Understanding Net Zero Commercial Real Estate

Origins, evolution, ambition and implementation

Case study Ireland

Part 1 · Understanding Climate Ambition

Part 2 · Understanding Climate Action

2025

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RKD

Report summary

Part 1
Understanding Ambition

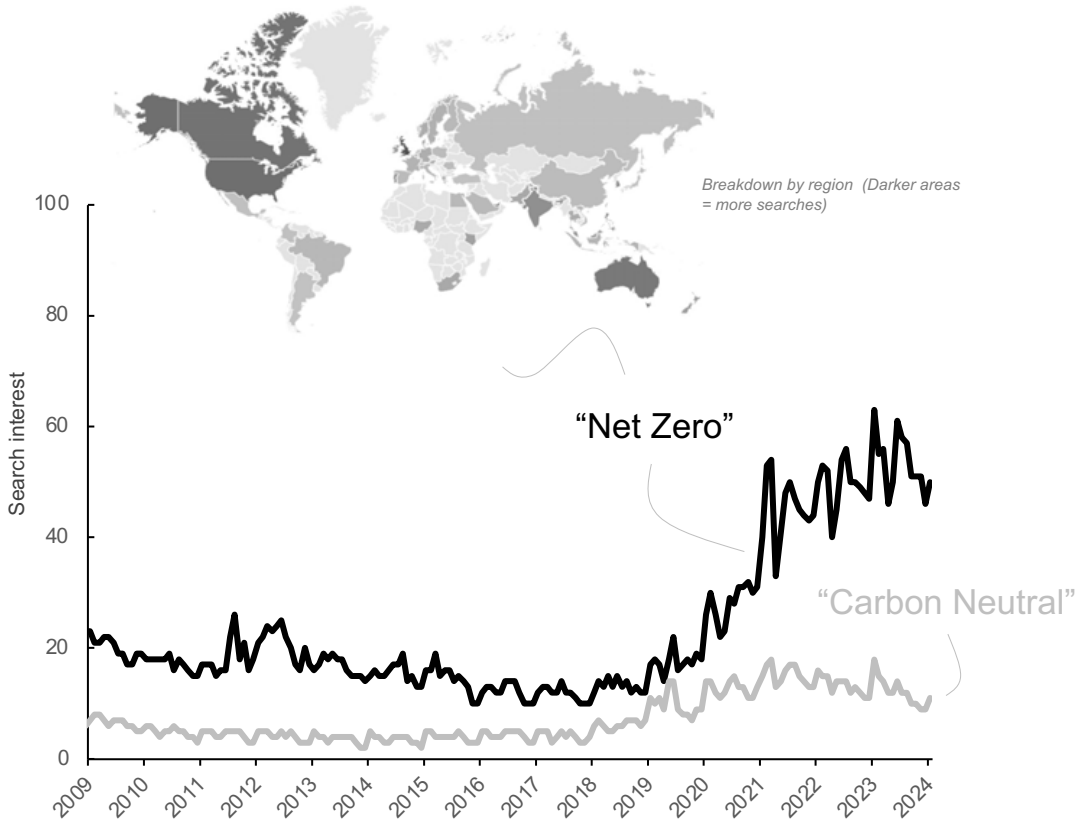
- Net Zero ambition is rising, but the required action to meet this ambition is lagging.
- Net Zero originated from climate science which also focuses on cumulative emissions (or “carbon budgets”).
- As the term entered the commercial world its origins and meaning began to blur, resulting in confusion.
- Disaggregating cumulative emissions into sectors and regions (e.g. Irish buildings) is prone to subjectivity.
- Ireland’s built environment does not have a single, agreed upon, Net Zero trajectory.
- Two detailed standards relevant to Irish commercial buildings have emerged recently – the UK Net Zero Carbon Building Standard (UKNZCBS) and the Science Based Target Initiative (SBTI) for Buildings. Both are reviewed.

Part 2
Understanding Action

- By 2030, the Irish construction workforce needs to almost double (x 1.8), the annual investment in global building efficiency needs to more than double (x 2.3) and the global heat pump stock need to triple (x 3.3) if Net Zero targets are to be met.
- Although “green” financing and investment must accelerate to meet Net Zero scenarios, recent evidence suggest a slowdown.
- Much of the technological solutions already exist but many case studies highlight the need for attentive data management to accompany these solutions.
- Occupant-landlord agency issues complicate action, as landlords make the investment, but occupants benefit.
- A “going green” value difference exists, but it is variable and case study dependent.

Introduction

“Net Zero” is on the rise...



The long-term trajectory search trajectory of the climate-related target. Data source: Google Trends – Web search | All categories | Worldwide

Since the Paris Agreement in 2015, the number of companies and countries signed up to some form of a Net Zero target has increased considerably (UNFCCC, 2015).

The latest University of Oxford-led *Net Zero Stocktake* report shows how 87% of GHG emissions are now covered by national Net Zero targets while 67% of total annual revenue is covered by companies with Net Zero targets (Net Zero Tracker, 2024). Other Net Zero metrics are documented in that same report showing how, over a 4-year period between 2020 and 2024, the global share of GDP, GHG emissions and population covered by a Net Zero claim has increased by 25%, 26% and 36% respectively.
A similar upward trajectory is observed by looking at the historical search-frequency of *Net Zero*.

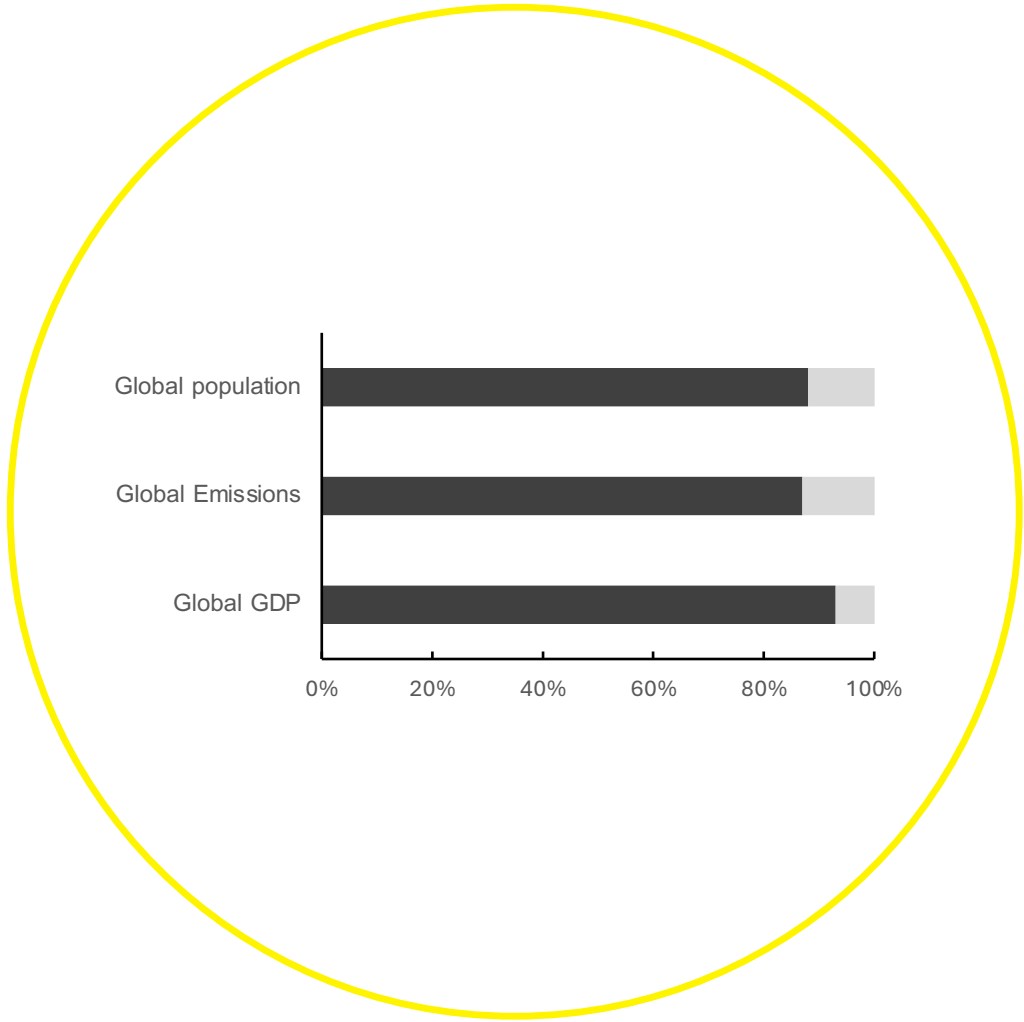
The chart on the left shows the long-term search trend of “Net Zero” between 2009 and 2024 – compared with “carbon neutral” for reference. The ramp-up in searches since 2019 lines up with the increased policy coverage. But while the global coverage of Net Zero targets continues to increase, the same report warns of limited signs of “Net Zero integrity” (Net Zero Tracker, 2024).
Net Zero integrity is defined in accordance with the UNFCCC’ Race to Zero campaign (UNFCCC, 2024) who cite five key requirements, grouped under 5 key “P”s. The World Green Building Council (WGBC, 2024) have a similar set of key components which loosely overlay the Race to Zero’s five Ps.

UNFCCC:
Pledge - **P**lan - **P**roceed - **P**ublish – **P**ersuade

WGBC:
Commit - **D**isclose - **A**ct - **V**erify - **A**dvocate

Low “integrity” scores imply a high probability that the disclosed ambition won’t be met. A gap is clearly emerging between ambition and implementation. And while this can be partly explained by the understandable lag between a planned action and the action itself, other rationale exist which are explored in this report. This sectoral-wide gap is also prevalent in the commercial real estate sector, the subject of this report.

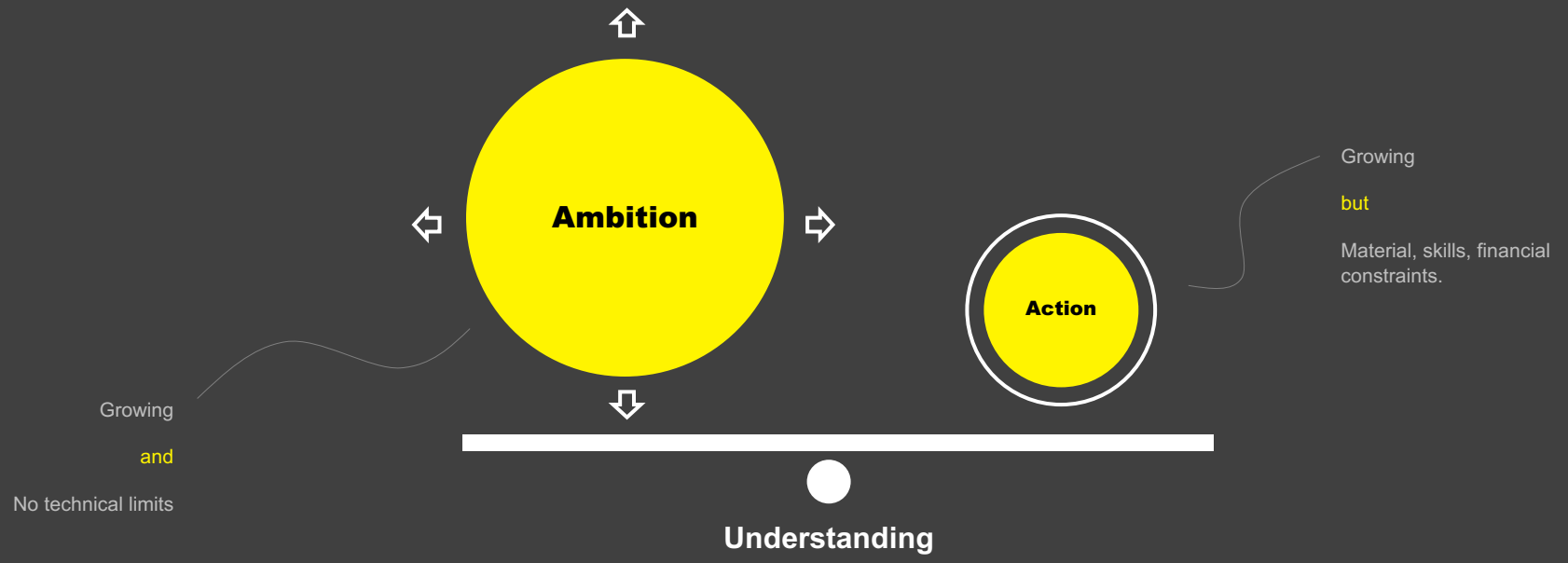
Net Zero ambition continues to rise, but only 3% of states & regions, and 5% of companies, meet the *Net Zero Tracker*’s “integrity” criteria
(Net Zero Tracker, 2024).



Net Zero target coverage by different metrics. Data from Net Zero Tracker (2024)

Introduction

Ambition vs. Action



Report objective

An understanding of where “Net Zero” and other climate-related targets came from and what they mean in the real estate sector is lacking.

This report aims to, within the context of the Irish commercial buildings sector,:

1. Present an understanding of “Net Zero” targets, their origin, uncertainty, and their relevance to different stakeholders.

2. Present an evaluation of the challenges to get to, and potential solutions required to arrive at, Net Zero.

> **To understand is to know what to do**
>
> *Ludwig Wittgenstein*

Part 1

Understanding ambition.

Key findings

- Net Zero ambition is on the rise globally, but a considerable gap between ambition and action remains.
- Closing this gap requires a better understanding of Net Zero.
- The origins of Net Zero are rooted in climate science's focus on cumulative emissions and carbon budgets.
- Part of that shift was a realisation that we would eventually have to reach Net Zero carbon emissions, the other part was that we need to limit cumulative emissions.
- The commercial real estate sector, like many other sectors and nations, has, to-date focused on Net Zero as the primary climate-related goal.
- More recent target ambitions either implicitly or explicitly refer to cumulative emissions – or carbon budgets.
- At a global level there is uncertainty related to the remaining carbon budget to keep within 1.5 ºC global warming limits.
- Disaggregating the budget by sector and/or region adds further uncertainty.
- A precise, technically verifiable, carbon budget for the Irish commercial real estate sector therefore does not exist.
- While all standards and guidelines differ due to the subjective nature of sectoral and national disaggregation, the existence of common frameworks are required, to at least create a level playing field.
- Two of the most comprehensive guides with numerical pathways for offices are the UKNZCBS and the SBTi Building Sector. Both could be adopted for Irish offices in the absence of an Irish-specific standard.
- Both could be used by Irish real estate entities to track performance and design to.

1.0 Section overview

Net Zero is confusing, everyone is confused.

This Section addresses the fragmented understanding of Net Zero and other climate-related targets emerging in the real estate sector. The confusion surrounding Net Zero is resulting in a seemingly infinite number of definitions which can have a paralysing impact on stakeholders who are seeking guidance (e.g. design teams, developers, agents, occupiers, investors, lenders).

As will be presented in this report, what is most important is that effort to decarbonise is maximised from a whole life carbon perspective and that pathways are used as a continuous guide to ensure alignment. The language used to describe ambition, along with the underlying science, continues to evolve.

Beginning with "Net Zero", the confusion it introduces is acknowledged right throughout the climate change policy literature. As stated by the UN's Secretary-General, António Guterres, *Net Zero* suffers from a:

"deficit of credibility and a surplus of confusion."
(United Nations, 2022)

While, M. R. Allen et al. (2022), one of the pioneering scientists behind Net Zero, noted how:

"Our understanding of Net Zero has morphed over the past 15 years from a scientific fact to a pragmatic solution to an estimation problem to an accounting target to an article of faith."
(Allen et al., 2022)

This section begins by summarizing the evolution of "Net Zero" terminology to help alleviate this confusion. We then discuss some of the emerging terminology such as "*Paris-aligned*", "*1.5ºC pathways*" and the various other references to science throughout the built environment discourse.

As the language in the building sector tends towards something scientific, the implied consequence of this is to keep global warming within a specific temperature limit. This is linked to a remaining carbon and Greenhouse Gas (GHG) emissions budget.

Hence, use of such targets requires a level of understanding of the science from which the targets are founded.

A light-touch discussion of these budgets and the uncertainties associated with them is presented. Finally, a detailed review of two pertinent emerging pathways for the Irish commercial real estate sector who cite alignment with a 1.5 ºC compliant budget is conducted.

This understanding is designed to inform Part 2 which is focused on the challenges facing implementation and solutions enabling it. The key ambition of this work is to present an understanding of what Net Zero means.

1.1 Background

Where did Net Zero all begin?

There is an extensive body of work covering the reasons why we need to reduce emissions to “Net Zero” and how the path to zero matters. The message from the IPCC reports is clear in terms of the direction of travel required – i.e. to decarbonise as much, and as fast as we can. But as that decarbonisation path gets pieced up into various segments (nations, sectors, emissions, combinations of these) the vision, targets and understanding become fragmented.

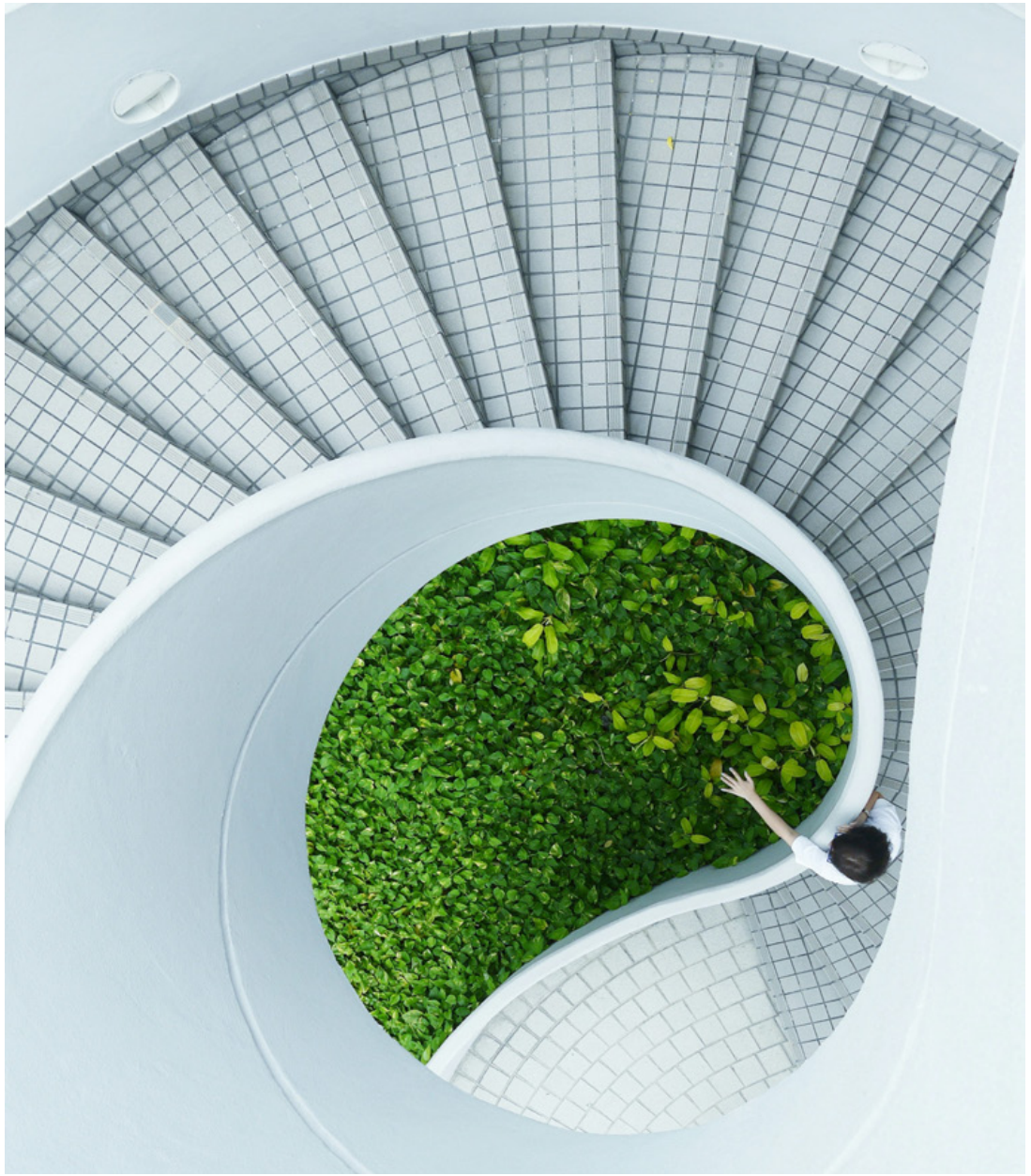
The origins of Net Zero provide a foundation to develop this understanding. A succinct summary of the Net Zero origin is best presented by John Lang (2021), who traces the current use of the two-term phrase back to a scientific paper published in 2009 by Allen et al. (2009) which also highlighted the importance of focusing on **cumulative carbon emissions**. The term then eventually found its way into the IPCC’s fifth assessment report in reference to “**net anthropogenic CO_2 emissions**”, which also introduced cumulative CO_2 emission budgets (IPCC, 2013). The coverage of “Net Zero” throughout the scientific literature is strongly linked to cumulative carbon emission limits. These emission limits are more frequently described, and perhaps better understood, as a budget – a total quantum of emissions we can use before we reach specific global warming temperature limits. e.g. a 1.5 ºC carbon budget.

In the most recent Intergovernmental Panel on Climate Change (IPCC) AR6 *Summary for Policy Holders* (IPCC, 2023a), it notes how:

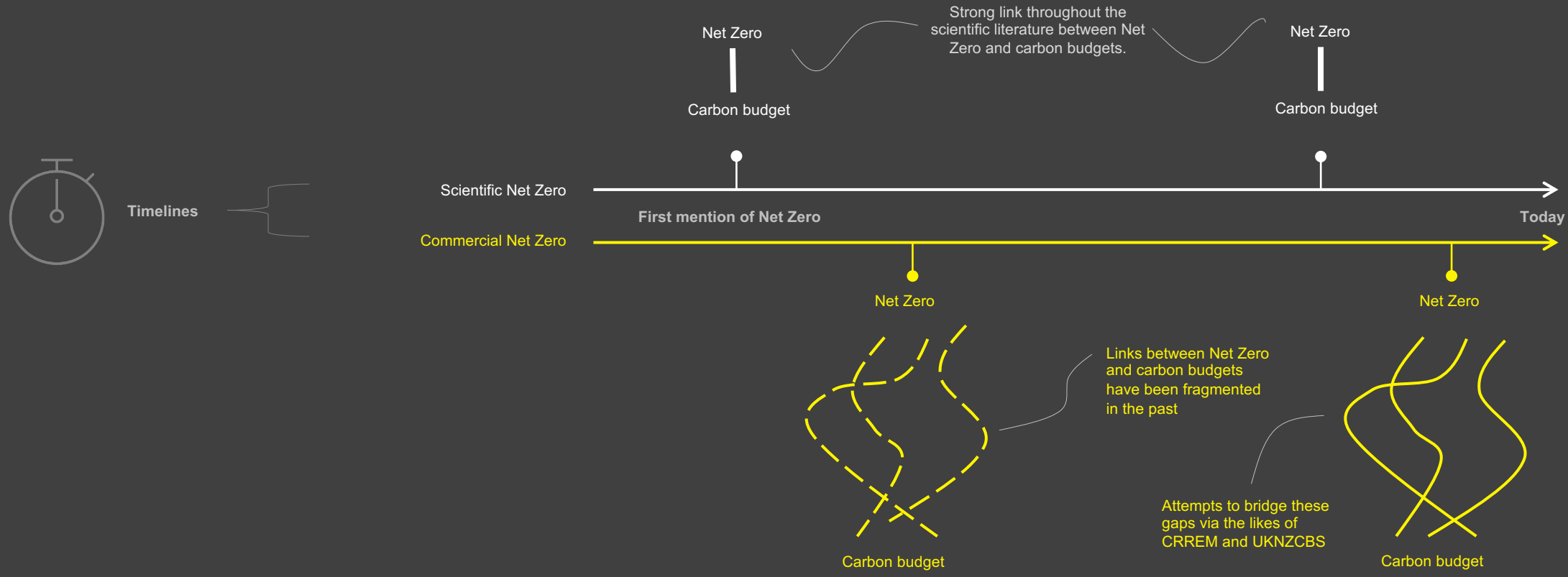
“From a physical science perspective, limiting human-caused global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least Net Zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions”

In summary, both the first and most recent IPCC definition of Net Zero are linked to a carbon budget. But as “Net Zero” enters the realm of policy and corporate discourse the lines begin to blur. It loses its link to carbon budgets.

For the context of this report: Carbon emission limits to keep global warming within specific temperature limits (e.g. 1.5 ºC) = “Carbon budget”



There is a strong link in the scientific literature between 1) the need to achieve Net Zero carbon emissions and 2) the requirement to limit cumulative carbon emissions within a carbon budget.



This link is less explicit in corporate guidelines and reports.

1.2 Net Zero Language

How and why climate targets have evolved?

While the climate physicists were working on establishing the most appropriate metrics for global warming targets through IPCC reporting, corporate climate-related ambition was evolving in several sectors.

Carbon neutral was popularised in the UK by PAS2060 in 2009. Carbon Neutral is a “destination-based target” enabling entities claim “Carbon Neutral” status by way of offsetting.

Net Zero targets, the now more common choice of target, can also be interpreted as a destination-based target, in that there is an end-point target and the pathway towards that target is non-explicit. The target date is usually to 2050, but it differs from carbon neutral in that it requires a considerable amount of emission reduction before offsetting is allowed, typically a portion of about 10% depending on the standard (Lang, 2024). The definition of carbon offsetting is also more stringent with Net Zero guides.

Although the term Net Zero is linked to cumulative emissions throughout the IPCC reports, its use in the corporate discourse is often just focused on the end point – i.e. to achieve Net Zero emissions at a given date as a percentage of a baseline in the past.

The language used in the commercial world has evolved in recent years towards more budget-style claims.

An evolution which has been closely covered in the real estate sector and has been succinctly synthesized in a recent report by Systemiq, which highlighted how many current standards and certifications are not aligned with effective climate limits (Systemiq, 2024).

The gold-standard of climate-related ambition is therefore concluded to align emissions within a carbon budget, below an emission “pathway” or aligned with a given temperature threshold.

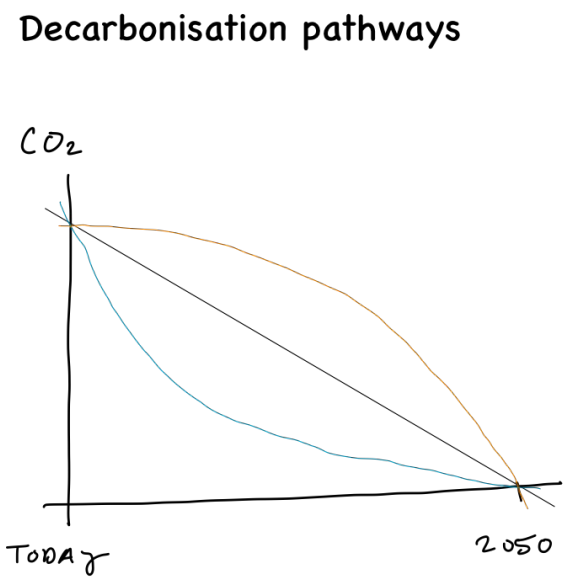
These terms (“pathway”, “temperature alignment”, “cumulative emissions”, etc.) are all synonymous with a carbon (or Greenhouse Gas (GHG) emission) budget. And while Net Zero claims could be interpreted as being flexible in terms of pathways and budgets, the emerging budget-style climate-claims are considerably more ambitious and require detailed strategic planning if action is to meet ambition. Different pathways result in different budgets, and these pathways require planning.

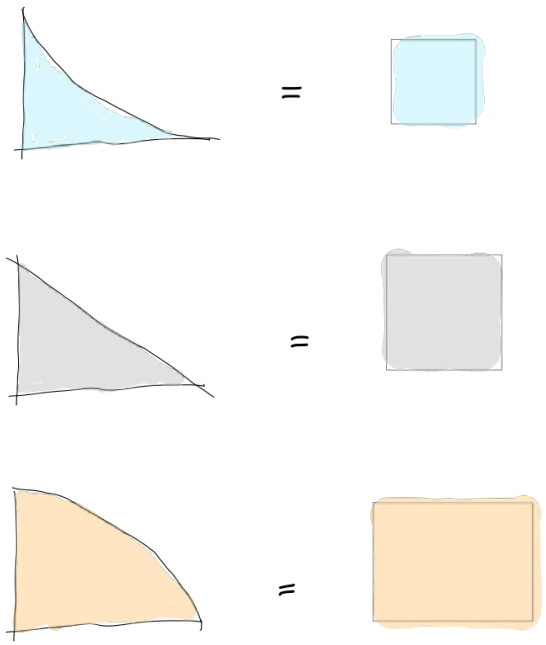
Climate ambition in the commercial world is maturing from destination- to budget-based targets. This means the pathway to Net Zero matters, and following that pathway requires planning.

The same Net Zero destination

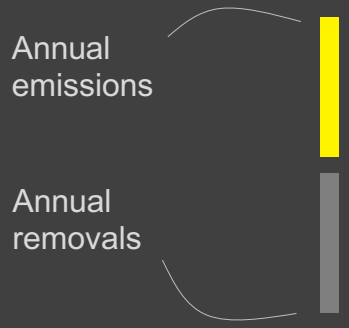
≠

The same cumulative emissions





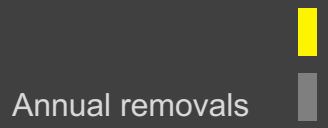
“Carbon neutral”



Destination-based

Offset emissions with removals. No limit on removals.

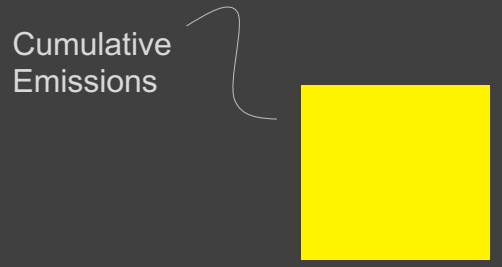
“Net Zero”



Destination-based

Offset emissions with removals. Limit on removals to be ~10% of a base level.

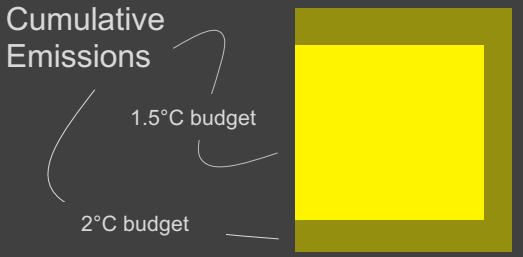
“1.5°C aligned”



Budget-based

Emission budget to remain within 1.5°C.

“Paris-aligned”



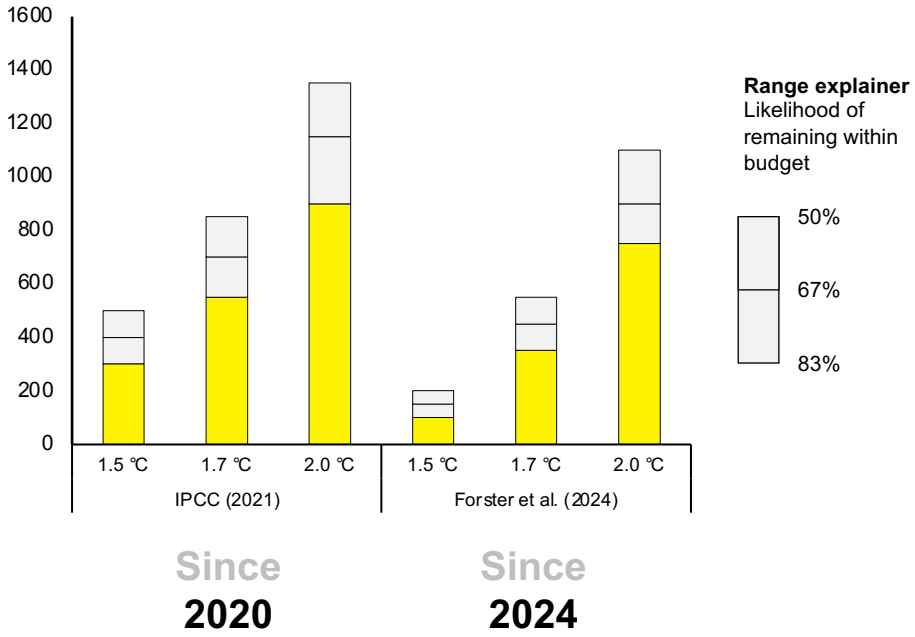
Budget-based

Emission budget to try and remain within 1.5°C and “well below” 2°C

1.3 The global carbon budget

What is it? And how much is left?

Total remaining global carbon budgets ($GtCO_2$)
Required to remain within different global temperature limits 1.5, 1.7 and 2.0ºC.



Global carbon budgets for different global warming limits (1.5, 1.7 and 2.0ºC) since 2020 in accordance with IPCC (2021) and since 2024 in accordance with Forster et al. (2024). Yellow bars represent an 83% likelihood.

Any given carbon budget is continuously reducing over time as we continue to produce carbon dioxide and other GHG emissions. This is illustrated on the left using data from the IPCC (2021) and an updated version of these from Forster et al. (2024). The budgets represent the remaining additional cumulative carbon emissions we have left to remain within different global warming limits. The likelihood range presented here is between 83% and 50% with the 87% likelihood figures highlighted. As an example, the global budget for all sectors of 500 $GtCO_2$ (50% likelihood) cited in the IPCC AR6 has been reduced to 200 GtCO2e since 2020. Forster et al. (2024) note that while 164 GtCO2 were produced between 2020 and 2023, the significantly reduced budget between 2020 and 2024 (300 GtCO2) also reflects updated warming estimates and methodologies.

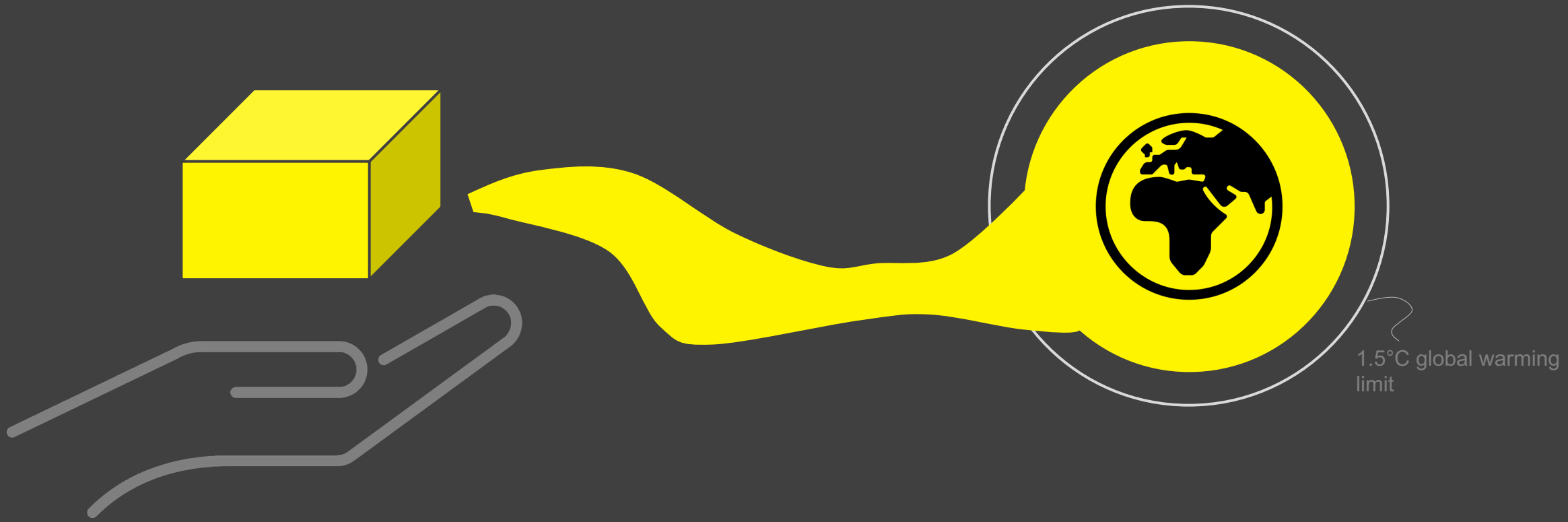
While the underpinning calculations are complex, and obviously outside the scope of this work, the considerable change over a short period of time highlights both the uncertainty and dynamic nature of budget-style targets. At a global level, there is uncertainty when specifying a carbon/GHG emission budget, captured by the different "likelihood" ranges associated with different global warming temperature thresholds. Every time the budget is then sliced up into different regions and/or sectors there are additional layers of subjectivity added. A global GHG emission budget is conceptualised in the next pages. These following sections introduce some concepts and sources relating to these different types of disaggregation.

There are several references to budget allocation by sector or region throughout the IPCC reports but there is no one specific recommendation.

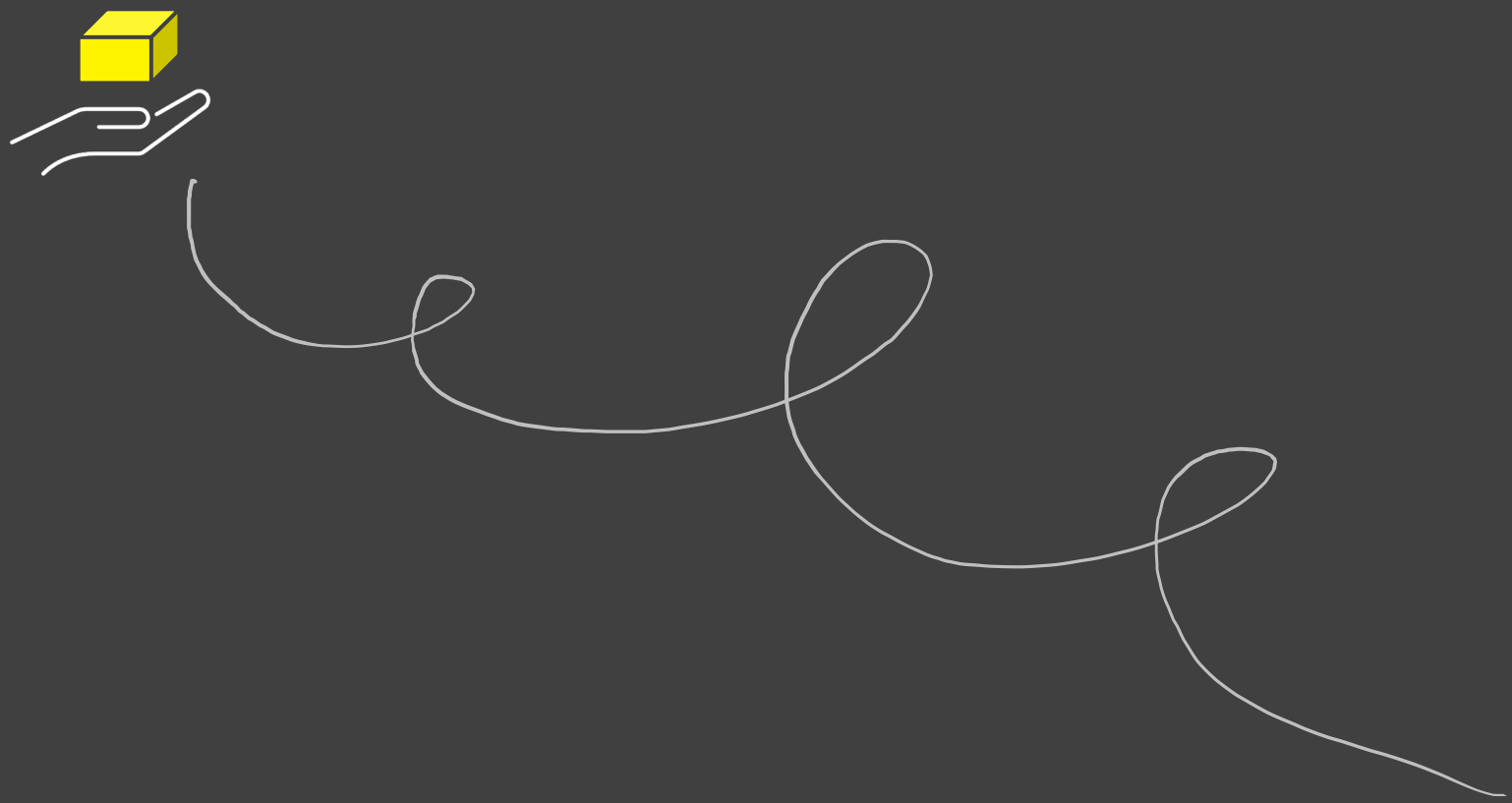
Consequently, the sum of national or sectoral budgets do not usually match global budgets. For a detailed overview of carbon budgets for buildings, readers are referred to Habert et al. (2020)

The global carbon budgets represents the remaining emissions left to stay within a specific warming temperature limit.

This is the amount of future greenhouse gas emissions left in our budget to stay within a global warming of 1.5°C.

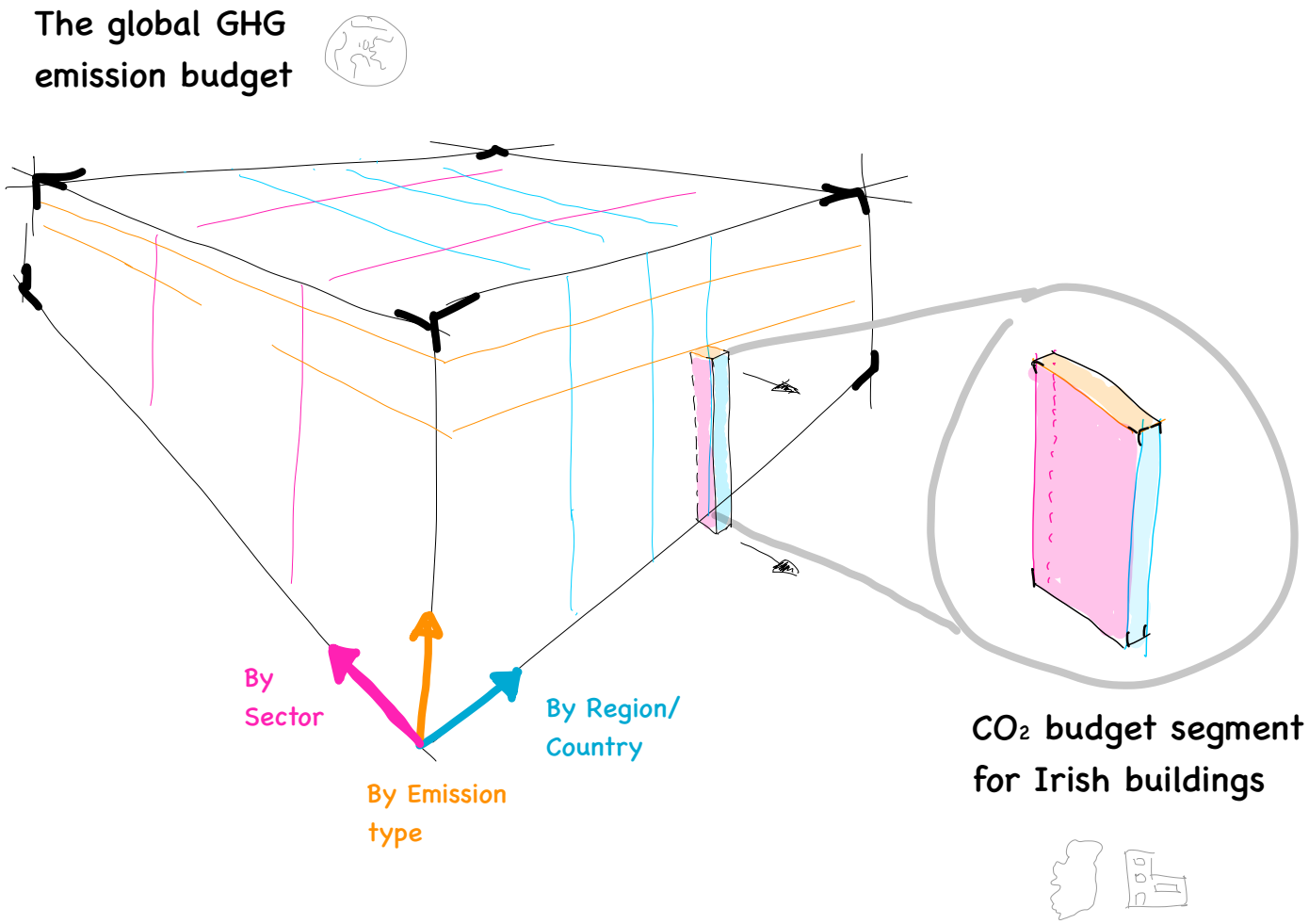


Net Zero implies using no more than this budget.



What proportion of this budget is our responsibility?

Dividing up the remaining global GHG emission budget.



1.4.1 Dividing up the remaining global GHG emission budget *by emission type*.

Global warming is influenced by CO_2 as well as other GHG emissions. An approximation of the impacts of these emissions is presented in the figure on this page.

The time-dependent impact of different GHG emissions over different time periods are captured on the following page, highlighting the long-lasting nature of CO_2 vs. other GHG emissions. While the origins of Net Zero lie in Net Zero carbon dioxide emissions rather than all GHG emissions (Allen et al., 2022), the Paris Agreement adopts an all-greenhouse-gas emission approach (UNFCCC, 2015).

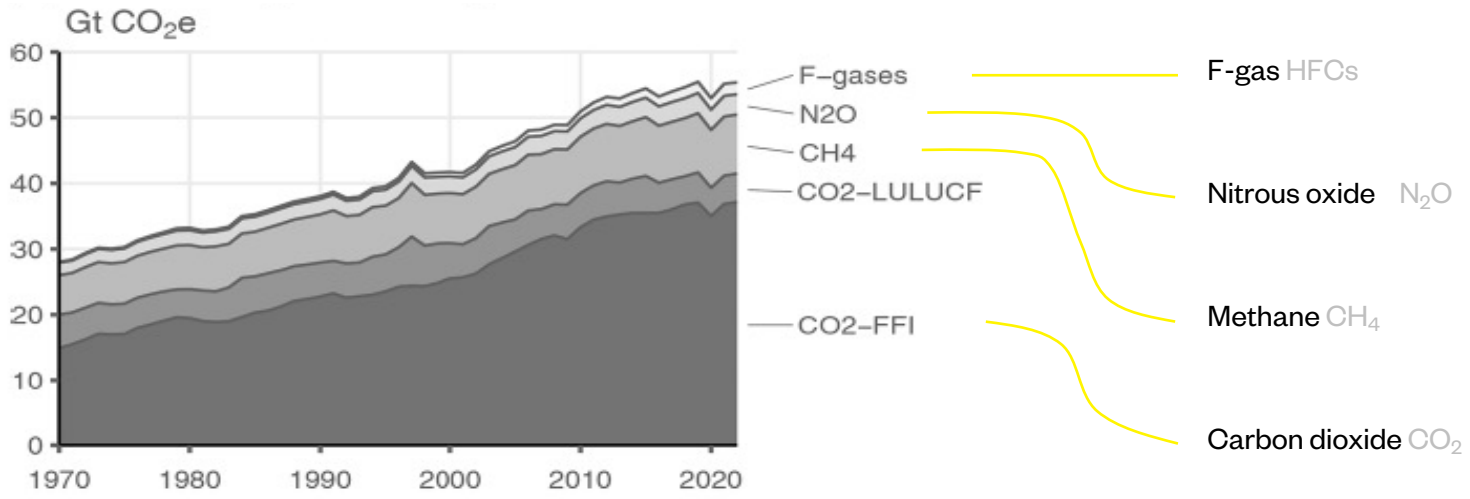
Consequently, a "Paris-aligned" ambition would suggest both CO_2 and non-CO_2 emissions are covered. This is particularly important for some sectors like the agriculture sector which is responsible for most non-CO_2 emissions. The IPCC summary for policy makers cites both, but with different objectives, (IPCC, 2023a):

"limiting human-caused global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least Net Zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions."

The majority of GHG emissions in buildings is from CO_2, with F-gases making up a small portion of total GHG emissions. In Ireland F-gases, derived primarily from refrigerant leakage, accounted for 1.3% of Ireland's total GHG emissions (EPA, 2024). For commercial buildings this figure can be up to 11% of all operational emissions (Goetsch and Deru, 2022), with CO_2 from direct combustion on-site and derived from electricity generation making up the remainder.

Given most GHG emissions in buildings are from CO_2 emissions, the two terms (GHG and CO_2 emissions) are often used interchangeably. And given the complexities associated with aggregating all GHG emissions together over a specific time period, assuming CO_2 emission budgets as the primary target for the building sector and dealing with F-gases separately is often adopted.

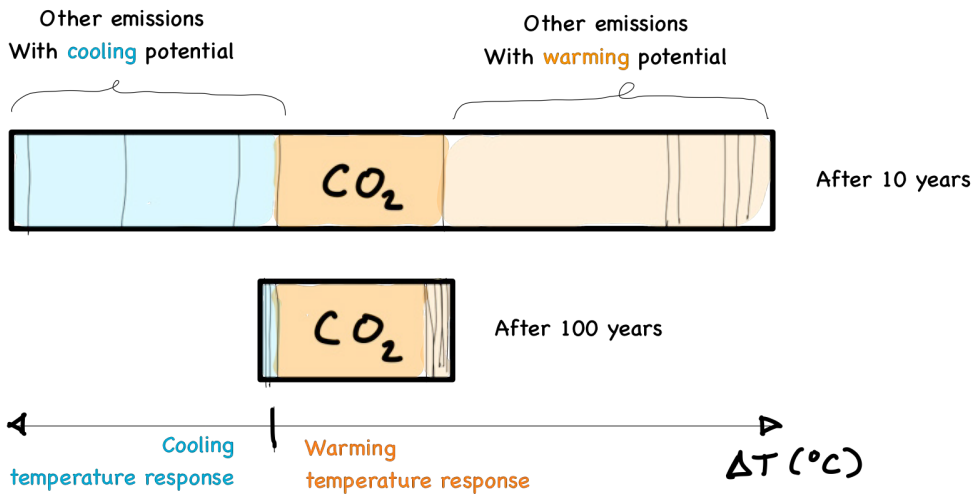
Annual global GHG Emissions
($GtCO_2$ Equivalent)



Overview of major emissions contributing to global warming by annual quantity (graph on the left taken from (Forster et al., 2024)) and by potency over a 100 year period (indices below the images on the right).

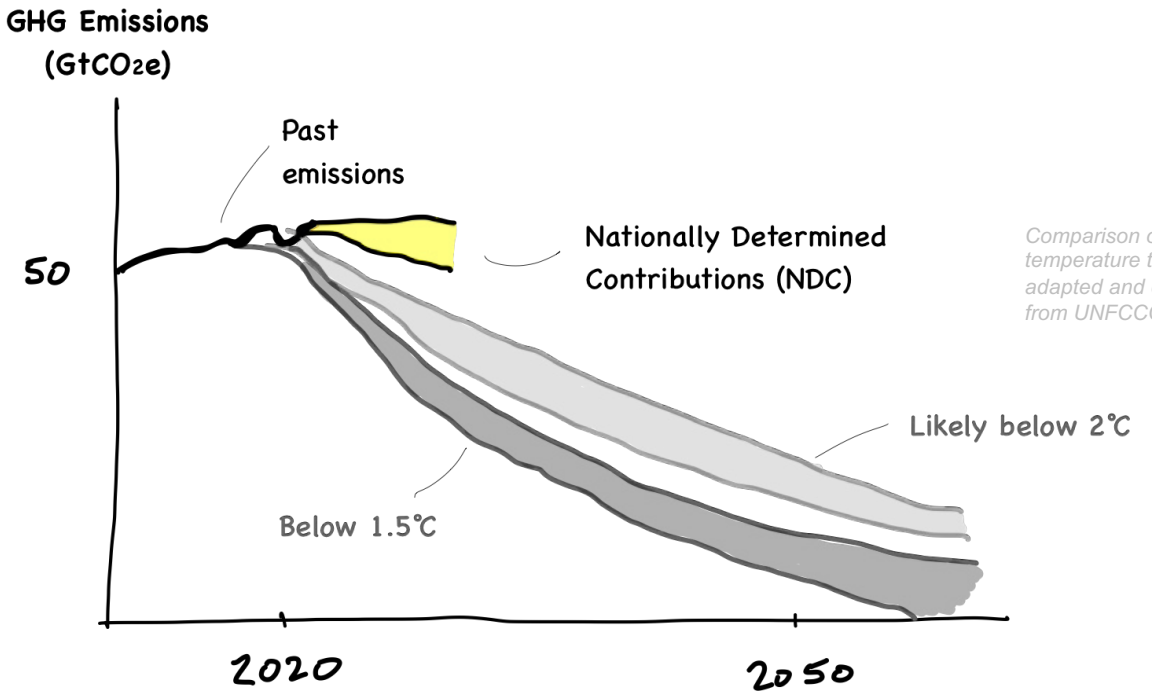
Carbon dioxide is a stubborn greenhouse gas.

Visualising the long lived nature of CO2 vs. Other GHG emissions



Response to a one year pulse of present-day different GHG emissions on global surface temperatures. The stubborn nature of CO_2 highlighted in orange. This figure is a conceptualisation adapted from that produced in IPCC (2021) – Figure TS.20. The lines drawn are not precise and are used to illustrate the change over time.

1.4.2 Dividing up the remaining global GHG emission budget *by region*.



Comparison of NDC's with IPCC temperature trajectories. Figure adapted and conceptualised from UNFCCC (2023).

Taking global carbon budgets and disaggregating them by country or region is a topic of continued debate. For a detailed Irish-focused discussion, readers are referred to McGuire et al. (2020). A lighter overview is provided here.

There are various ways to divide the budget based on different principles including a countries' current and projected population, their historical emissions and their ability to pay. In accordance with the Paris Agreement, each nation is responsible for deriving its own budget via their Nationally Determined Contributions (NDC) (van den Berg et al., 2020). This has resulted in different approaches (and hence, ambition) adopted at a national level. 98% of the parties assessed in a UNFCCC progress report consider their NDCs "to be fair and ambitious" (UNFCCC, 2023).

However, when considered together the UNFCCC's research showed that NDCs are not on track to meet the ambition set out in the Paris Agreement.

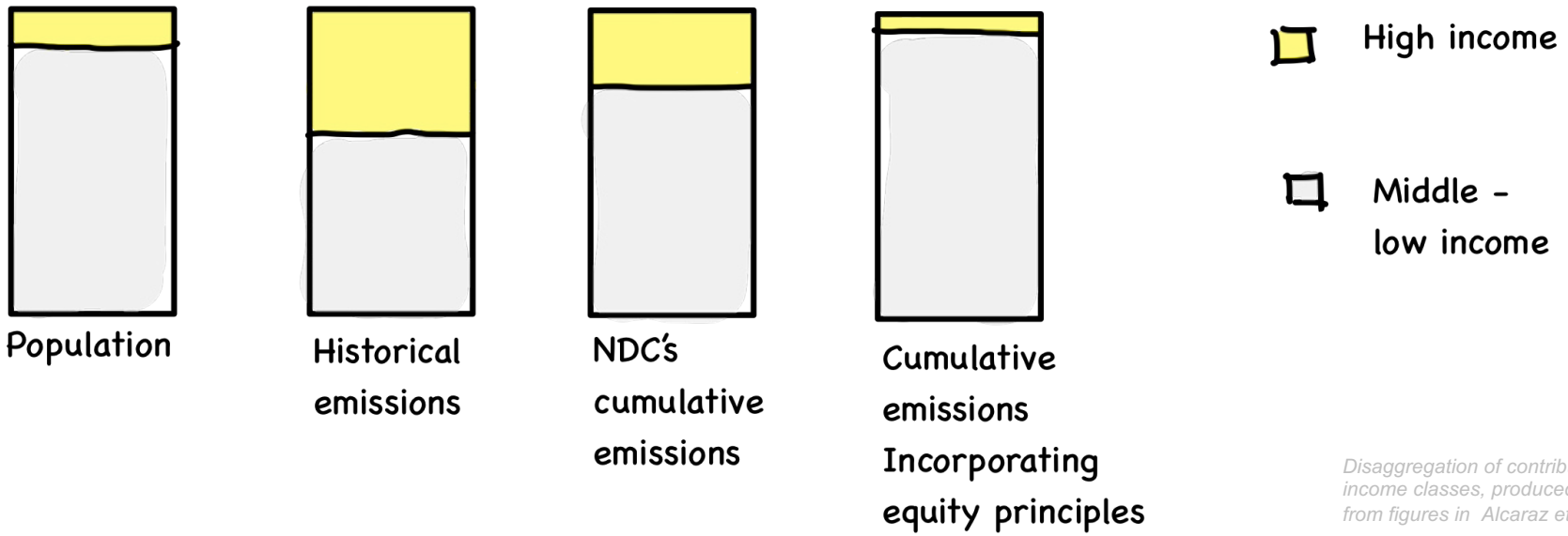
The Paris Agreement cites "equity" but there isn't universal agreement on what that means. This is unsurprising considering the complex issues surrounding national/regional disaggregation of a global carbon budget and who benefited from past emissions (Evans, 2021; Evans and Viisainen, 2023).

This report does not aim to suggest a right or wrong approach but simply highlight the variability at this national level and illustrate the scale of the challenge associated with a 1.5ºC-aligned or Paris-aligned ambition. For any sector to be aligned with the Paris Agreement, that sector, or an entity within that sector, would likely need to be more ambitious than the nation's NDCs.

A simple interpretation of this "equity" approach is presented by a UNFCCC publication which presents an overview of the Paris Agreement and associated budget based on a model of climate justice (Alcaraz et al., 2022). According to this approach, which captures equity principles, the high-income countries should have a 9.1% share of the remaining carbon budget, despite having 15.2% of the population in 2020.

The reality, however, is that the sum of high-income countries' emission aspirations to 2030 (through their NDCs) is 25.2% of the global figure.

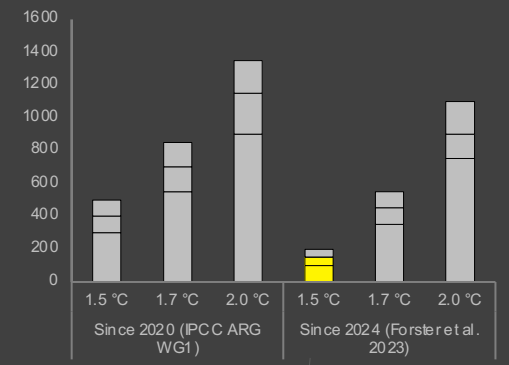
How are past and projected emissions split between high- and low-income nations?



Disaggregation of contributions by different income classes, produced and conceptualised from figures in Alcaraz et al. (2022)

Higher income countries have used more of the carbon budget than their population share historically. They also plan to use more than this share int the future.

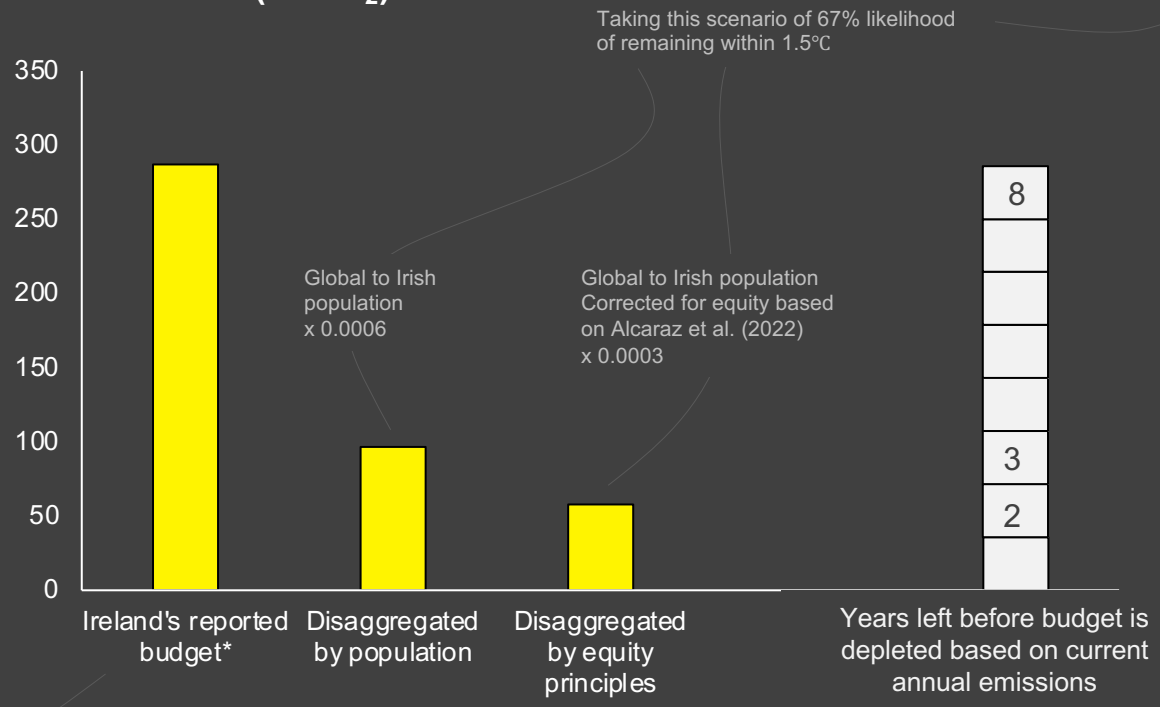
What is Ireland's carbon budget?



Graph from Page 13

Global carbon budget scenarios required to remain within different global temperature ($GtCO_2$)

Variability in Ireland's carbon budget from 2024 depending on the disaggregation method used ($MtCO_2$)



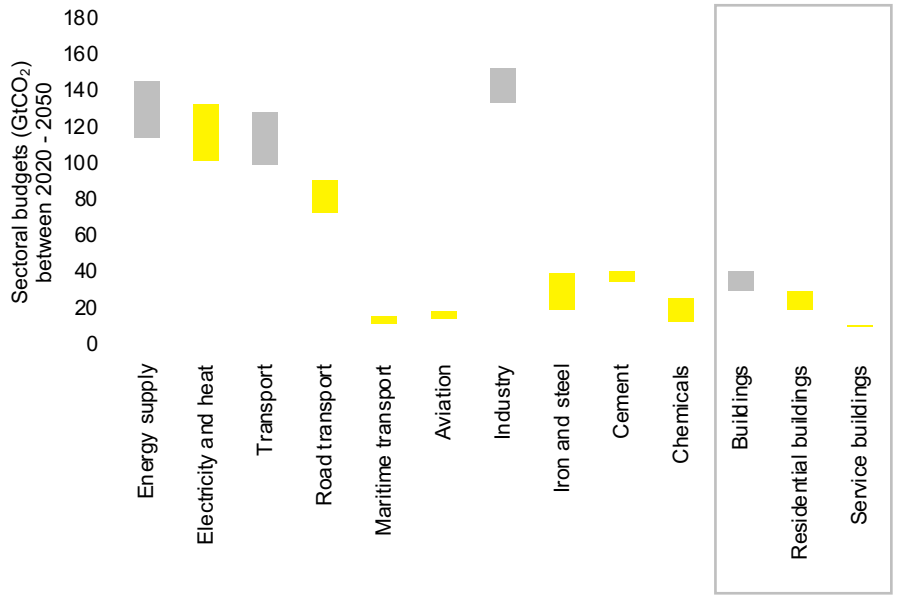
646 $MtCO_2e$ (2021 – 2035)
Sum of emission budget between 2020 and 2035 (from the Climate Advisory Council Table 2-3)

395 $MtCO_2$ (2021 – 2035)
Corrected from all GHG to CO_2 by ~61% as per average relative emissions in 2021, 2022 and 2023

287 $MtCO_2$ (2024 – 2035)
Minus carbon emissions in 2021, 2022 and 2023

1.4.3 Dividing up the remaining global GHG emission budget *by sector*.

Example of sectoral budgets, produced using data reported in (SBTI, 2021)



The uncertainties associated with national disaggregation have been presented with Ireland's budget from 2024 until 2050 landing anywhere between 58 and 280 $MtCO_2$ and beyond – depending on the approach applied.

Arriving at a budget for a specific sector within a nation further increases the uncertainty. Sectoral disaggregation for buildings can be split at a global level and then divided internationally, or it can be disaggregated from a national budget. Ireland sets sectoral ceilings by disaggregating its national budget for example. It references a sectoral ceiling for commercial buildings but that figure accounts for Scope 1 emissions on-site only. It does not include the emissions associated with electricity use and hence the budgets are not particularly useful for asset owners who have ambitions to cover emissions scopes 1, 2 and 3. The sectoral-disaggregation approach is also highlighted by Allen et al. (2022) for its subjectivity:

"Sector-specific guidance is under development by the Science Based Targets initiative (SBTi) but remains elusive due to its inherent subjectivity, as it requires disassembling the global Net Zero target into slices on a regional or industry basis."
(Allen et al., 2022)

Although imperfect, the Science Based Targets Initiative (SBTi) provides a useful overview of a sectoral split. This is often simpler for corporate entities to apply given the geographical spread of some of these larger companies. It does mean however that equity principles do not get considered.

1.5 Comparing Net Zero standards

The emergence of two potential “1.5°C” pathways that could be used for Irish offices.

Given the uncertainty associated with setting a budget at a global-, regional-, and sectoral- level, a single standard which outlines clear targets and mechanisms to achieve those targets would be helpful. In Ireland, the Irish Green Building Council (IGBC) published a set of definitions for Net Zero carbon buildings. This guidance compiled definitions from several UK and global sources in 2024. It refers to the likes of the World Green Building Council (WGBC) and the Low Energy Transformation Initiative (LETI) as well as local targets in Ireland’s Climate Action Plan (which have been cited on page 21). There is, however, no Net Zero numerical targets derived specifically for Ireland based on carbon budgets or Irish data for commercial buildings.

Although not derived specifically for Ireland, two potentially relevant standards to Irish commercial buildings have recently emerged as front-runners in that they refer to carbon budgets and include a suite of numerical targets.

The two standards compared here are the Science Based Targets Initiative (SBTi) Buildings Sector, and the UK Net Zero Carbon Building Standard (UKNZCBS). Both standards were published in 2024, and both cover operational energy and embodied carbon emissions, but both have a different objectives and, hence, some differences in method and scope. A comparison of both is described in the following pages as a guide to adopters.

Importantly they enable a level playing field. The emergence of these two standards means that claims of “Net Zero” or “1.5ºC-alignment” now have a reference with which claims can align themselves to. While there are other comprehensive standards and guidelines such as the Danish Reduction Roadmap (Reduction Roadmap, 2024) this comparison focuses on those most likely to be adopted in Ireland in the absence of something Irish-specific.

1. The UK Net Zero Carbon Building Standard (UKNZCBS)

At present, this is one single document which has been designed specifically for individual buildings and is currently in an initial pilot version. It includes criteria for a range of metrics including operational energy, embodied carbon, heating demand and refrigerants, amongst others. The comparison here focuses on operational energy and embodied carbon.

2. The Science Based Targets Initiative (SBTI) – Buildings Sector

This is a broader initiative which is targeted at all companies within the building sector with ambition to decarbonise. Guidance for the Buildings Sector has recently been published in August 2024. This guideline notes that:

“companies operating in the buildings sector shall adhere to sector-specific requirements for target setting and minimum ambition levels” (SBTI, 2024a).

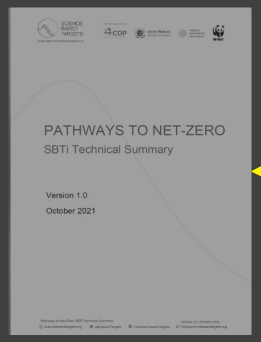
The standard published several reports, which are mapped out on page 24. The standard has a list of 14 criteria (C1 – C14) which need to be met to be validated by the SBTi and which are described in the *Buildings Sector Science-Based Target-Setting Criteria. Version 1.0* (SBTI, 2024b). The specific indicators which need to be reported are then documented in the *SBTi Criteria Assessment Indicators: Buildings Sector: Version 1.0* (SBTI, 2024c).

Details around the criteria and the methodology more generally are documented then in the *Buildings Sector Science-Based Targets Explanatory Document: Version 1.0* (SBTI, 2024a). This current work is concerned with the underlying methods and limits set by the SBTi for operational and embodied emissions and hence focuses on the explanatory document and the methodologies it refers to for operational and embodied emissions. For operational emissions it refers to CRREM (Carbon Risk Real Estate Monitor, 2023) which was developed in collaboration with SBTi principles. For embodied carbon, an additional and separate document is available (SBTI, 2024d).

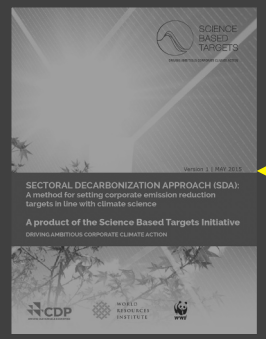
The SBTI corporate standard is cited by the WGBC in their definition of a Net Zero carbon building. There are some approaches common to both standards compared on pages 28-30. The comparison in this work focuses on operational energy limits and embodied carbon limits. The UKNZCBS focuses obviously on the UK industry, but as a close neighbour to Ireland, is more relevant than most national standards which exist. The SBTi’s approach is global for embodied carbon while individual national pathways are derived for operational energy use via the CRREM pathways. Perhaps the UK’s embodied carbon pathway, and the SBTi/CRREM energy use pathway are most applicable to Ireland. In any case it is worth comparing both.

SBTi Building Sector Framework map

SBTi – General methods



Pathways to Net Zero (2021)
22 pages



Overarching SBTi SDA method (2015)
104 pages

Cited on page 80

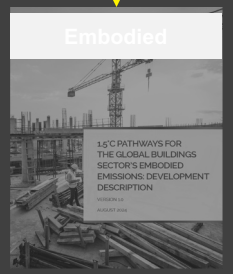
Cited on page 23

Cited on page 23

Cited on page 82

SBTI Building Sector Methodology (2024)
103 pages

CRREM methodology (2023)
93 pages



SBTi Embodied carbon (2024)
43 pages

SBTi Building Sector Tool
Excel spreadsheet

SBTI Buildings Sector Methodology Criteria Indicators (2024)
25 pages

SBTI Buildings Sector Methodology Criteria (2024)
34 pages

PCAF

GRESB

GHG protocol

Other cited and aligned standards and frameworks

1.5 Comparing Net Zero standards

Analysis of operational energy approaches and how they relate to Irish offices.

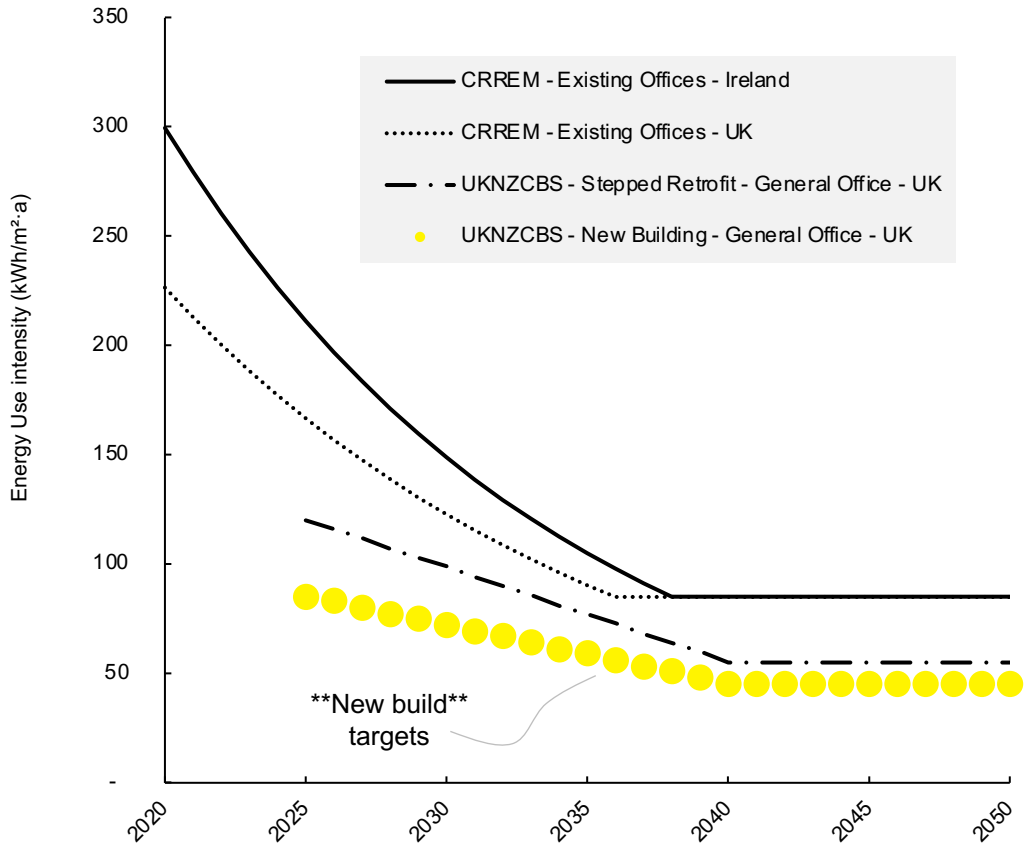
Both CRREM and the UKNZCBS use similar energy use intensity metrics, and both are similar in scope. Despite these similarities, and both reporting 1.5ºC alignment, the different alignment targets are of interest.

These different values are likely due to the difference in how office buildings are allocated emission budgets and how those budgets are then converted into energy limits. This finding resonates with the subjective nature of national- and sectoral-disaggregation discussed earlier.

It questions the validity of any truly 1.5ºC aligned pathway at a building level. The Irish CRREM EUI pathway's starting point for 2025 of 211 kWh/m²·a begins at a higher level than the UK's 2025 limit of 167 kWh/m²·a, but both arrive at 85 kWh/m²·a by 2038.

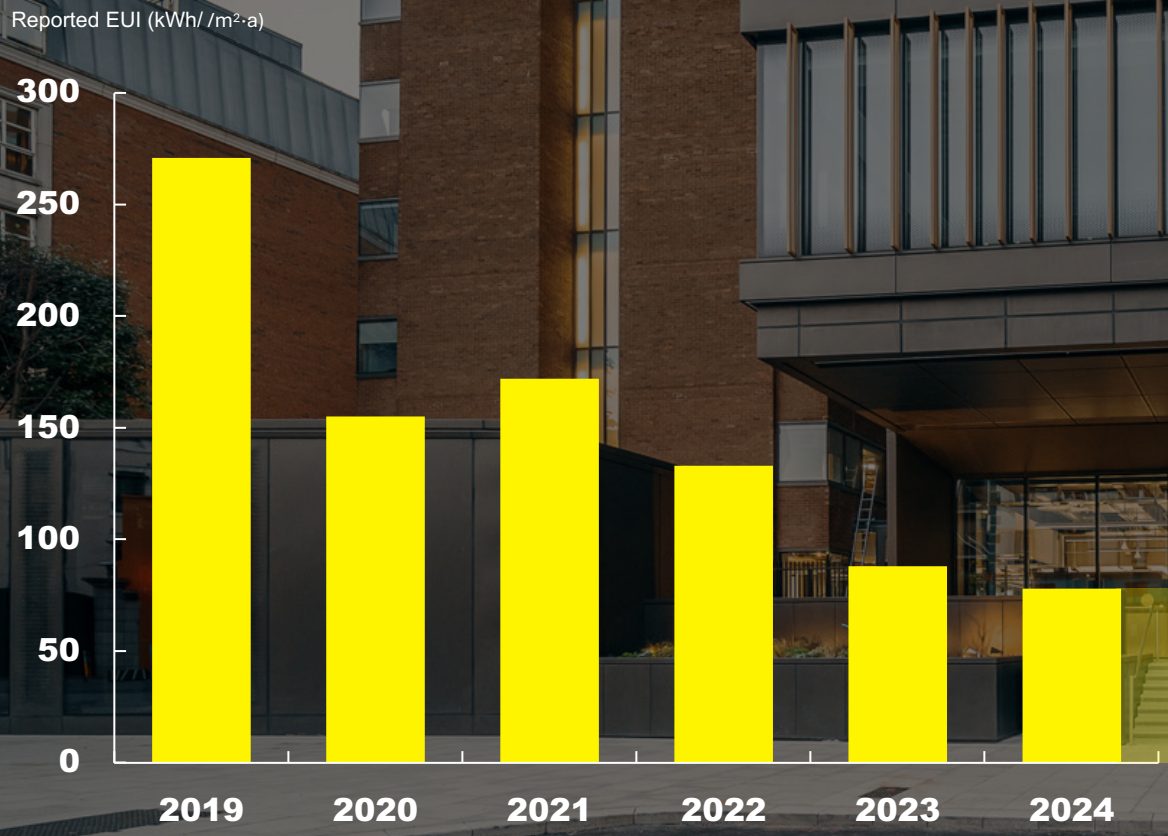
The CRREM and UKNZCBS pathways for existing/retrofitted buildings are different given the different energy mixes and expected growth rates they derive from. The UKNZCBS has other pathways for different offices, with trading offices for example starting with a limit of 147 kWh/m² for 2025 instead of the 85 kWh/m² for general offices. An interesting limit difference.

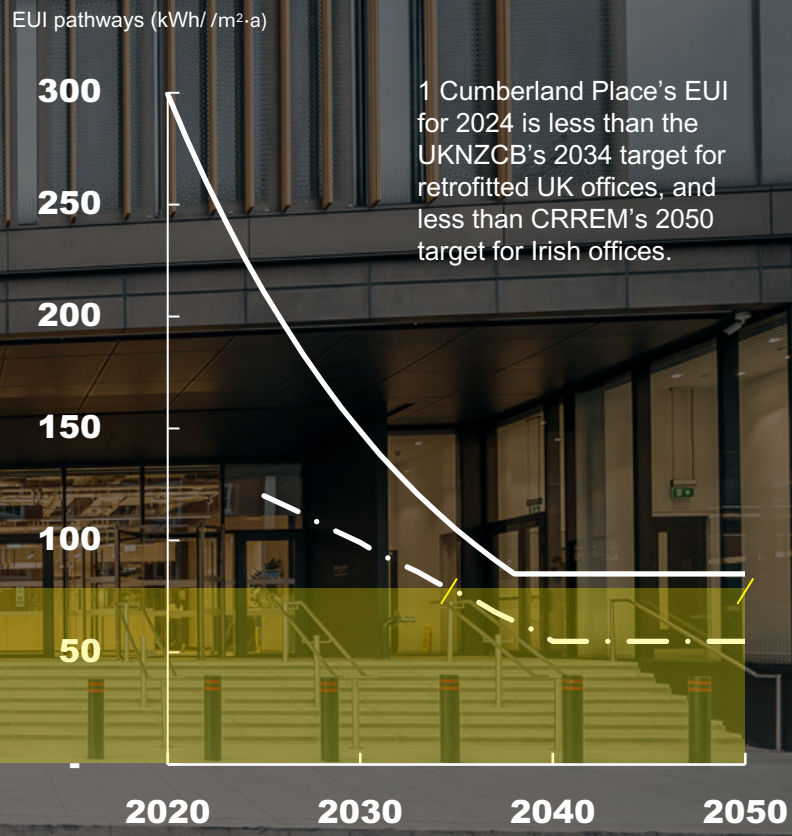
A pathway for new offices is also provided by the UKNZCBS, which as expected, is lower than those of existing offices.



Energy use intensity 1.5ºC pathways for UK based on CRREM and UKNZCBS and for Ireland with CRREM.

Case study – 1 Cumberland Place





1 Cumberland Place's EUI for 2024 is less than the UKNZCB's 2034 target for retrofitted UK offices, and less than CRREM's 2050 target for Irish offices.

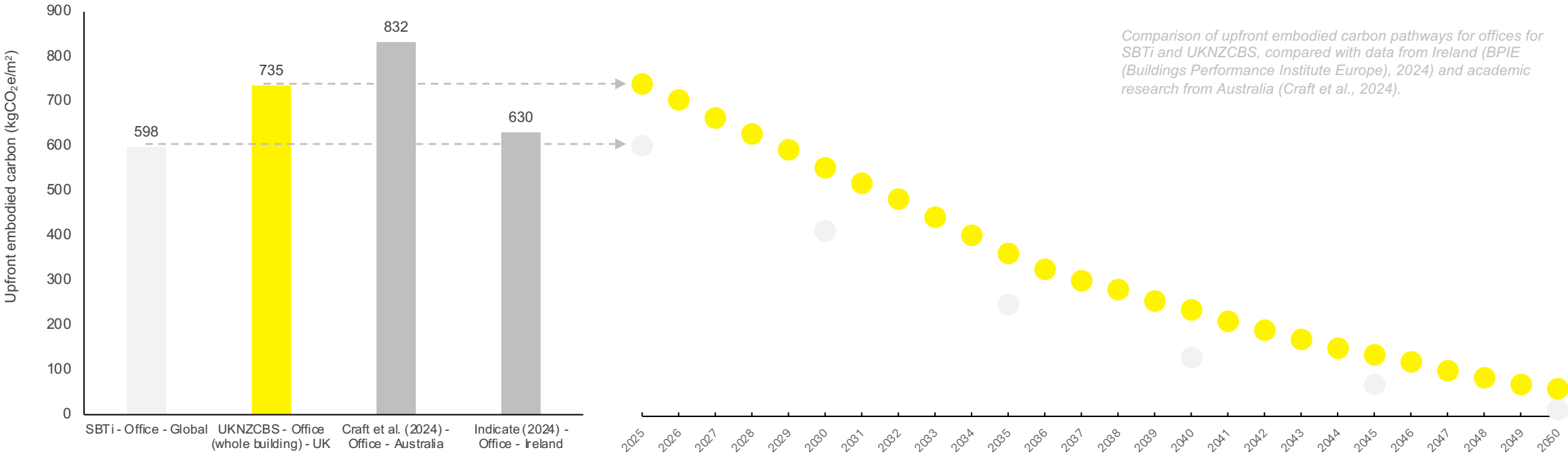
Reported EUI vs CRREM and UKNZCB targets

1.5 Comparing Net Zero standards

Analysis of embodied carbon approaches and how they relate to Irish offices.

Limits for upfront embodied carbon (that is the A1 – A5 LCA boundaries) also vary considerably. There are significant differences in the databases developed, methods followed, and scope covered – making arriving at a benchmark challenging more generally. Consequently, the pathways are going to differ depending on the database adopted and both the UKNZCBS and the SBTi use different databases. Although not completely clear, they seem to report similar scopes and metrics for floor area. The UKNZCBS is more explicit in its reference to the use of RICS whole life carbon assessment method (RICS, 2024a) while no specific methodology beyond mentions to EN 15978 is cited by the SBTi. The UKNZCBS in its current form therefore offers a clearer and more detailed pathway to follow to measure embodied carbon. The methodology used for embodied carbon disclosure is, in any case, due to be updated in all EU member states (including Ireland), following the requirements of the most recent EPBD (EPBD, 2024). Despite the differences, a comparison can be useful to understand limit values. These are compared below which show similar trajectories but different starting points. The 2025 start values reported in SBTi (598 kgCO2e/m2) and UKNZCBS (735 kgCO2e/m2) are then also compared with recently published average values for Ireland (630 $kgCO_2e/m^2$) (BPIE (Buildings Performance Institute Europe), 2024) as well as a recent comprehensive academic study of offices in Australia (832 $kgCO_2e/m^2$). Once again significant differences are observed.

It is evident from the research on embodied carbon that a clear baseline has not yet been established.



Comparison of upfront embodied carbon pathways for offices for SBTi and UKNZCBS, compared with data from Ireland (BPIE (Buildings Performance Institute Europe), 2024) and academic research from Australia (Craft et al., 2024).

1.6 SBTI vs. UKNZCB Table (1/3)

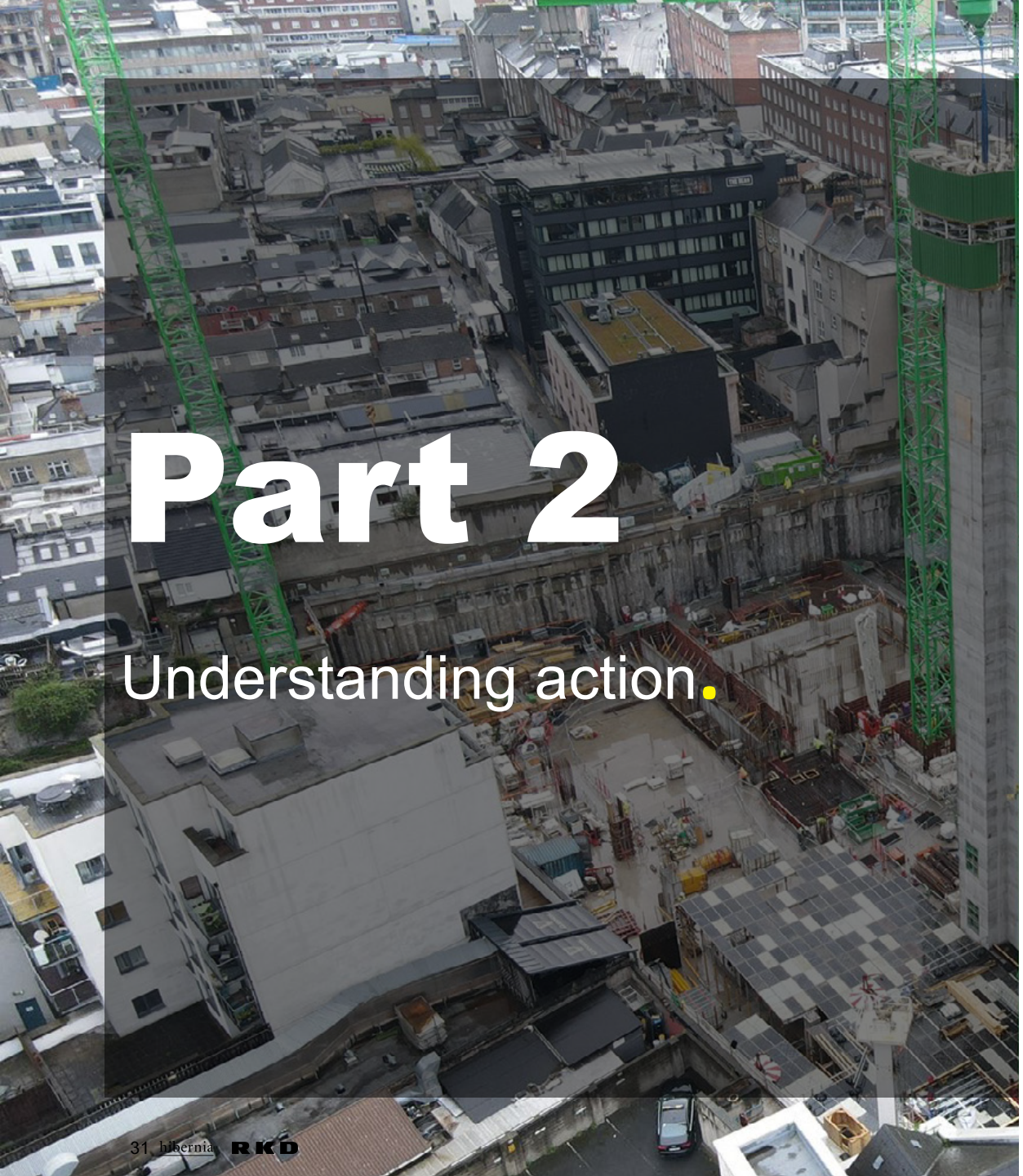
Agreement Divergence Neutral/ Not clear	**SBTi** Specifies how much and how quickly a company would need to reduce its emissions to be aligned with different temperature targets with 1.5 °C being the focus pathway.	**UKNZCBS** A new standard led by the UK construction industry which defines what a "Net Zero carbon aligned building" is. The standard means there is now a common definition of what “Net Zero” status means in the UK.
General		
Who is this aimed at?	Companies in the building sector "Corporates and financial institutions who own, develop and finance buildings”.	The UK building industry "Everyone within the UK real estate industry”.
Primary focus area	Portfolio level but can be applied at a building level. The CRREM guidance is designed primarily for existing buildings and hence target numbers reflect this.	Building level. The standard includes targets for both new and existing buildings.
Emission scope	Both carbon budgets and GHG emissions are cited throughout, but emphasis is on all GHG emissions.	CO_2e is referenced throughout suggesting all emissions. A separate section is allocated to refrigerants.
Claims of 1.5°C alignment	Yes - explicitly states alignment.	Yes – implied and noted at the webinar on the 31st of October 2024. The targets are derived from UK energy and carbon budgets.
Publication date	2024	2024
Location	Global	UK
Stakeholder	The standard is intended for those companies whose building-related emissions are significant including: financial institutions, developers, owner-occupiers, owner-lessors, and property managers. The different pathways can be commented on by other relevant stakeholders in the building sector: Architects, contractors, tenants etc.	The standard is designed for specific buildings not companies. Hence all, and any, stakeholder of the building can claim involvement in a “Net Zero carbon aligned building”.
Validation	SBTI validate the data and reported criteria.	The technical verification requirements will be published separately.
Commercial building type	"Office”	Three office types for operational: “General”, “Call center”, “Trading floors”. Two types for embodied: “Whole building” and “Shell and core”.
Methodology		
How the emission pathway is derived	A “convergence approach” is used which is derived from a sectoral budget, which itself is disaggregated from a global carbon budget. Reference to the IEA’s Net Zero by 2050 is cited for estimating the sectoral budget (IEA, 2023). A company’s pathway then converges to the sectoral intensity pathway in the long term. The steepness of the pathway is dependent on the starting point and the activity growth.	No detail provided in the reviewed document, but reference made to the UK’s remaining carbon and energy budgets.
National disaggregation method	A convergence approach from 2020 is used. No equity principles followed, but all pathways converge to zero.	Based on UK budgets. Unlikely equity principles are applied. Not clear.
Sectoral disaggregation method	Uses the (Sectoral Decarbonization Approach) which is referred to in SBTi documents. It refers to CRREM for operational targets which cites a budget of 91Gt from 2020 - approximately 20% of a global CO_2 budget of 468 Gt.	No detail provided in current documentation but a top-down / bottom-up approach is cited.
Defining a base year / starting point	Part of the process is to “decide a base year” from which the pathways can be developed.	Not clear (to the authors of this table at least) if a building which is not aligned in earlier years will have to make up for the additional energy used in later years. A building might be under the curve now and aligned for a particular year but not aligned from a cumulative energy use perspective.

1.6 SBTI vs. UKNZCB Table (2/3)

Operational Energy		
	SBTI	**UKNZCBS**
General	The SBTi refers to CRREM for setting its operational targets. "*The SBTi uses these CRREM-SBTi 1.5°C-aligned decarbonization pathways for in-use operational emissions target setting by applying the SDA.*". This table refers primarily therefore to the CRREM document: *From Global Emission Budgets To Decarbonization Pathways At Property Level* (Carbon Risk Real Estate Monitor, 2023).	Section 5.2 of UKNZCBS looks at operational energy. Operational energy is reported separately to other operational indicators like refrigerant leakage, water use, and onsite renewable energy generation.
Budget derived from…	Derived from the IPCC budget of 500 $GtCO_2$ (50% likelihood per IPCC) and 759 $GtCO_2e$ (references PBL for correction to all emissions.).	Refers to the UK's "*national carbon and energy budgets*" but doesn't provide any further information within the document currently.
Metric	Energy use intensity (kWh/m^2) Also gives pathways for GHG emissions ($kgCO_2e/m^2$) and CO_2 only ($kgCO_2e/m^2$).	Energy Use Intensity (EUI) (kWh/m^2)
From CO_2 and emissions to energy	The Energy intensity targets are calculated by converting carbon intensity pathways to energy intensity limits based on the energy mix and emission factors of the various sources.	Not explained in current documentation. Likely linked to referenced energy budget.
Floor area	GIA	Targets for both GIA and NIA are provided.
Scope	All energy use	All energy use Explicit exceptions include EV charging; External works; car parks; laundry.
Renewables	The EUI includes all energy consumed on site including fossil fuels, grid electricity and on-site renewables. "*CRREM energy-reduction pathways refer to the so-called end-energy consumption, as it can be read off electricity meters and utility bills, plus renewable energy produced and consumed on-site (sometimes also referred to as 'site-energy*"	The EUI includes all energy consumed on site including fossil fuels, grid electricity and on-site renewables. "*Renewable electricity generated on-site (see section 5.3.1.2) and used by the building shall be included in energy use measurements (i.e. this energy will count towards a building's operational energy use limit)*"
Transmission and Distribution (T&D) Losses	Excluded. *Does not affect reported EUI but might affect derivation of the EUI limits.	Included. *Does not affect EUI only affects operational carbon.
Tenant / Landlord	Both are included.	Both are included.
Degree days	Energy targets account for heating and cooling degree days. Meaning countries requiring more heating and/or cooling will have higher energy intensity targets.	Not explained.
New build vs Retrofit.	Does not provide separate pathways. The focus of CRREM, however, is on existing buildings.	Separate EUI targets for new and retrofit.
Refrigerants	Included in operational emission limits for GHG emissions.	Dealt with separately in Section 5.9.

1.6 SBTI vs. UKNZCB Table (3/3)

Embodied Carbon		
	SBTI	**UKNZCBS**
Embodied carbon pathway derivation	Several pathways are presented using different attribution principles and corrections for renovation. A single pathway is not stated as favourite but the “grandfathering downscaling approach, corrected for renovation” is cited as the default and general approach. These values are reported in Table 13 of the SBTI, (2024d).	Not described in current published documentation.
Metric	$kgCO_2e/m^2$	$kgCO_2e/m^2$
Floor area	“Gross floor area”	GIA
LCA Stages	Upfront – A1-A5 However, allowance for renovation is included in some pathways which would incorporate some of the use LCA stage.	Upfront – A1-A5
Database	Several databases are compared but the database of Röck et al. (2020) is cited as the one used. “Given the benefits in global coverage and harmonization efforts made, we consider the values reported by Röck et al. (2020) to be the most relevant ones.”	Unclear. BECD cited as a database to report to but not cited as the database used to derive limits.
Measurement methodology to follow	Not explicitly cited.	RICS Whole life carbon assessment for the built environment. Global. 2nd Edition.
Scope	“Building structure, envelope, internal walls, internal finishes and technical installations are part of the scope.”	All RICS Building Element Categories (RICS, 2024b).
New vs Retrofit.	Different pathways are presented which account for renovation by either including the m^2 of floor area that will need to be retrofit in the setting of the overall limit or by only accounting for new built floor area and leaving budget for retrofit. Separate limits aren’t clearly disclosed.	Separate embodied carbon targets for new and renovated cases.



Part 2

Understanding action.

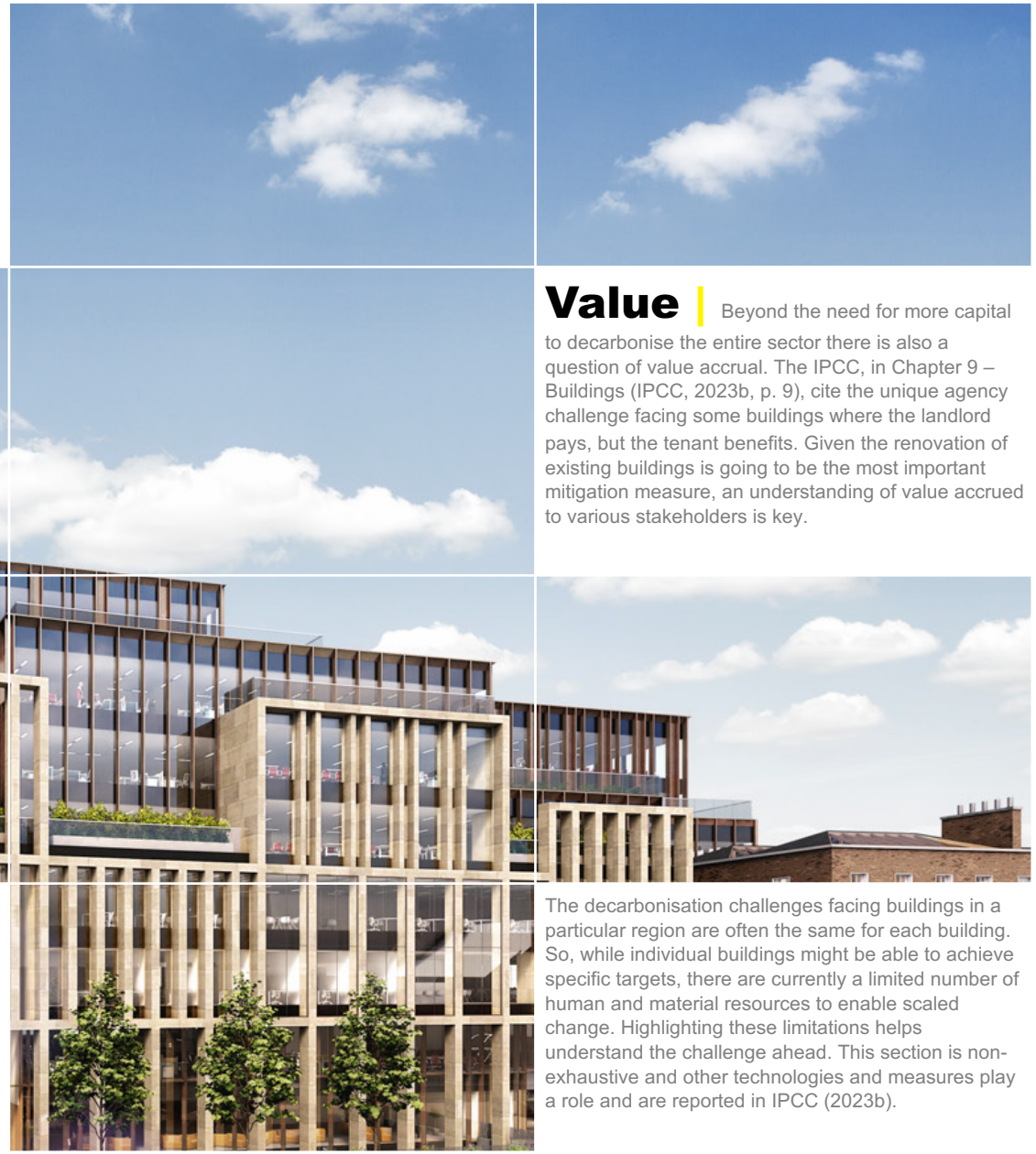
Key findings

- While understanding what Net Zero means helps set meaningful targets (Report Part 1), understanding the challenges and solutions helps enable different stakeholders to take action (Report Part 2).
- Challenges to decarbonising the commercial real estate sector include skills, material and capital limitations.
- In Ireland the skills gap between what we have today and what we need by 2030 to reach our building goals has been reported to be 46%.
- Material limits aren't as tight for buildings as for example the power sector and its reliance on critical minerals, but considerable increase in heat pump and insulation supply are needed.
- There is a slowdown in investment and debt available to finance the global decarbonisation. This investment needs to accelerate, not decelerate, if targets are to be met.
- In terms of solutions to decarbonise office buildings, several efficiency and electrification technologies exist. Choosing the right one needs a whole life carbon perspective applied to individual buildings.
- Office buildings face a unique agency challenge, whereby the tenant benefits from reduced energy bills, but the landlord pays.
- An increasing dataset of studies is showing that there is a value-add for going "green".
- Emerging Net Zero standards and regulation aims to formalise the definition of what that "green" means.

2.0 Section overview

Challenges – Solutions – Value

Understanding the climate-related ambition of commercial real estate enables better, more effective Net Zero strategy. This also requires an understanding of the challenges, technologies available, and the potential value accrued by transitioning to ambitious climate targets. This section discusses these three key themes as they relate to the commercial real estate sector.



Challenges

Limited human, material and financial resources impact the pace at which the sector can decarbonise effectively. An increase in demand, driven by the commercial real estate sector's ESG ambitions can drive supply but the extent of this is complex to understand and outside the scope of this work. Ambition is essential, but as already presented, ambition is already high globally, this section focuses on the challenges as they exist today.

Solutions

The technological solutions presented here reflect the current state of knowledge but are expected to evolve as new publications and case studies emerge; it is important to note that real-world evidence remains limited, and each building will face unique challenges and follow their own decarbonisation pathway. Retrofit takes focus as the area of greatest potential for commercial real estate managers and developers.

Value

Beyond the need for more capital to decarbonise the entire sector there is also a question of value accrual. The IPCC, in Chapter 9 – Buildings (IPCC, 2023b, p. 9), cite the unique agency challenge facing some buildings where the landlord pays, but the tenant benefits. Given the renovation of existing buildings is going to be the most important mitigation measure, an understanding of value accrued to various stakeholders is key.

The decarbonisation challenges facing buildings in a particular region are often the same for each building. So, while individual buildings might be able to achieve specific targets, there are currently a limited number of human and material resources to enable scaled change. Highlighting these limitations helps understand the challenge ahead. This section is non-exhaustive and other technologies and measures play a role and are reported in IPCC (2023b).

2.1 Background

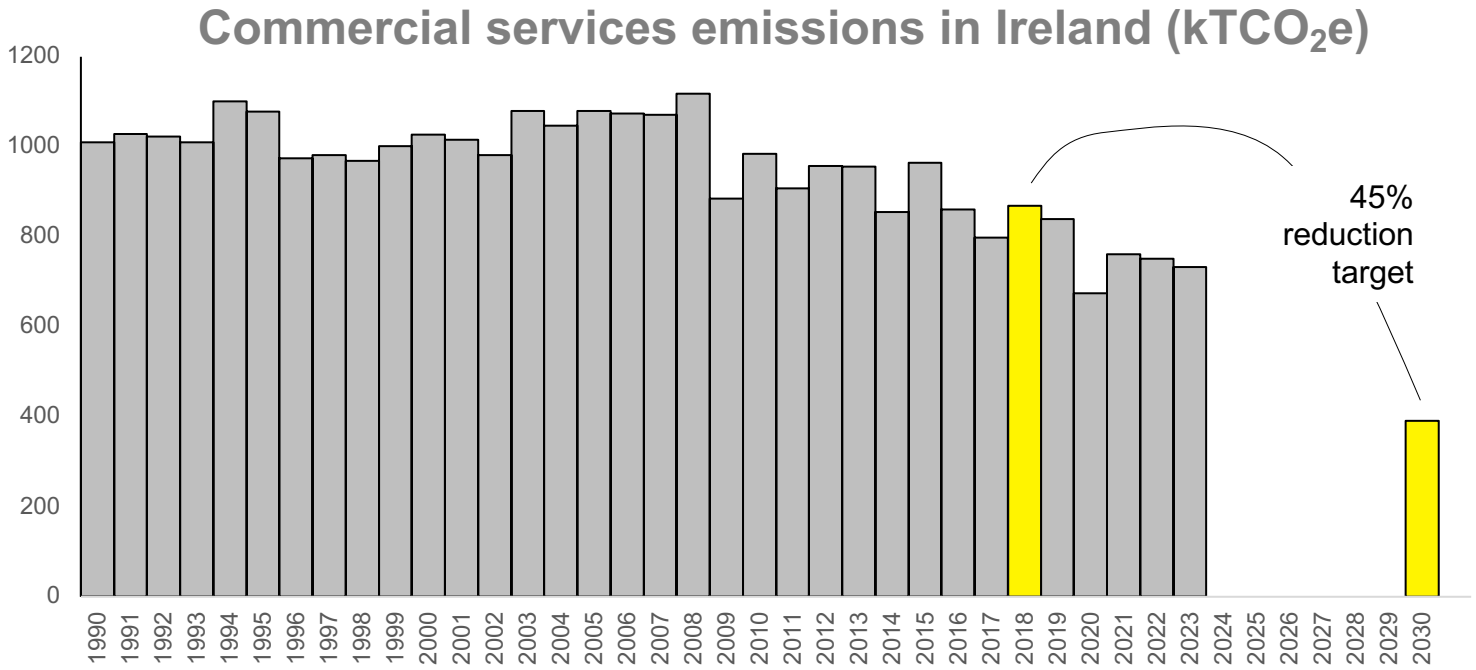
Understanding the importance of renovation.

Ireland's emission reduction target for commercial buildings will come from upgrading the performance of the existing stock.

Many of the challenges facing new developments and renovation, such as skills- and material-shortages are similar, but there are also key differences. It is easier for new buildings to achieve operational energy targets compared to renovated buildings which are constrained by existing layouts.

Conversely, it is easier for renovated buildings to meet embodied carbon targets given less material is needed. An optimisation balance therefore exists between ensuring the whole life carbon emissions are minimised over a given lifetime of a building. This work considers challenges and solutions for both new and renovated commercial offices with a particular focus on renovation given the greater impact renovation has at a sectoral level.

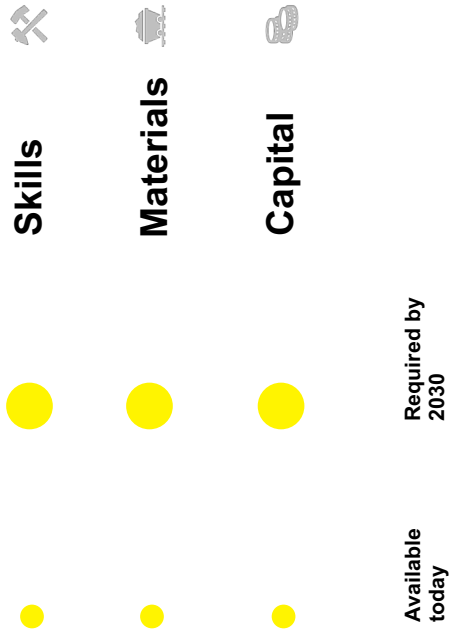
Ireland has set a sectoral annual emission reduction target of 45% for commercial and public buildings from 2018. To achieve this target, existing offices need to be renovated.



Historical annual emissions of the commercial services. Data is taken from the EPA (EPA, 2024). Note: targets for the power sector are separate and hence the electrification of offices will reduce commercial services emissions, but overall emissions will occur only if the grid is simultaneously decarbonised. This therefore is primarily offices scope 1 emissions.

2.2 Challenges

Many of the challenges can be overcome at an individual building level but are more pertinent at a sectoral level. Achieving a Net Zero building is therefore easier than achieving a Net Zero portfolio.



Conceptualising the need for skills, materials and capital

2.2.1 Challenges
Skills

One of the biggest challenges is ensuring the skills exist to enable the scaled decarbonization.

Perhaps the greatest challenge is ensuring adequate human resources, in the form of construction workers and building professionals are available. Several attempts to industrialise buildings to reduce the reliance on labour in the past have failed. One famous example is that of the Levitt and Sons case study in the US residential sector (Potter, 2024). While there is hope at a government level that the latest attempt, by the name of Modern Methods of Construction (MMC), might succeed, the building industry faces unique challenges which make industrialisation difficult. Buildings, unlike many other manufactured products, are highly heterogenous (IPCC, 2023b). They are also bigger than most things that are shipped around the world in containers. The variability challenge opposes ideal manufacturing conditions where repetition is desirable for optimisation of production lines. For renovated buildings, the heterogeneity challenge is magnified further. Consequently, even if the MMC roll-out proves to be successful, the considerable requirement for skills to deal with renovation will remain.

According to a *Build Up Skills Ireland* report, a 46% gap exists between the number of skilled people needed to achieve Ireland's 2030 built environment targets, and what we currently have today (BUSI2030, 2023). While the construction and renovation work might get completed to deal with an increase in demand, there is a risk that a lower quality output could manifest in the absence of adequate training and upskilling of the industry.

A recent Irish study found that the thermal performance of the building fabric can be more than twice as bad as the expected design performance (O'Hegarty et al., 2024). A plausible explanation for this is thermal bypass of the insulation layer which can occur as a result of poor installation practices (Little, 2005). There are similar results emerging for the performance gap between heat pumps where inadequate sizing and installation can decrease expected performance by more than 40% (O'Hegarty et al., 2021).
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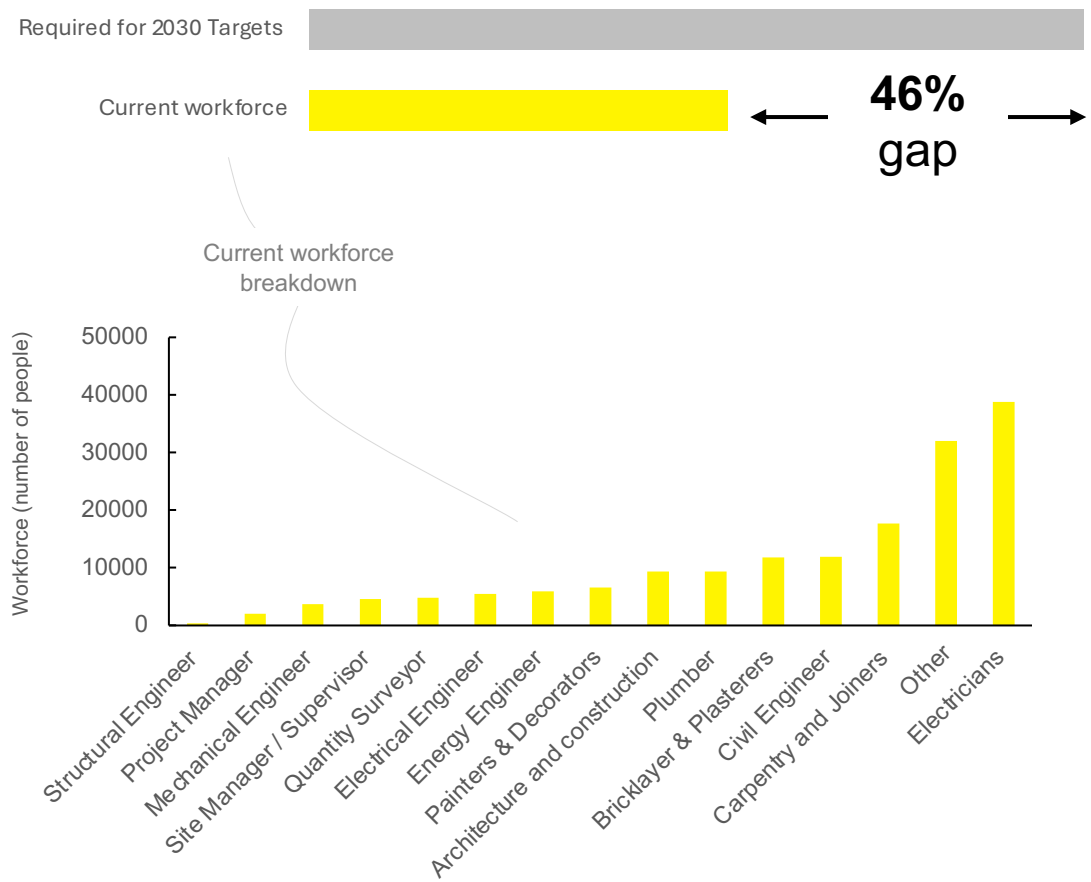


Skills gap for Ireland's built environment workforce. Data taken from Ireland's Build Up skills 2030 (BUSI2030, 2023)

2.2.2 Challenges

Materials

Renovating existing buildings reduces the need for raw materials. Most material limitations impact the electricity grid (i.e. a building's Scope 2 emissions) but items like insulation and heat pumps are also impacted.

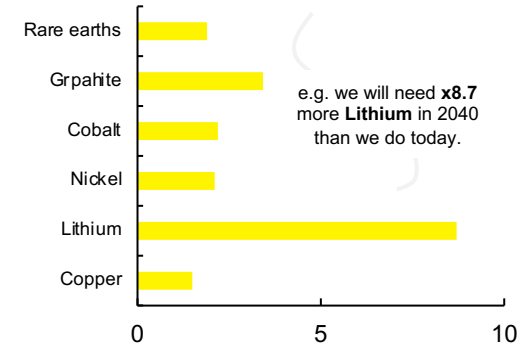
Although material limitations for renovation (e.g. insulation, PVs and heat pumps) aren't as critical as those for other parts of the Net Zero transition (e.g. batteries and grid infrastructure), annual material availability is still limited. Copper is the critical material most relevant to building technologies given its requirement for manufacturing heat pumps as well as improving the energy grid and general MEP enhancements.

A step change in building efficiency at a sectoral level would require step changes in the production of key renovation materials and therefore require capital investment at production facilities. This would require certainty over market demand to justify the cost of expansion. The IEA cite how building insulation materials pose one example of where a heavy investment in the manufacturing capacity is now a risk following revenue declines of the industry (IEA, 2024a).

There is complex interplay between ensuring material supply required for the energy transition can meet demand without overshooting on supply and risking closure of production facilities.

Buildings are an end-user in the Net Zero transition and are constrained by generation capacity of the grid for clean energy, and the production capacity from some industries to enable sufficient supply of technologies like heat pumps and insulation. The European Heat Pump Association has targeted 60 million heat pumps to be in stock by 2030, a x2.4 increase from today (EHPA, 2024). While the challenge discussed here is a scale challenge, rather than a limitation for individual buildings, it is likely a longer-term issue once the efforts to carry out energy renovations surpass available supply. The slowdown in heat pump sales and the requirement to 2030 are presented in the figure on the following page.

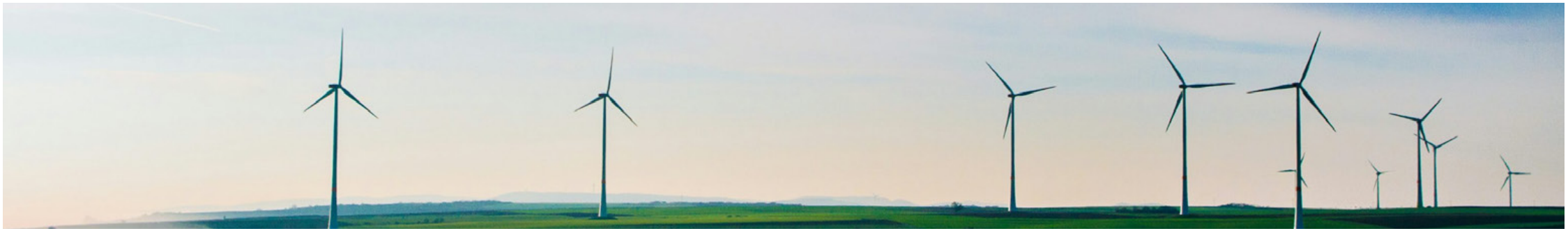
Material scale-up required between 2024 to 2040 to meet the IEA's NZE scenario



Primary Use (Building emission scope impact)

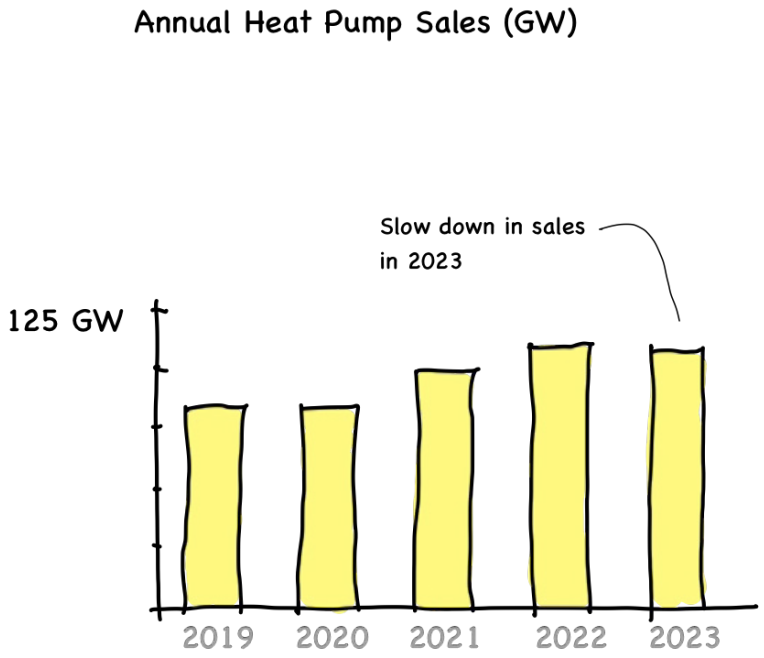
- Wind turbines (Scope 2)
- Batteries (Scope 1+2)
- Batteries (Scope 1+2)
- Batteries (Scope 1+2)
- Batteries (Scope 1+2)
- Electricity grid (Scope 2)

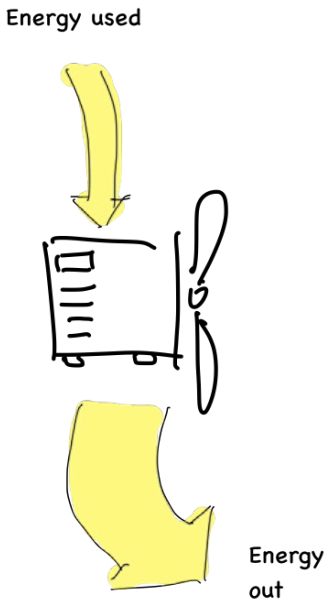
Most of the critical minerals required to achieve the IEA's Net Zero Emissions scenario are indirectly related to buildings since they impact the speed at which the power system can decarbonise. This impacts a building's Scope 2 emissions. The figure is derived from data presented in the IEA's most recent Critical Mineral report (IEA, 2024d), licensed under CC BY 4.0.

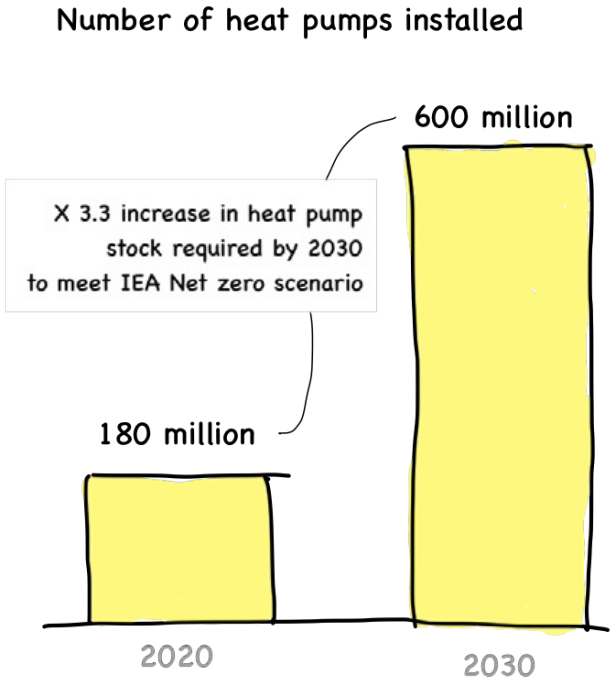


2.2.2 Challenges
Materials (Heat pumps)

Heat pumps are considered a key technology of the transition to Net Zero, but sales are slowing globally.







Heat pump historic sales (in GW of installed capacity) and required number (#) of heat pumps installed by 2030. The figures are conceptualised and derived from data reported in the IEA's Energy Systems – Buildings – Heat pumps webpage (https://www.iea.org/energy-system/buildings/heat-pumps) and Net Zero by 2050 Roadmap report (IEA, 2023). Licensed under CC BY 4.0.

2.2.3 Challenges

Capital – How much is needed?

The IEA report an annual target investment of ~850 USDbn by 2030 for all buildings to be on track to meet their Net Zero emissions scenario (IEA, 2024c p153). Assuming a linear ramp up in investment, this would equate to ~4,300 USDbn investment between 2024 and 2030. Savills report that global real estate is valued at 379.7 USDtn and that 50.8 USDtn of that is in commercial real estate (Savills, 2023).

From an Irish perspective the challenge is considerable. A white paper produced by Davy Decarbonisation (McNamara, 2024), estimates the need for an investment of 13 €bn in the Irish commercial buildings sector to enable the energy transition to 2030, all of which would come from private funding, and mostly in the form of debt (12 €bn from debt, 1.3 €bn from equity). The investment would include spending on insulation, heat pumps, district heating and "other". This reported investment (over a 6-year period) equates to 9% of the value of the Commercial Real estate Sector (valued at 144 €bn by the Central bank).

The IEA report the need for an annual investment requirement of ~600 USDbn in energy efficiency specifically by 2030 to meet the required Net Zero scenario (IEA, 2024c). This would be a x2.3 increase in annual investment in just efficiency measures. McKinsey cite the need for 400 USDbn of annual spending on just insulation in their Net Zero scenario estimates (McKinsey Global Institute, 2022).

Despite the need to increase spend on energy efficiency and heat pumps to decarbonise, a slowdown is instead observed. The slowdown in building energy efficiency investment growth from 2023 reported by the IEA is expected to extend to 2024 due to a combination of higher interest rates and cutbacks in government funding for efficiency incentive programmes (IEA, 2024a). The same report also highlights a slowdown in heat pump sales and cite high interest rates, upfront costs and a reduction in natural gas prices as a cause.

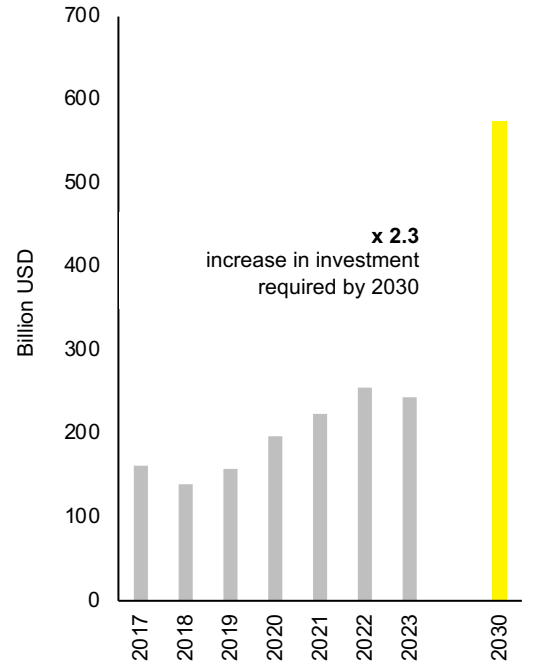
Beyond the global cost of decarbonisation, localised waning in government energy efficiency incentives and an easing-off of consumer enthusiasm, other more pertinent financial challenges exist for the commercial real estate sector in some locations.

A recent study on "Decarbonizing real estate portfolios considering optimal retrofit investment and policy conditions to 2050" (Petkov et al., 2023) concluded that:

"achieving Net Zero necessitates significant investments, largely through thermal energy efficiency measures and low-CO_2 energy systems, as early as possible to avoid locked-in emissions."

Thoughts on findings - If resources are limited, a question emerges as to how best use them to maximise efficiency returns and carbon savings. Looking at the built environment holistically, the most efficient route might be to carry out light-medium renovations on as many buildings as possible. Raising the floor rather than the ceiling. Of course, the reality is different, and funding allocation does not work like this. Additionally, deep retrofitting some buildings to showcase what is feasible, can provide inspiration and highlight plausibility.

Annual investment in energy efficiency in the buildings sector in the IEA's Net Zero Scenario



Past and expected investment in energy efficiency int the buildings sector. Adapted from International Energy Agency (IEA), Tracking Buildings https://www.iea.org/energy-system/buildings, 2023. Licensed under CC BY 4.0.

2.2.3 Challenges

Capital – Where is it coming from?

The IEA make an important distinction between the capital providers (the ones who make the investment decisions e.g. governments, households and private sector) and finance providers (those who provide the funds e.g. financial institutions as well as other public and private sources of capital). In terms of the capital providers, corporate spend on energy reduction makes up almost 50% (IEA, 2024a). The IEA note that "Government" refers to state-owned companies and state-owned assets (in the case of buildings for example). "Corporates" refer to private and publicly listed companies. Households contribute to 15% on average but have increased from 9% in 2018 to 18% in 2030 through e.g. energy efficiency and rooftop solar measures.

In terms of the capital structure, the IEA report that 46% of investment in clean energy will come from debt. The same report also cites a decline in debt issuance since a peak in 2021 (right of Figure).

Bloomberg NEF report a bigger portion of debt used for energy transition purposes (BloombergNEF, 2024). A presentation by *Climate Strategy and Partners* in 2021 presented some data showing how approximately one third of finance for commercial building renovation comes from debt (Sweatman, 2021). In any case, debt in the form of bonds and loans, play a significant role, and would need to increase rather than decline to meet any Net Zero scenario.

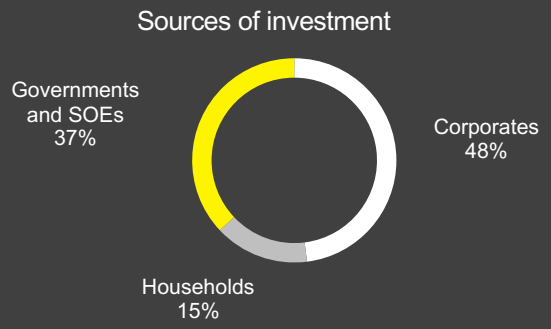
The promotion of debt financing through "green" bonds and loans in the building sector aims to increase the sector's access to finance. A-HQE GBC et al. (2024) for example cite the important role of green bonds and green loans in providing a mechanism for the real estate sector to access capital. The same report also lists several barriers to the financing of the green building transition, including a limited understanding of ways to use green building rating tools (BREEAM, LEED, etc). They present a map of the difference in global taxonomies, including the EU taxonomy. Specifically in relation to bonds, the *Climate Bond Initiative* report the certification of 3.8 USDbn in bond issuances for climate compliance of both commercial and residential buildings and present their framework for asset certification to a 2ºC global warming scenario (Climate Bonds Initiative, 2023). Their principles include a focus on emissions over energy, and a focus on landlord over tenant. They also cite the acceptance of the LEED and BREEAM certifications as proxies to:

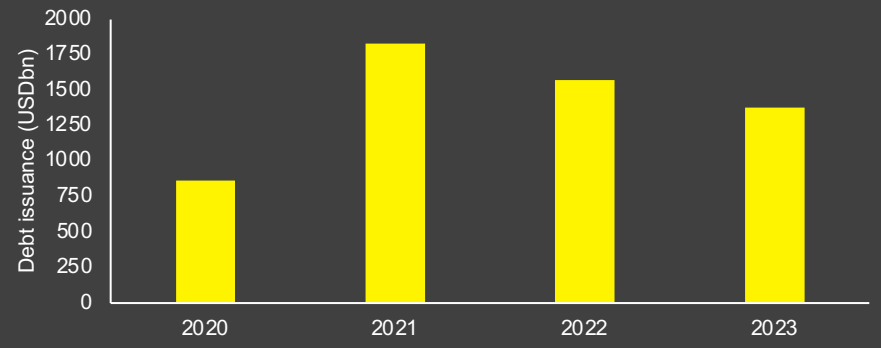
"demonstrate the necessary level of performance of the buildings assets in question."

So, while more investment is required to decarbonise the sector, including investment from loans and bonds, there are global trends showing a slowdown in investment under some metrics. Additionally, there are emerging definitions for what should be categorised as a climate/green investment.

Left of figure: Sources of investment in the energy transition averaged between 2018 and 2023. Adapted from International Energy Agency (IEA), World Energy Investment 2024. Licensed under CC BY 4.0.

Right of figure: Trend in sustainable debt issuances between 2020 and 2023. Adapted from IEA (2024), Sustainable debt issuances, 2020-2023, IEA, Paris https://www.iea.org/data-and-statistics/charts/sustainable-debt-issuances-2020-2023, Licence: CC BY 4.0





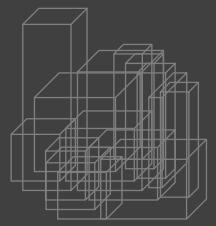
The value of commercial Real Estate

Total value and investment needed by 2030 to meet Net Zero requirements.

There is uncertainty surrounding the precise cost of achieving Net Zero for the buildings, their different sectors and regions. The figures here are derived from several cited sources and can, hence, only serve as an indication of what sort of scale we are talking about. This simple exercise highlights the significant investment needed but also the considerable uncertainty associated with that investment. The exercise of estimating Net Zero investment cost is not simple.

Global
(All buildings)

Valued at in 2023:
379,700 USD bn
Source: Savills (2024)



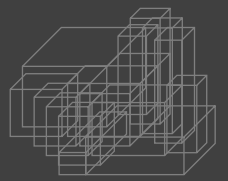
Investment required between 2024 and 2030 to meet IEA's Net Zero Emission scenario:

4,308 USD bn (1.2% of total value)

Source: IEA (2024) assuming linear growth from 350 USDbn in 2023 to 853 bn US $ / year by 2030

Ireland
(Commercial buildings only)

Valued at in 2023:
144 €bn
Source: Central Bank of Ireland (2024)



Investment required between 2024 and 2030 to meet Ireland's energy transition targets:

13 €bn (9% of total value)

Source: DAVY Decarbonisation (2024)

2.3 Solutions

Energy Renovation

Decarbonisation of the real estate sector in Ireland and many other nations requires significant energy renovation of the existing office stock. Solutions for office renovations are therefore discussed here as the primary focus. Similar technologies apply for new buildings but are easier to implement. Focusing on renovation additionally indirectly focuses on embodied carbon given the most effective strategy to reduce embodied carbon is to make best use of what already exists. A complete list of technologies or solutions is outside the scope of this report - if such a list even exists. Technologies are constantly evolving and emerging, so we instead present (and comment on) a list provided by the UKGBC (UKGBC, 2024). A summary of these solutions is presented on the following page.

One of the solutions cited in the report is "Optimisation" which involves an iterative process of monitoring, checking and adjusting controls to ensure there are no wasted energy sources. The report cites a potential 26% saving from this method which includes "reduced tenant loads" (UKGBC, 2024). It suggests moving energy intensive servers to cloud based systems as an example of reduced tenant loads. However, it should be noted that moving to a cloud-based system just shifts the energy consumption to a data centre. While some research suggests that cloud systems are more efficient than local systems (Peuhkuri et al., 2012) the reduction in a building's energy consumption is largely a shift from Scope 2 to Scope 3 related emissions.

The second most effective strategy on the UKGBC's list from an EUI savings perspective is the decarbonisation of heat. This is achieved through the installations of heat pumps primarily. The installation of heat pumps is well covered in all key global decarbonisation pathways for buildings (e.g. IPCC, IEA, BloombergNEF etc.) and is an important pillar of Ireland's climate action plan.

The transition to electrical heating can have particularly effective decarbonisation benefits when implemented in tandem with the decarbonisation of the national grid (O'Hegarty and Kinnane, 2023). Heat pumps typically operate at a lower outlet temperature (40ºC) to traditional boilers (60ºC), and care must be taken to ensure the renovation is conducted without significantly increasing the embodied carbon through significant MEP replacement to upgrade the distribution system to low temperature radiators or under floor heating. The whole life carbon numbers should be computed when considering such interventions. There are also high-temperature heat pump technologies emerging which could theoretically be installed using existing radiators.

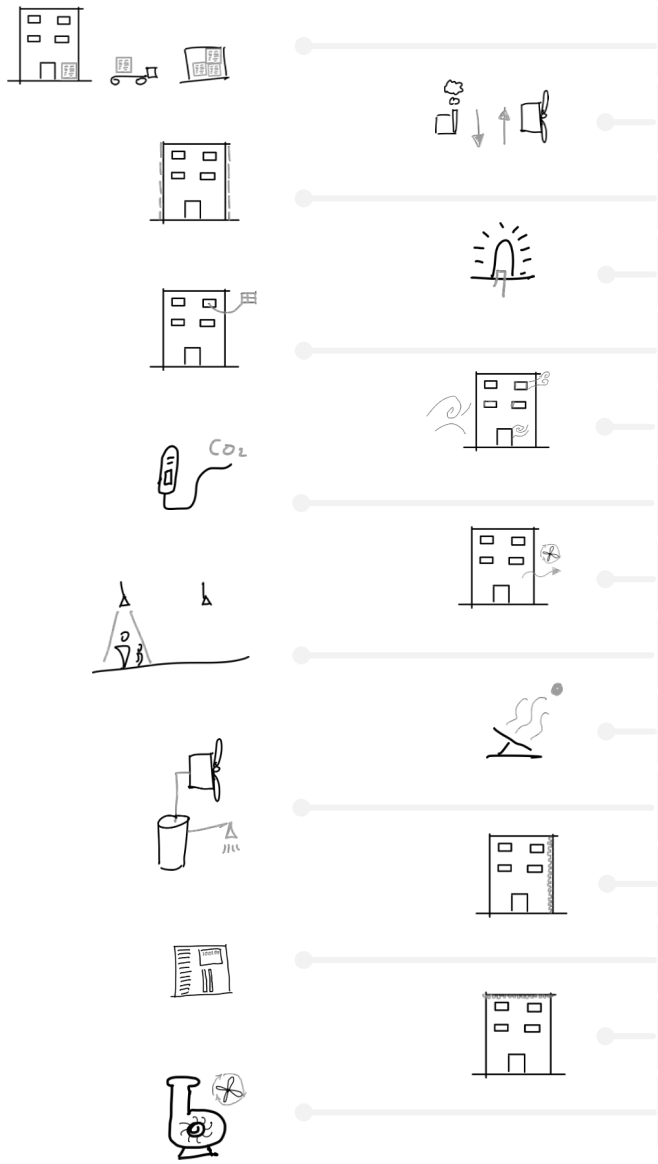
The insulation and thermal improvement of the façade and windows are also significant contributors to reduced energy loads. The savings are highly dependent on the building's geometry, existing levels of insulation and type of insulation used.

Another solution with big potential as the grid becomes increasingly renewable is smart demand response systems which identify periods where renewable energy is abundant to schedule loads like heating and EV charging.

Case studies

These general optimisation strategies have also been used effectively by Hibernia Real Estate Group for their One Cumberland Place office (page 26) and the Observatory building (page 44). 1 Cumberland Place is a completed renovation (completed almost 10 years ago) where a hands-on approach to building energy management is being applied. The application of *Symphony Energy*'s optimisation technology have resulted in reduced energy consumption, with initial indication of a 23% reduction in operational energy since installation. Details can be found in the "Towards Net-Zero Whole Life Carbon Emissions" report (RKD, 2023). Details on Case Study #2 (Observatory), an energy renovation is described on Page 44.

Action Items, embodied carbon impacts and operational energy savings data from the UKGBC's "Building the Case for Net Zero: Retrofitting Office Buildings." Comments and insights made in the context of renovating Irish offices (UKGBC, 2024).



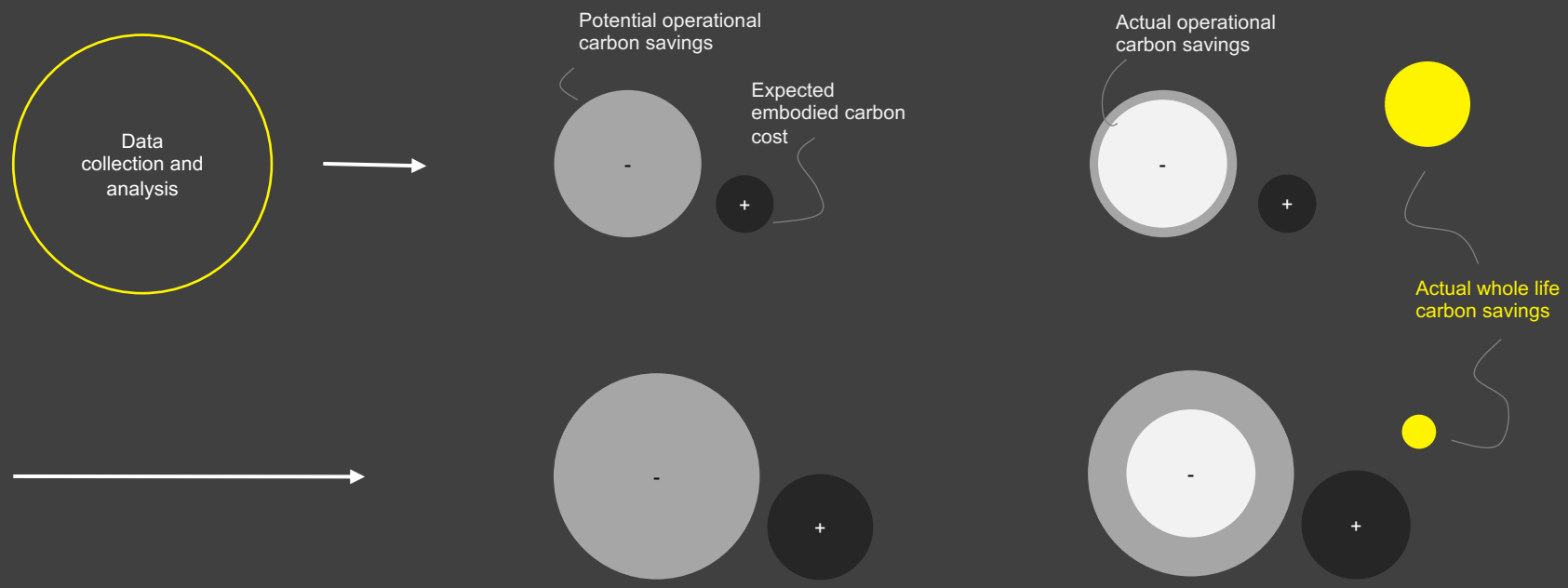
Action	Embodied carbon impact	Operational energy saving (EUI)	Comment and insight
Reduce Tenant Loads (e.g., moving to cloud servers)	low	23.1%	This moves energy use from an office to a data center. Some research indicates that data stored in data centers is more efficient than in individual servers.
Decarbonising heat	low	17.6%	The heat pump itself might have a relatively low embodied carbon but the disruption to the heat distribution system for low temperature applications and renovation works could be higher than reported here.
Façade replacement	high	11.4%	Highly dependent on geometry and existing level of insulation. The savings here could be more significant if starting form an uninsulated base.
Low Energy Lighting	low	8.5%	Relatively easy measure to implement. Further circular economy benefits could be accrued by using lighting as a service.
Window Replacement	mid	7.4%	A whole life carbon assessment should be conducted to see if the additional carbon embodied in triple glazing is justified by the energy savings made over double glazing.
Building Airtightness	low	7.2%	Often an effective way of reducing operational emissions without requiring much material. Logical to consider this before deep retrofit.
CO_2 ventilation control	low	6.5%	Health and wellbeing benefits also.
Mechanical Ventilation with Heat Recovery system	low	5.8%	Efficiency savings made by transferring heat from extracted extracted air to incoming fresh air.
Lighting Controls	low	5.7%	This can be integrated as part of a more holistic control system.
Solar PV	low	5.3%	Doesn't affect EUI targets in line with CRREM or UKNZCBS but impacts emission targets.
Air source heat pump for DHW	mid	4.8%	Hot water preparation requires a higher output temperature than space heating and therefore has a lower efficiency. Still more efficient than immersion heating.
Wall insulation	high	4.1%	This is similar to façade replacement. Extra caution required for internal insulation given the risks of moisture formation and localised heat loss.
BMS Upgrade	low	4.0%	Should be generally maintained.
Roof insulation	high	1.5%	Could be significantly higher for a flatter building.
Pump Motor Replacement	low	1.2%	Should be checked as part of maintenance.

2.3 Solutions

Whole life carbon matters.

Building-first
Approach

Technology-first
Approach



Evaluate the existing building

- Investigate the service lives of existing material and components.
- Evaluate architectural significance.
- Inspect limitations/risks of different technologies.
- Check tenant leases and impact/plausibility of a deep retrofit on tenant displacement.

Model the potential savings

- Review available technologies.
- Simulate operational savings .
- Measure embodied impact.
- Compare lifetime impact.

Monitor actual savings

- Monitor operational performance and measure embodied impact.
- Compare with expectations.
- Track progress towards targets.

Case study – The Observatory Building

Energy Renovation Dublin

Hibernia have made the decision to refurbish their Observatory building due to the strong potential for it to become stranded in the short term based on poor energy and carbon performance, reliance on fossil-fuel-based heating, and lack of occupier comfort controls. In 2024 a refurbishment commenced of the twenty-year-old building, with the sustainability improvements including:

- Improve the BER rating of the asset.
- Remove the use of fossil fuels and install heat pump technology.
- Improve thermal integrity through roof insulation.
- Install on site renewables through a solar PV array.
- Upgrade to a smarter building controls system.
- Install demand control ventilation on vacant floors.
- Commence certification to LEED O+M.
- Provide all occupiers with bespoke online energy and carbon performance dashboards.

Energy modelling predicts the refurbishment (due to be complete in 2025) will decrease annual carbon emissions by 45% and prevent this building from stranding in the short to medium term.

A whole life carbon assessment concluded that the refurbishment will add a further 8% or less to the lifetime embodied carbon emissions of the building – the upfront carbon emissions from the original build making up the 78% and a further intervention in 30 yeas time to replace the façade, contributing to the remaining 14%.

Successfully transitioning this asset requires:

Skills

The team involved in this project, and key to prioritising the lowest embodied and operational carbon emissions were:

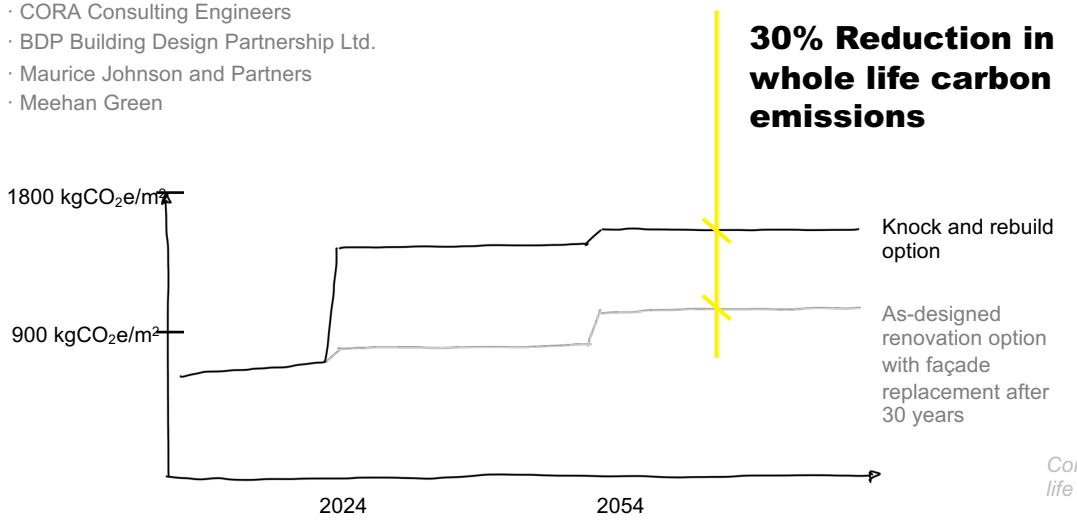
· Connect Construct
· MCA Architects
· CORA Consulting Engineers
· BDP Building Design Partnership Ltd.
· Maurice Johnson and Partners
· Meehan Green

Materials

Apart from maintaining the original structure and façade, priority was given to reusing existing raised access floors, ceiling tiles and mechanical and electrical plant and equipment where it was suitable for extended use – thus reducing the embodied carbon emissions from this refurbishment. The installation of heat pumps was preceded by rigorous testing of the existing AHUs and ductwork to ensure the new system would handle operating at lower flow rates.

Capital

The cost of operating Observatory had increased since 2020 due to higher energy prices and was expected to increase as carbon taxes are committed to rise above €100/tonne of CO_2 by 2030. This, combined with a lack of renewable energy generation onsite increased the risk of this building becoming stranded in the short term, impacting leases and asset valuations negatively. Therefore, the decision to refurbish this asset was seen as positive by Hibernia's owners, Brookfield Asset Management, who approved approximately ~€1.5m towards improving the energy efficiency of the asset as part of the wider refurbishment. This equates to less than 2% of the current valuation of the asset and was funded through a shareholder loan.



Comparison of two options based on a real whole life carbon study conducted by BDP.

2.4 The value of a “green” office

There is a high-level value-add for going “green”, but how much of this value is accrued by the different “green” measures is not clear.

Beyond the challenges to access adequate skills, material and capital, a unique challenge facing the commercial real estate sector is a question of who benefits from the investment, and who makes the investment. Many of the renovation solutions listed above come at an economic cost to the landlord but an operational saving to the tenant. The IPCC cite this challenge in their *Buildings Chapter*:

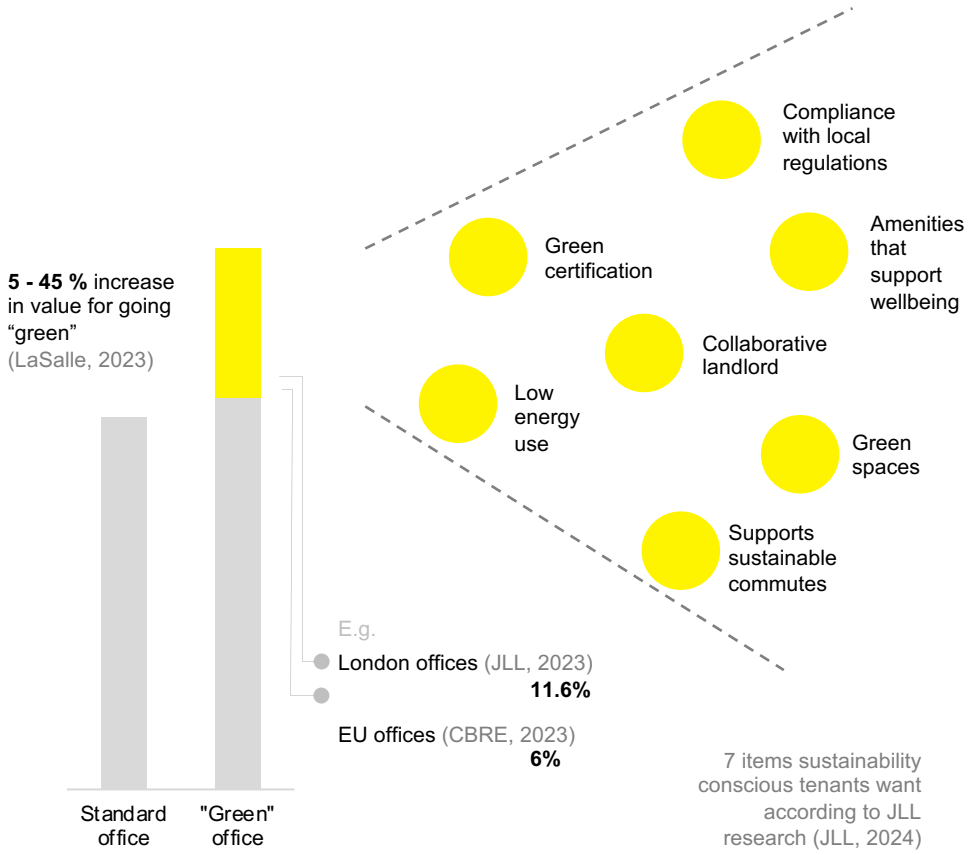
“rented property faces principal/agent problems where the tenant benefits from the decarbonisation investment made by the landlord.”

While tenants will be the biggest beneficiary of energy bills, there is emerging results showing that tenants are beginning to acknowledge this among other benefits and are therefore willing to pay a “green premium” for more sustainable offices. The data on this is fragmented however, with different numbers emerging from different locations based on different definitions of what is considered “green”. Despite this there appears to be a general trend that there is a difference in value between “green” and “standard” offices.

LaSalle conducted an impressive meta-analysis of 100+ reports from both industry (including CBRE, Savills, JLL, Frank Knight, among others) and academia aiming to quantify the value of “green” (LaSalle, 2023). They acknowledge the different interpretations between a “green premium” and a “brown discount” in the literature and note that, of more importance to the direction of the difference, is the fact that there is a difference between two groups of assets, one of which is “greener”.

They therefore instead introduce the “value of green” term and found that this value ranges from anywhere between 5 – 45%. The range varies depending on location, methodology used and definition of “green”. For example, green-certified offices in London are valued 11.6% higher according to JLL research (JLL, 2023) while the CBRE report a value increase of 6% for offices in Europe with sustainability certification (CBRE, 2023).

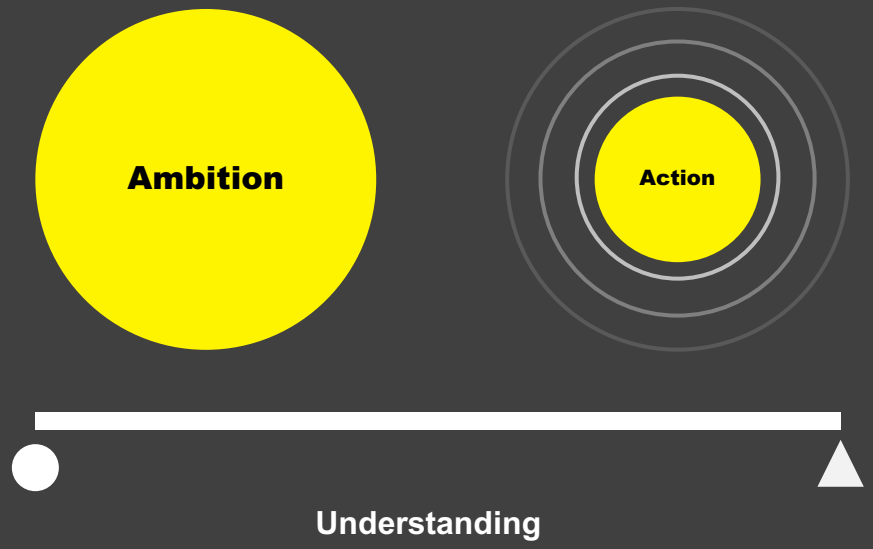
As an example of a recent attempt to standardise the ESG data required for real estate valuations, the RICS’ (2024c) “*ESG data list for real estate valuations*” neatly lists several indicators to understand, capture and disclose. The list includes a mixture of pathways to follow (including the CRREM pathway cited earlier), key metrics to quantify (e.g. energy intensity), key technologies, as well as a list of green building certifications.



Comparing the value of “green” , adapted and derived from data from (CBRE, 2023; JLL, 2024, 2023; LaSalle, 2023).

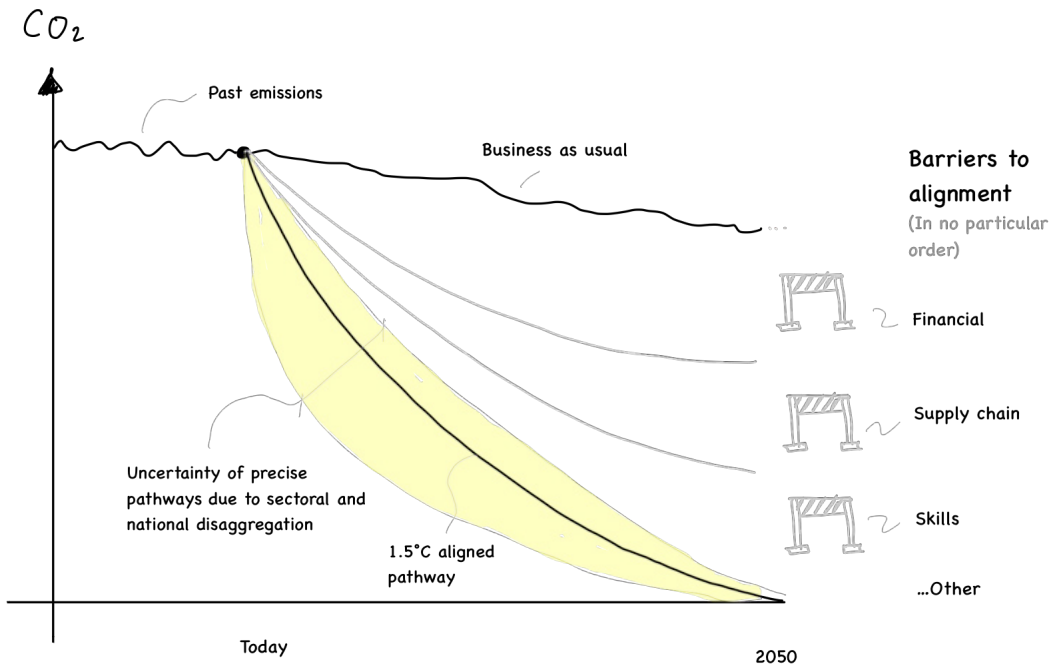
Part 1 • Understanding Ambition ✓

Part 2 • Understanding Action ✓



Conclusion

Understanding what Net Zero means and how to get there is crucial to developing a coherent Net Zero strategy.



The commercial real estate sector's decarbonisation ambition is increasing in both breadth and depth. More companies who build, own or use buildings are setting Net Zero targets. At the same time, these targets are becoming increasingly ambitious and stringent.

Although imperfect, emerging Net Zero building guidance is edging increasingly closer to the scientific definitions of what Net Zero is, and how it relates to carbon budgets. This increase in ambition comes with an increased responsibility to understand what these targets mean. There is very limited room in the Net Zero equation for emission offsetting and delayed action. Continuous reductions in emissions towards a Net Zero end goal are required within a given cumulative budget.

From an Irish office perspective, best-in-class guidance currently includes the UKNZCBS and the SBTI Building Sector Standards. Although there are technically valid questions over the true accuracy of 1.5ºC alignment, there is enough commonality in both standards to give asset managers in the Irish office sector confidence that alignment with both or either of these would be a good result.

Setting sectoral-national decarbonisation pathways are prone to subjective disaggregation in the absence of one common framework. Consequently, precise claims of 1.5ºC alignment are questionable. Explicitly disclosing alignment with a given standard might instead be the more appropriate route.

More importantly, however, is that efforts to decarbonise a given portfolio of assts are maximised. Achieving this requires an understanding of the sectoral, regional and building-specific challenges (skills, materials, capital) as well as the solutions (e.g. efficiency and electrification).

Confidence of the value-add by either reducing risk of stranding or increasing value through a green premium is needed. Emerging data from academia and real estate consultancies is hinting at a growing value add for being "green" in several EU locations. The definitions for what this means and how one might get there require further effort at global and EU level.

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Acronyms

BPIE - Buildings Performance Institute Europe

BUSI2030 - Build Up Skills Ireland 2030

CRREM - Carbon Risk Real Estate Monitor

EHPA - European Heat Pump Association

EPA - Environmental Protection Agency

EPBD - Energy Performance of Buildings Directive

ESG - Environmental, Social, and Governance

GHG - Greenhouse Gas

GIA - Gross Internal Area

HFCs - Hydrofluorocarbons

IEA - International Energy Agency

IPCC - Intergovernmental Panel on Climate

LCA - Life Cycle Assessment

LETI - London Energy Transformation Initiative

MMC - Modern Methods of Construction

NIA - Net Internal Area

RICS - Royal Institution of Chartered Surveyors

SBTi - Science Based Targets Initiative

SOE - State Owned Enterprise

UKNZCBS - UK Net Zero Carbon Building Standard

UNFCCC - United Nations Framework Convention on Climate Change

WGBC - World Green Building Council

References (1/2)

A-HQE GBC, BRE, GBCA, SGBC, USGBC, 2024. Financing Transformation: A Guide to Green Building for Green Bonds and Green Loans. Alliance HOE Finance, London, UK.

Alcaraz, O., Balfegó, M., Cruanyes, C., Retamal, C., Sureda, B., Turon, A., 2022. Equity in the Paris Agreement regime Are current NDCs built on equity?

Allen, M.R., Frame, D.J., Huntingford, C., Jones, C.D., Lowe, J.A., Meinshausen, M., Meinshausen, N., 2009. Warming caused by cumulative carbon emissions towards the trillionth tonne. Nature 458, 1163–1166. https://doi.org/10.1038/nature08019

Allen, M.R., Friedlingstein, P., Girardin, C.A.J., Jenkins, S., Malhi, Y., Mitchell-Larson, E., Peters, G.P., Rajamani, L., 2022. Net Zero: Science, Origins, and Implications. Annu. Rev. Environ. Resour. 47, 849–887. https://doi.org/10.1146/annurev-environ-112320-105050

BloombergNEF, 2024. Energy Transition Investment Trends 2024. Tracking global investment in the low-carbon transition. Abridged version.

BPIE (Buildings Performance Institute Europe), 2024. How to establish Whole Life Carbon benchmarks Insights and lessons learned from emerging approaches in Ireland, Czechia and Spain [WWW Document]. URL https://www.bpie.eu/publication/how-to-establish-whole-life-carbonbenchmarks-insights-and-lessons-learned-from-emerging-approaches-in-ireland-czechia-and-spain/ (accessed 11.1.24).

BUSI2030, 2023. Build Up Skills – Ireland 2030. Analysis of the National Status Quo.

CRREM, 2023. From Global Emission Budgets To Decarbonization Pathways At Property Level. Iiö Institute For Real Estate Economics.

CBRE, 2023. The Value of Sustainable Building Features.

Climate Bonds Initiative, 2023. Aligning Buildings with the Paris Climate Agreement: Insights and Developments from the Green Bond Market. Climate Bonds Initiative, London, United Kingdom.

Climate Change Advisory Council, 2021. Carbon Budget Technical Report. Climate Change Advisory Council.

EHPA, 2024. Executive Summary: European Heat Pump Market and Statistics Report.

EPA, 2024. Latest emissions data 2023. Ireland. Environmental Protection Agency [WWW Document]. URL https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/latest-emissions-data/ (accessed 10.8.24).

EPBD, 2024. Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast) (Text with EEA relevance).

Evans, S., 2021. Analysis: Which countries are historically responsible for climate change? [WWW Document]. Carbon Brief. URL https://www.carbonbrief.org/analysis-which-countries-are-historically-responsible-for-climate-change/ (accessed 10.8.24).

Evans, S., Viisainen, V., 2023. Revealed: How colonial rule radically shifts historical responsibility for climate change [WWW Document]. Carbon Brief. URL https://www.carbonbrief.org/revealed-how-colonial-rule-radically-shifts-historical-responsibility-for-climate-change/ (accessed 10.8.24).

Forster, P.M., Smith, C., Walsh, T., Lamb, W.F., Lamboll, R., Hall, B., Hauser, M., Ribes, A., Rosen, D., Gillett, N.P., Palmer, M.D., Rogelj, J., von Schuckmann, K., Trewin, B., Allen, M., Andrew, R., Betts, R.A., Borger, A., Boyer, T., Broersma, J.A., Buontempo, C., Burgess, S., Cagnazzo, C., Cheng, L., Friedlingstein, P., Gettelman, A., Gütschow, J., Ishii, M., Jenkins, S., Lan, X., Morice, C., Mühle, J., Kadow, C., Kennedy, J., Killick, R.E., Krummel, P.B., Minx, J.C., Myhre, G., Naik, V., Peters, G.P., Pirani, A., Pongratz, J., Schleussner, C.-F., Seneviratne, S.I., Szopa, S., Thorne, P., Kovilakam, M.V.M., Majamäki, E., Jalkanen, J.-P., van Marle, M., Hoesly, R.M., Rohde, R., Schumacher, D., van der Werf, G., Vose, R., Zickfeld, K., Zhang, X., Masson-Delmotte, V., Zhai, P., 2024. Indicators of Global Climate Change 2023: annual update of key indicators of the state of the climate system and human influence. Earth System Science Data 16, 2625–2658. https://doi.org/10.5194/essd-16-2625-2024

Goetsch, H., Deru, M., 2022. Operational Emissions Accounting for Commercial Buildings (No. NREL/TP-5500-81670, 1876014, MainId:82443). https://doi.org/10.2172/1876014

Habert, G., Röck, M., Steininger, K., Lupisek, A., Birgisdottir, H., Desing, H., Chandrakumar, C., Pittau, F., Passer, A., Rovers, R., Slavkovic, K., Hollberg, A., Hoxha, E., Jusselme, T., Nault, E., Allacker, K., Lützkendorf, T., 2020. Carbon budgets for buildings: harmonising temporal, spatial and sectoral dimensions. Buildings & Cities 1. https://doi.org/10.5334/bc.47

IEA, 2024a. World Energy Investment 2024.

IEA, 2024b. Investments in end-use sectors in the Net Zero Emissions by 2050 Scenario, historical versus 2030.

IEA, 2024c. Buildings - Energy System [WWW Document]. IEA. URL https://www.iea.org/energy-system/buildings (accessed 11.7.24).

IEA, 2024d. Global Critical Minerals Outlook 2024.

IEA, 2023. Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, 2023 Update. International Energy Agency (IEA).

IGBC, 2024. Net Zero Carbon Definitions Guidance for IGBC members April 2024.

IPCC, 2023a. Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. https://doi.org/10.59327/IPCC/AR6-9789291691647.001

IPCC, 2023b. Intergovernmental Panel on Climate Change (IPCC), ed. Chapter 9 Buildings. In: Climate Change 2022 - Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2023:953-1048. 953–1048. https://doi.org/10.1017/9781009157926.011

IPCC, 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

JLL, 2023. The commercial case for making buildings more sustainable.

References (2/2)

Lang, J., 2024. Untangling our climate goals [WWW Document]. Energy & Climate Intelligence Unit. URL https://eciu.net/analysis/infographics/our-climate-goals (accessed 10.22.24).

Lang, J., 2021. Net Zero: A short history [WWW Document]. Energy & Climate Intelligence Unit. URL https://eciu.net/analysis/infographics/net-zero-history (accessed 8.20.24).

LaSalle, 2023. What is the value of green? Looking at the evidence linking sustainability and real estate outcomes.

Little, J., 2005. Construct Ireland - Partial Fill Cavity Walls. Construct Ireland magazine, Issue 8 volume 2.

McGuire, J., Rogan, F., Daly, H., Glynn, J., Balyk, O., Ó Gallachóir, B.P., 2020. The role of carbon budgets in translating the Paris Agreement into national climate policy (Report). MaREI Centre, University College Cork.

McKinsey Global Institute, 2022. The Net-Zero Transition: What It Would Cost, What It Could Bring. Executive summary. McKinsey & Company.

McNamara, F., 2024. Davy Decarbonisation. Investing in Tomorrow: Shaping a Net-Zero Future.

Net Zero Tracker, 2024. Net Zero Stocktake 2024: NewClimate Institute, Oxford Net Zero, Energy and Climate Intelligence Unit and Data-Driven EnviroLab.

O'Hegarty, R., 2022. The Embodied Carbon of Buildings. Share your Green Design. URL https://www.shareyourgreendesign.com/the-embodied-carbon-of-buildings-2/ (accessed 8.4.22).

O'Hegarty, R., Amedeo, G., Kinnane, O., 2024. The impact of compromised insulation on building energy performance. Energy and Buildings 316, 114337. https://doi.org/10.1016/j.enbuild.2024.114337

O'Hegarty, R., Kinnane, O., 2023. A whole life carbon analysis of the Irish residential sector - past, present and future. Energy and Climate Change 4, 100101. https://doi.org/ricsmanudod

O'Hegarty, R., Kinnane, O., Lennon, D., Colclough, S., 2021. Air-to-water heat pumps: Review and analysis of the performance gap between in-use and product rated performance. Renewable and Sustainable Energy Reviews 111887. https://doi.org/10.1016/j.rser.2021.111887

Petkov, I., Lerbinger, A., Mavromatidis, G., Knoeri, C., Hoffmann, V.H., 2023. Decarbonizing real estate portfolios considering optimal retrofit investment and policy conditions to 2050. iScience 26, 106619. https://doi.org/10.1016/j.isci.2023.106619

Peuhkuri, M., Laakkola, R., Costa-Requena, J., Manner, J., 2012. Datacenters - Energy hogs or helping to optimize energy consumption, in: 2012 International Conference on Smart Grid Technology, Economics and Policies (SG-TEP). Presented at the 2012 International Conference on Smart Grid Technology, Economics and Policies (SG-TEP), IEEE, Nuremberg, Germany, pp. 1–4. https://doi.org/10.1109/SG-TEP.2012.6642387

Potter, B., 2024. Why Levittown Didn't Revolutionize Homebuilding [WWW Document]. URL https://www.construction-physics.com/p/why-levittown-didnt-revolutionize (accessed 9.26.24).

Reduction Roadmap, 2024. Reduction Roadmap [WWW Document]. URL https://reductionroadmap.dk (accessed 10.31.24).

RICS, 2024a. Whole life carbon assessment for the built environment. Global. 2nd Edition, September 2023. Version 3, August 2024. Effective from 1 July 2024.

RICS, 2024b. Whole life carbon assessment implementation guides and supporting documents [WWW Document]. URL https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/construction-standards/whole-life-carbon-assessment/whole-life-carbon-assessment-implementation-guides-and-supporting-documents (accessed 10.30.24).

RICS, 2024c. ESG data list for real estate valuations A practical reference document on legislative, market-driven and future ESG requirements for valuers and financial clients in the EU. Royal Institution of Chartered Surveyors (RICS).

RKD, 2023. Towards Net-Zero Whole Life Carbon Emissions. Lessons from an Irish Case Study 1 Cumberland Place.

Röck, M., Saade, M.R.M., Balouktsi, M., Rasmussen, F.N., Birgisdottir, H., Frischknecht, R., Habert, G., Lützkendorf, T., Passer, A., 2020. Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. Applied Energy 258, 114107. https://doi.org/10.1016/j.apenergy.2019.114107

Savills, 2023. Total Value of Global Real Estate: Property remains the world's biggest store of wealth. Savills Impacts. URL https://www.savills.com/impacts/market-trends/the-total-value-of-global-real-estate-property-remains-the-worlds-biggest-store-of-wealth.html (accessed 11.8.24).

SBTI, 2021. Pathway to Net-Zero: Science-Based Targets for Business. Version 1.0.

SBTI, 2024a. Buildings Sector Science-Based Targets Explanatory Document: Version 1.0. The Science Based Targets Initiative.

SBTI, 2024b. Buildings Sector Science-Based Target-Setting Criteria. Version 1.0. The Science Based Targets Initiative.

SBTI, 2024c. SBTi Criteria Assessment Indicators: Buildings Sector: Version 1.0. The Science Based Targets Initiative.

SBTI, 2024d. 1.5° C Pathways for the Global Buildings Sector's Embodied Emissions: Development Description. Version 1.0. The Science Based Targets Initiative.

Sweatman, P., 2021. Finance & Investing in Decarbonising Europe's Buildings Six financial levers to accelerate the decarbonisation of the construction and operation of European buildings. Climate Strategy and Partners.

Systemiq, 2024. Seeing is Believing: Unlocking the Low-Carbon Real Estate Market.

UKGBC, 2024. Building the Case for Net Zero: Retrofitting Office Buildings. UK Green Building Council. UK Green Building Council.

UNFCCC, 2024. Race to Zero Criteria [WWW Document]. Climate Champions. URL https://climatechampions.unfccc.int/system/criteria/ (accessed 9.4.24).

UNFCCC, 2023. Nationally determined contributions under the Paris Agreement: Synthesis report by the secretariat. United Nations Framework Convention on Climate Change.

UNFCCC, 2015. Paris Agreement. United Nations Framework Convention on Climate Change.

United Nations, 2022. Guterres highlights key role of Net-Zero experts | UN News [WWW Document]. URL https://news.un.org/en/story/2022/04/1117062 (accessed 8.20.24).

van den Berg, N.J., van Soest, H.L., Hof, A.F., den Elzen, M.G.J., van Vuuren, D.P., Chen, W., Drouet, L., Emmerling, J., Fujimori, S., Höhne, N., Köberle, A.C., McCollum, D., Schaeffer, R., Shekhar, S., Vishwanathan, S.S., Vrontisi, Z., Blok, K., 2020. Implications of various effort-sharing approaches for national carbon budgets and emission pathways. Climatic Change 162, 1805–1822. https://doi.org/10.1007/s10584-019-02368-y

WGBC, 2024. The Net Zero Carbon Buildings Commitment [WWW Document]. World Green Building Council. URL https://worldgbc.org/thecommitment/ (accessed 10.22.24).

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