

MAP REAL ESTATE MARKET INSIGHT

Frankfurt, October 2023

BEYOND ENERGY EFFICIENCY: UNVEILING THE HIDDEN IMPACT – EMBODIED CARBON IN REAL ESTATE

Introduction

Under the keyword ESG, in addition to many other aspects, the mitigation of greenhouse gas emissions plays an important role for the players in the real estate industry. The focus is on constructing highly efficient buildings in terms of energy consumption which are in demand among buyers and tenants. In this Market Insight, we will show that this view may fall short. On the one hand, it does so from the point of view of climate policy, because it focuses only on the emissions generated during the operation of the building and neglects the greenhouse gas emissions which are generated by the sum of the materials and processes required to construct and maintain a building (embodied emissions). However, it also falls short from an investor's point of view because the perception of embodied emissions as a challenge is just beginning to gain acceptance in the market. Therefore, current decisions that do not take this into account could prove to be suboptimal in the future. We highlight in this Market Insight that players who recognize this at an early stage and take embodied emissions into account in their decisions today will be rewarded.

We substantiate our view by closely analyzing the current state of affairs on the subject of embodied emissions in the real estate industry. First, we briefly highlight the scale of the challenge facing the real estate markets as many countries move toward a carbon-neutral future. We then describe what exactly is understood by embodied emissions and why they are so significant, even though they have tended to play a minor role for investors in the past. However, our analysis of current regulations proves that the market's view of embodied emissions will likely change in the future, especially via the EU Taxonomy. We conclude our considerations with the practical challenges that will arise from this for the real estate markets.

Greenhouse gas emissions in the real estate sector – the case for action

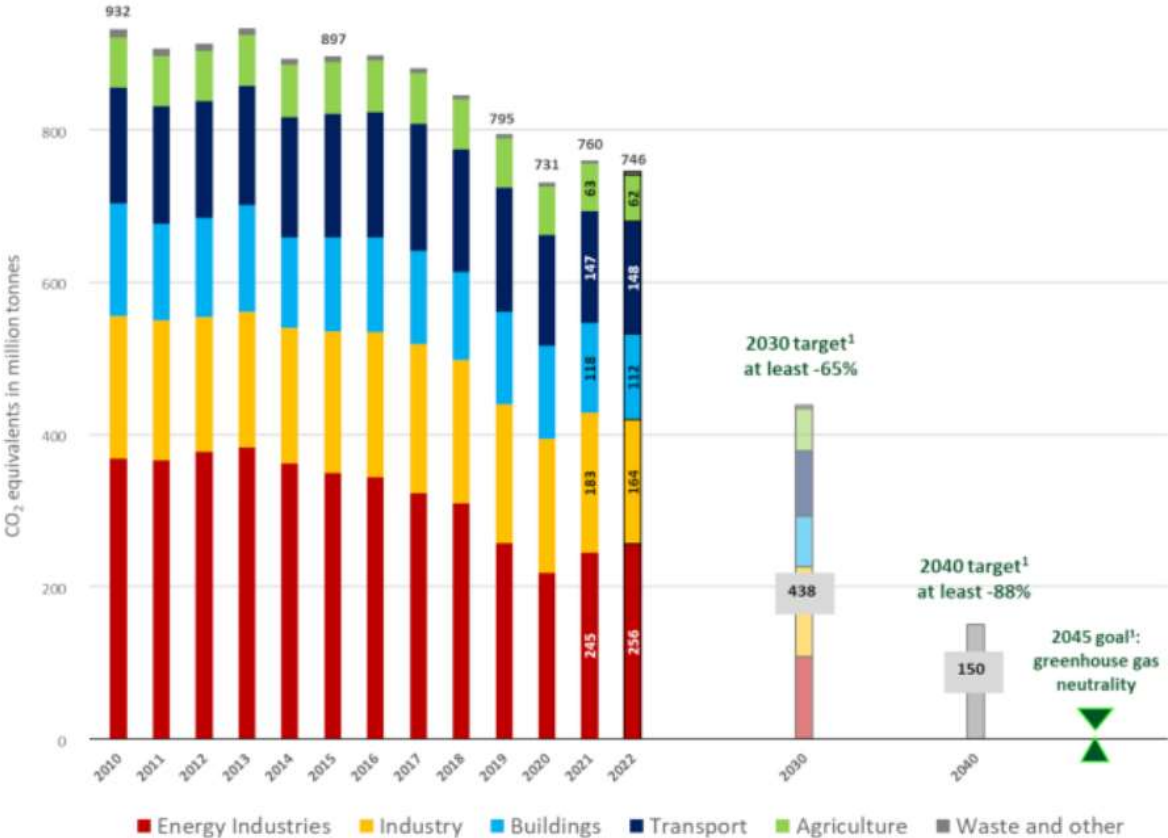
In Market Insight 12/22 we pointed out that although reductions in greenhouse gas (GHG¹) emissions have been achieved in the past, there can be no doubt that the current development path is not compatible with global mitigation targets to which countries have committed themselves in the Paris Agreement of the UN Framework Convention on Climate Change (1.5° C - target²). In line with this treaty, the EU has set itself various objectives, of

¹ GHG emissions are measured in CO₂-equivalent (CO₂-e) to provide a standardized way to compare the global warming potential of different greenhouse gases. This standardization is essential because different greenhouse gases have different warming effects on the Earth's atmosphere. CO₂-e is a unit that expresses the impact of various greenhouse gases in terms of the equivalent amount of carbon dioxide (CO₂) that would have the same warming effect over a specific timeframe, usually 100 years. There are several greenhouse gases, including methane (CH₄), nitrous oxide (N₂O), fluorinated gases, and others, each with different warming potentials.

² In the exact wording, the 196 participating parties commit to limiting global warming to well below 2° C, preferably to 1.5° C, compared to pre-industrial levels.

which the two central goals are a 55%-reduction in GHG emissions in 2030 compared to 1990 levels and a carbon neutrality goal for 2050. Germany has committed to its own national climate targets to complement the EU goals. The Climate Action Law, which came into force in December 2019, gives these emission targets a legally binding character. The most important of the German goals are a reduction target for GHG emissions of -65% in 2030 compared to 1990 levels and climate neutrality in 2045.

Figure 1: Greenhouse Gas Emission Trends: Emissions, Projections and Targets for Germany – in Million Tons of CO₂-e



1) 2030, 2040 and 2045 targets as stated in the Climate Action Law.
 Note: Without emissions from land use, land-use change and forestry (LULUCF).
 With the 2021 climate law reform, Germany introduced GHG emissions sink targets for this sector (-25mln t CO₂ eq by 2030, -35mln t by 2040 and -40mln t by 2045).

Source: Clean Energy Wire, 2023: Germany’s carbon pricing system for transport and buildings.
<https://www.cleanenergywire.org/factsheets/germanys-planned-carbon-pricing-system-transport-and-buildings>

The historical emissions trend shown in Figure 1 demonstrates that Germany is not on the path to obtain these goals without additional policy action. While the sharp drop in emissions in 2020 was due to the Covid-19 crisis, the following rise in 2021 reflected the partial conversion of the country's energy supply to coal-fired generation as a result of the Russian attack on Ukraine. The gap between what will be achieved with existing policies and the trajectory that is in line with the reduction targets will have to be closed with significantly increased efforts. When we issued Market Insight 12/22 it already was foreseeable that the real estate sector will become more involved in this respect than in the past. In 2023, the discussion about the amendment to the Building Energy Act ('Gebäudeneergiesetz', GEG)

then brought the topic to the forefront of the general public, with corresponding consequences for the prices of unrenovated family homes.³

Investors also have become more aware of the risk of a sharp decline in the value of assets or portfolios in the future. The risk of an asset or portfolio becoming 'stranded' increased. A stranded asset is confronted with potential write-downs and devaluations, because in addition to rising operating costs, there are other financial risks, such as market effects, technological disruptions, legal liabilities and reputational risks. In the following, we show that the topic of embodied carbon is likely to follow a similar course. In this case, too, early action is likely to pay off once the recognition of embodied emissions has become established in all spheres of the market.

Embodied Carbon – definition and general context

Embodied carbon, sometimes also referred to as gray emissions⁴, are the GHG emissions that occur during the manufacturing, transportation, installation, maintenance, and disposal of building materials (see Figure 2). They are therefore not synonymous with the greenhouse gas that is physically bound in the building but are defined more comprehensively. The counter term is that of operational carbon, by which are understood the GHGs which result from the energy consumption of the building. In terms of methodology, embodied carbon is usually determined on the basis of a life cycle assessment (LCA) of the production factors used (materials, products etc.). The emissions that occur over the full life cycle of a product or process are calculated.

Figure 2: Embodied Carbon and Operational Carbon across the Key Life Cycle Stages of a Building



Source: Carbon Leadership Forum, 2020: Embodied Carbon 101. <https://carbonleadershipforum.org/embodied-carbon-101/>

Figure 3 is a schematic representation of the distribution of embodied and operational emissions of a building over its life cycle. It is clearly visible that most of the embodied carbon of a building is generated upfront. The operational emissions, which are colored gray here, decrease over time because the energy consumed in the building more and more comes from renewable sources as the decarbonization of the economy progresses.

The share of embodied emissions in total emissions can vary greatly from building to building. In a detailed LCA-study of 46 German office buildings and 4 residential buildings of different sizes, which were awarded a sustainability certificate by the DGNB, embodied

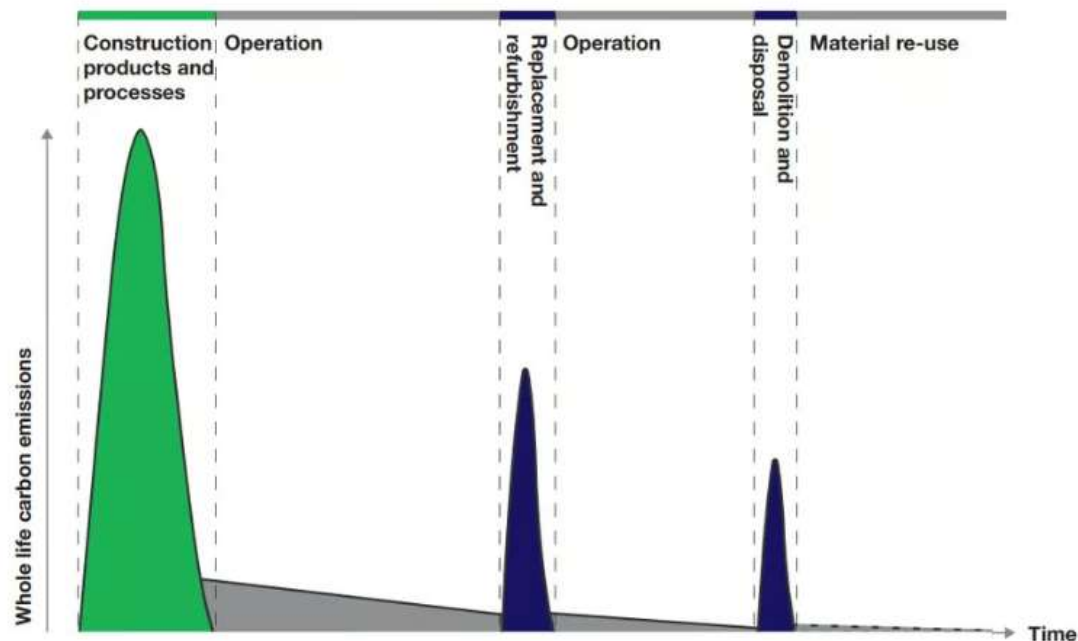
³ Tagesschau, 2023: Preisverfall bei unsanierten Häusern.

<https://www.tagesschau.de/wirtschaft/verbraucher/immobilien-preise-heizungsplaene-100.html>

⁴ Gray emissions must not be confused with gray energy. Gray energy is the energy input over the entire life cycle of the materials and processes used in a product, while gray emissions are the resulting GHG emissions. The lower the share of renewables in the gray energy production, the higher they are. Cf. Gebäudeforum Klimaneutral: Graue Energie und Emissionen. <https://www.gebaeudeforum.de/wissen/ressourcen-und-emissionen/graue-energie-und-emissionen/>

emissions accounted for an average of 35%.⁵ The construction method and materials used were the biggest influencing factors. Other studies arrive at similar estimates of 20-50%.⁶

Figure 3: Whole Life Cycle Carbon Emissions of a Building



Source: Haberkorn, J., 2023: Embodied Carbon Werte: Benchmark Studien Übersicht. <https://www.builtworld.com/magazine/article/embodied-carbon-werte-studien>

However, when comparing older buildings with a high energy consumption with modern efficient buildings, it is easy to see that the energy efficiency of the building has a major impact on the relevance of embodied carbon. This becomes evident in Figure 4 which shows a typical long-term distribution of embodied and operational carbon. It is based on the resource input for a fictional medium-sized commercial office building that is constructed in 2020 and will remain in place until 2050, the year in which the electricity supply in this example is generated entirely from renewable sources. The GHG emissions for the energy consumed in the building decline steadily. Naturally, the changes are greater in the case of a standard performance building than for an already very energy efficient high-performance building. Extreme cases of highly advanced buildings surpass a share of embodied emissions in total emissions of 90%.⁷ In addition, there seems to be a trade-off between the goal of building a high efficiency building and reducing embodied emissions at the same time. Often, more materials and technical equipment are needed, which increase the embodied part of the carbon footprint. However, comprehensive analyses of realized projects prove that it is indeed possible to achieve both goals and to combine energy efficiency and low embodied carbon.⁸

⁵ DGNB (Deutsche Gesellschaft für nachhaltiges Bauen, German Sustainable Building Council), 2021: BENCHMARKS FÜR DIE TREIBHAUSGASEMISSIONEN DER GEBÄUDEKONSTRUKTION. Ergebnisse einer Studie mit 50 Gebäuden.

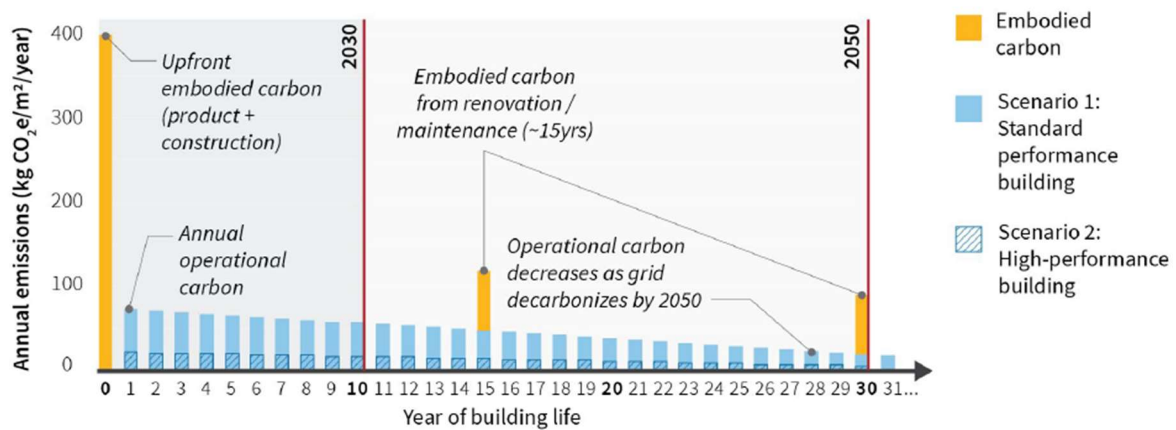
⁶ Cf. the meta-analysis of more than 650 life cycle assessment studies in Röck, M. et al., 2020: Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. In: Applied Energy, vol. 258, pp. 1-12.

⁷ Cf. ibid.

⁸ Cf. ibid.

It is evident that the share of embodied emissions in total life cycle emissions of the building stock will increase on the path to climate neutrality, which is targeted for 2045 in Germany. The need to reduce these emissions as well will increase accordingly. The pressure on investors to analyze their portfolios in this respect and to look for ways to reduce the carbon footprint will intensify from all sides, from tenants, buyers, the public and, not least, from the government. In the following paragraph we will look at the regulations currently in place.

Figure 4: Relative Impact of Embodied and Operational Carbon of a New Building from 2020-2050



Source: Carbon Leadership Forum, 2020: Embodied Carbon 101. <https://carbonleadershipforum.org/embodied-carbon-101>

Regulation of embodied emissions today

An important mechanism through which environmental targets are incorporated into business activities within the EU is the EU Sustainability Taxonomy.⁹ It is intended to contribute to the implementation of the European Green Deal, which includes the EU GHG reduction targets mentioned above. Better known by the acronym ESG (Environmental, Social, and Corporate Governance), its guidelines are intended to encourage financial markets to channel financial flows into investments that contribute to the desired transformation of the economy. The EU Taxonomy focuses on six environmental objectives:

1. Climate Change Mitigation
2. Climate Change Adaptation
3. Sustainable Use and Protection of Water and Marine Resources
4. Transition to a Circular Economy
5. Pollution Prevention and Control
6. Biodiversity and Ecosystems

To be considered environmentally sustainable according to the EU Taxonomy, an economic activity must substantially contribute to at least one of these objectives and do no significant harm to the others. The Sustainable Finance Disclosure Regulation (SFDR)¹⁰ requires financial market participants and financial advisors to publish information about the

⁹ European Commission, 2023: EU taxonomy for sustainable activities.

https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

¹⁰ European Commission, 2023: Implementing and delegated acts – SFDR.

https://finance.ec.europa.eu/regulation-and-supervision/financial-services-legislation/implementing-and-delegated-acts/sustainable-finance-disclosures-regulation_en

environmental and social impacts of their investments. This includes details about how they integrate sustainability risks into their investment decision-making process and the adverse impacts of their investment decisions on sustainability factors.

Until recently, only the first part of the Taxonomy, dealing with the first two of the above objectives, had been adopted. It did not take embodied carbon into account: the Taxonomy was focused on limiting operational carbon emissions. There were justified objections that saw the Taxonomy “turning a blind gray eye”¹¹, because it primarily directed investment to construction of new efficient buildings.¹² Yet even a climate-positive building does not make a real contribution in terms of climate protection until embodied emissions are retroactively offset over the entire life cycle via climate-positive operation.

However, the taxonomy was supplemented by a Delegated Act¹³ in June 2023. It now also addresses the other four environmental objectives. In relation to the real estate industry, it specifically describes how a new construction project, or a renovation project must be designed. In both cases, this includes that “the life-cycle Global Warming Potential (GWP) of the building resulting from the construction has been calculated for each stage in the life cycle and is disclosed to investors and clients on demand.”¹⁴

This will become the starting point for the establishment of embodied emissions in the planning of projects in the EU countries. Further regulations will be added to those already in place in some countries. Mandates for life cycle-based reporting which include embodied carbon are already in force or will soon be introduced in several countries (e.g., France, Denmark and Sweden). In some countries, cities are leading the way (e.g., London).¹⁵ In Germany, there is no comprehensive regulation in this area to date, but there are numerous laws and ordinances that regulate areas in which the generation of embodied emissions is also influenced. One example is the Substitute Building Materials Ordinance (“Ersatzbaustoffverordnung”) which stipulates how substitute mineral building materials may be produced and used in technical structures. It regulates the sampling and inspection of unprocessed soil material and specifies the requirements concerning the separate collection of mineral waste removed from engineering structures.¹⁶

Challenges of practical implementation

The greatest challenge for a comprehensive LCA of a building is obtaining the necessary data. Figure 5 shows the activities that generate GHG emissions at each stage of the life cycle - embodied and operational. For embodied emissions, the stages are usually divided

¹¹ Schenk, M., 2022: Auf dem grauen Auge blind. In: Immobilien Zeitung, 5/2022.

<https://www.iz.de/meinung/news/-auf-dem-grauen-auge-blind-2000003884>

¹² INREV, 2023: Falling through the cracks: SFDR’s impact on real estate investment. INREV Member Briefing.

<https://www.inrev.org/library/falling-through-cracks-sfdrs-impact-real-estate-investment>

¹³ A Delegated Act is an adoption of the EU Commission that regulates details that have been delegated to it. On the website of the EU Commission, the new Environmental Delegated Act is listed as adopted on 27 June 2023 with the addition: “not in force until it is published in the Official Journal”.

https://finance.ec.europa.eu/regulation-and-supervision/financial-services-legislation/implementing-and-delegated-acts/taxonomy-regulation_en

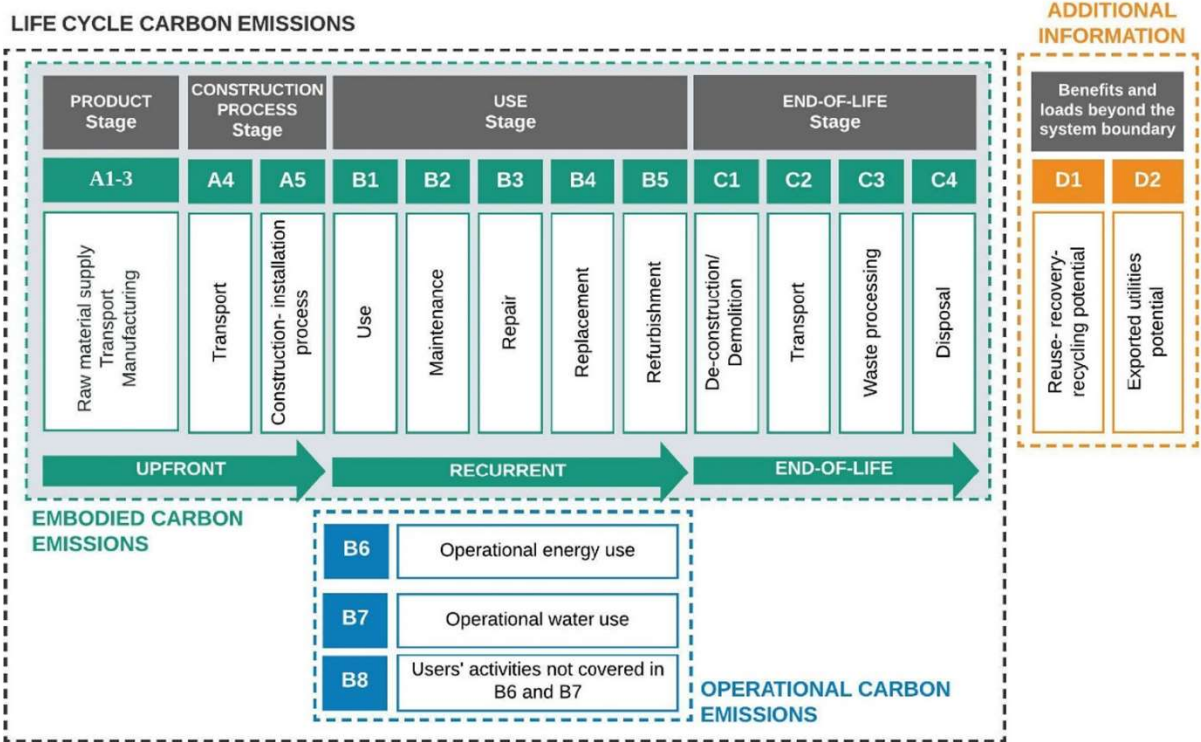
¹⁴ European Commission, 2023: Annex to the Commission Delegated Regulation supplementing (EU) 2020/852 [...], Brussels 27.6.2023

¹⁵ Lützkendorf, T. and Baloutski, M., 2022: Embodied carbon emissions in buildings: explanations, interpretations, recommendations. In: Buildings and Cities, 3(1), pp. 964–973

¹⁶ <https://ersatzbaustoffverordnung.de/>

into upfront, recurrent and end-of-life. Ideally, separate LCAs must be prepared for all materials and processes used at these stages. In addition, plausible assumptions must be made, e.g., about the expected replacement times of technical installations and much more. Today, these data are available for many materials and equipment in specialized databases.¹⁷ Nevertheless, the challenges for a comprehensive LCA are great, because the quality of these data is crucial for the reliability of the result.

Figure 5: Life-cycle Model of a Building with Stages of Embodied and Operational Emissions Generation



Source: Lützkendorf, T. and Baloutski, M., 2022: Embodied carbon emissions in buildings: explanations, interpretations, recommendations. In: Buildings and Cities, 3(1), pp. 964–973

Sustainable building certifiers such as DGNB, LEED and BREEAM offer tools for LCAs and have already integrated their results into their assessments. However, there is still potential for action in the procurement of data and further improvement of the tools. In general, the availability of data for new buildings is much better than for old buildings, which is one of the many reasons why new buildings are often preferred under ESG criteria.¹⁸ However, especially in the case of energetically inefficient old buildings, refurbishment is almost always more advantageous than demolition and new construction due to the high embodied emissions.¹⁹

¹⁷ Lützkendorf, T. and Baloutski, M., 2022: Embodied carbon emissions in buildings: explanations, interpretations, recommendations. In: Buildings and Cities, 3(1), pp. 964–973

¹⁸ DGNB (Deutsche Gesellschaft für nachhaltiges Bauen, German Sustainable Building Council), 2021: BENCHMARKS FÜR DIE TREIBHAUSGASEMISSIONEN DER GEBÄUDEKONSTRUKTION. Ergebnisse einer Studie mit 50 Gebäuden

¹⁹ Savills, 2021: ESG: Nicht mehr nur in aller Munde, sondern auch in aller Portfolien. https://www.savills.de/research_articles/260049/322061-0

In-depth comparisons of LCAs of buildings with different construction features also show interesting results.²⁰ For example, solid or reinforced concrete buildings can have a lower carbon footprint overall than wood hybrid buildings. The lifespan of building components also plays a very important role, because the GHG emissions that occur when components must be replaced can be very high. Overall, however, the available studies show that LCAs are already possible today and are a useful tool for assessing the benefits of projects involving embodied and operational emissions if the input data are of sufficient quality.

Conclusion

The bottom line of our analysis is that it is very likely that embodied emissions from buildings will become increasingly important for players in the real estate markets in the future. The emphasis on the life cycle approach in the EU taxonomy is a very decisive step that will promote the issue. Our conclusion is also supported by the fact that many investors are convinced that climate protection is crucial, and the significance of embodied emissions is too high to continue to be largely ignored. Last but not least, as the economy decarbonizes and building efficiency increases, the importance of operational emissions will decline, and embodied emissions will become more and more crucial.

The mechanisms by which embodied emissions will find their way into the calculations of investors, developers and all other players in the real estate markets will be similar to those that have made the topic of ESG so influential for the industry in the recent past. After all, the concept of embodied emissions is ultimately just an extension of the 'E' in ESG. Thus, the most important path is financing, because meeting the standards creates better financing options for investors. As banks appreciate the opportunities which ESG-compliant portfolios offer, also in terms of marketing, they reward this customer-behavior. It can be assumed that in the future the certification of embodied carbon in real estate will also result in more favorable financing costs for properties i.e., a lower interest rate and probably also a little higher LTV (loan-to-value) from the investor's point of view.

Legislation will also make building standards that take the life cycle into account more binding as is already the case today for operational emissions. There will be no way around the obligation to radically reduce emissions for all sectors of the economy. A possible politically motivated delay of this task might also prove difficult, because the German climate goals are legally binding for the Government since they were laid down in the Climate Action Law. Similar to the statutory thresholds in air pollution control, which in 2018 were enforced by legal action through driving bans, the courts could decide in the future that climate protection measures should be tightened. However, it is foreseeable that this task will not be accomplished without an expansion of state support, especially in the area of embodied emissions in real estate.

Regarding the building itself, anything that extends its lifetime durability will be more in demand than today and will be rewarded accordingly by the market. This can be high-quality materials or recycled or recyclable materials. New buildings will benefit from flexible concepts which can expand the lifetime of a building by anticipating future changes in use or combine different usages in the same building. Flexibility in use and third-party usability will be crucial

²⁰ DGNB (Deutsche Gesellschaft für nachhaltiges Bauen, German Sustainable Building Council), 2021: BENCHMARKS FÜR DIE TREIBHAUSGASEMISSIONEN DER GEBÄUDEKONSTRUKTION. Ergebnisse einer Studie mit 50 Gebäuden

features of an asset as much as a building design which favors upcoming repairs, renovations and remodeling. For the same reasons, the change of use of old buildings, where feasible, will become more important. We have addressed this issue several times in past Market Insights. The conversion of office buildings into micro-apartment concepts is already worthwhile for many reasons. It offers a wide range of opportunities to create living space in sought-after urban locations and crises resilient opportunities for investors. However, as embodied emissions are incorporated into ESG thinking, the business case for this is likely to improve further.

So far, new buildings are preferred by investors with an affinity for ESG. This will change, because from the perspective of the concept of embodied emissions the refurbishment of the old building stock is often much more advantageous than the strategy of demolition and new construction. Therefore, the latter is likely to be more difficult to implement in the future, and preservation may be more strongly demanded and promoted. It will become much more important to turn to the existing stock and improve its ESG compliance. From the point of view of the owner willing to sell, it is more advantageous to implement the necessary certification by himself, because the buyer would always include a safety margin in the discount he will make on the purchase price of a not sufficiently certified property.

Overall, it can be assumed that embodied emissions will trigger innovation processes at many levels, as is generally the case in the transformation process of the economy toward a carbon neutral future. Where CO₂ emissions are already taxed at the materials level and the players are aware that the CO₂ price will rise in the future, this process has already been initiated. For example, a great deal of research is being carried out in the field of 'green' cement and initial successes are visible. Other examples are self-healing concrete which reduces the necessity for future repairs, graphene-based coatings of steel to lower material consumption or construction techniques like modular construction. Other innovations take place in the field of software and digitization. These developments are all very promising and it is in the interest of every investor to take direct and pecuniary advantage of these innovations and be prepared for an increased consideration of embodied emissions in real estate.

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