

Trends in the development of energy-efficient construction

Lali Gasitashvili

Technical University of Georgia, Tbilisi, Kostava 77, 0160

l.gasitashvili@gtu.ge

DOI: <https://doi.org/10.52340/building.2025.71.22>

Abstract Energy-efficient construction plays an important role in reducing energy consumption and greenhouse gas emissions. Human activity significantly increases the global problems caused by climate change. Modern energy-efficient and energy-saving technologies and materials used in the construction sector significantly contribute to reducing the effects of global warming. The article discusses the measures to be taken to solve the above problems facing the construction industry.

Keywords: energy-efficient construction, renewable energies and energy-efficient technologies, carbon footprint, greenhouse gases, green buildings, passive and active buildings.

Introduction:

Implementation of the priority direction of socio-economic development - construction of modern housing at an affordable price, presents the construction industry with the task of developing new energy-efficient technologies in construction

The most pressing issue facing humanity today is "global warming," which is manifested in climate change. "Global warming" has often become a motivator for various environmental movements. The world is asking the question: can humans slow down climate change by taking certain measures?

1. The construction sector and climate change

The development of renewable energies and energy-efficient technologies is an

indispensable response to the pressing environmental, economic and social challenges facing the world's population. It is a necessary condition for mitigating climate change and conserving biodiversity, as well as ensuring human well-being and quality of life.

The Earth has been an urban planet for decades, with 2008 being the last year in history when the majority of the world's population lived in rural areas, and since 2009 we have been living on an urban planet. By 2050, 68% of the nearly 10 billion people on Earth will be city dwellers. This means that many of us will be surrounded by urban infrastructure – buildings and structures. By 2060, the area of buildings is expected to double, meaning construction will also increase. New construction and renovation of existing buildings will affect the economic performance of every country, as well as climate change anywhere in the world.

Climate change is a global emergency that transcends national borders. This challenge requires coordinated solutions at all levels and international cooperation to help countries transition to a low-carbon economy.

Impacts and problems

The first problem we face when talking about the climate impact of the construction industry is that it is difficult to measure this impact. Construction is a long, complex process that involves many activities, from mining to waste disposal. Typically, the carbon footprint of construction is "packaged" in indicators for individual industries - energy, cement production, steel, etc.

However, even with this approach, it is

clear that the overall carbon footprint of the industry is huge, as it involves many resource- and energy-intensive processes. Cement production alone accounts for 7% of global greenhouse gas emissions. Cement, steel, aluminum, and glass all require high temperatures, which means a lot of energy. Energy generation for steel production accounts for more than 7-9% of energy emissions, and about half of the steel is used in construction. 35% of all energy generation and 38% of energy emissions are related to the construction and operation of buildings. In addition, many energy industries can only operate on hydrocarbon sources.

Buildings typically have a lifespan of decades, and the products of each stage determine to some extent the carbon footprint of the next stage. For example, high-quality building materials can improve energy efficiency and reduce emissions during operation.

2. Solutions and Innovations

The World Green Building Council defines the types of greenhouse gas emissions in construction:

- Emissions from the extraction, production, and transportation of materials and resources account for approximately 11% of global emissions and are typically not considered construction emissions.
- Primary emissions are associated with the construction phase. These emissions are the most difficult to reduce. They will account for approximately 50% of the industry's carbon footprint in the coming decades.
- Direct operational emissions are the most obvious part of a city's carbon footprint, with the greatest potential for reduction. They include emissions from energy production for building operations. They can account for up to 40% of a city's carbon footprint.

• Embedded operational emissions from materials and processes required to maintain the building throughout its life cycle.

• End-of-cycle emissions from transportation, disposal and recycling of construction waste.

As a reminder, the EU Green Deal is a new initiative of the European Union, its goal is to make Europe the first carbon-neutral continent by 2050. The interim target is to reduce greenhouse gas emissions by 55% by 2030 compared to 1990.

In addition to climate change, buildings and structures are subject to environmental impacts, and these impacts will increase. This is especially true for areas with special conditions - permafrost zones, coastal zones, areas with a high risk of flooding. As conditions change, the approach to building comfort and the structure of energy consumption change. Although traditionally in central and northern countries most of the energy is spent on heating, in the future the same buildings may need additional cooling during hot periods.

We need to build much more efficiently than we do now: with fewer resources and energy, but at the same time more resistant to external influences, more comfortable and convenient.

Experience shows that the most effective results can be achieved by combining measures to reduce emissions and adapt to new conditions. Increasing energy efficiency is today the most important and realistic way to quickly reduce emissions.

Today, there are a number of classifications of building energy efficiency, one of the most common - BER (Building Energy Rating) - is used in the European Union countries. Its characteristics take into account energy consumption and losses and their determining factors - insulation, use of natural energy, etc.

Low-energy houses are usually called passive houses; houses that not only consume but also produce energy (for example,

through renewable energy installations) are called active houses. From 2021, all new buildings in the European Union must comply with the passive house standard.

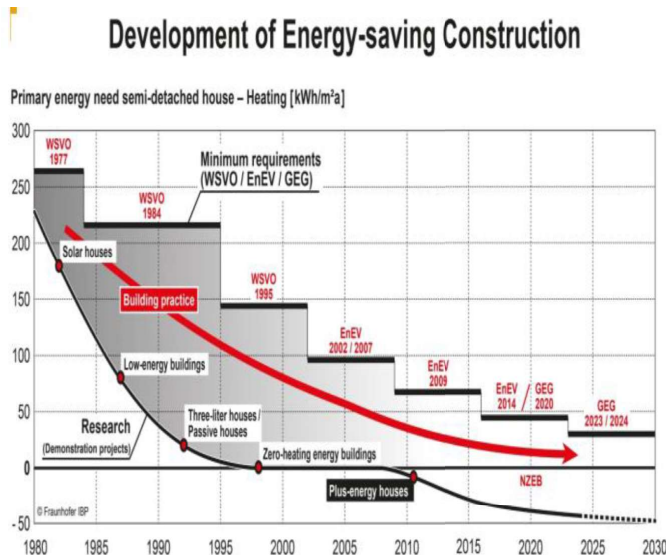


Fig. 1 Reducing energy consumption using the example of Germany.

Construction is one of the industries that is always growing. There is always a demand for residential, office, recreational and other spaces, and the supply is not slow. In just 6 years (2013 - 2019), the turnover of the construction industry has increased from 4.6 billion GEL to 8.3 billion.

The number of construction projects, whether residential or commercial, is increasing every year throughout Georgia.

Over time, the field has evolved, and with it, the demands for building quality have changed. As awareness has grown, various components have been added to the definition of building quality. Today, we can say with certainty that an essential component of the quality of a modern building is its energy efficiency.

Before discussing the energy efficiency of buildings, it is important to understand two main principles of energy efficiency:

1. Get the same thing using less energy
2. Get more with the same energy.

These two principles directly serve to improve the quality of human life, which (1) is felt immediately: whether it is cost savings or optimal use of resources, and (2) has a benefit that is very important in the long term: environmental protection and awareness.

61% of heat in a building is lost through its roof, walls and windows. Buildings are responsible for 39% of the world's total CO₂, of which 28% comes from the operation of the building, i.e. its heating, cooling and lighting.

In the world, more and more attention is paid to buildings, the principles of their construction and dismantling, the materials used and construction techniques. The variety of international and local certificates confirms that modern standards always take into account the impact of a building on the environment, not only during the period of its commissioning, but also from the stage of site selection and design. The new goal of the standards is to reduce CO₂ emissions.

Energy efficiency of buildings is also gaining relevance in Georgia. In early 2020, the Georgian Parliament adopted a law on energy efficiency. According to it, all new buildings in Georgia must meet certain standards within a few years. It is also gratifying that the law applies not only to physical construction, but also to the design of the building. This means

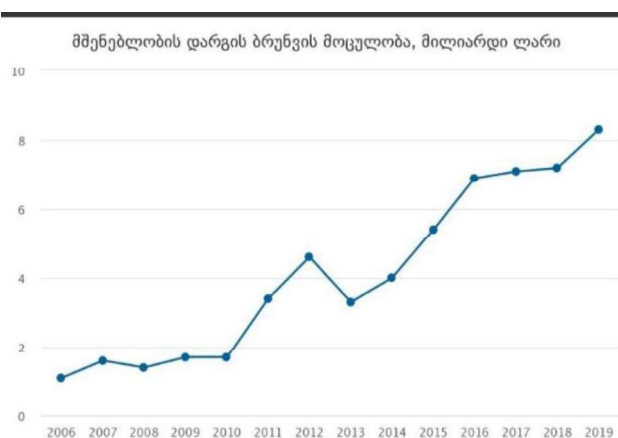


Fig. 2 Development of the construction sector in Georgia.

that the energy efficiency component will be taken into account from the very beginning.

According to the NDC:

- Georgia makes an unconditional commitment to reduce national greenhouse gas emissions by 35% by 2030 compared to 1990 levels (≈ 45 Mt CO₂ eq.). This target does not include the land use, land use change and forestry (LULUCF) sector. This means that in 2030, total national emissions, excluding LULUCF, should not exceed 29.25 Mt CO₂ eq.
- With international support, Georgia commits to reducing its national greenhouse gas emissions by 50-57% (to 22.5-19.35 Mt CO₂ eq.) by 2030 compared to 1990 levels, if global emissions are to be limited to a 2°C or 1.5°C scenario[5].

In the case of Georgia, the reform of the energy sector is defined by the Association Agreement with the European Union and the Protocol on Georgia's Accession to the Treaty establishing the Energy Community. The legal basis for the reform of Georgia's energy sector is created by transposing European directives into national legislation.

Nowadays, everything we do requires energy, and as time goes by, the demand for it increases. Given that the world still receives energy from exhaustible sources, it is important to use it correctly and wisely. The world is actively working on creating new technologies for energy security that will make it possible to use renewable energy sources. One way to solve this problem is to use energy efficiently.

Conclusion:

The consumer properties of residential and public construction are constantly changing, taking into account the accumulated experience and economic capabilities of the country," - "The creation of comfortable and environmentally friendly buildings that will meet the needs of modern consumers involves

a number of problems, many of which require careful analysis and study." It is their solution that will allow us to build energy-efficient comfortable buildings with relatively small capital investments, thereby creating the prospect of large savings in the future.

References

- [1] "Paris Agreement" | LEPL "Georgian Legislative Herald" (matsne.gov.ge) / On the ratification and entry into force of the "Paris Agreement" | LEPL "Georgian Legislative Herald" (matsne.gov.ge) (Georgian)
- [2] Georgia's Fourth National Communication to the UN Framework Convention on Climate Change | UNDP Georgia. (Georgian)
- [3] „Georgia's Updated Nationally Determined Contribution (NDC)“(matsne.gov.ge) (Georgian)
- [4] <https://mepa.gov.ge/Ge/PublicInformation/29290> [5] <https://mepa.gov.ge/Ge/PublicInformation/29290>
- [6] National Greenhouse Gas Inventory Report in Georgia 1990–2017 | UNDP Georgia (Georgian)
- [7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC
- [8] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.328.01.0210.01.ENG
- [9] https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan_en
- [10] WEG, http://weg.ge/sites/default/files/energy_poverty_web_ii_4.pdf <https://www.undp.org/ka/georgia/press-releases/energy-efficiency-awards> http://weg.ge/sites/default/files/medea_inashvili.pdf <https://tenders.procurement.gov.ge/public/library/files.php?mode=que&file=521101&code=1553279683>