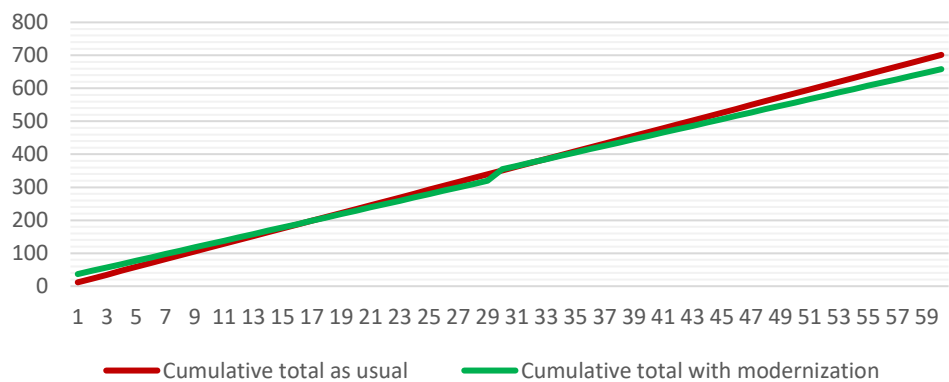


Fig. 5. Comparison of total greenhouse gas emissions.

Source: Compiled by the authors.

The diagram below (Fig. 6) compares the embodied greenhouse gas emissions that have been spent on the production of insulation and the reduction of greenhouse gas emissions due to the application of this insulation to the building during its operation.

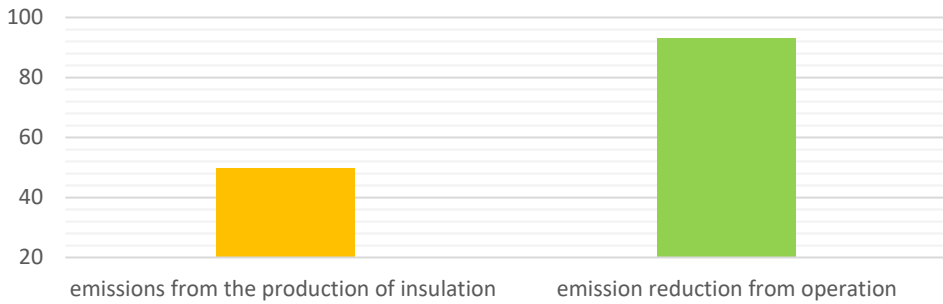


Fig. 6. Comparison of embodied emissions and reduction of indirect energy emissions of greenhouse gases.

Source: Compiled by the authors.

The following conclusions can be drawn from the calculation:

- The annual reduction of greenhouse gas emissions due to savings on energy consumption for heating after reconstruction is 13.5%;
- One should note that the renovation increases the initial greenhouse gas emissions by producing additional insulation. These emissions will be reflected in another sector of the economy – GDP (production growth) – and not as an indicator of residential and public building energy efficiency;
- The reduction of greenhouse gas emissions throughout the entire life cycle of a building, subject to reconstruction, is 2,4% or 43.2 tons of CO₂ including emission on the production of insulation;
- Compensation of initial emissions for reconstruction by reducing emissions during the operation is achieved in 17 years. In other words, the “payback period for emissions” is ten years;
- Over a life cycle of 60 years, the embodied emissions spent on insulation production are 50 tons of CO₂e, and the reduction in indirect energy emissions is 93.2 tons of CO₂ excluding emission on production of insulation;
- As planned by the existing regulations and plans, substantial insulation of the building does not allow one to achieve significant reductions in greenhouse gas emissions. To reduce greenhouse gas emissions, one requires systematic optimization of real sectors of the economy that interact with housing, such as energy, transport, production of materials, waste processing, and construction.

4 Discussion

The obtained results reveal the critical dependence of reducing emissions of renovation projects on the life-cycle of the building and the choice of building materials and technologies [11]. The authors have identified the lack of topics on this theme in the Uzbekistan during the research. Since international methods and calculation criteria are based on regulatory documents official for their countries, these methods are challenging to apply in projects on the territory of the Uzbekistan [7]. The research is limited by the absence of the Environmental Product Declaration (EPD) for most building materials produced in the

Uzbekistan, making it impossible to determine the embodied carbon dioxide in building materials in more complex projects.

The research reveals the necessity to develop a tool for automated accounting of embodied carbon dioxide in building materials [8]. Failure to take this criterion into account in ongoing projects overestimates emission reductions and is misleading. Since there is no unified calculation methodology, the research has been conducted in hopes that further research will lead to creating a unified calculation method and modern tools for accounting for embodied carbon dioxide.

5 Conclusion

If one carries out the traditional calculation of greenhouse gas emissions while considering the energy consumption during the operation only, misconceptions can arise that improving the energy efficiency of buildings in any case leads to a reduction in greenhouse gas emissions by reducing the consumption of fossil fuels. Nonetheless, as the analysis of the life cycle of the buildings has shown, it is essential to consider all stages of the product life cycle since a significant part of greenhouse gases can be latent or, in other words, “embodied” greenhouse gas emissions. These emissions are carried out during the reconstruction and repair of the building by entirely third-party enterprises. For example, they include insulation, cement, or steel production. In the authors’ example, the reconstruction possesses the environmental feasibility since production. The actual embodied emissions for reconstruction are more than two times lower than the reduced indirect energy emissions. However, it will not necessarily be repeated at other residential, and public buildings since the volume of emissions are highly dependent on a significant number of factors, such as primary fuel, the energy efficiency of the heating system, technology for the production of building materials, logistics, etc.

References

1. Law of the Republic of Uzbekistan No. ZRU-491 of 02 October 2018 "On ratification of the Paris Agreement".
2. Resolution of the President of the Republic of Uzbekistan of October 4, 2019 No. PP-4477 “On approval of Strategy for transition of the Republic of Uzbekistan to green economy for 2019-2030”
3. Presidential Resolution No. PP-436 of 02 December 2022 "On measures to improve the effectiveness of reforms aimed at transitioning the Republic of Uzbekistan to a Green Economy until 2030".
4. EBRD (2021), A Carbon Neutral Electricity Sector in Uzbekistan: Summary for Policy Makers, European Bank for Reconstruction and Development (EBRD), <https://www.ebrd.com/Carbon-neutral-electricity-sector-in-Uzbekistan.pdf> Accessed on June 1, 2024
5. Energy Charter Secretariat, 2022. Boulevard de la Woluwe, 46 B-1200 Brussels, Belgium. ISBN 978-905948-241-8 (PDF, English), ISBN 978-905948-240-1 (Paperback, English). Depot Number: D/2022/7850/1. In-Depth Review of the Energy Efficiency Policy of the Republic of Uzbekistan. Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects PEEREA
6. Age Toshkent – Toshkent www.age.tashkent.uz Accessed on June 1, 2024
7. F. Asdrubali, G. Grazieschi, Life cycle assessment of energy efficient buildings. Energy Reports **6** (2020) 270–285

8. D. Densley-Tingley, J. Giesekam, S. Cooper-Searle, "Applying circular economy principles to reduce embodied carbon," in embodied carbon in buildings: Measurement, management, and mitigation. *Procedia CIRP* **80** (2018) 619-624
9. Z.G. Maryina, A.Yu. Vereshchagin, A.V. Novozhilova, et al., Increase of enclosing structures thermal properties of NARFU brick building. *Trudy BGTU* **1** (2018) 78-84
10. P. Pihelo, T. Kalamees, K. Kuusk, nZEB renovation with prefabricated modular panels. *Energy Procedia* **132** (2017) 1006-1011
11. B.I. Zabalza, C.A. Valero, U.A. Aranda, Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential. *Building and Environment* **46** (2011) 1133-1140
12. M. Raimjanova, L. Sabirova, N. Khanova, Sh. Asamkhodjaeva, K. Nosurullaev, Impact of investments on the economy of the Republic of Uzbekistan and the importance of its geographical location. *E3S Web of Conferences* **244**, 10042 (2021) <https://doi.org/10.1051/e3sconf/202124410042>
13. A. Babajanov, U. Islomov, S. Umarov, R. Abdiramanov, M. Inoyatova, Organizational and economic mechanisms of regulating land relations in agriculture. In *BIO Web of Conferences* **65** (2023) <https://doi.org/10.1051/bioconf/20236503005>
14. B. Menglikulov, S. Umarov, A. Safarov, T. Zhyemuratov, N. Alieva, A. Durmanov, Ways to increase the efficiency of transport logistics - Communication services in Uzbekistan. *E3S Web of Conferences* **389** (2023) <https://doi.org/10.1051/e3sconf/202338905036>
15. D. Bazarov, S. Umarov, R. Oymatov, F. Uljaev, K. Rayimov, I. Raimova, Hydraulic parameters in the area of the main dam intake structure of the river. *E3S Web of Conferences* **264** (2021) <https://doi.org/10.1051/e3sconf/202126403002>
16. A. Toshboev, D. Mamadiyarov, S. Baymuradov, U. Alimov, S. Iskandarov, Efficiency of agrobusiness development in agriculture. *E3S Web of Conferences* **244** (2021) <https://doi.org/10.1051/e3sconf/202124403019>
17. D. Ziyadullaev, D. Muhamediyeva, S. Ziyaeva, ... K. Kayumov, O. Ismailov, Development of a traditional transport system based on the bee colony algorithm. *E3S Web of Conferences* (2023) <https://doi.org/10.1051/e3sconf/202336501017>