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Decarbonising Real Estate

Foundations for Success

ShareAction»

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Contents

Executive Summary	4
Introduction	6
The importance of decarbonising real estate	6
Decarbonising real estate is material to investors	6
Time for action	9
Part I: The ins and outs of decarbonising buildings	10
Sources of emissions	10
Key emission reduction targets	13
1. Net Zero Embodied Carbon	16
- 1.1 Decarbonising new buildings	17
- 1.1.1 Product stage: Materials	17
- 1.1.2 Construction process stage: Design and Construction	20
- 1.2 Decarbonising existing buildings	22
- 1.2.1 Use and retrofit stage	22
- 1.2.2 End of life	24
2. Net Zero Operational Carbon	25
- 2.1 Heating and cooling	26
- 2.2 Energy	29
- 2.3 Appliances and cooking	29
- 2.4 Smart technology	31
Reporting	31
Part II: Investor recommendations	32
Engagement Targets	32
Engagement Questions	32
- Risk Management	32
- Decarbonisation strategy	33
- High-Level Considerations	33
- Embodied Carbon	33
- Operational Carbon	34
- Reporting and Governance	35
References	37

Executive Summary

Energy use in buildings contributes more than 17.5 percent to global greenhouse gas emissions, and their construction is a key driver behind demand for steel and cement, which together are responsible for another 10.2 percent of emissions. Hence, decarbonising the real estate sector is unavoidable in order to reach net zero emission targets by 2050.

The European Union is bringing forward a raft of regulation to bring the sector on track. This includes the potential addition of buildings' emissions in the EU Emission Trading System (EU ETS), and directives for energy performance and sustainable construction materials. As a result, existing building stock without extensive retrofits, and non-aligned new housing, are at high risk of significant losses in value.

In order for investments to be aligned with the Paris Agreement, buildings need to reduce both their **embodied carbon**, in other words the emissions that are “locked into” the structure of the buildings (such as emissions from the steel, windows or insulation produced to construct, maintain and refurbish a building), as well as their **operational carbon**, in the form of emissions from energy used for heating, running appliances and other end uses.

Ultimately, for Paris alignment, according to the European Union and the World Green Building Council, all new buildings must already be built as nearly-zero energy buildings (NZEB), and have net zero operational carbon by 2030. Further, they must have a 40 percent reduction in embodied carbon by 2030 and have net zero embodied carbon by 2050. Existing buildings need to be retrofitted at a rate of 5 percent annually and must also have net zero operational and embodied carbon by 2050.

Getting to net zero embodied and operational carbon relies on a multitude of solutions ranging from decarbonising input materials, net zero design, and carbon neutral construction, to renewable energy solutions, heat pumps (to replace fossil fuel-based heating) and smart technology, alongside increased reuse and recycling of construction materials. Part I of this report outlines the technical steps on the road to decarbonisation for buildings in detail.

Action today could save the industry \$1 billion, while a ten-year postponement may cost up to \$2,500 billion. Investors can be at the forefront of ensuring a timely transition. They can put pressure on the industry to align practices with the goals of the Paris Agreement, consequently safeguarding existing and future investments, as well as preserving our planet and economy for future generations.

Investor recommendations

Recommendations for investors on how to engage with companies in their portfolio can be found in Part II of this report. Key outcomes resulting from the investor-led engagement process should be:

- Companies along the buildings value chain set net zero targets for 2050, with relevant short- and medium-term milestones, that bring down embodied carbon by 40 percent in 2030, and operational carbon to net zero by 2030 for new buildings.
- Companies provide a plausible climate strategy based on scenario and carbon pricing modelling in line with IPCC 1.5 degrees Celsius “limited-to-no overshoot” pathways. Their strategies should outline key actions, including respective capital spending plans, and quantifiable greenhouse gas emission reductions from all main emission sources.

- Companies show clear commitments and plans for all relevant aspects of embodied carbon and operational carbon, as outlined in this report.
- Companies use life cycle assessments and environmental product declarations (EPD) as a foundation for decision making.
- Last but not least, companies pursue property labelling in line with best practice standards, such as the EU's Level(s) guidelines, and disclose their Scope 1, 2 and 3 emissions, alongside TCFD reporting.



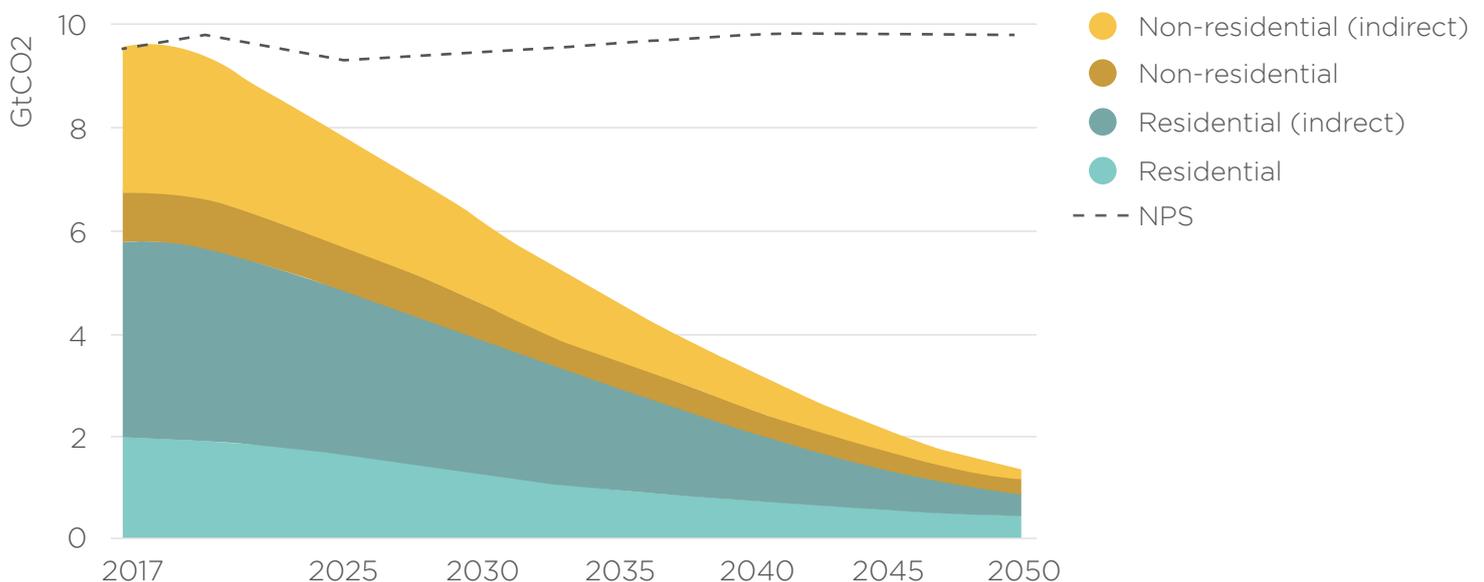
Introduction

The importance of decarbonising real estate

In order to limit global warming to 1.5 degrees Celsius, global emissions need to reach net zero by 2050ⁱ. This includes significant direct greenhouse gas (GHG) emissions from energy use in the real estate sector representing 17.5 percent of the global total emissions, out of which 10.9 percent come from residential buildings and 6.6 percent from commercial buildingsⁱⁱ. In addition, the real estate sector is a large consumer of carbon-intensive products such as steel and cement, which combined are responsible for another 10.2 percent of global GHG emissionsⁱⁱⁱ.

While buildings' energy intensity per square metre has improved, total emissions have risen by over 25 percent since 2000 as demand for housing has increased^{iv}. This means a steep decline in buildings' emissions is needed over the next 30 years to meet the requirements of the Paris Agreement (Figure 1), according to the IEA's Fast Transition Scenario^v. This compares to the New Policies Scenario (NPS), which can be seen as a proxy for business-as-usual, where emissions from buildings are expected to stay fairly stable. It should also be noted that the IEA's Fast Transition Scenario is modelled to limit global warming to 2 degrees Celsius^{vi}, and is therefore likely to underestimate the reductions needed to limit global warming to 1.5 degrees Celsius. Hence, emissions must fall even further and faster.

Figure 1: IEA Fast Transition Scenario building-related CO₂ emissions over time



Notes: NPS = New Policies Scenario; Indirect CO₂ emissions result from upstream generation of electricity and heat used in buildings. IEA 2019. All rights reserved.

Source: IEA, 2019

Decarbonising real estate is material to investors

The European Union (EU), where buildings are responsible for 40 percent of the bloc's energy consumption and consequently 36 percent of its emissions from energy^{vii}, is putting a focus on the buildings sector in order to achieve its own net zero target for the bloc by 2050. Globally, the pressure on new construction is a key focus, as floor space is expected to increase to meet the

demand for housing of a growing population. However, in the EU, where 85-95 percent of the existing housing stock is expected to still stand in 2050^{viii}, the union also has a strong agenda for retrofitting. Part of the drive to decarbonise buildings is a set of actions currently being discussed by the European Commission that would introduce carbon pricing for buildings and new regulatory standards for construction and operation alongside other pieces of regulation (Figure 2).

Figure 2: Summary of (planned) regulation by the EU and UK on decarbonising the buildings sector

Name	Description	Timeline
EU Taxonomy ^{ix}	The investor facing Sustainable Finance Action Plan has set out, through the EU Taxonomy, what activities can be defined as sustainable. These then need to be disclosed as a percentage of an investor's portfolio, enhancing asset owner scrutiny. Such criteria include strict standards for green buildings.	July 2020
Level(s) ^x	These new voluntary guidelines take a life cycle approach to sustainable buildings, providing decarbonisation and sustainability standards from design to construction and renovation.	2020 (voluntary)
Renovation Wave ^{xi}	The EU has launched an action plan to "at least double the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations". This is putting a focus on the 85-95 percent of the current housing stock, which will still exist in 2050, through grants and other incentives.	2020
Energy Performance of Buildings Directive ^{xii}	According to this legislation, all new buildings need to be "nearly zero-energy buildings (NZEB)" and all building stock must achieve energy efficiency targets in line with the EU's decarbonisation plans.	December 2020 & 2020-2050 targets
EU Emissions Trading System (ETS) ^{xiii}	Today the EU ETS, a "cap and trade" system for reducing carbon emissions, covers around 30 percent of buildings' heating and cooling emissions. The EU commission is set to review this in 2021, to price in more carbon from buildings, in order to achieve its target of net zero emissions in 2050.	2021
Construction Products Regulation ^{xiv}	In order to reduce whole life cycle emissions of buildings, the EU is set to revise the Construction Products Regulation to incorporate the usage of sustainable construction materials.	2023
UK equivalents	Many targets set in legislation have been made voluntary in recent years, including the "Code for Sustainable Homes" ^{xv} . However, for the country to reach its net zero targets, it is likely that such codes aimed at net zero carbon homes will be re-introduced. Current steps by the UK government include introducing green incentives in the form of the Green Homes Grant and the Future Homes Standard where new homes will need to be "'zero carbon ready' and have 75-80 percent lower carbon dioxide emissions than those built to current standards" ^{xvi} .	As soon as possible

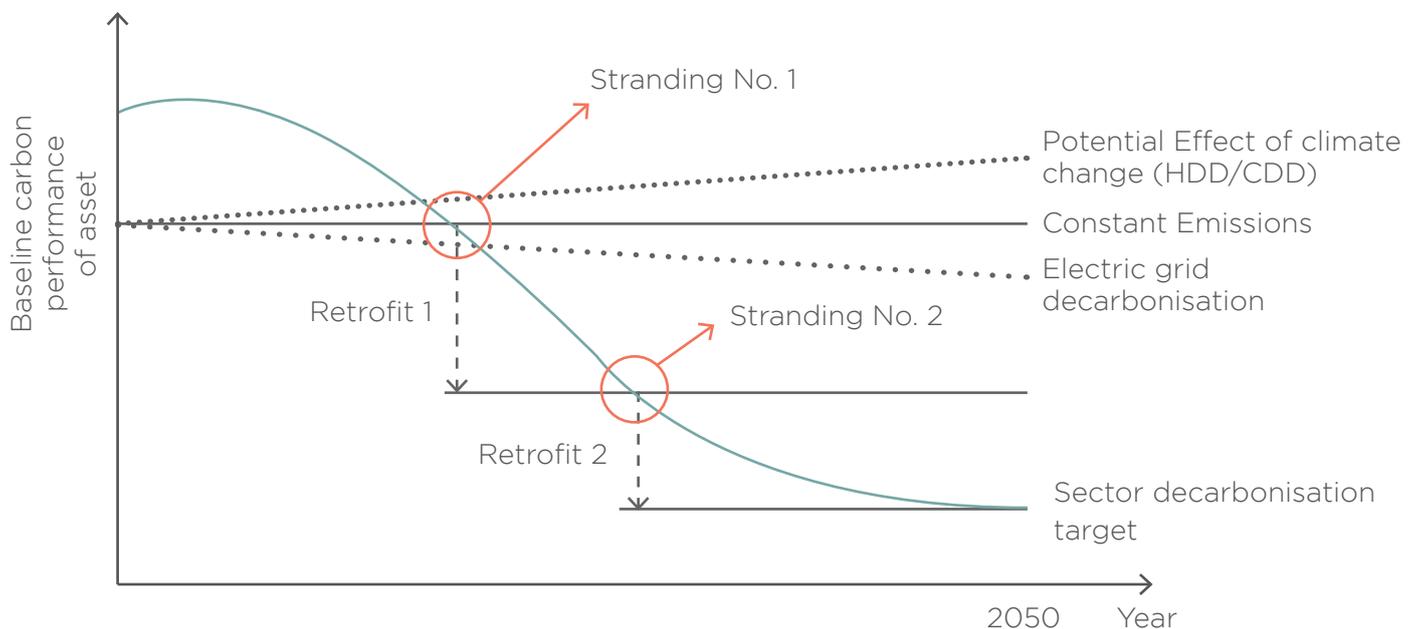
Hence, EU and UK-wide climate commitments, and respective building regulation, have far-reaching implications for the real estate sector itself, and investors providing capital to it. The need to build new housing subject to net zero constraints and retrofit existing housing stock is unavoidable.

This means an increasing number of assets will be left at a high risk of stranding

This means an increasing number of assets will be left at a high risk of stranding (Figure 3). As emission intensities need to fall in line with the reductions set out by the EU to achieve carbon-neutrality, retrofits might be needed sequentially (e.g., “Retrofit 1” and “Retrofit 2” in Figure 3 below) to meet increasingly stringent standards over time. If buildings do not meet those standards, their re-sale value is likely going to decrease to a level where the asset might be considered as “stranded”. Income from rental might also be affected, if landlords are prevented from letting out property that does not meet environmental standards.

Investors will need to position themselves to avoid such headwinds, but also to harness new opportunities resulting from the transition. Engaging with companies along the value chain is a key tool that investors have at their disposal to ensure the viability of holdings in a net zero carbon future.

Figure 3: CRREM¹ Stranding Diagram^{xvii}



Source: CRREM, 2020

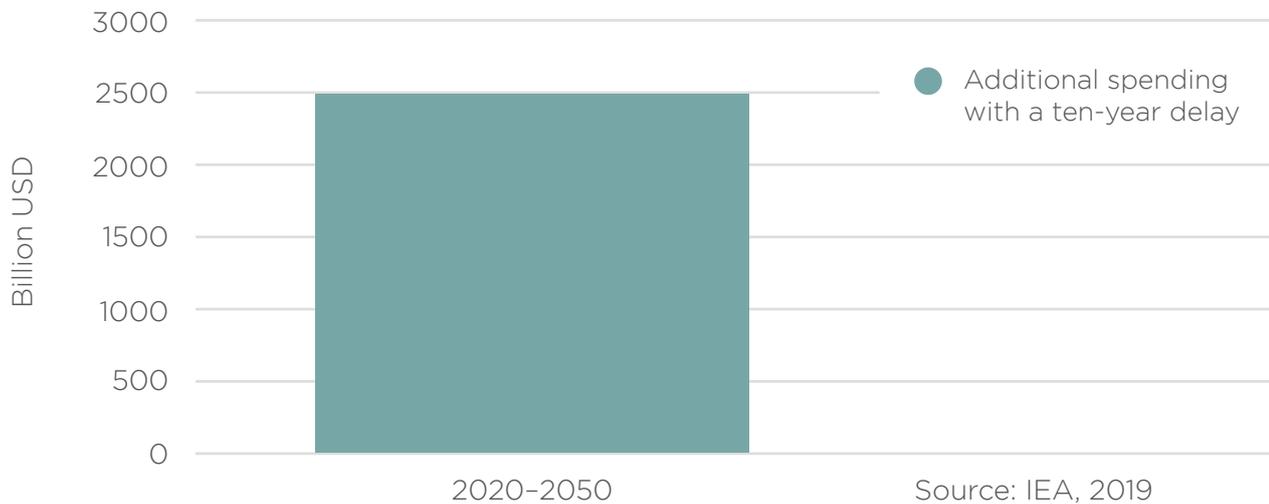
1 The Carbon Risk Real Estate Monitor is an EU-funded research project aimed at helping the real estate industry tackle decarbonisation. More information can be found on their website here: <https://www.crrrem.eu/about-crrrem/>

Time for action

Apart from regulatory pressure forcing the industry to transition, sustainable buildings harbour significant economic potential. They could save up to \$1bn compared to the status-quo. However, a successful transition would require significant upfront investments^{xviii}.

Making these investments now is critical, as a delay would result in serious costs. For example, a ten-year delay of measures aimed at improving the sustainability of building envelopes would come at a price tag of about \$2,500bn^{xix} (Figure 4), due to the higher energy demand and therefore increased costs.

Figure 4: Costs associated with a ten-year delay of building envelope measures



Definition box^{xx}

“Building envelope” refers to the walls, floor, roof, windows and similar that together form the separation between the exterior and interior of a building; whereby in a multi-party house floors, walls and ceilings shared between flats also count towards the building envelope.

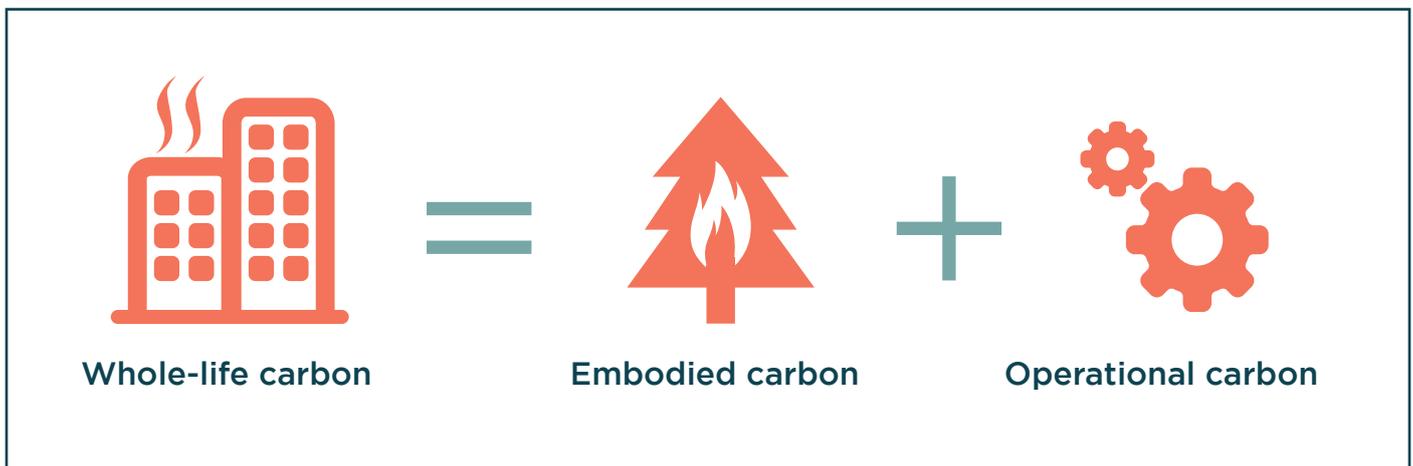
Part I: The ins and outs of decarbonising buildings

The first part of the report highlights the causes of emissions from buildings and outlines key steps to decarbonise the whole value chain in line with milestone targets.

Sources of emissions

The carbon footprint of buildings needs to be viewed from a life cycle point of view to account for all greenhouse gas emissions along the value chain. As part of that, whole-life carbon can be split into two main sources, namely embodied carbon, and operational carbon (Figure 5&6)^{xxi}.

Figure 5: Whole life carbon equation



Definition box

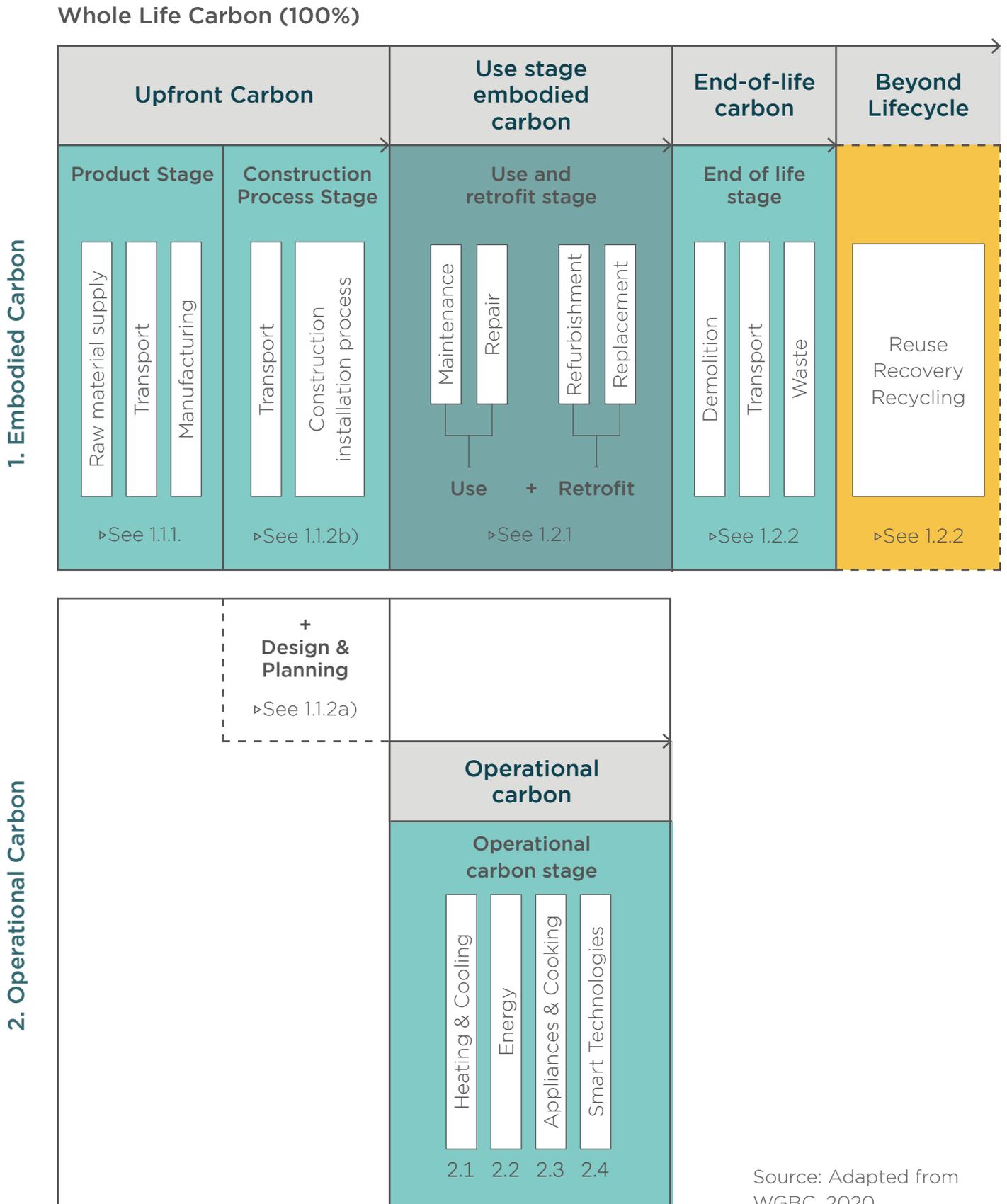
“Life cycle emissions” and “whole-life carbon” refer to the practice of considering emissions from cradle to grave, hence incorporating all emissions along the complete value chain, including the production of input materials, transport, and end-of-life disposal.

“Embodied carbon” refers to the carbon emitted to construct, maintain, and demolish a building.

“Operational carbon” refers to emissions caused during the operation of a building, hence mainly referring to energy used for heating, lighting, appliances, etc.

A detailed breakdown can be found in Figures 6a&6b below.

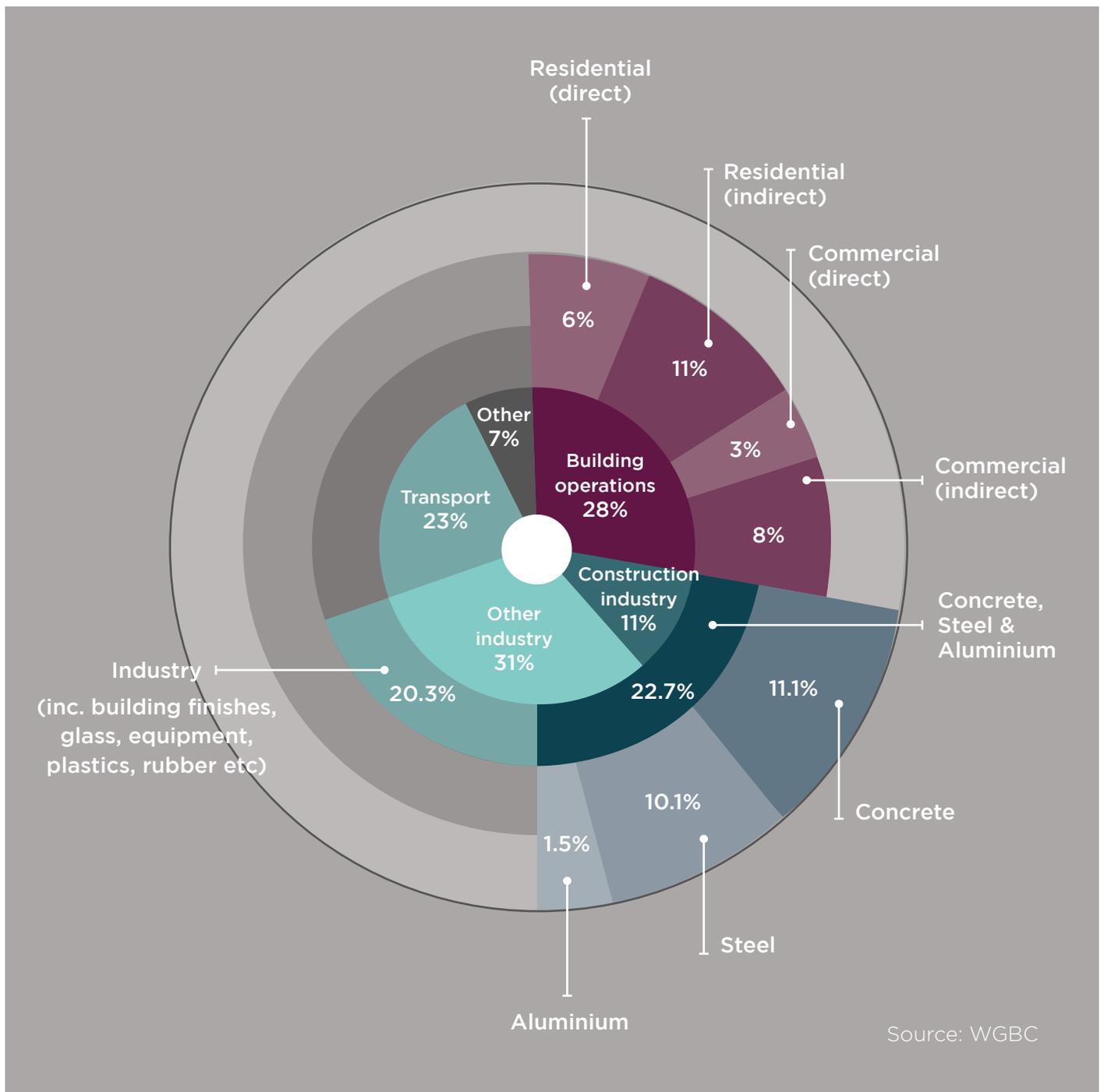
Figure 6a: Breakdown of carbon emissions along the real estate value chain



To get an idea of the scale of emissions at different value chain levels, Figure 6b^{xxii} breaks down the sources of emissions from buildings globally, to give investors a starting point for prioritising engagement activity.

However, it should be notes that emissions do differ by region and building type.

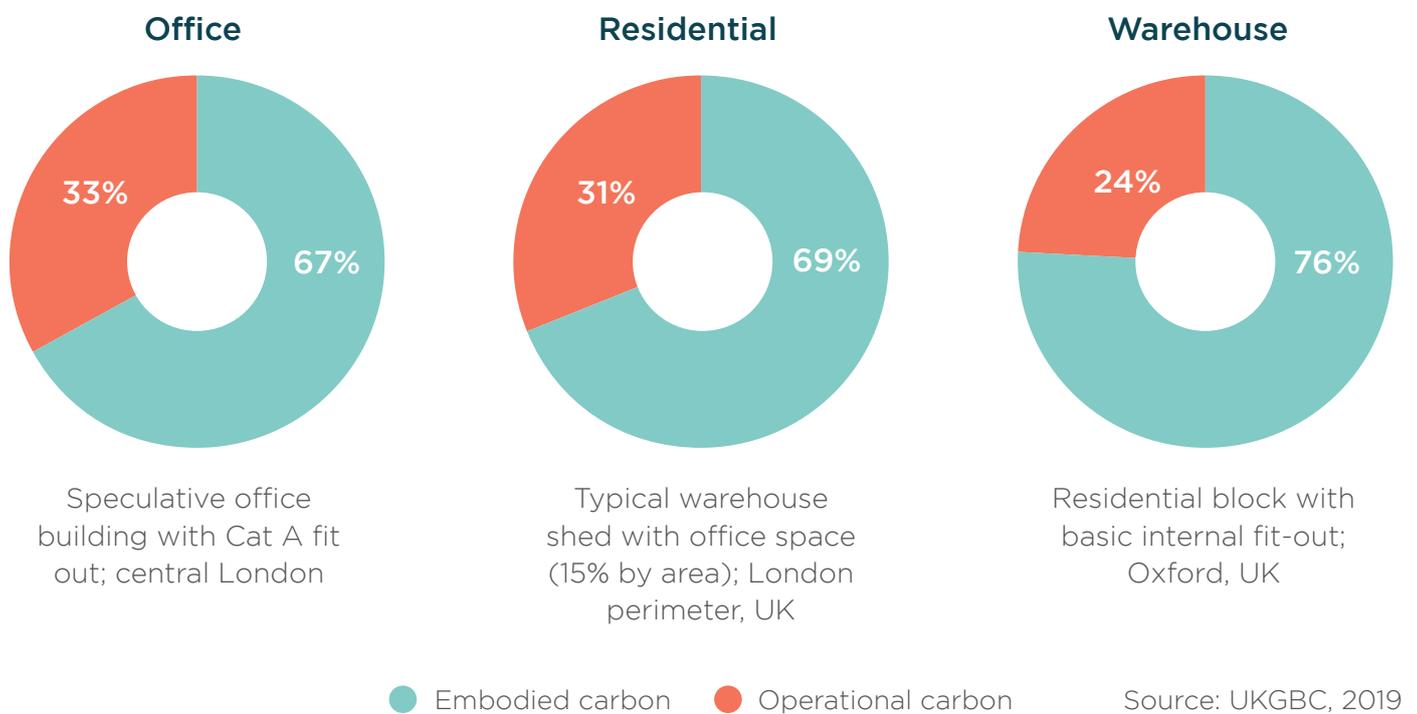
Figure 6b: The sources of building emissions globally



In fact, the makeup of buildings' carbon emissions between embodied and operational carbon differs by building type (Figure 7), resulting in varying levels of importance of decarbonising each aspect depending on the type of building an investor is directly, or indirectly, invested in.

... resulting in varying levels of importance of decarbonising each aspect depending on the type of building an investor is directly, or indirectly, invested in.

Figure 7^{xxiii}: Breakdown of embodied and operational carbon in different types of buildings



For the sector to reach net zero by 2050, all parts of the value chain need to decarbonise, requiring multiple targeted solutions for each part. The following chapters of this report will focus on ways to reduce embodied carbon from new, as well as existing, buildings, followed by a breakdown of the key levers to decarbonise emissions from operations (operational carbon).

Key emission reduction targets

Emission reduction targets should be set in the context of **embodied** and **operational** carbon for a) new and b) existing buildings respectively, as their timelines to decarbonisation differ.

For example, in the context of new buildings compared to existing buildings, retrofitting all existing buildings is likely to take longer than building new property with net zero considerations already in mind, resulting in different carbon timelines.

Further, decarbonising embodied and operational carbon requires differentiated approaches to setting milestone target years. For example, the decarbonisation of embodied carbon requires the production of net zero steel and cement, as described further down in the report, which are far from being widely deployed, while net zero operational carbon can rely on existing technologies such as heat pumps and renewable electricity. This once again results in different timelines for each type of carbon.

Hence, decarbonisation targets can be seen as relating to **embodied** carbon for a) new buildings and b) existing buildings, as well as **operational** carbon for a) new buildings and b) existing buildings, and will show different milestone years for each subset.

A combination of existing EU and World Green Building Council objectives provides investors with a clear idea of what to expect from companies in their portfolio (Figure 8) and by when. These objectives will likely be supplemented by more granular regulation, as described earlier in this report.

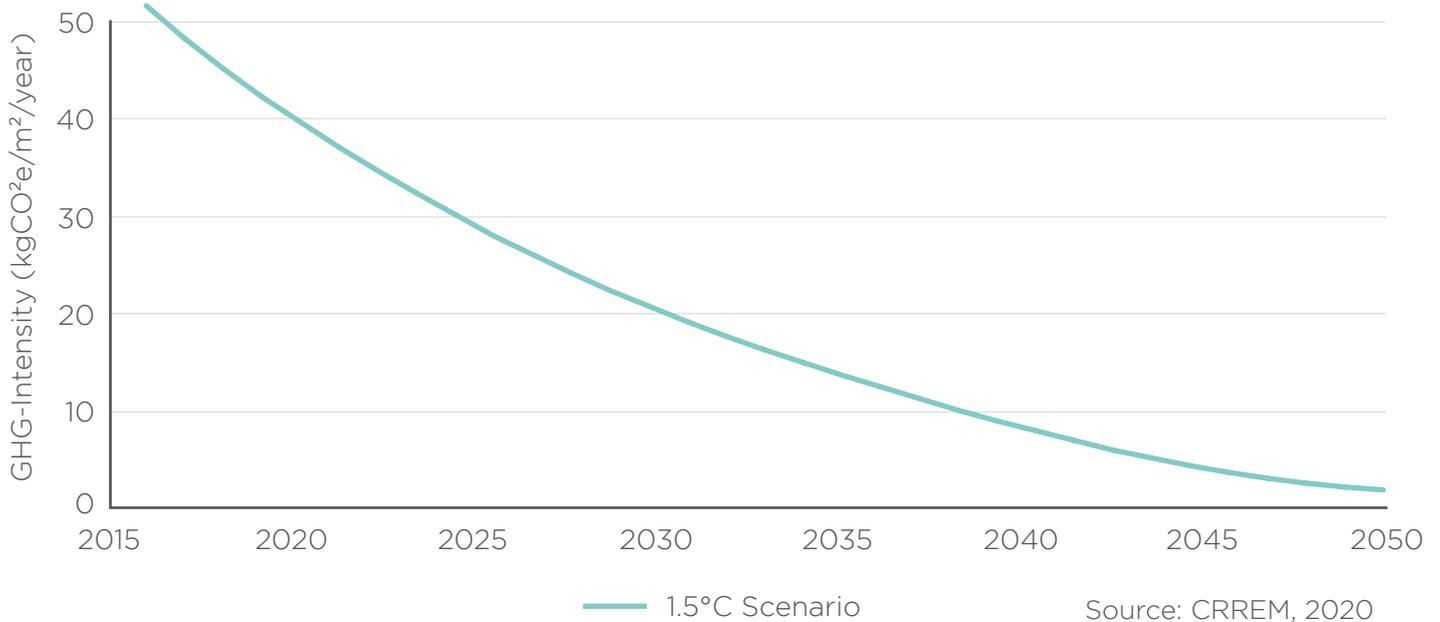
Figure 8: Milestone targets for a net zero real estate sector



Source: WGBC, European Commission

Investors can benchmark a direct or indirect holding's carbon intensity over time and engage with companies to ensure it is in line with a global 1.5 degrees Celsius pathway, as outlined by CRREM (Figure 9)^{xxix}, in combination with the milestone targets above.

Figure 9: GHG intensity pathway for 1.5 degrees Celsius



As the carbon footprint of different types of buildings differs, investors can supplement the high-level targets above with more granular targets for residential and commercial buildings (not part of this report). The transition pathways developed by CRREM^{xxx} offer detailed guidance for emission and energy intensity pathways related to such assets.

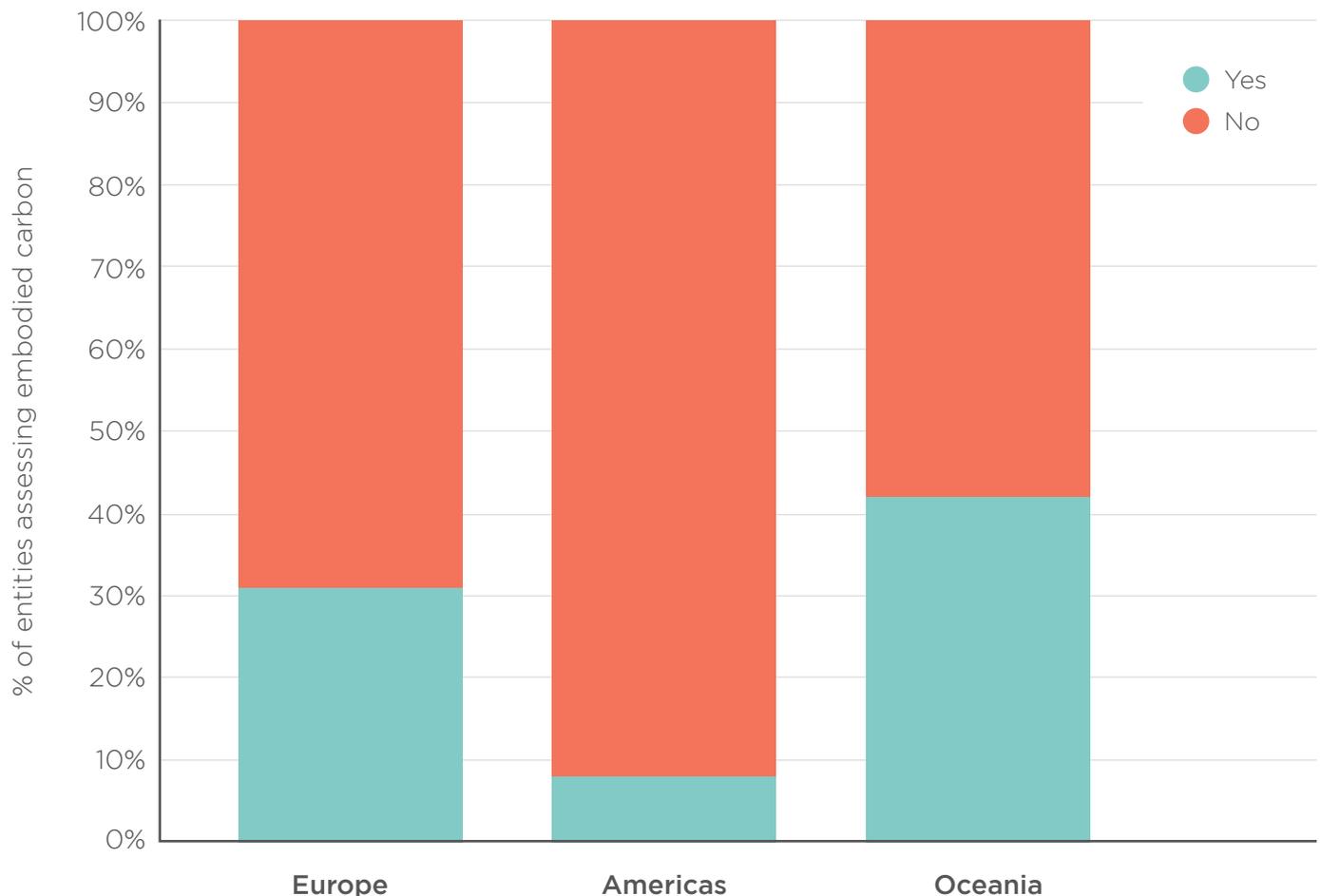
The main tools for decarbonising embodied and operational carbon, irrespective of the building type and use, however, are fairly consistent and described in detail on the following pages of this report.

2 GRESB is an organisation providing real estate and infrastructure benchmarks in regards to material ESG issues. More about GRESB can be found here: <https://gresb.com/about/>

1. Net Zero Embodied Carbon

This part of the report will outline the steps and considerations needed to decarbonise embodied carbon within real estate. Currently, taking the GRESB² sample as an indicator, only around 31 percent of European building development entities account for embodied carbon (Figure 10)^{xxxi} in their life cycle assessments.

Figure 10: Embodied carbon assessments across regions



Source: GRSB, 2020

... hence delaying action on decarbonising embodied carbon emissions would have significant detrimental effects in the long-run.

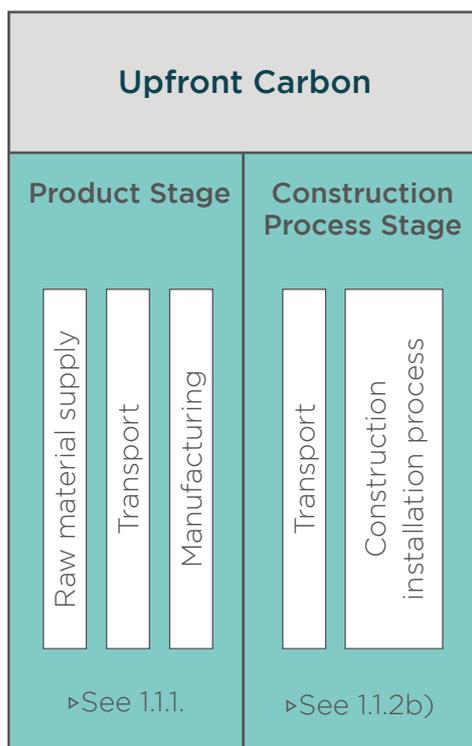
While operational carbon can be reduced through improvements in energy usage and efficiency over time, embodied carbon is locked-in at the construction stage^{xxxii}, hence delaying action on decarbonising embodied carbon emissions would have significant detrimental effects in the long-run.

As an investor, accounting for embodied carbon can be done by splitting underlying assets into new buildings, yet to be constructed, and existing assets, which need to undergo retrofitting. This allows for applying correct milestone targets to different types of investments.

1.1. Decarbonising new buildings

The life cycle carbon emissions distinct to a new building are oftentimes called “upfront carbon” (Figure 11) and refer to emissions stemming from the production of materials needed for construction and the construction process itself^{xxxiii}. Lowering these emissions is critical to climate objectives, as they represent around 11 percent of total global emissions^{xxxiv}.

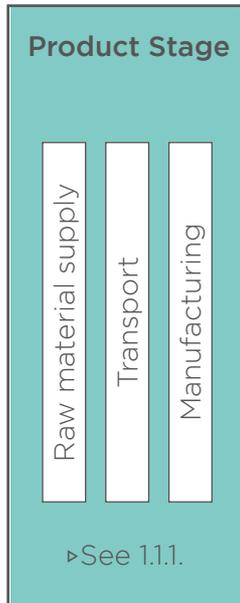
Figure 11: Upfront carbon breakdown



1.1.1. Product stage: Materials

The building sector is a major consumer of cement and steel, which combined are responsible for 10.2 percent of global GHG emissions^{xxxv}. This is in addition to carbon emitted through the production of other building materials such as aluminium, glass and plastic, which together with steel and cement make up 22.7 percent of a building’s carbon footprint^{xxxvi}. Hence, decarbonising traditional building materials, and/or establishing the use of alternative materials, forms an important part of a net-zero life cycle target for the real estate sector. This also includes product sourcing and transport, alongside manufacturing considerations (Figure 12)^{xxxvii}.

Figure 12: Sources of carbon emissions from building materials production



With a potential revision of the Construction Products Regulation by the EU in 2023, and building emissions being taken up by the EU ETS, legislative proposals are quickly moving to price in embodied carbon, especially in the form of emissions from construction materials.

Many solutions already exist today to significantly decrease emissions at the product stage, but rely on demand from the real estate sector sending the right signals.

Hence, companies along the buildings value chain, same as investors, have a crucial role to play not only to react to existing and upcoming regulation but also to show leadership in demonstrating and demanding sustainability best practices from suppliers.

This section of the report highlights actions that can be taken today to reduce embodied carbon in new buildings at the product stage, in the shape of decarbonising input materials.

Key levers to decarbonising construction materials are as follows:

► Life cycle assessments

In order to gain a concrete understanding of a building's potential carbon emissions, a life cycle assessment helps account for such emissions from cradle to grave. A life cycle assessment (LCA) is defined as "a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to a building, infrastructure, product or material throughout its life cycle (ISO 14040: 2006)^{xxxviii}."

Hence, conducting appropriate life cycle assessments allows for effective decision-making regarding the design, materials usage and waste management of a building^{xxxix} in order to reduce life cycle emissions in line with milestone targets. Without it, planning and accounting for buildings' emissions properly is near impossible. It therefore represents the essential first step for every development.

► Transport electrification

In order to eliminate emissions from transport, with the wide-spread availability of electric vehicles (EV), any road transport involved in the production stage should be carried out, as much as possible, through renewably-charged electric fleets. Where heavy-duty vehicles are needed, there should be a clear, Paris-aligned timeline for transport to be decarbonised using solutions such as green hydrogen or electrification. Current best practice for (supply chain) companies is represented by signatories of the Climate Group's EV100 initiative, aimed at creating clear company commitments for the electric vehicle transition^{xl}. Transport solutions should be fully electric by 2030.

3 Available online at: <https://shareaction.org/wp-content/uploads/2019/10/CementBriefingForInvestors.pdf>

► Net zero traditional materials

Due to the significant emissions from traditional building materials such as steel and cement, decarbonising these inputs to reach net zero by 2050 is critical. Companies along the real estate value chain are well-positioned to put demand-side pressure on manufacturers of such goods in order to achieve their own climate targets and comply with potential upcoming EU regulation. This should further include a focus on glass, aluminium and plastics alongside other common materials used in the construction of buildings.

Some guidance and initiatives on net zero for such materials already exist. “SteelZero”, an initiative by the Climate Group and Responsible Steel brings together leading demand-side organisations to speed up the transition to a net zero steel industry^{xii}. Further, ShareAction’s report called ‘Decarbonising Cement: The Role of Institutional Investors’³ outlines clear action points for the cement industry to decarbonise and how investors can support its transition.

In addition to steel and cement, all products used in construction should account for their environmental footprint as part of an environmental product declaration (EPD)^{xiii}, allowing designers to compare different product specifications, set appropriate decarbonisation targets, and where possible, replace traditional products with alternative low-carbon materials.

Further, setting clear decarbonisation targets in line with reducing embodied carbon by 40 percent in 2030 and reaching net zero in 2050 for material suppliers can be supported by a push for corporate commitments to initiatives such as EP100 and RE100, which help companies set required energy efficiency and renewable energy targets.

The Climate Group Commitments

RE100: A corporate initiative of companies committed to using 100 percent renewable power. Companies aim to meet this goal in the shortest time possible and by 2050 at the latest. Together, they send a powerful signal to policymakers and investors to accelerate the transition to a clean economy.

EP100: A corporate initiative of companies committed to improving energy productivity and commit to net zero carbon buildings. Members of EP100 can choose between three commitments: double energy productivity within 25 years, implement an energy management system alongside energy productivity targets, or commit to zero carbon buildings.

EV100: A corporate initiative bringing together companies committed to accelerating the transition to electric vehicles (EV). Companies can do so by committing to switch their fleets to EVs, require EVs in service contracts, and/or install charging for staff and/or customers at all corporate locations.

SteelZero: A global initiative that brings together leading demand-side organisations committed to procuring, specifying or stocking 100% net zero steel by 2050. SteelZero also provides a platform for leading organisations, their peers and suppliers to come together and address some of the barriers currently facing them in their steel supply chains.

► Alternative materials and circular economy

Apart from procuring only net zero steel, cement and other common building materials by 2050 at the latest, traditional building materials should be replaced, wherever feasible, by low-carbon alternatives in any new-built property. This approach is aimed at reducing upfront carbon to the largest extent as possible, as soon as possible.

For example, in a study^{xliii} conducted by the UK Green Building Council, total upfront carbon was reduced 39 percent in office buildings where a full timber structure was incorporated and concrete basements taken out. The same study showed a reduction of total upfront carbon in residential buildings of 21 percent where a timber frame was used.

In fact, the usage of timber instead of steel has possible carbon sequestration potential, as the carbon absorbed by the biomaterial throughout its lifetime is locked into the building. However, the sustainable sourcing of timber, as well as other materials such as bamboo and hemp, in addition to its treatment at the end-of-life stage are paramount in ensuring the actual net or negative carbon properties of the construction material^{xliv}.

Furthermore, with construction making up 30 percent of the UK's total waste generation^{xlv}, the reuse and carbon neutral recycling of materials should supersede the production of new materials for construction purposes, with the intent of creating a circular economy and reducing carbon emissions from waste.

► **Level(s)**

While the EU's 'Level(s)' guidelines are currently voluntary^{xlvi}, they set out comprehensive standards for buildings to be deemed sustainable. An alignment with such standards would allow the industry to account for life cycle carbon and set appropriate targets. Current work by organisations such as the World Green Building Council is aimed at turning "Level(s)" into a legal framework^{xlvii}. It is therefore highly encouraged for new, as well as existing developments, to align with the guidelines as soon as possible.

1.1.2. Construction process stage: Design and Construction

The initial design of a building has a decisive influence on the amount of its carbon emissions throughout its lifetime, while the construction process itself nearly matches the carbon emissions of input materials today^{xlviii}, highlighting the importance of putting decarbonisation considerations at the heart of these processes. The following methods can be used today to help reduce embodied carbon in future buildings from a design and construction perspective.

1.1.2. a) In the design stage:

► **Net zero materials**

As described in previous sections, using net zero input materials by 2050 at the latest is critical in ensuring net zero embodied carbon for new buildings by key milestone dates. Their incorporation, however, needs to already happen at the design stage, especially where traditional materials are exchanged for alternative ones with different properties.

Designers can make use of an increasing array of tools to assess the effects of design changes to the levels of embodied carbon in a potential building through building information modelling (BIM) tools such as "The Embodied Carbon Calculator for Construction (EC3)" or life cycle assessment tools like ELODIE, eToolLCA, and One Click LCA^{xlix}.

► **Modular design**

Part of a building's carbon footprint is the construction, maintenance (including replacements and renovation), as well as demolition of a building. The carbon intensity of these stages, and wastage caused, can be significantly reduced through a modular designⁱ, whereby parts can be easily exchanged and replaced.

► **Material design**

While making material inputs carbon neutral alone would contribute to the reduction of life cycle emissions to net zero, this should happen in conjunction with design and construction approaches that lower the inherent demand for materialsⁱⁱ to prevent inefficiencies upfront and reduce embodied carbon during the transition period material producers will undergo over the next 30 years.

► **Building envelope**

The design and materials used for the building envelope can have a significant effect on the carbon performance of a building throughout its lifetime. There are several ways in which the construction can benefit net zero building targets, however it should be noted that these are highly dependent on the building type and locationⁱⁱⁱ.

Key design toolsⁱⁱⁱⁱ are a) effective insulation (for cold as well as warm climates), b) appropriate use of passive design choices adapting the building fabric, ventilation and control of solar gains to the climactic circumstances, c) external shading and reflective surfaces to reduce solar heat gain, and d) size and glazing of windows to protect from undesirable heat losses and gains.

Together these considerations affect the upstream suppliers of materials, helping to reduce emissions from inputs, as well as the construction, maintenance and operation of the building, as described in the following parts of this report.

1.1.2. b) In the construction stage:

It is the construction installation process, as well as associated transport, that causes carbon emissions at this point of a building's life cycle (Figure 13), making their key decarbonisation relatively straight-forward compared to other stages.

Figure 13: Sources of emissions in the construction process stage

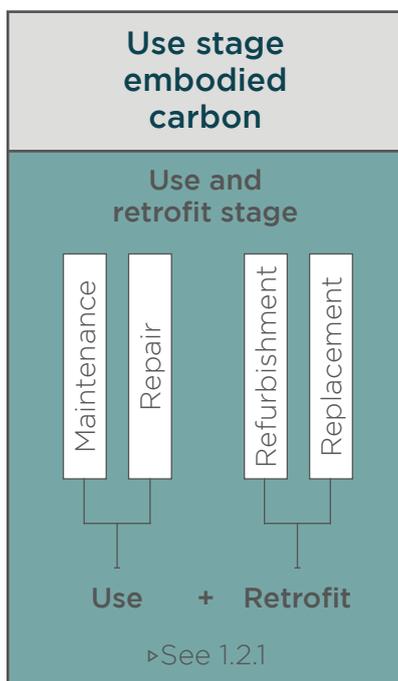


1.2. Decarbonising existing buildings

1.2.1. Use and retrofit stage

As 85-95 percent of the current housing stock is still expected to stand in 2050, retrofitting such housing and lowering use stage emissions (maintenance, refurbishment and renovations as per Figure 14) is paramount to achieving the EU’s carbon targets.

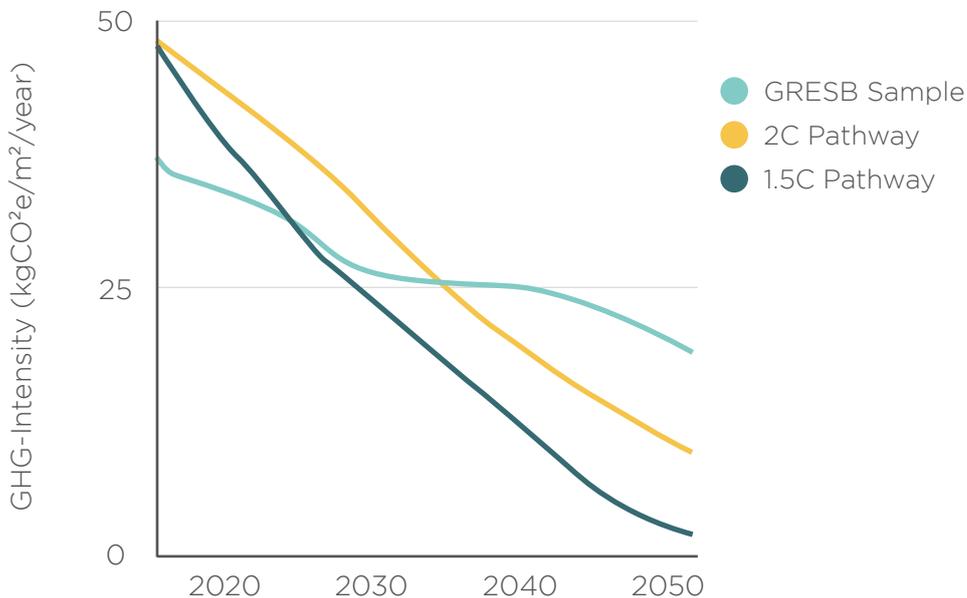
Figure 14: Use stage carbon emission sources



However, a sample by GRESB shows that assets are currently on track to be overshooting 1.5 degrees Celsius pathways by a significant margin (Figure 15)^{iv}. An analysis by CRREM highlights that the EU must see a 5 percent increase in the annual renovation rate to stay on a 1.5 degrees Celsius pathway^{iv}. This stands in contrast to current renovation trends in the EU, where the annual weighted renovation rate is at around 1 percent, with deep renovations only making up 0.2 percent despite being the main renovation type needed^{vi}.

Figure 15: EU real estate assets' projected pathway using the GRESB sample

GRESS EU Sample Performance Against CRREM Pathways



Source: GRSB, 2020

Not unlike designing a new building, retrofits, renovations and replacements need to be approached from a life cycle perspective. They touch upon similar techniques to decarbonisation as in the design stage, and are predominantly focussed on improving the thermodynamics of a building.

The main techniques are as follows^{lvii}:

► Insulation

Insulation can help with the thermodynamics of buildings in both cold and warm climates, meaning old or insufficient insulation should be replaced by appropriate newer solutions. This should be subject to a positive life cycle assessment, as insulation material production can be carbon-intensive itself. Pushing for and procuring carbon neutral insulation in production also forms part of the material decarbonisation objectives, as outlined earlier on in this report, where all material inputs should be carbon neutral by 2050.

Further insulation targets for 2030 should also include the insulation of roofs and walls of at least 20 percent of the building stock, which should increase to at least 50 percent by 2040, and 100 percent of new and existing buildings by 2050.

► Windows

To further reduce heat losses and/or gains, depending on the location of a building, advancing double and triple glazing, whereby all buildings should be double or triple glazed by 2050 (where cost effective), is as important as boosting the usage of low-e window coatings and solar gain controls. “Low-e” refers to the coating of windows, which acts as a filter of light that can either reduce unwanted heat gain through solar radiation or unwanted heat loss, by preventing heat from escaping the home^{lviii}. Such coatings should be retrofitted in buildings where appropriate, and the procurement of windows subject to net zero constraints by 2050.

► Shading and reflective surfaces

Last but not least, to further improve the energy efficiency of a building, effective shading and reflective surfaces can be used. By integrating (movable) elements, shading can achieve similar effects as solar optimised windows, and light-coloured surfaces with reflective pigments can further reduce cooling needs. Hence, where the location of a building means that residents have considerable cooling needs, such techniques should be present and widespread by 2050.

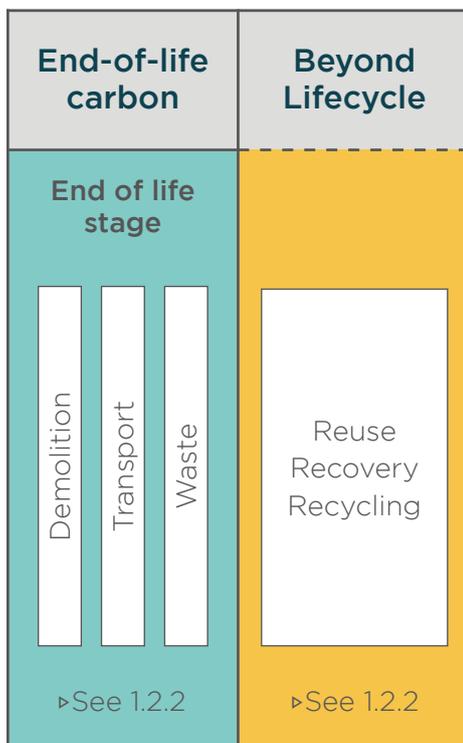
In addition to the points outlined above^{lix}, other important considerations include the local environment and best practices (as local needs can differ and therefore so do best possible local solutions), landlord-tenant relationships, as well as reporting and auditing (discussed later on in the report).

Further, as mentioned before, decisions related to embodied carbon factors have important consequences on operational carbon as well, with improvements in the envelope of a building, or its retrofit, having knock-on effects on the thermodynamics of a building and consequently the amount of heating, cooling and energy needed to keep tenants comfortable.

1.2.2. End of life

As with the initial construction of a building, its demolition brings along emission reduction levers and value chain opportunities (Figure 16), per the outline below.

Figure 16: Emission sources and opportunities arising at the end-of-life stage of buildings



► Demolishment and transport

Similar to the construction process, the demolition of real estate assets should be energy and resource efficient in its process, and subject to renewable energy and low-carbon transport methods.

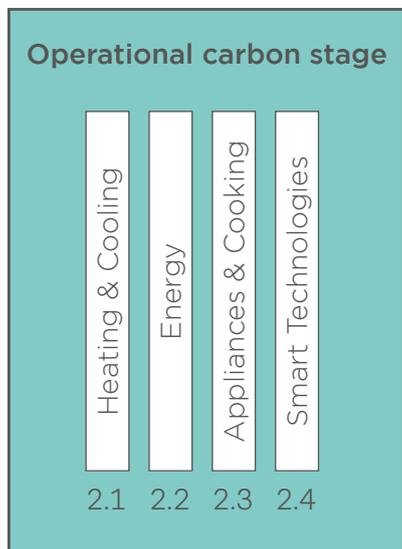
► Waste and circularity

Ensuring waste is processed in a carbon-neutral way is only the second-last step in a building's journey. With the EU's Green Deal, a focus on the circular economy includes the building sector, opening up favourable circumstances for the reuse of building materials at the end of an asset's life. Clear opportunities will continue to open up as the bloc creates viable marketplaces and support for wide-spread recycling^{lx}.

It is therefore of high importance that circularity considerations are front and centre at the end-of-life stage of a building

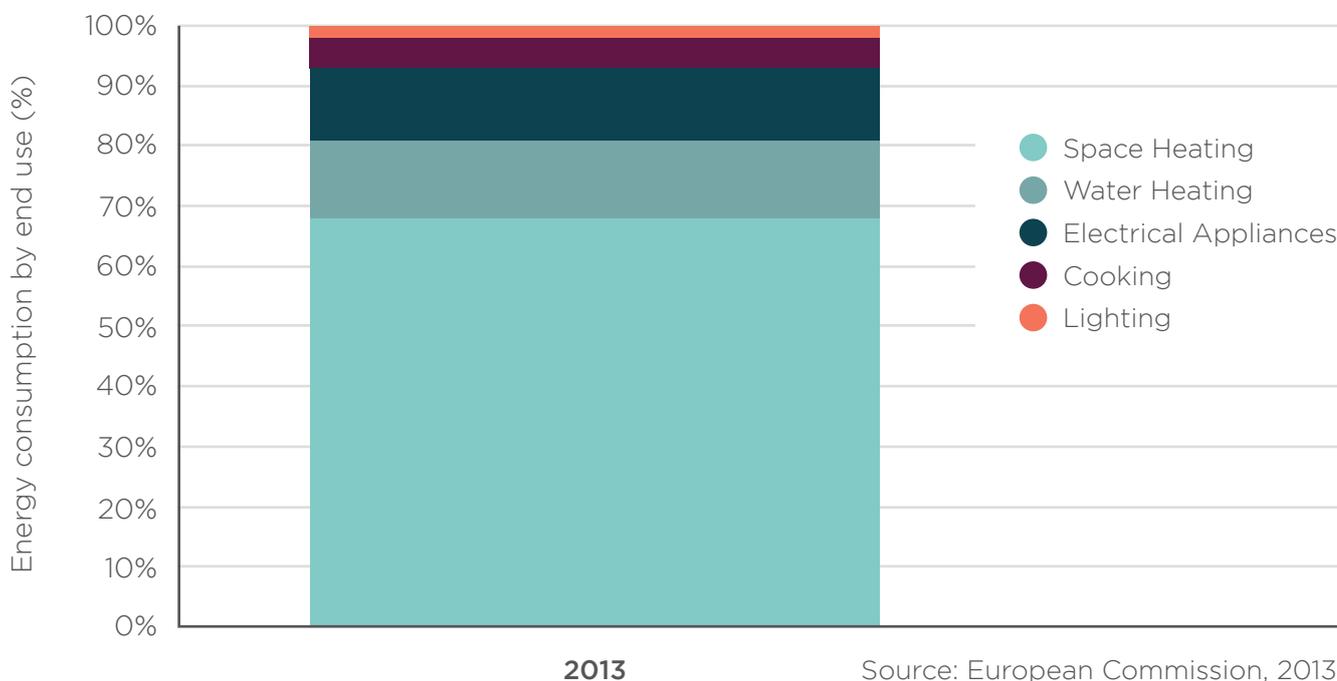
2. Net Zero Operational Carbon

Figure 17: Operational carbon emission sources



Operational carbon, on average, currently makes up more than 50 percent of global buildings' carbon footprint^{xi}. It stems from energy use (Figure 17) for different end usages such as heating and lighting. While this percentage is set to decline and the prominence of embodied carbon to increase, this development underlies strong assumptions. These assumptions are based on the decarbonisation of the energy usage in buildings across all end uses (Figure 18)^{xii}, with a particular focus on heating and cooling, as well as electrification. The following part of this report will highlight the opportunities and challenges linked to decarbonising each aspect of operational carbon.

Figure 18^{xiii}: Energy usage in European buildings by end use



2.1. Heating and cooling

Heating and cooling, including water heating, by far make up the largest proportion of operational carbon, and therefore solutions to reduce emissions are of high importance.

For heating, there are several existing approaches to achieve this. At its core, fossil fuel-based heating, such as gas boilers, should be replaced with low-carbon alternatives as soon as possible, and all new installations by 2025 the latest^{xiv} (as the lifespan of a new boiler is about 25 years).

The main alternatives are as follows^{xv}:

► **Electric heating**

Heating running on 100 percent renewable energy could provide a low-carbon heating solution. However, as further outlined below, the resulting electricity demand might render this solution infeasible in many locations and preference should be given to alternatives as per below.

► **Heat pumps**

Heat pumps are devices that transfer the warmth out of the air, water, or ground outside to warm the inside of a building, by transferring heat through radiators (see 'Case Study: Heat pumps'). Being highly energy efficient at around 400 percent (compared to a 100 percent efficiency of conventional electric heaters)^{xvi}, they use relatively little energy in addition to being emission free in their heat generation process. Hence, heat pumps are a perfect example of a technology helping buildings to achieve net zero targets. They are expected to be the most dominant type of heating technology in 2050. Yet, it is important that they run on renewable energy only to be completely carbon neutral in operation.

4 More information around the carbon neutrality myth of biomass can be found in ShareAction's report here: <https://shareaction.org/wp-content/uploads/2019/01/InvestorReport-Biomass.pdf>

Case Study: Heat Pumps^{lxvii}

A heat pump works by absorbing low-grade warmth from the ground, air, or water. This warmth is brought into a heat exchanger where it causes a refrigerant to evaporate. These refrigerants need very little warmth, meaning that heat pumps can work in very cold conditions of up to -20 degrees Celsius. The evaporated refrigerant is then compressed, using electricity (ultimately renewable electricity for the process to be carbon neutral), which drives the temperature up. This transforms the low-grade warmth to useable high temperature that heats up a water tank, which in turn connects to hot water and the central heating systems.

Figure 19: Visualisation of a heat pump^{lxviii}

Example of how a typical air source heat pump (ASHP) works



Source: The Renewable Energy Hub, 2020

► Hydrogen and Biomass

Further, hydrogen can offer ways of decarbonising existing gas boilers, by replacing the fossil fuel with a higher concentration of the low-carbon gas. However, the boiler would ultimately need to be replaced by a fully efficient hydrogen or biomass boiler by 2050. It is important to note, however, that the readiness of infrastructure to deliver hydrogen is lagging behind, proving a significant challenge to its deployment. Hydrogen would need to come in the form of “green” hydrogen^{lxix}, hence having been produced from renewables alone, to be completely carbon neutral, while biomass would need to stem from waste or credible sustainable sources only.⁴

► **Solar thermal**

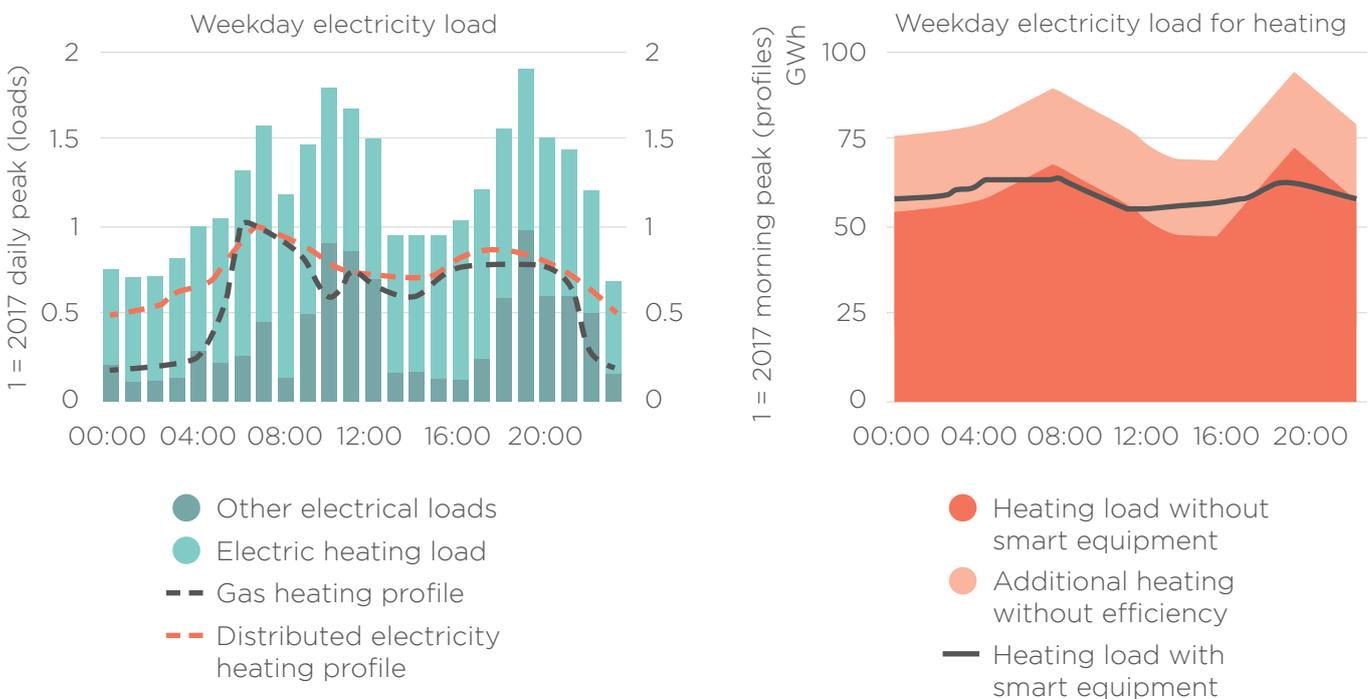
Where the location of a building is suitable, the installation of solar thermal technology provides a low-carbon way of heating buildings. Hereby solar panels on the roof heat a water tank, which in turn provides heat to radiators and hot water. A cost-benefit and life cycle analysis can help compare this option to other available solutions, especially as heat pumps are expected to make up at least 50 percent of heating solutions in Western Europe.

► **Geothermal**

Increased mapping of geothermal potential should allow for all buildings in a suitable location to be supplied by direct geothermal heating. Developers should therefore take geothermal potential into account when planning and constructing buildings.

Replacing fossil fuel heating options with clean solutions oftentimes means an increase in electricity demand, due to the increased electricity requirements of the low-carbon solutions as outlined above (compared to heating run on oil and gas, requiring no to very little electricity), with some forecasts expecting a tripling of early morning, and doubling of early evening, energy demand in European households. This has a significant impact on the grid (Figure 20) and potentially electricity prices, as meeting peak demand requires additional electricity generation that is mainly dormant during off-peak hours.

Figure 20^{lxx}: Net zero heating and energy could increase peak loads significantly



Source: IEA, 2020

As seen above, the need for net zero heating solutions also highlights the importance of building envelope measures (described under *1. Net Zero Embodied Carbon* of this report) and smart solutions (described further down in this report) to reduce heating, and therefore electricity demand in the first place. Further, district network heating offerings can significantly minimise peak load demands, as efficiencies can be maxed out on the district level first, and use made of excess solar and wind energy, before putting pressure on the national grid.

As global warming is causing increased temperature rises across the world, the demand for cooling is expected to triple world wide. Hence, decarbonising cooling is equally important as decarbonising heating in order to achieve net zero for buildings. The main levers to achieve this are efficiency improvements of air conditioning technology of a minimum of 50 percent by 2030 and 100 percent by 2050. This can be accompanied by innovative solutions such as connecting air conditioning units to rooftop solar or cold water/ice water storage. Further, traditional air conditioning units can be replaced with reversible heat pumps that can both heat and cool the home, where heat pumps prove to be the superior technology.

2.2. Energy

The solutions to net zero energy for buildings already exist today, and as energy demand from buildings is set to rise, switching to fully renewable energy is an easy step on the road to net zero. Hence, landlords and tenants should be encouraged to use renewable energy providers, with initiatives like RE100 providing a platform for companies to stimulate renewable power demand and support best practice approaches to ensuring 100 percent renewable usage in their buildings. Consequently, power supply should be at least 60 percent renewable by 2030, 90 percent renewable by 2040, and 100 percent renewable by 2050^{lxxi}.

Further aspects to a carbon-free energy supply are the increased deployment of rooftop solar and the construction of electric vehicle charging infrastructure for tenants in all buildings, where cost effective, by 2050^{lxxii}, and a credible ramp-up roadmap up until mid-century.

2.3. Appliances and cooking

The last proportion of energy used in buildings that is not yet covered above, refers to cooking and electrical appliances. As with heating and energy, apart from using renewable energy only, a focus on energy efficiency, and therefore a reduction in energy usage, is key.

For cooking, this means replacing inefficient gas hobs, which spend at least half of their heat on warming the ambient air instead of food, with electrical stoves. Here, induction hobs, which use magnetic fields to heat up a pan or pot directly, have proven to be the superior technology in regard to energy efficiency over other types of stoves and should therefore be preferred as an installation choice^{lxxiii}.

Moreover, smaller electrical appliances should be subject to stringent labelling and only the most efficient products used to replace older appliances. Last but not least, innovation for larger appliances such as refrigerators, dishwashers and dryers could show opportunities for the usage of (reversed) heat pumps^{lxxiv}.

Most energy savings from more efficient appliances tend to benefit tenants, highlighting the importance of the landlord-tenant relationship. A workshop by RE100 and EP100 served as a platform to debate challenges and opportunities relevant to this aspect of decarbonisation (Case Study: RE100 – Landlord and Tenant relationship).

Case Study: RE100 and EP100 (part of The Climate Group) – Landlord and Tenant Relationship

During a RE100 and EP100 workshop with its real estate members, building tenants have highlighted that it can be challenging to implement energy efficiency measures and switch to a renewable source of electricity in assets that they don't have full control over (leased assets).

While appetite for implementing decarbonisation measures may be high, there are several commonly highlighted challenges that act as a barrier to effective change. These broadly relate to:

- Communication – not knowing who to speak to or where to start
- Perception of high costs
- Buy-in within the organisation
- Accountability and legal frameworks – where the cost and benefits are felt

In parallel, landlords noted that they sometimes encounter a lack of interest from tenants for the more sustainable solutions they offer. Despite their efforts to redefine the value proposition of their premises, other priorities will come first in companies' real estate decisions (e.g., location, costs, etc.).

Hence, the workshop highlighted the issues both tenants and landlords encounter when approaching carbon emission reductions. The resulting approaches can help stakeholders tackle the problems:

- Establishing the right contact person and clarifying requested actions and outcomes
- Tenants could refuse to sign contracts for assets that do not meet the sustainability criteria set out in this report
- Data on energy usage and efficiency should be shared transparently to establish decisions on how to decrease energy demand

Since that event, The Climate Group partnered with the Better Buildings Partnership to form the Owner and Occupier forum to bring together senior real-estate decision makers from both parties to collaborate with the objective of delivering net zero carbon buildings by 2050. The owner and Occupier Forum acts as a cross-sector working group which further enables owners and occupiers to tackle barriers around carbon reduction initiatives.

2.4. Smart technology

Last but not least, information technology solutions can play a pivotal role in the decarbonisation of buildings by dynamically optimising the usage of electricity and heating^{lxv}, addressing some of the grid issues this report has touched on. As buildings become more electrified, reducing energy usage and increasing efficiency can be achieved through several “smart” technologies.

For example, smart meters in buildings can transmit information on energy usage, helping the grid electricity provider optimise loads. Further, smart devices such as smart heating and cooling could predict occupation patterns and consequently optimise energy needs accordingly, making use of off-peak electricity as much as possible. Other smart solutions include dynamic EV charging and real time pricing, working on similar principles. Together, these smart solutions play a key role in reducing energy demand and helping to put pressure off peak loads.

Reporting

To support the deployment of climate solutions, reporting on the emission and sustainability aspects of buildings lay a vital foundation for action. Hence, best practices include^{lxvi} a) building life cycle assessments, b) building labelling, including building energy codes and respective codes for retrofits, c) product labelling and life cycle assessments, and d) audits to systematically check systems in place.

This allows for the challenges and opportunities outlined in this report to be met and for stakeholders, including investors, to track progress, which provides the basis for engagement targets, as outlined in Part II below.

Part II: Investor recommendations

The second part of this report looks at how investors can use the findings in Part I to engage with companies on achieving net zero by 2050 in the buildings sector. It also provides a tangible outcome (“Tracking outcome”) investors can track to measure company performance, the success of engagements over time, and take appropriate action.

Engagement Targets

The following engagement questions are designed for investors with holdings in listed real estate companies, such as in the Stoxx 600 Real Estate index. However, they can also be adapted for investments in REITs (real estate investment trusts) and property funds.

Further, as the buildings value chain involves a number of different players, some of the questions are also directly applicable to:

- Real estate development and construction companies
- Property management companies
- Manufacturers of building materials (such as steel, cement, glass, aluminium, insulation, etc.)
- Companies with large real estate footprints (such as retail, banks and logistics, etc.)

Investors are encouraged to consider their holdings related to real estate and adapt the engagement questions to best reflect investment needs. Disclosure on carbon sources by companies might also guide the prioritisation of certain aspects (e.g., operational carbon or embodied carbon) of decarbonisation, where time constraints might be present.

Engagement Questions

Risk Management

- 1 Does the company conduct scenario analysis on the different decarbonisation pathways in line with IPCC 1.5 degrees Celsius limited-to-no overshoot pathways?

Tracking outcome: The company a) conducts scenario analysis with a focus on 1.5 degree Celsius limited-to-no overshoot pathways, b) publicly reports on inputs and assumptions, c) publicly reports on outputs from the analysis, highlighting key risks and what steps the company needs to take to mitigate them, and c) updates scenarios as new IPCC reports are released.

- 2 Does the company use an internal carbon price to assess existing **and** future projects?

Tracking outcome: The company uses a regional carbon price aligned with scientific recommendations for IPCC 1.5 degrees Celsius limited-to-no overshoot scenarios. The carbon price is used to assess existing and future projects. Outputs from the analysis are made publicly available alongside a description of assumptions.

Decarbonisation strategy

High-Level Considerations

- 3** Does the company have a net zero emission target for 2050?

Tracking outcome: The company has a) a net zero commitment for 2050 at the latest, and b) short- and medium-term targets aligned with IPCC 1.5 degrees Celsius limited-to-no overshoot pathways and CRREM 1.5 degrees Celsius carbon intensity pathways. Where applicable, it further commits to embodied and operational carbon targets as outlined under point 8 and 14 below.

- 4** Does the company have a plausible strategy to achieve its targets?

Tracking outcome: The company identifies key actions it needs to take to achieve its emission reduction targets, quantifying their contributions to reducing emissions from core sources. These should be interlinked with the company's scenario analysis and carbon pricing analysis, and made publicly available.

- 5** How does the company ensure its investments are aligned with its strategy and targets?

Tracking outcome: Capital spending and R&D are planned in accordance with climate targets and form a core part of a company's climate strategy disclosure, as per above.

- 6** Has the company signed up to initiatives focused on reducing emissions?

Tracking outcome: Signatory to relevant initiatives such as (not exclusive or exhaustive) SBTs, RE100, EP100, EV100 and SteelZero, as well as the World Building Council's commitment.

- 7** Does the company use life cycle assessments and environmental product declarations (EPD) as a foundation for its decision making?

Tracking outcomes: The company conducts life cycle assessments and environmental product declarations. Where these fall outside of the firm's scope, it engages with relevant stakeholders along its value chain.

Embodied Carbon

- 8** Does the company have embodied carbon targets aligned with the World Green Building Council (WGBC) recommendations^{lxviii}?

Tracking outcome: The company aligns with WGBC commitments to reduce embodied carbon by 40 percent in new buildings by 2040, and reach net zero embodied carbon for new and existing buildings in 2050.

- 9** How does the company plan to achieve net zero emissions from materials?

Tracking outcome: The company has a clear commitment to net zero emissions from materials and plausible plans to reach the target. That includes targets for a) material substitution (e.g., timber), b) recycled content and recycling of used materials, c) membership to initiatives such as SteelZero, and d) materials covered by environmental product declarations (EPD). The company actively engages with suppliers in its value chain and aligns with Level(s) recommendations.

10 How does the company incorporate climate change considerations into the design and planning process of a building?

Tracking outcome: The company uses building information modelling (BIM) to assess the effects of design changes to the levels of embodied carbon in a potential building. Further, designers focus on a) using net zero building materials, b) improving material design to reduce the total amount of materials needed, c) incorporating modular design thinking for easy demolition and replacements, and d) designing the building envelope in accordance with net zero embodied and operational carbon considerations.

11 Does the company ensure net zero emissions from construction and demolition?

Tracking outcome: The company has set out criteria for construction and demolition partners, in order for them to qualify for contracts. This includes targets on a) net zero transport (including commitments to initiatives such as EV100), and b) net zero processes.

12 How does the company contribute to increased circularity of goods?

Tracking outcome: The company aligns with best practice standards as set out in Level(s). Further, it targets a) a high recycled content percentage, and b) a high recycling rate.

13 Does the company have ambitious enough retrofitting targets (where needed)?

Tracking outcome: The company has a clear strategy to retrofit existing properties, which in turn feeds into its climate strategy as described above. It roughly aims at deep renovation (including building envelope) targets of at least 2 percent, and ideally 5 percent, per annum.

Operational Carbon

14 Does the company have operational carbon targets aligned with the World Green Building Council (WGBC) recommendations^{lxxviii}?

Tracking outcome: The company has plans in place that ensure net zero operational carbon in new buildings by 2030, and in all buildings (including existing ones) by 2050.

15 How does the company plan to decarbonise heating?

Tracking outcome: The company has clear guidelines on the replacement of fossil-fuel heating systems in existing buildings, whereby all such systems are replaced as soon as feasible and no later than 2050, and a commitment to carbon-free heating solutions for new buildings, with all fossil-fuel boilers having been replaced by 2025 for new installations.

16 How does the company plan to decarbonise cooling?

Tracking outcome: The company has set air conditioning efficiency targets, such as a minimum improvement of 50 percent by 2030 and 100 percent by 2050, and is exploring new cooling technologies like reversed heat pumps.

17 How does the company plan to decarbonise energy needs?

Tracking outcome: The company has a clear commitment to 100 percent renewable energy by 2050, with interim targets of 60 percent by 2030 and 90 percent by 2040, and might even be a signatory of RE100. It further deploys solar photovoltaic at all properties where such deployment is cost effective. Last but not least, it has an integrated plan to increase energy efficiency through building envelope, heating and appliance targets, and might even be a signatory of EP100.

18 Does the company have targets for solar photovoltaic and electric vehicle charging deployment?

Tracking outcome: The company has guidelines and targets for the deployment of solar photovoltaic and electric vehicle charging infrastructure at its properties, with all properties being equipped with such, where cost effective, as soon as feasible.

19 How does the company plan to decarbonise appliances usage?

Tracking outcome: The company commits to replace existing appliances with the most energy efficient alternatives available, including replacing cooking stoves with induction hobs.

20 Does the company have targets for smart solutions deployment?

Tracking outcome: The company has a strategy on smart solution deployment that makes use of, at a minimum, smart meters, smart thermostats and dynamic electric vehicle charging to reduce grid peak loads.

Reporting and Governance

21 Does the company pursue labelling of existing and future properties?

Tracking outcomes: The firm shows a best-effort approach in aligning with the EU Level(s) guidance, and sets clear targets for property labelling, outlining if, why, and when such labelling is not pursued.

22 Does the company report its Scope 1, 2 and 3 emissions, and does it report in line with the Task Force on Climate-related Financial Disclosures (TCFD)?

Tracking outcome: The company reports at least Scope 1 and 2 emissions, with a clear target to report on (material) Scope 3 emissions before 2025. It further reports in line with TCFD disclosures, and other external reporting initiatives such as CDP or GRSB.

23 Is data and information on emissions and energy usage audited externally?

Tracking outcome: Data is audited externally. Where this is not done, the company must prove it has strong internal processes for data creation and verification.

24 Is there board level oversight of climate-related strategies?

Tracking outcome: The board has an independent board member for climate, and a member of the executive, with climate related oversight. Further, the company has a dedicated climate change committee, which reports to the board. Beyond decarbonisation, these board members and committees also look at other climate-related risks such as water scarcity, biodiversity and physical risks (not part of this report).

25 Is remuneration linked to decarbonisation targets, and how are board level sustainability capabilities ensured?

Tracking outcome: The CEO's and senior executives' remuneration is linked to tangible climate KPIs and greenhouse gas reduction targets. The company has processes and criteria in place to assess board-level competency over climate issues and appraises the board according to those.

26 Are the firm's lobbying activities aligned with achieving global climate objectives?

Tracking outcome: The company follows best practices as set out in the Responsible Lobbying Framework - <https://www.responsible-lobbying.org/the-framework>.

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ShareAction is a campaigning organisation pushing the global investment system to take responsibility for its impacts on people and planet, and use its power to create a green, fair, and healthy society.

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