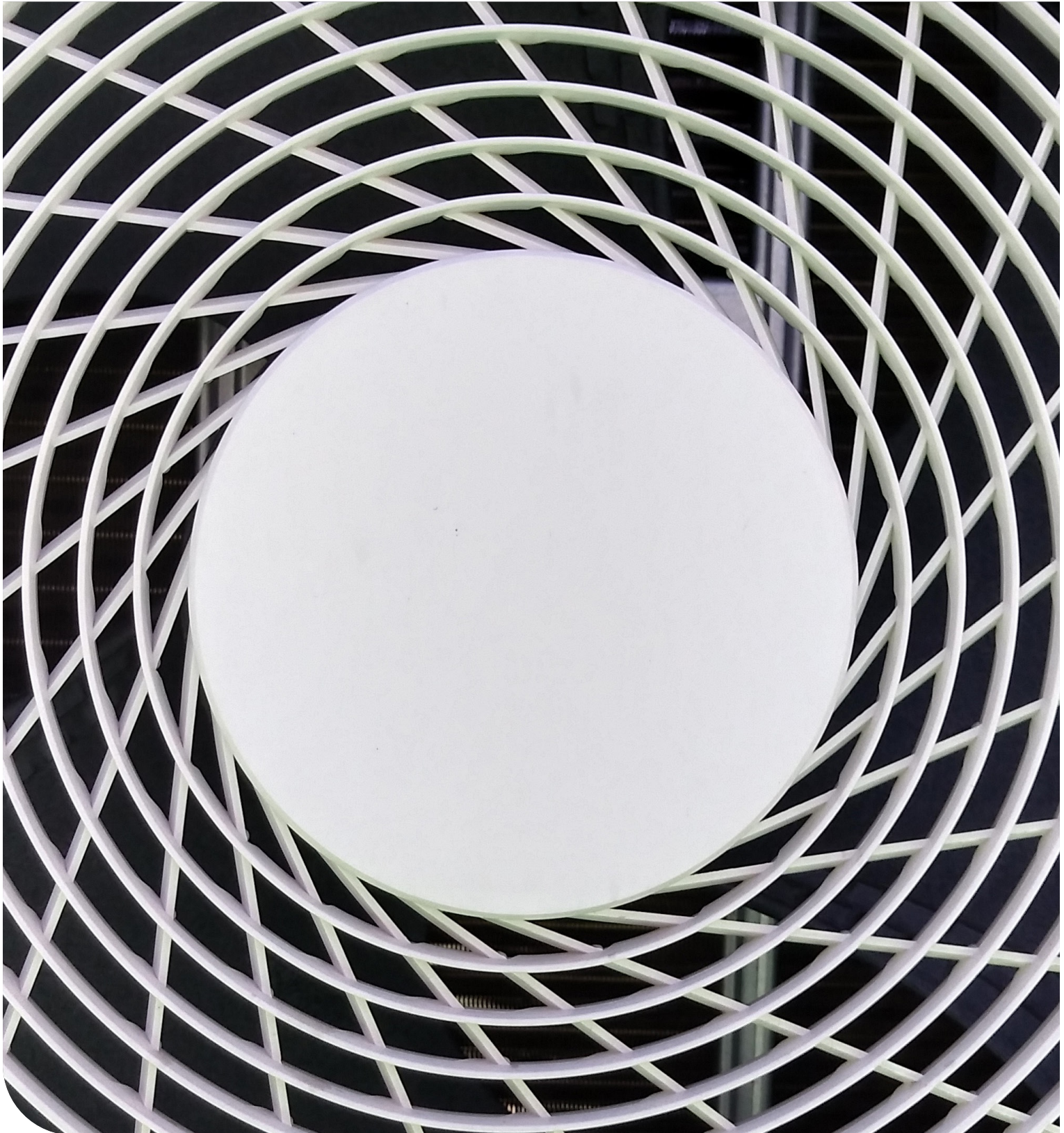


Transforming construction:

The building blocks for a low-carbon future

2024



TRANSFORMING CONSTRUCTION: THE BUILDING BLOCKS FOR A LOW-CARBON FUTURE

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The buildings and construction sector encompasses everything from our homes and workplaces to roads and bridges to the industrial facilities or manufacturing plants that power and supply our world. It is therefore an integral and essential part of modern life and a key pillar of the economy. However, it is also one of the world's largest emitters of greenhouse gases (GHG), exceeding both the transportation and industrial sectors. To mitigate its environmental impacts, the buildings and construction sector needs to overcome challenges related to both operational and embodied carbon. The way forward involves transforming the way buildings are designed, built and run, thus setting the stage for a more sustainable and resilient built environment, as Melanie Beyeler, Senior Portfolio Manager, details in this thought piece.

Accounting for 30% of total energy demands, primarily due to operational needs such as heating and cooling, the buildings and construction sector is a major energy consumer. In fact, it is estimated that it is responsible for 21% of global GHG emissions.¹ Without significant changes to the way buildings are managed, operated and constructed, emissions from the built environment could increase by between 10% and 15% by 2030.² However, by adopting well-established energy efficiency policies, the sector could drastically cut its energy consumption. This would not only reduce emissions from buildings but also lead to cost savings for energy consumers, all without compromising the quality of energy services provided.³

Existing buildings: Importance of retrofits

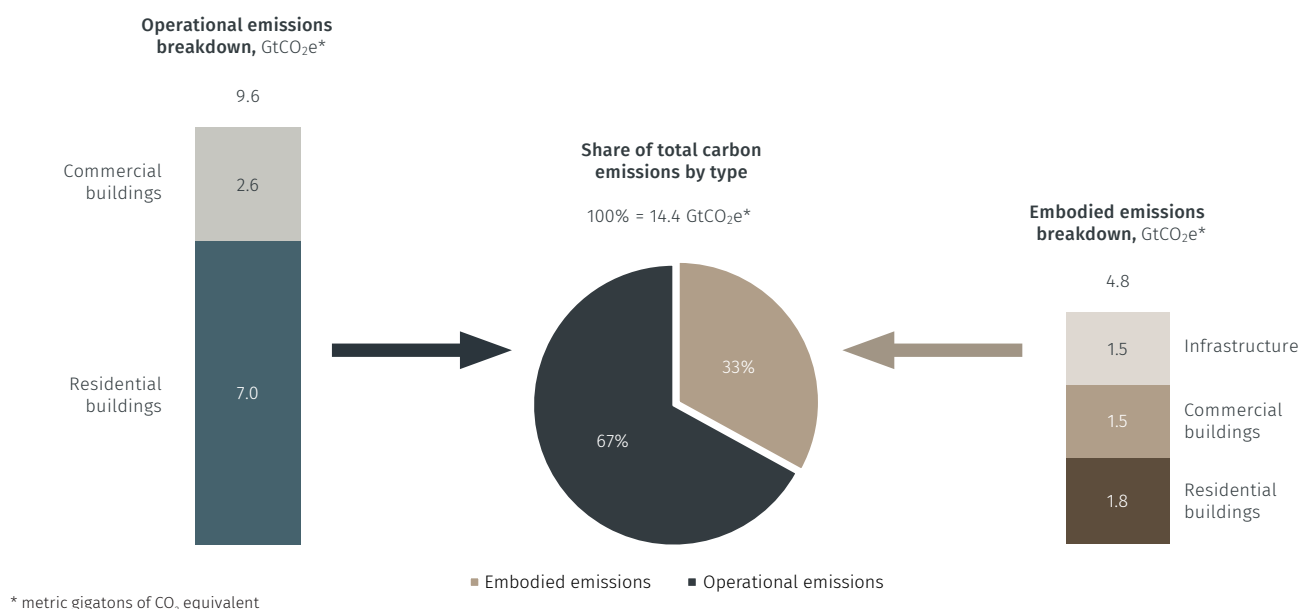
Given that buildings have a typical lifespan of between 30 and 130 years, around 80% of the building stock that will exist when we reach 2050 has already been constructed.⁴ This figure highlights the critical need to retrofit existing buildings to improve their environmental footprint. However, the

current retrofit rate is only about 1% per year, with buildings upgrades typically resulting in a reduction in energy intensity of less than 15%.⁵ To achieve alignment with the goals of the Paris Agreement, retrofit rates would need to rise to between 2.5% and 5% annually by 2030.⁶ Moreover, these retrofits have to be extensive, encompassing insulation and glazing upgrades, as well as enhancements to heating and cooling systems. In addition, they need to incorporate passive and nature-based solutions to reduce service demands.

New buildings: Importance of building codes

Since 2010, the total global area of constructed buildings has expanded by around one third to just over 250 billion square meters, of which nearly 80% is residential.⁷ This increase in building floorspace is driving up the energy demand for buildings themselves and also for construction materials. Despite this, energy intensity per square meter improved by 3.5% from 2021 to 2022 due to stricter building codes and the enhanced performance of construction materials, particularly in colder climates.⁸

Figure 1. Built environment with operational and embodied emissions spread across commercial and residential buildings, as well as infrastructure



Source: McKinsey Sustainability, Building value by decarbonizing the built environment, June 2023

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Globally, there is considerable variation in building policy landscapes, with many countries still lacking comprehensive strategies to foster sustainability and improve energy performance in the building sector. However, an increasing number of countries are implementing stricter regulations around building energy use and CO₂ emissions, aligning with international goals to limit the increase in global temperatures to 1.5°C compared to pre-industrial levels.⁹

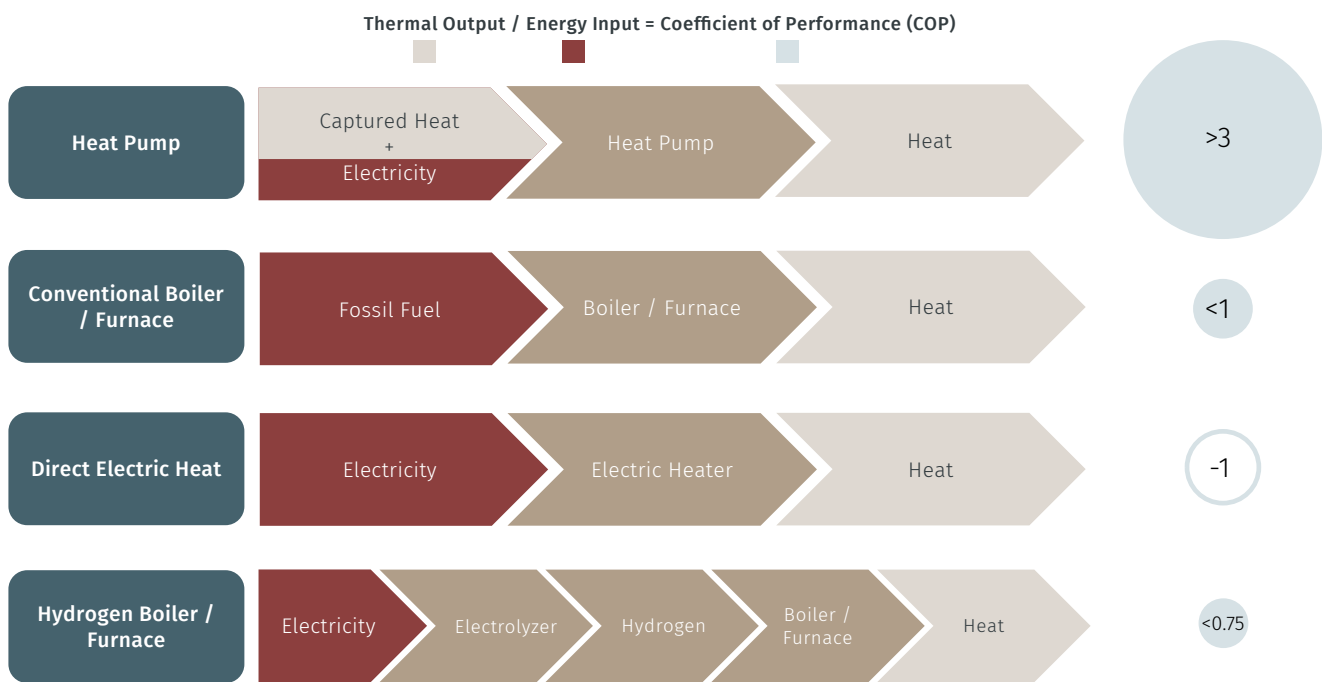
Operational carbon: Decarbonizing with heat pumps

Heating systems are responsible for around 50% of the emissions from buildings, with most systems still powered by fossil fuels.¹⁰ Heat pumps are one solution with the potential to deliver significant improvements, potentially cutting CO₂ emissions from buildings by half.¹¹ Suitable for a wide range of climates, heat pumps can be designed to provide both heating and cooling, or just heating. Unlike traditional heating systems that are unable to reach 100% efficiency due to the production of thermal energy, heat pumps capture existing heat from the air, ground or water and transfer this “free” heat to buildings in order to heat the spaces within them or to heat water. This process enables heat pumps to achieve efficiencies of 300-500%, providing 3-5 kilowatt-hours of heat for every kilowatt-hour of electricity consumed, thus making them a highly efficient and environmentally friendly option.¹²

Heat pumps come in a variety of configurations and can be used with different heat sources - from air or water to ground heat. They employ various methods to distribute the heat generated, either through air or water. They also vary in terms of the refrigerants they use, and their size and quality. Each configuration offers unique advantages and drawbacks, which are shaped by factors such as the local climate, the age of the building, the current heating, ventilation and air conditioning (HVAC) system, and practical aspects such as cost, available outdoor space, ground type and water source access. Air source heat pumps are particularly popular, accounting for more than 60% of global sales.¹³ Given the additional costs and geographical constraints associated with ground source and water source heat pumps, air source units are likely to continue to dominate the residential market.¹⁴

Heat pumps have been around for a while, but electric heat pumps have only recently been recognised as a key technology for decarbonizing heat production. In 2021, they accounted for less than 10% of global heating needs.¹⁵ To align with the goal of reaching net zero emissions by 2050, the global stock of heat pumps would need to almost triple by 2030 in order to meet at least 20% of worldwide heating requirements.¹⁶ While manufacturing capacity is expected to grow in the coming years, the exact rate of expansion remains uncertain, as announcements for such projects are rarely made public.¹⁷ Significant challenges remain regarding it's the broader adoption of heat pumps. There is a critical need

Figure 2. Different heating technologies and their coefficient of performance (COP)



Source: Barclays Equity Research, Heat pumps, March 2024

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Figure 3. Heat pump configurations by heat source and sink

		Heat Sink (2 nd term)	
		Air Distributes warm air via ductless ‘minisplits’ or ducted systems	Water H ₂ O-based hydronic distribution via radiators, floor heating or fan-coils
Heat Source (1 st term)	Air-sourced Ambient outside air	Air-to-air	Air-to-water
	Ground-sourced Geothermal energy via a closed-looped fluid	Ground-to-air	Ground-to-water
	Water-sourced H ₂ O energy via open open-looped source (river, lake, sea)	Water-to-air	Water-to-water

Source: Barclays Equity Research, Heat pumps, March 2024

for enhanced policy support and technological innovation, especially in reducing upfront costs, addressing market barriers that stand in the way of renovations to existing buildings (e.g. to ensure they have the requisite level of insulation), and developing products and systems that use refrigerants with lower environmental impacts.

Embodied carbon: Decarbonizing building materials

Until now, the construction sector has primarily focused on reducing “operational carbon” that includes emissions from heating, cooling and lighting systems in buildings. However, efforts to lower “embodied” carbon emissions – i.e. those stemming from the design, production and deployment of building materials like cement, steel and aluminium – have lagged far behind. In 2020, emissions from embodied carbon accounted for 16% of all global CO₂ emissions.¹⁸ Within the construction value chain, the sourcing and manufacturing of materials represent 92% of these embodied carbon emissions.¹⁹

Cement is the main ingredient of concrete, which is the most widely used building material globally. In each cubic meter of concrete, cement typically accounts for about 90% of the carbon footprint. In 2020, the cement sector was responsible for 2.3 Gt of CO₂ emissions, corresponding to 43% of the embodied emissions in construction.²⁰ There are several strategies for the decarbonization of cement: Reducing the clinker-to-cement ratio; increasing the use of cement alternatives, from Hempcrete and Ashcrete to Ferrock; transitioning to electric kilns powered by renewable energy; and enhancing concrete production through carbon capture

and use during the manufacturing process. Updating building codes and educating architects, engineers and builders about the best available technologies, could save over 25% of cement by reducing overengineering.²¹

Steel is an essential material in construction and is used in structural elements, reinforced concrete, pipelines and rail tracks, to name a few examples. More than half of all the steel produced globally (52%) is used by the construction sector.²² Steel production was responsible for 24% of the sector’s emissions in 2020.²³ The most effective strategies for reducing emissions from steel include transitioning from traditional blast furnaces to direct reduced iron technology, combined with the use of electric arc furnaces powered by renewable energy. Additionally, emphasizing the reuse and recycling of steel is critical, as producing steel from scrap can save between around 60% and 80% of the energy required compared to new steel production.²⁴

Other construction materials such as **glass, aluminium, plastic, rubber, wood, minerals** and **bitumen** contributed to 1.4 Gt of CO₂ emissions in 2020, corresponding to 25% of construction emissions.²⁵ Decarbonizing sectors like glass and aluminium is challenging due to their high energy demands and the long lifespans of the plants. Aluminium production is particularly energy intensive, with electricity as its main energy source, making the greening of the electricity grid a key factor in reducing its emissions.²⁶

Conclusion

In conclusion, for the buildings and construction sector to meet global climate targets, it must accelerate its efforts to reduce operational carbon as well as tackling the

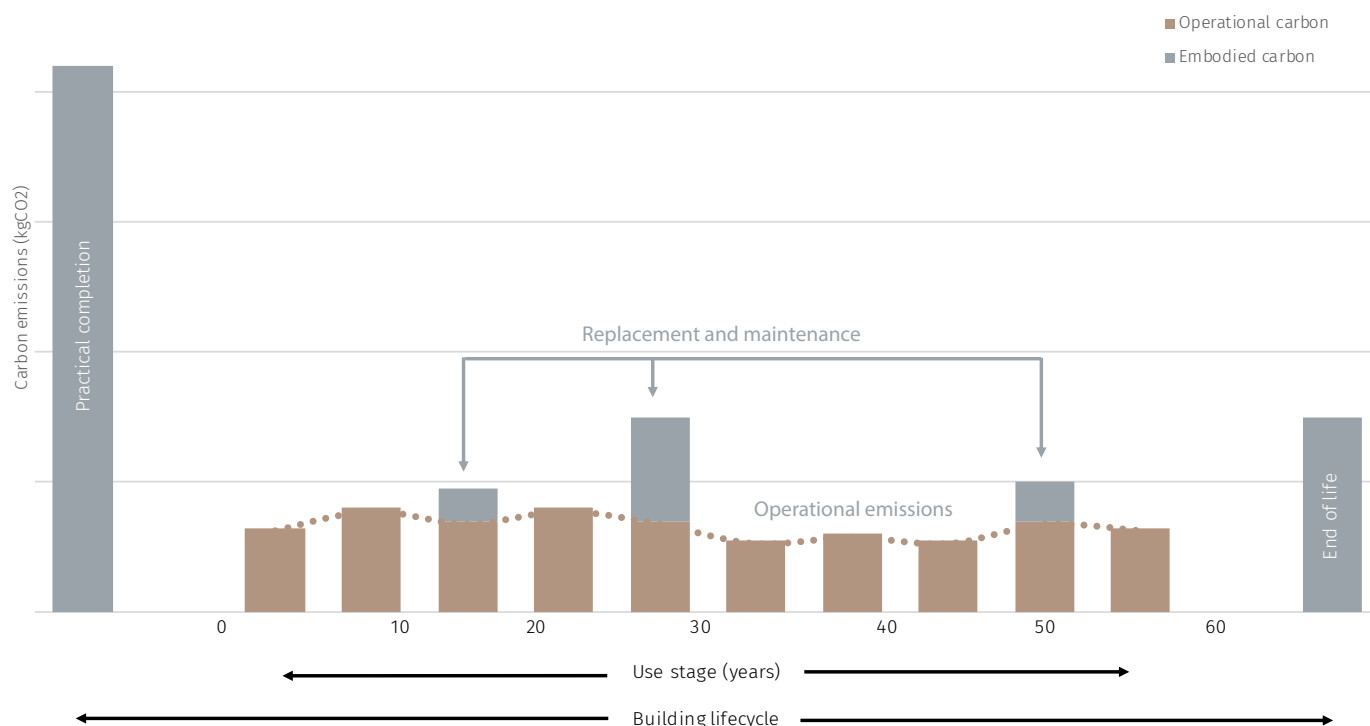
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issue of embodied carbon. This calls for the widespread adoption of energy-efficient technologies such as heat pumps and for innovative approaches to the design, production and deployment of materials such as cement, steel and aluminium. Essential actions include enforcing stricter building codes, boosting material recycling rates

and promoting the production and use of alternative, less carbon-intensive building materials. By focusing on these comprehensive strategies, the sector can effectively lower emissions, ultimately paving the way for a more resilient and sustainable built environment.

Figure 4. Emission breakdown of a building's life cycle



Source: London Energy Transformation Initiative (LETI) (2020)

Footnotes

^{1, 5, 6, 9} UN Environment Program, Beyond foundations, 2024

^{2,4} McKinsey Sustainability, Building value by decarbonizing the built environment, June 2023

³<https://www.iea.org/commentaries/more-efficient-and-flexible-buildings-are-key-to-clean-energy-transitions>

^{7, 8, 10, 11} <https://www.iea.org/energy-system/buildings>

^{12, 14} Barclays Equity Research, Heat pumps, March 2024

¹³ HSBC Global Research, Green building, March 2023

^{15, 17} IEA, Energy technology perspectives, 2023

¹⁶ <https://www.iea.org/energy-system/buildings/heat-pump>

18,19, 20, 22, 23, 25 Shell in collaboration with Deloitte, Decarbonising construction, 2023

^{21, 24, 26} UN Environment Program. Building materials and the climate. 2023.

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