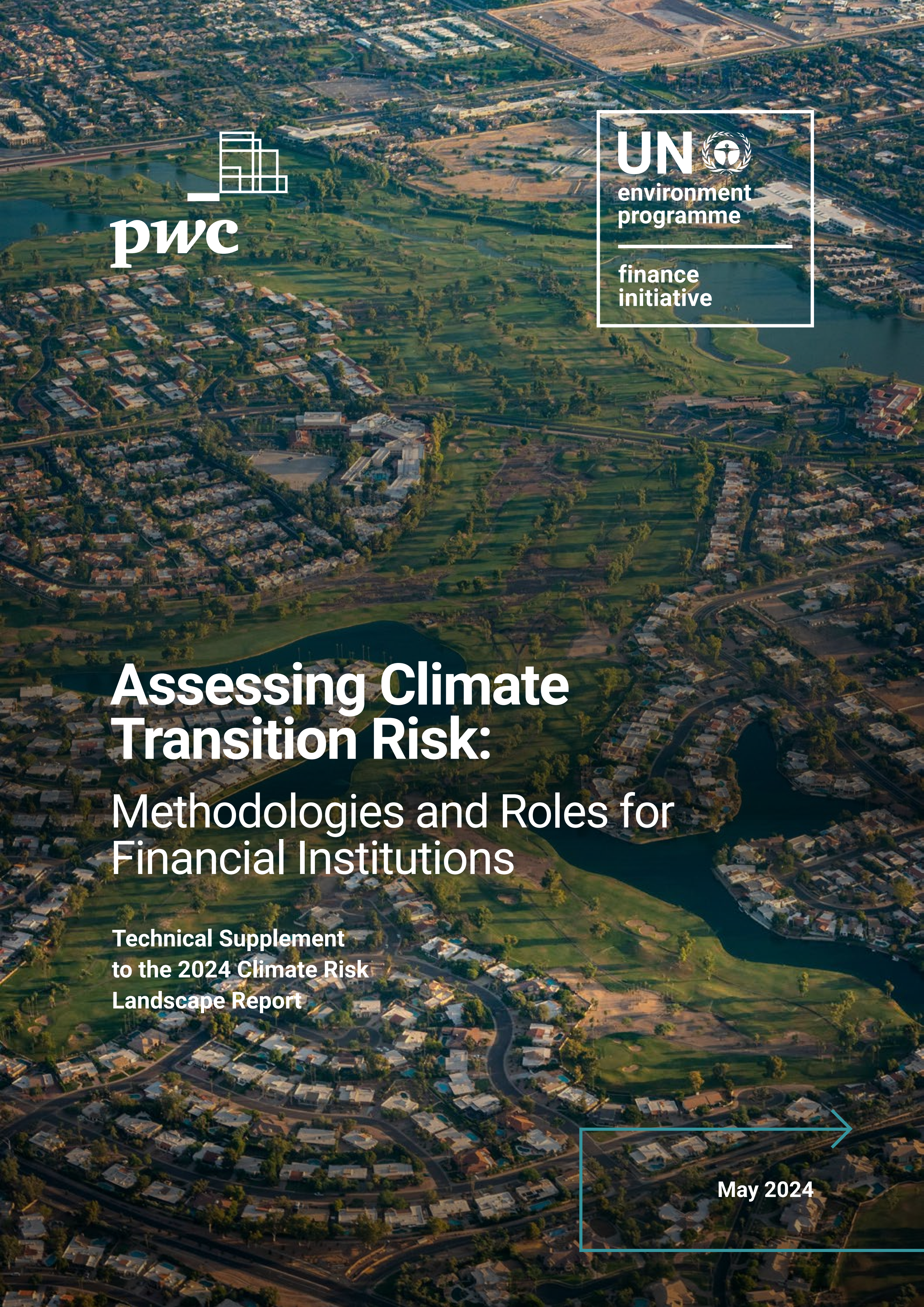


UN environment programme

finance initiative

Assessing Climate Transition Risk:

Methodologies and Roles for Financial Institutions

Technical Supplement to the 2024 Climate Risk Landscape Report

May 2024

Disclaimer

Suggested citation: United Nations Environment Programme (2024). *Assessing Climate Transition Risk: Methodologies and Roles for Financial Institutions,* Geneva.

This report is the result of a collaborative effort by the United Nations Environment Programme Finance Initiative (UNEP FI) Risk Centre team, in conjunction with experts from PricewaterhouseCoopers GmbH Wirtschaftsprüfungsgesellschaft (PwC). The report has the following authors:

pwc

Thomas Haasz
Felix Neu
Juliane Feen Strohmeyer

UN environment programme finance initiative

Wenmin Li

The project was set up, managed, and coordinated by UNEP FI, specifically: Remco Fischer (kai.fischer@un.org), David Carlin (david.carlin@un.org) and Lea Lorkowski (lea.lorkowski@un.org).

Contents

List of figures and tables

Figures

Tables

Abbreviations and acronyms

CO_2	Carbon Dioxide
CRR	Capital Requirements Regulation
CRREM	Carbon Risk Real Estate Monitor
CSRD	Corporate Sustainability Reporting Directive
EFRAG	European Financial Reporting Advisory Group
EIOPA	European Insurance and Occupational Pensions Authority
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESG	Environmental, Social, and Governance
EU	European Union
EU BCT	EU Buildings Climate Tracker
G20	The Group of Twenty
GFANZ	Glasgow Financial Alliance for Net Zero
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicator
MEES	Minimum Energy Efficiency Standards
PCAF	Partnership of Carbon Accounting Financials
PRI	Principles for Responsible Investment
PwC GmbH WPG	PricewaterhouseCoopers GmbH Wirtschaftsprüfungsgesellschaft
SBTi	Science-Based Targets initiative
UNEP	UN Environment Programme
UNEP FI	United Nations Environment Programme Finance Initiative
UNGC	United Nations Global Compact
NZAMI	Net Zero Asset Managers Initiative
NZBA	Net-Zero Banking Alliance
WRI	World Resource Institute

Executive summary

The building sector plays a vital role in advancing global climate objectives. The pursuit of limiting global warming to 1.5°C requires substantial advancements in reducing energy consumption and greenhouse gas (GHG) emissions within this sector. Achieving these objectives depends on the deployment of targeted retrofitting strategies and the avoidance of stranded assets. Both steps need to be underpinned by a clear understanding of key performance indicators (KPIs) that track progress towards these ambitious environmental milestones. **Recent regulatory developments**, such as those outlined in the Corporate Sustainability Reporting Directive (CSRD), emphasise the importance of setting clear climate targets and delineating actionable plans to reach these goals, signalling a move towards more comprehensive retrofit analysis at the portfolio level to uphold net-zero commitments.

The financial sector faces a particularly acute challenge in this regard. **As the landscape shifts towards a lower-carbon future, the valuation of real estate assets will increasingly reflect their energy efficiency**. Inefficient buildings are emerging as tangible financial risks, influenced by factors such as carbon pricing and its impact on operational costs. For investors and insurers, this underscores the strategic importance of retrofitting as a means to capitalise on the growing demand for energy-efficient buildings. Banks, meanwhile, may view such retrofits as enhancements to asset security, bolstering borrowers' income stability.

This report emerges from a collaborative effort between the United Nations Environment Programme Finance Initiative (UNEP FI)'s Climate Risk and Task Force on Climate-related Financial Disclosures (TCFD) programme and PricewaterhouseCoopers GmbH Wirtschaftsprüfungsgesellschaft (PwC GmbH WPG). It delves into **retrofitting within the financial sector**, highlighting the critical nature of retrofits, evaluating existing methodologies for assessing climate risks in real estate portfolios, and exploring the roles that various stakeholders play in facilitating the retrofitting process.

A primary concern for financial institutions remains the accessibility of detailed information on specific energy consumption or Energy Performance Certificates (EPC).[1] Bridging this gap with **reliable, open-source, and globally applicable proxy data** could mitigate current challenges, enabling more effective climate risk management in the real estate sector. Achieving this goal requires joint efforts across stakeholders: financial institutions, governments, non-governmental organisations, and real estate companies must collaborate closely and engage actively in these initiatives. In this way, they can push forward the adoption of retrofitting measures that meet our collective environmental goals.

1 Energy performance certificates (EPCs) provide information to consumers on buildings that they plan to purchase or rent. EPCs include an energy performance rating and recommendations for cost-effective improvements (EU, 2024).

1. Introduction: Building a sustainable future

Credit: unsplash.com/@joelfilip

1.1 The essential roles of real estate and finance in meeting the 1.5°C goal

The Paris Agreement of 2015 set a landmark goal for the global community: achieve net-zero emissions by 2050 to hold the increase in the global average temperature to well below 2°C (UNFCCC, 2015). This ambition establishes a critical "carbon budget" for the next three decades, underscoring the urgency and scale of the actions needed (UBS, 2024). Within this framework, the real estate sector is identified as a critical area for intervention, accounting for roughly 35 per cent of global carbon emissions. A deeper examination reveals that nearly 80 per cent of these emissions originate from building operations. The construction phase, which includes embodied carbon from materials such as cement and iron, accounts for the remaining 20 per cent, as indicated in Figure 1 (Architecture 2030, 2024). Consequently, achieving significant emission reductions in both areas, especially operational emissions, is essential for the sector's alignment with global and national climate objectives.

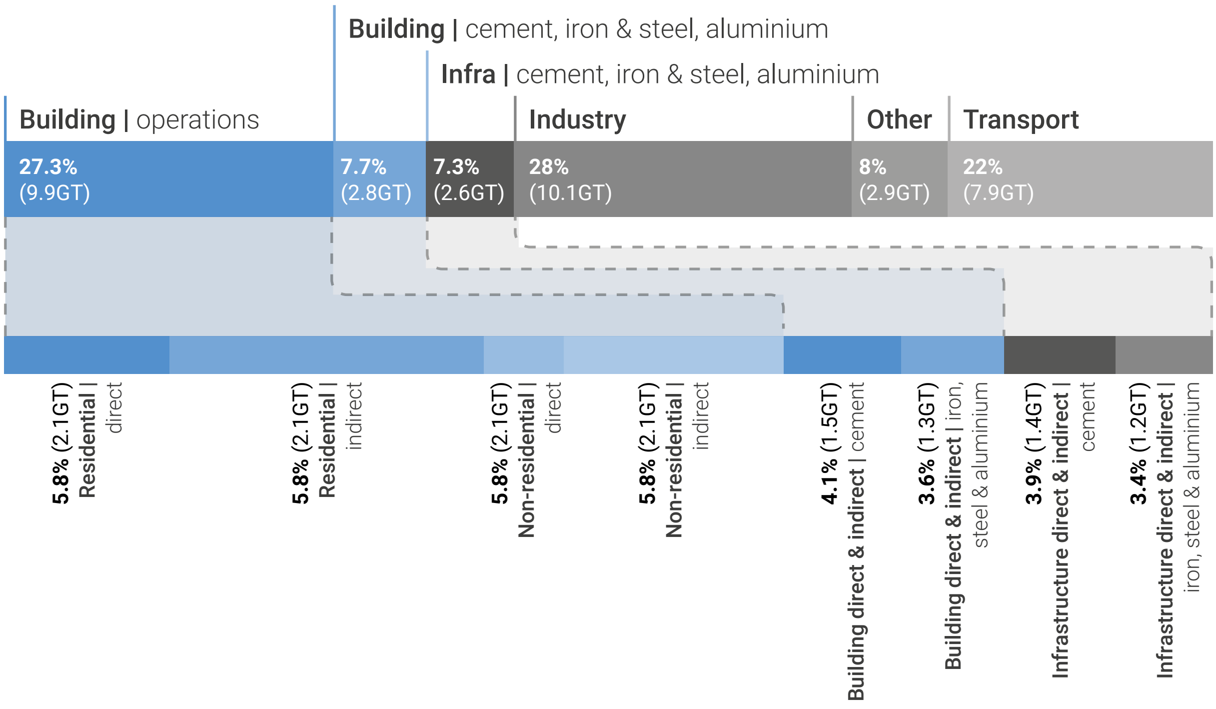


Figure 1: Total annual global CO_2 emissions by sector (Architecture 2030, 2022).

The theoretical and scientific pathways for the building sector have been clearly delineated, yet the real-world progress paints a different picture. According to data from the Carbon Risk Real Estate Monitor (CRREM), only 15 per cent of global real estate assets are on track to meet the 1.5°C decarbonisation pathway of the Paris Agreement. To fulfil the Agreement's ambitions and cap global warming within the 1.5°C to 2.0°C range, 37 per cent of global buildings must be decarbonised by 2030 (CBRE, 2022).

A growing number of countries are instituting measures to keep the global temperature increase below the 1.5°C threshold, despite varying levels of regulatory maturity across nations. The European Union (EU), for instance, has revised its Energy Performance of Buildings Directive (EPBD) to mandate zero emission standards for new buildings by 2030. The EU also plans to phase out fossil fuel boilers by 2040. In India, meanwhile, where 40 per cent of national carbon dioxide (CO_2) emissions are attributed to buildings, the government enacted legislation in 2022 to initiate carbon trading and sustainable building codes (UNEP, 2024). Beyond mandatory regulations, market-driven initiatives such as the Net-Zero Banking Alliance (NZBA), Principles for Responsible Investment (PRI), Glasgow Financial Alliance for Net Zero (GFANZ), and Net Zero Asset Managers Initiative (NZAMI) are also putting pressure on companies to minimise their (financial) risks and secure their future viability and competitive position (PwC, 2024).

The UNEP's 2022 Global Buildings Climate Tracker has raised alarms about the persistent shortfall in the sector's decarbonisation journey. The EU Buildings Climate Tracker (EU BCT) provides an index that assesses progress toward climate neutrality by 2050 for the EU's building stock. Unfortunately, the tracker shows **a significant gap remains on the path to desired decarbonisation levels**. With the decarbonisation of building stock lagging, an urgent need exists to escalate efforts, necessitating an annual increase of 10 decarbonisation points to meet the 2030 milestone—a stark increase from the six points previously projected, as illustrated by Figure 2 (GlobalABC, 2022). Every additional year passing below the desired threshold will increase the mitigation burden in the following years (UNEP, 2024). This situation emphasises the critical need for both the construction of new, efficient, and resilient buildings and the retrofitting of existing buildings with low-carbon materials and energy-efficient designs.

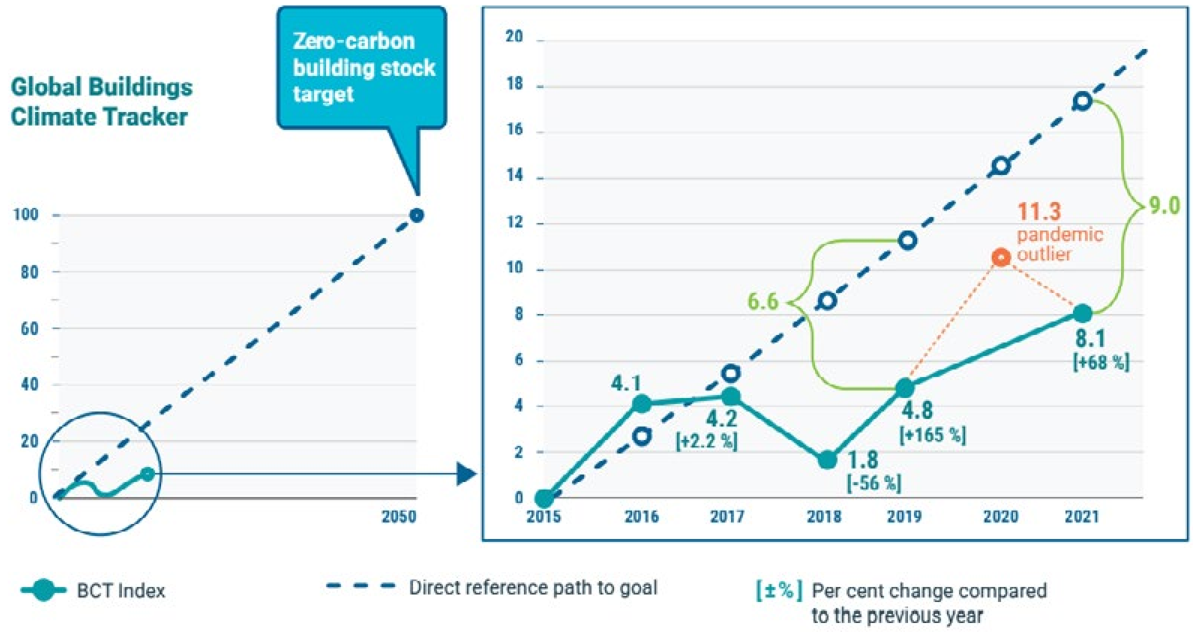


Figure 2: Direct reference path to a zero-carbon building stock target in 2050 (left), and zoom into the period between 2015 and 2021, comparing the observed Global Buildings Climate Tracker to the reference path (right) (GlobalABC, 2022).

The financial sector plays a pivotal role in steering the real estate industry towards sustainable practices and emission reduction, particularly as real estate and infrastructure have become essential components of mainstream investment portfolios. Importantly, the market has observed that properties with high emissions have experienced declines in value following the implementation of climate-related policies. This trend underscores the market's growing preference for sustainable assets, from large institutional investors to individual homeowners (UNEP FI, 2022)—a theme that will be further discussed in the following chapters. This alignment with global climate and sustainability goals not only advances environmental objectives; it also presents financial institutions with opportunities for risk mitigation and value preservation or even gaining a competitive advantage in their real estate portfolios. Such opportunities underscore the mutual benefits of transitioning towards more sustainable building practices.

1.2 Benefits and importance of retrofitting

In recent years, there has been a growing awareness that the real estate faces significant transition risks as economies decarbonise. To mitigate the impact of potential transition risks, financial institutions must be proactive (UNEP FI, 2022). The European Environment Agency highlights a critical challenge facing our built environment: approximately 75 per cent of the existing building stock in Europe is not energy-efficient. This problem is compounded by the fact that over 85 per cent of today's buildings are projected to still be in use by 2050 (EEA, 2023). Moreover, retrofitting an existing building can result in 50–75 per cent less carbon than constructing the same building from scratch (RMI, 2023). These realities illuminate the **critical importance of implementing structured approaches to retrofit existing buildings**, enhancing their energy efficiency, and aligning them with climate change adaptation measures.

Retrofitting involves the comprehensive upgrading of buildings to improve their environmental and operational performance, utilising low-carbon technologies and materials. This process aims to **achieve marked energy efficiency while making the structures more climate resilient**. Whole-building retrofits can encompass a range of modifications, from adding insulation to installing energy-efficient windows and modernising heating and cooling systems with alternatives like heat pumps. Such deep energy retrofits are known to decrease energy consumption by at least 50 per cent, leading to substantial reductions in GHG emissions (NRC, 2023).

Beyond the pivotal goals of mitigating climate change and reducing carbon emissions, the advantages of retrofitting extend across a spectrum of benefits, as outlined by PlanRadar (2023):

1. **Increased energy efficiency:** Implementation of advanced insulation and integration of renewable energy sources, such as solar panels, biomass, and wind turbines, in order to elevate a building's energy performance.

2. **Cost savings and return on investment:** Energy consumption reductions translate into significant utility bill savings, enhancing the financial attractiveness and market value of retrofitted properties.

3. **Environmental sustainability:** Retrofitting prioritises eco-friendly materials and practices, extending its impact beyond carbon emission reductions to broader environmental stewardship.

4. **Improved indoor comfort and health:** By focusing on holistic building performance, retrofitting initiatives contribute to healthier, more comfortable indoor environments, which fosters wellbeing, productivity, and reduced absenteeism.

5. **Adaptation to modern needs and technologies:** Retrofits facilitate the integration of smart technologies and systems, enhancing building functionality and operational efficiency.

6. **Enhanced resilience to natural disasters:** Strengthening buildings against extreme weather and seismic events is a critical aspect of retrofitting, ensuring the safety and durability of the built environment.

The CRREM and UNEP FI's 2023 report on "Embodied Carbon of Retrofits" highlights that strategic retrofitting can significantly reduce a building's embodied carbon, especially when sustainable materials and construction practices are employed (CRREM, 2023). Given these extensive benefits, retrofitting stands out not just as a response to environmental challenges but as a multifaceted strategy integral to achieving sustainability ambitions. It empowers stakeholders across the board—from building owners to asset managers, with the notable inclusion of financial institutions—with effective tools to mitigate transition risks and adapt to a shifting economic landscape.

This report, a collaborative effort by UNEP FI and PwC, delves into **retrofitting methodologies for the financial sector** and explores **the roles of various stakeholders in achieving the 1.5°C goal**. While acknowledging the aforementioned advantages, the technical supplement centres on the crucial role of retrofitting as a means for the financial sector to evaluate and navigate climate-related transition risks effectively. Chapter 1 sets the stage by underscoring the significance and context of retrofitting analysis. Chapter 2 delves into current methodologies for evaluating climate risks in the real estate sector, enriched with detailed case studies derived from the retrofit analysis. Chapter 3 further explores the essential roles that stakeholders such as surveyors, governments, the financial sector, and regulatory bodies play in advancing sustainable building practices, highlighting their crucial contributions towards achieving the net-zero target by 2050. Finally, Chapter 4 summarises the key findings of the report and identifies steps to enhance on key challenges that financial institutions seem to have in common.

2. Evaluating climate risk in building assessments: Current metrics and methodologies

Credit: unsplash.com/@alexwillss

Climate risk assessment is increasingly recognised as an essential element in the strategic planning of various sectors, including real estate. In this field, the potential impacts of climate change are profound, affecting asset values and the long-term sustainability of property investments. As real estate stakeholders face both physical and transition-related climate risks, understanding these exposures and their possible consequences is critical. Transition risks, for example, necessitate insights into future technological advances, comprehensive emissions data, and a range of climate and economic models (UNEP FI, 2023).

To assist the financial sector in navigating these complexities, UNEP FI has developed a comprehensive **series of resources that deepen the understanding of the climate risk assessment process**. Key resources include:

- **The 2024 and 2023 Climate Risk Landscape Report:** Delivers insights on the latest trends, innovations, and best practices in the market for climate risk tools, including case studies and strategic recommendations.
- **Technical Supplement of the 2023 Climate Risk Landscape Report:** Offers a comprehensive analysis of climate risk assessment outcomes from multiple vendors, detailing the variations in tools regarding methodologies, metrics, and assumptions, using a dummy portfolio for demonstration.
- **The Climate Risk Dashboard:** Presents a detailed overview of more than 60 climate risk tools, highlighting their features, methodologies, and common applications, with updates provided quarterly.

In the realm of real estate, the urgency to develop robust climate strategies and adjust portfolios aligns with targets set forth by the Paris Agreement. The market is responding with a range of **effective metrics, methodologies, and practical tools** tailored to help real estate companies accurately assess climate risks. These tools are invaluable not only for regulatory compliance but also for improving standings in environmental, social, and governance (ESG) evaluations and climate-focused reporting frameworks.

This chapter focuses on showcasing the **metrics, methodologies and tools that are particularly relevant for retrofit analysis** in the real estate sector for financial institutions. The examples provided are illustrative rather than exhaustive, chosen to offer practical guidance and demonstrate how stakeholders can effectively manage their climate risks.

2.1 Temperature score analysis: Measuring climate alignment

As the urgency to address climate change grows, the real estate sector is increasingly recognising the need to assess and mitigate the environmental impact of buildings. One emerging tool in this regard is the 'Temperature score analysis'. This chapter aims to provide an overview of a Temperature Score as a metric and its relevance to the real estate sector, highlighting its potential benefits to assess climate risks.

The Temperature Score is a metric that **quantifies the baseline and future climate impact of a building and, as such, its potential long-term contribution** to global warming. The temperature rating methodology is based on energy consumption and associated GHG emissions of the respective building on a 1.5°C pathway by 2050. The Temperature Score provides a measure to compare the climate impact of different buildings, allowing stakeholders in the real estate sector to make informed decisions regarding energy efficiency improvements and carbon reduction strategies.

The Temperature Score offers several benefits. Firstly, it provides a single unambiguous score that is clear and intuitive. This metric can be used to communicate the environmental performance of a building to investors, tenants, and other stakeholders based on sector-specific emissions pathways. Moreover, the temperature scoring metric enables benchmarking and comparison of buildings within a real estate portfolio. Property owners and managers can identify underperforming assets and prioritise energy efficiency upgrades or retrofits to reduce GHG emissions output and thereby improve their Temperature Scores. Furthermore, this metric encourages the adoption of sustainable building practices in the real estate sector overall through incentivising energy-efficient design, renewable energy integration, and reduction measures. This drives innovation and promotes the use of green building technologies and materials, ultimately leading to a more sustainable and efficient built environment.

Transparency about the environmental performance of a building or portfolio can enhance marketability and value for properties with comparably low Temperature Scores, as they are perceived as more sustainable and aligned with the Science Based Targets initiative's goal of limiting global temperature rise to 1.5°C. Investors can use the Temperature Score to assess the status and ambition within the real estate sector. Since investors increasingly consider ESG factors when evaluating potential properties, a lower Temperature Score can indicate a building's resilience to climate-related transition risks and align with sustainable investment strategies.

One drawback of the Temperature Score is that **there is no generally agreed upon approach or recognised methodology to calculate the KPI**. Therefore, the following section aims at increasing transparency by providing a documented approach.

The Temperature Score approach can base on a comparison of the emissions intensity of a specific building type with the CRREM benchmarking pathway and a subsequent translation into a temperature value. The GHG emissions consumption and the underlying emissions budget are set in relation and a certain area ratio is derived. As can be seen in Figure 3, initially less budget is used than is available for a 1.5°C target (shaded area on the left). The emissions intensity of a building asset, which depends on its type and the energy sources used, varies widely. For instance, in scenarios where the base year emissions intensity of an asset already exceeds the target values aimed for in decarbonisation pathways. In this case, continuing at the intersection of the two axes, around 2026, emissions of the demo asset are higher than the available budget to meet the 1.5°C target. The resulting area ratio is finally converted into an associated temperature value. In the demo asset in the graph below, the balance moves from positive to an overshoot of emissions compared to the emission budgeted. This overshoot implies that the 1.5 target of the scenario is not achieved, and the associated temperature value tends towards 2°C or higher.

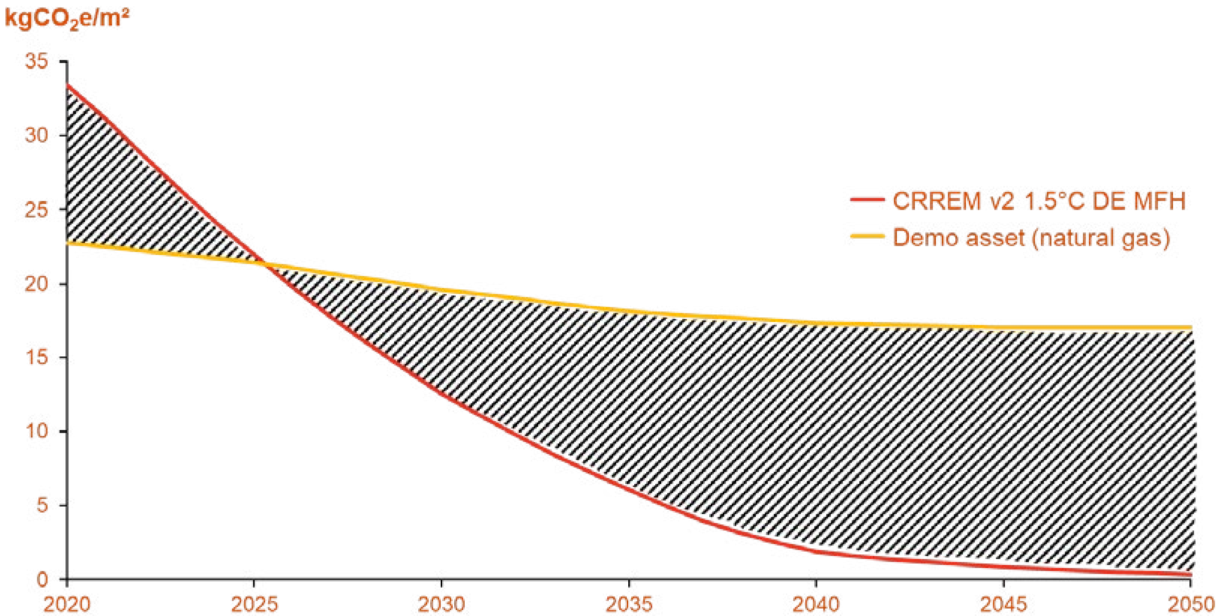


Figure 3: Illustration of the underlying carbon budget methodology for determining temperature score (PwC, 2024).

Currently, there is **no standardised methodology on the derivation of a Temperature Score** to ensure consistency and comparability across the real estate sector. If this were to be changed in the future, this metric could influence building regulations and certifications. Governments and industry bodies may incorporate Temperature Score requirements into building codes or sustainability certifications, encouraging compliance and driving the adoption of energy efficient practices. Hurdles for the standardisation and implementation of the Temperature Score are data availability and accuracy. For old buildings in particular, obtaining reliable energy consumption and emissions data poses a challenge (CDP Worldwide and WWF International, 2020).

For a holistic foundation for decision-making, the Temperature Score should be **used in combination with other sustainability metrics**. It is important to consider the broader environmental, social, and economic impacts of buildings to ensure a comprehensive approach to sustainability in the real estate sector.

In summary, the Temperature Score is a valuable tool for the real estate sector to assess and mitigate the environmental impact of buildings. Its ability to quantify the potential contribution to global warming provides transparency, benchmarking capabilities, and informs investment decisions. By promoting sustainable building practices, the Temperature Score contributes to the transition towards a low-carbon built environment. However, addressing challenges related to data availability and standardisation, while also considering other sustainability metrics, is crucial for its effective implementation. The real estate sector should embrace the Temperature Score as part of its commitment to sustainability and climate action.

2.2 Net-zero pathways analysis: With the Science-Based Targets Initiative

Net-zero pathways are crucial for aligning various sectors with global climate goals. Many organisations, including the Network for Greening the Financial System (NGFS), International Energy Agency (IEA), and the Intergovernmental Panel on Climate Change (IPCC), provide scenarios for reaching these targets (UNEP FI, 2023). However, the Science-Based Targets initiative (SBTi) stands out in the context of building climate risk assessment due to its **specific focus on sectoral and regional analyses**. This focus is enhanced by SBTi's collaboration with CRREM, which provides detailed decarbonisation pathways tailored to different building types and specific countries—details often not as thoroughly covered by the foundational scenarios offered by the IEA.

The SBTi and its partner organisations, which comprise CDP, the United Nations Global Compact (UNGC), World Resource Institute (WRI) and the World Wide Fund for Nature (WWF), provide sector-specific guidance for companies to set science-based climate targets in line with the goals of the Paris Agreement. The agreement of 2015 was to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels" (UN, 2024). However, the recent IPCC 6th Assessment Report has highlighted the need to keep global warming within a temperature rise of 1.5°C.

Based on the urgency of climate action, **the SBTi has developed new 1.5°C-aligned methodologies, guidance, and tools.** These have caused the level of climate ambition to rise and are encouraging companies to meet the 1.5°C target. By providing a specific guidance for financial institutions and the real estate sector, the SBTi helps companies to overcome the complexities of setting science-based targets and outlines necessary actions and milestones to achieve net-zero emissions by 2050 or earlier (SBTi, 2024). This guidance includes reducing operational energy consumption and thus carbon emissions through energy efficiency measures, transitioning to renewable energy sources, and addressing embodied emissions through sustainable construction practices and material choices. It also considers the unique characteristics of the sector, such as the long lifespan of buildings and the diverse range of stakeholders involved. It provides methodologies for calculating emissions, guidance on target setting, and recommendations for engaging with stakeholders to drive sector-wide decarbonisation efforts (SBTi, 2023a). The adoption and validation of science-based targets is completely voluntary but is of fundamental importance for corporate climate strategies.

In 2023, the SBTi developed an **initial net-zero standard as a conceptual framework** with underlying criteria for financial institutions. The framework, which is due to be finalised later in 2024, outlines both the requirements for the final state of a net-zero portfolio and the intermediate steps required to ensure that financial institutions achieve this state in line with the 1.5°C pathway. Figure 4 shows the key elements required to set net-zero targets, distinguishing between short-term and long-term science-based targets. Achieving long-term net-zero adaptation targets means bringing the portfolio's emissions to a level close to zero by 2050. Only the residual emissions can then be neutralised through permanent removals and storage of carbon from the atmosphere (SBTi 2023c).

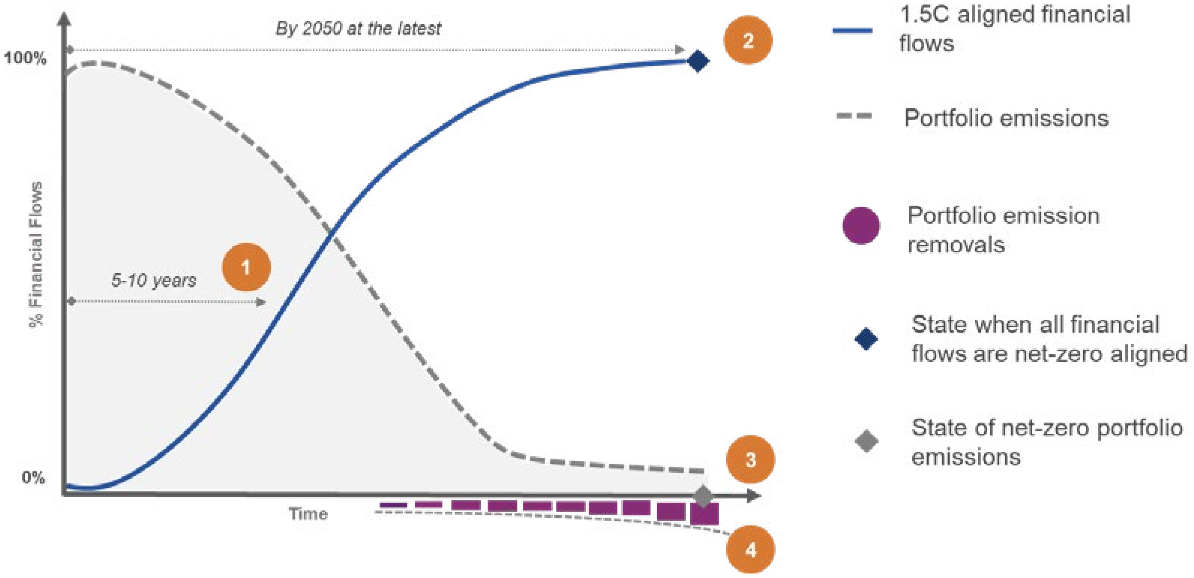


Figure 4: Key elements of net-zero targets: (1) Set near-term science-based targets; (2) Set long-term science-based targets, (3) Reduce portfolio emissions to residual levels; and (4) Neutralise residual portfolio emissions (SBTi, 2023c).

In addition to the building's sector guidance, the SBTi provides **a target-setting tool for the building sector to assess the status quo** of the emission intensity of buildings and required decarbonisation pathways in the near term and long term. For this approach, the SBTi refers to the carbon budgets derived by the IPCC in alignment with the IEA 1.5°C net-zero emission scenario and incorporated the CRREM pathways. This allows users to set country-specific and building type-specific climate targets. In this context, the SBTi tool differentiates between in-use operational targets, upfront embodied targets, and long-term net-zero targets (SBTi, 2023b). Figure 5 shows the total in-use carbon emissions and in-use emissions intensity for the base year and a short-term target year, which together provide an annual reduction pathway to achieve the 1.5°C target.

			Base year 2022	Target year 2032	% Reduction 2022 - 2032
Europe | Germany | Residential, Multi-Family	Total in-use emissions	tCO_2e	66,19	22,96	65,3%
	Overall in-use emissions intensity	$kgCO_2e / m^2$	45,65	15,28	66,5%

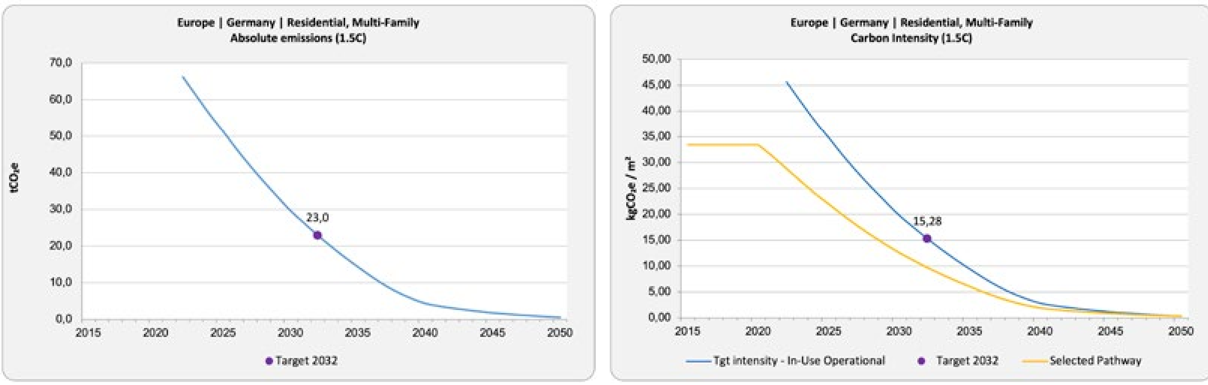


Figure 5: Exemplary 1.5°C aligned carbon reduction pathway for German residential building using SBTi's buildings sector target-setting tool draft (SBTi, 2023b).

With the underlying methodologies and tools, the SBTi enables companies and institutions to set building-specific as well as portfolio-related climate targets that can be integrated into a corporation's climate strategy. By providing the reduction pathways on an annual level, stakeholders can regularly monitor their progress and adjust their steering mechanisms accordingly. The next chapter focuses on a concrete analysis tool that generates specific retrofit measures to achieve the 1.5°C target.

2.3 Stranding risk analysis: Identifying economically unviable assets

Asset stranding is the process of collapsing expectations of future profits from invested capital (the asset) as a result of disruptive policy and/or technological change (Semieniuk et al., 2022). In recent years, the concept of 'stranded assets' has gained significant attention in the context of the transition towards a low-carbon economy.

Stranding analysis is a crucial tool used to **assess the potential risks associated with investments in assets that may become economically unviable before the end of their useful lifetime** (Binsted, et al., 2020). This process identifies factors that could precipitate the premature obsolescence or reduced attractiveness of properties, encompassing both physical and transitional risks. Physical risks might include hazards like extreme weather events, which are exacerbated by climate change and can directly damage infrastructure. **Transitional risks involve shifts in policy, legal landscapes, technological advancements, market dynamics, reputational impacts, and evolving standards in energy efficiency** (Gabrielli, 2020; Caldecott, Tilbury, & Ma, 2013). Such transitions can render assets like buildings with poor energy efficiency ratings or outdated infrastructure less appealing as market preferences pivot towards more sustainable and more energy-efficient alternatives. This section provides a detailed exploration of stranded assets, particularly those arising from transition risks, and examines their integration with decarbonisation scenarios. In addition, it aims to shed light onto the connection to regulatory developments such as Energy Performance Certificate (EPC) classes.

Decarbonisation scenarios outline potential pathways to achieve significant reductions in GHG emissions and limit global warming. Stranding analysis plays a crucial role in assessing the **compatibility of real estate assets with these decarbonisation scenarios**. By evaluating the risks associated with stranded assets, stakeholders in the real estate sector can make informed decisions about investments and ensure alignment with long-term sustainability goals (Firdaus & Mori, 2023). For example, a building with poor energy efficiency may be considered a stranded asset if it becomes less attractive to tenants or buyers due to increasing demand for energy-efficient and sustainable properties.

Energy efficiency of buildings in the real estate sector is assessed and rated within the EU by using EPCs as an instrument. EPCs provide an energy efficiency rating and information about improvements for buildings up for sale or rent (European Commission, 2024). The assessment principle may differ in different EU countries, as each country has its own regulations and standards for the energy assessment of buildings. For this reason, the EU has revised the Energy Performance of Buildings Directive (EPBD) under the European Green Deal to unify energy efficiency standards and strengthen transparency in the building sector. Among other measures, the agreement on the revised EPBD facilitates improved comparability of EPC ratings through common criteria and a harmonised scale from A-G across the EU (EPBD, 2024). These compatibility efforts contribute a higher degree of reliability of EPC ratings and facilitate investment in energy-efficient buildings within its member countries.

Meanwhile, at the country level, **the Netherlands and the United Kingdom have been at the forefront of regulatory developments aimed at accelerating the transition to a low-carbon economy.** These regulatory changes in energy efficiency standards have the potential to impact the value and viability of real estate assets. For example, the UK Minimum Energy Efficiency Standards (MEES) regulation is a legal requirement that aims to improve the energy efficiency of commercial properties in the UK. In the case of MEES, properties with low energy efficiency ratings may become less desirable to tenants and potential buyers, as energy-efficient buildings are increasingly sought after due to their lower operating costs and environmental benefits. By enforcing this regulation, MEES aims to reduce the number of inefficient properties in the market, encouraging landlords to improve the energy performance of their buildings (Department for Energy Security and Net Zero, 2023).

In the Netherlands, regulations for energy performance go even further but at the same time follow a different assessment principle. One of the key regulations set in the Netherlands is the BENG regulation, which translates into “Nearly Energy Neutral Buildings”. It sets requirements for good insulation of a building, energy-efficient installations, and the use of sustainable energy of both residential and non-residential buildings (Netherlands Enterprise Agency, 2023). This not only helps to reduce carbon emissions and combat climate change but also mitigates the risk of properties becoming stranded assets. Landlords who fail to comply may face financial penalties and difficulties in attracting tenants or selling their properties in the future.

Stranding analysis is directly related to energy performance by considering the potential risks associated with investments in buildings with lower energy efficiency ratings. As regulations and market preferences shift towards more sustainable buildings across the EU, assets with lower EPC classes may strand, lose value, or see their market competitiveness drop. Investors and property owners need to consider the potential risks of stranded assets when making decisions about retrofitting or investing in energy-efficient buildings.

Overall, the methodology of stranding analysis plays a crucial role in navigating the transition towards a low-carbon economy in the real estate sector and ensuring sustainable investments. Stakeholders should proactively assess the risks of stranded assets to mitigate potential financial losses and contribute to a more sustainable future for the real estate industry. Section 2.4 of this report presents two case studies that exemplify the integration of retrofitting and stranding analysis. These examples utilise PwC's Climate Excellence tool to illustrate practical applications of these methodologies, providing clear insights into how they can be effectively implemented to enhance the sustainability of property investments.

2.4 Retrofit impact case study: Utilising PwC's Climate Excellence model

PwC's "Climate Excellence" tool empowers companies from both financial and real economic sectors to conduct climate scenario analyses, ensuring their portfolios are resilient to climate change risks and opportunities. Specifically, the Retrofit Analysis tool within the Climate Excellence for Real Estate module—developed in collaboration with the vdpResearch GmbH and Hypovereinsbank, part of the UniCredit Group—enables **detailed assessments of real estate portfolios concerning energy performance** and **potential renovation costs to meet sector-specific climate targets**. This tool covers the double materiality of climate change: it evaluates the impact of assets on the climate and calculates the impact of climate change on real estate portfolios and individual assets. The holistic approach of Climate Excellence helps stakeholders to address both, transition risks and climate-related physical risks accelerated by climate change (PwC, 2024).

The Retrofit Analysis tool, part of PwC's Climate Excellence suite, simplifies the estimation of property-specific energy consumption and assesses building energy performance against established EPC rating systems. Using decarbonisation pathways like CRREM or IEA scenarios, the tool crafts tailored energy and emission reduction strategies. This streamlined process requires **minimal data inputs** such as: construction year, total size, use type, and heating source. These master data help approximate annual heating and electricity use, drawing on benchmarks from reputable institutions such as the German Energy Agency and the German Federal Environment Agency (German Energy Agency, 2016, UBA 2017), with adjustments made for different countries and building types.

Additionally, the tool generates **detailed characteristics of the building envelope**, including the roof, walls, windows, and basement/ceiling, using data from the European TABULA project (EU, 2024). This information, along with insights from the EU's long-term renovation strategies (European Commission, 2024a) and building stock observatory

(European Commission, 2024b), aids in calculating the ‘u-value’ or heat transfer coefficient. The u-value is essential for evaluating and enhancing a property’s energy efficiency (please refer to the Appendix for more information).

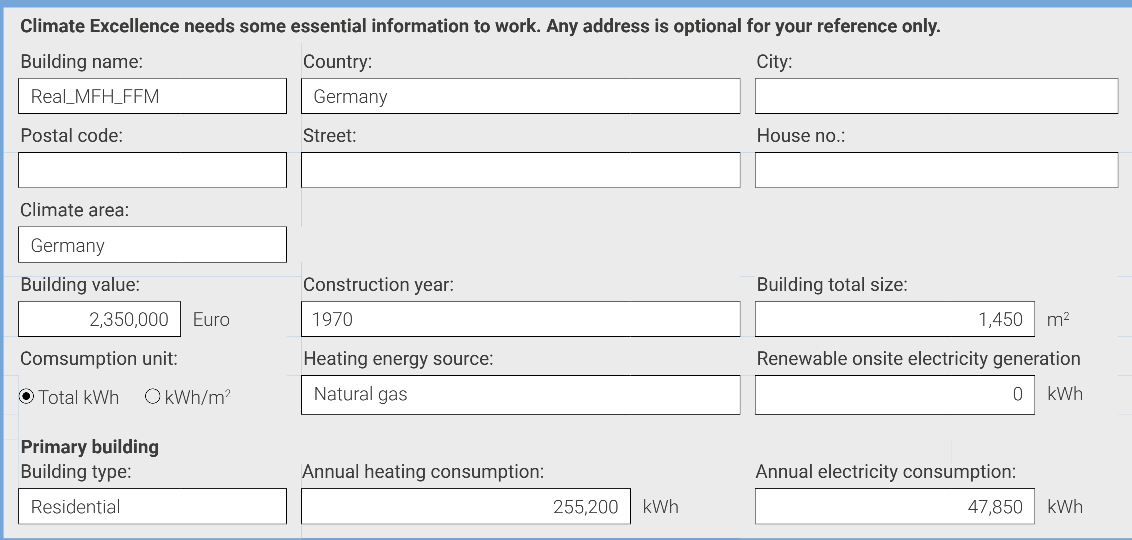
As described in the previous section on stranded assets, the Retrofit Analysis tool evaluates if a building’s current energy or emissions intensity aligns with decarbonisation targets like the 1.5°C IEA NZE or CRREM scenarios. It identifies if a building, based on its specific type and characteristics, is already a stranded asset at the start. The tool projects whether these buildings might meet, exceed, or align with required decarbonisation pathways in future decades, or even continue to comply with targets up to mid-century without any energy retrofit interventions.

These case studies exemplify how the retrofit analysis process works and what the results look like, providing readers with practical insights into assessing and enhancing building energy performance. By showcasing specific examples, this sub-chapter illustrates the comprehensive and adaptable nature of the tool, emphasising its utility in navigating the complexities of energy-efficient retrofitting in geographic and regulatory contexts.

Credit: unsplash.com/@benobro

2.4.1 Case study 1: Retrofit Analysis of a Multi-Family House in Germany

This case study focuses on a multi-family residential building constructed in 1970 in Germany, featuring a total area of 1,000m² and utilising natural gas for heating. The initial step in the analysis involves inputting essential data into the Climate Excellence dashboard, as depicted in Figure 6 below. These inputs allow the tool to approximate energy consumption and other crucial parameters that influence the analysis quality.


Climate Excellence needs some essential information to work. Any address is optional for your reference only.

Building name: Real_MFH_FFM
Country: Germany
City:
Postal code:
Street:
House no.:
Climate area: Germany
Building value: 2,350,000 Euro
Construction year: 1970
Building total size: 1,450 m²
Comsumption unit: ◉ Total kWh ○ kWh/m²
Heating energy source: Natural gas
Renewable onsite electricity generation: 0 kWh
Primary building
Building type: Residential
Annual heating consumption: 255,200 kWh
Annual electricity consumption: 47,850 kWh

Figure 6: Retrofit input mask for master data (building name, country, climate area, building value, construction year, building total size, heating energy source) with approximated energy consumption (PwC, 2024).

Using the data provided, the Retrofit Analysis tool calculated the building's current energy intensity at 209 kWh/m². When assessed against the 1.5°C CRREM decarbonisation scenario and the associated decarbonisation pathway in relation to the specific energy consumption, the building was identified as a 'stranded asset' due to exceeding the permitted energy intensity in the base year. This designation prompts significant considerations for asset owners and financial institutions regarding the future viability of the property.

To address this, the tool executed automated retrofit pathways that incorporated the associated u-values from planned energy-efficient renovation measures. The analysis projected that, with an investment of approximately €193,560, the building could achieve a reduced energy intensity of 47.54 kWh/m². This investment would cover comprehensive upgrades including the basement ceiling, heating technology, outer walls, roof, and windows.

Window	Area:	Type:	Window frame:	Window frame:
	230 m²	Dual-plane glazing (low-conductivity)	Plastic	Plastic
Roof	Area:	Construction type:	Insulation type:	Insulation thickness
	286 m²	Flat roof (no insulation)	Insulation (flat roof)	6 cm
Basement ceiling/bottom plate:	Area:	Construction type:	Insulation type:	Insulation thickness
	286 m²	Concrete ceiling (no insulation)	Insulation (concrete ceiling)	2 cm
Outer wall:	Area:	Construction type:	Insulation type:	Insulation thickness
	860 m²	Concrete panels	N/A	0 cm
Heating:	Technology:			
	Natural gas, gas-fired boiler, wall			

Figure 7: Approximated building envelope elements including windows, roof, basement ceiling, outer wall and heating technology (PwC, 2024).

The analysis further explored various energy-saving pathways, detailing their costs and benefits. The 'best-in-class' pathway, illustrated in Figure 8, showcases a suite of retrofit measures using the highest performing building materials and technologies, without consideration of cost. In contrast, the 'cost-efficient' pathway highlights measures offering the most favorable cost-benefit ratio. Both pathways consider construction costs adjusted by the German construction cost index and regional factors specific to German postal codes. Additionally, a country-specific, comparative price level index is applied to ensure the analysis remains relevant for other regions.

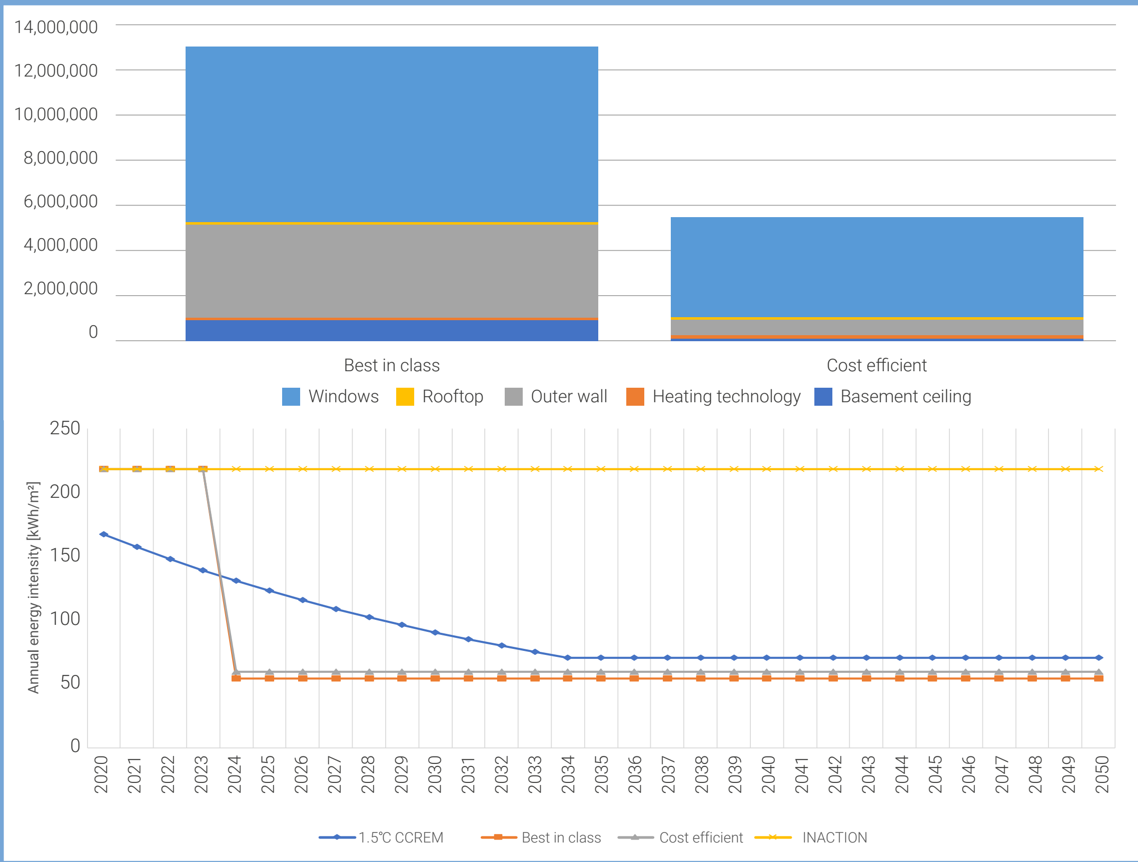


Figure 8: Retrofit analysis results for exemplary residential building showing different energy-related pathways and associated investment costs for retrofit measures (PwC, 2024).

2.4.2 Case study 2: Retrofit Analysis of the Dreischeibenhaus Office Building in Düsseldorf, Germany

Figure 9: Dreischeibenhaus, Düsseldorf, Germany (AWD, 2024).

This case study focuses on the Dreischeibenhaus, a notable office building located in Düsseldorf, Germany. Constructed in 1960 and covering a total area of 33,700m^2, this building is primarily heated using natural gas. The initial data input for the Retrofit Analysis is depicted in Figure 10, outlining the building's foundational parameters.

Taking into account automated decarbonisation pathways with associated energy-related renovation measures, the building is judged to have an energy intensity of 71.79 kWh/m² and corresponding investment costs of €5.52 million (cost-efficient). Besides the consideration of automated reduction pathways, such as 'best-in-class' and 'cost-efficient', Retrofit Analysis allows users to create customised retrofit pathways to meet period-specific targets and corresponding EPC ratings.

Area: Dreischeibenhaus	Country: Germany	City: Dusseldorf
Postal code: 40211	Street: August-Thyssen-Strasse	House no.: 1
Climate area: Germany		
Building value: 100,000,000 Euro	Construction year: 1960	Building total size: 33,700 m²
Comsumption unit: ◉ Total kWh ○ kWh/m²	Heating energy source: Natural gas	Renewable onsite electricity generation: 0 kWh
Primary building Building type: Office	Annual heating consumption: 6,975,900 kWh	Annual electricity consumption: 1,853,500 kWh

Figure 10: Input mask for master data with approximated energy consumption before energy-related renovation (PwC, 2024).

Window Area: 5,636 m²	Type: Dual-pane glazing (low-conductivity)	Window frame: Plastic
Roof Area: 1,450 m²	Construction type: Insulation (ventilated flat roof)	Insulation type: Ventilated flat roof (no insulation)
Basement ceiling/bottom plate Area: 2,185 m²	Construction type: Concrete ceiling (no insulation)	Insulation type: N/A
Outer wall Area: 20,116 m²	Construction type: Masonry of hollow blocks or honeycomb bricks	Insulation type: N/A
Heating Technology: Natural gas, gas-fired boiler, wall		

Figure 11: Approximated building envelope elements for office building including windows, roof, basement ceiling, outer wall and heating technology (PwC, 2024).

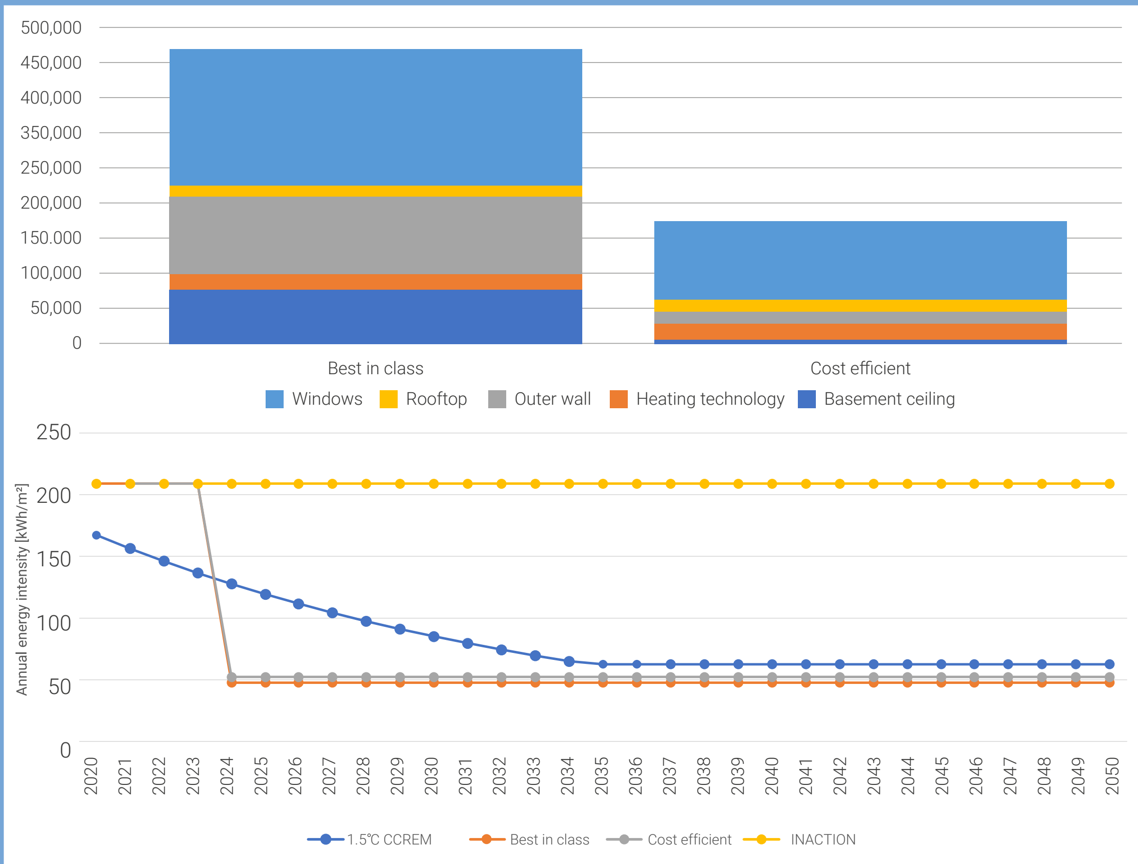


Figure 12: Retrofit analysis results for office building Dreischeibenhaus (PwC, 2024).

Additionally, the tool enables the customisation of retrofit pathways to meet specific period targets and comply with EPC ratings, enhancing the building's alignment with the EU Taxonomy. This strategy aims to position the Dreischeibenhaus within the top 15 per cent of buildings in Germany based on energy performance while achieving a 30 per cent reduction in energy use. Specifically, it targets elevating the building's EPC to the highest categories, A+ or A, which represent the most energy-efficient buildings in the country. The amortisation period for the investment can be calculated from projected savings in energy costs and emissions-related expenses.

Under the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS) E1–1 Climate Change, the building's retrofitting process also supports compliance with mandatory disclosure requirements. These include providing detailed transition plans that outline net-zero targets and specific actions to mitigate climate change.

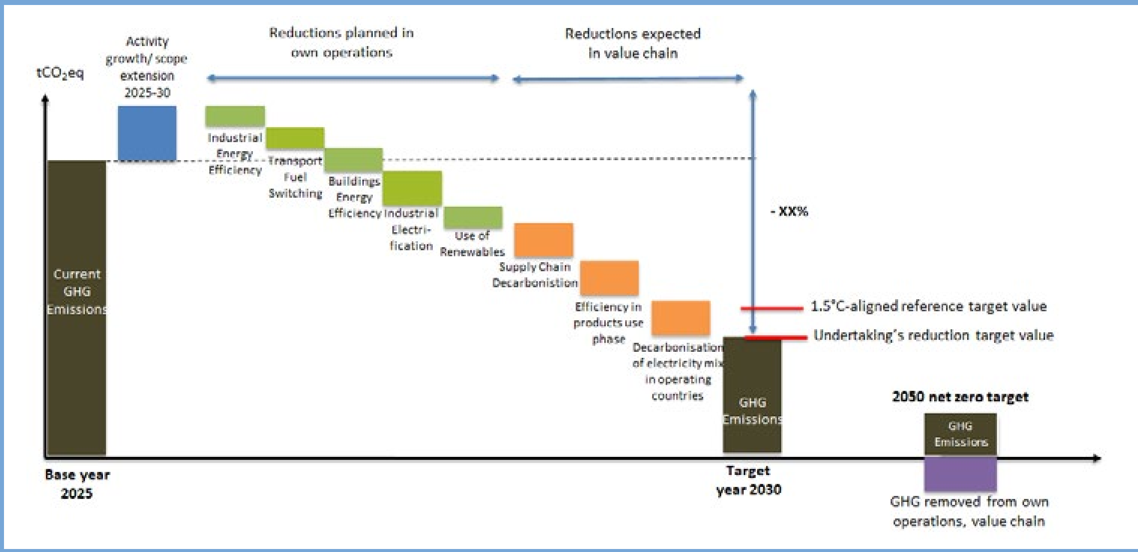


Figure 13: GHG emissions reduction targets and climate change mitigation actions (EFRAG, 2022).

As shown in Figure 13, this case study demonstrates how a detailed analysis of potential decarbonisation actions—facilitated by the Retrofit Analysis tool—can quantify energy and GHG emission savings. This quantification aids the building in achieving both interim and long-term net-zero targets, showcasing the potential benefits of strategic energy-efficient retrofits in the commercial real estate sector.

Credit: unsplash.com/@gk3

2.5 Methodological review and implications

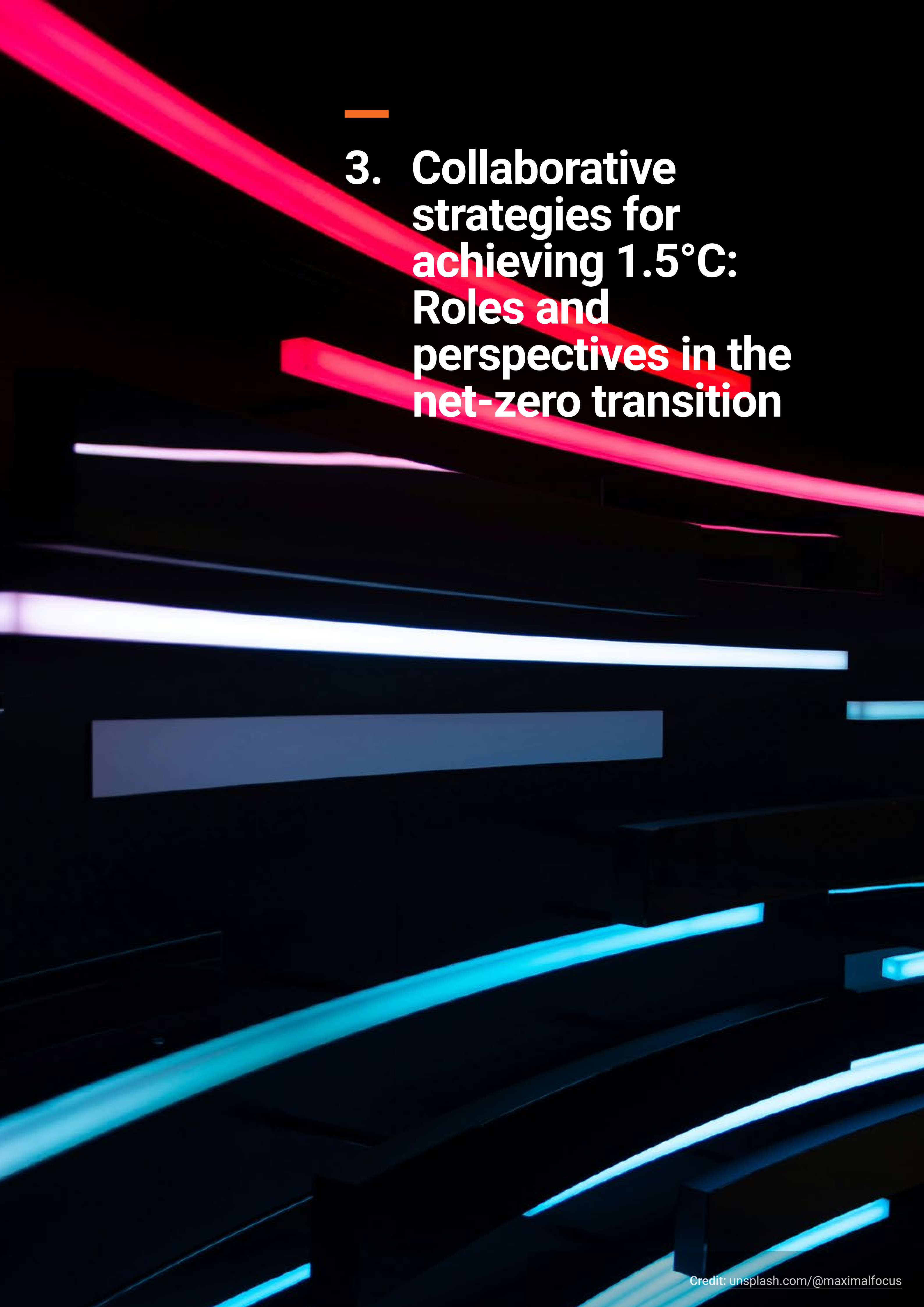
In concluding the exploration of methodologies for financial institutions to assess climate transition risks within their real estate holdings, it becomes evident that such assessments are far more than compliance exercises—they are essential components of a forward-thinking management strategy. Table 1 below presents the summary of pros and cons of each methodology discussed in this chapter.

The available methodologies provide a robust framework for these institutions to not only understand the climate vulnerabilities of their real estate assets but also to integrate this understanding into comprehensive risk management and investment or financing strategies. This approach enables them to align with global sustainability benchmarks and secure the long-term value and resilience of their portfolios. However, the journey does not end with assessment; it extends into the integration of these insights into actionable strategies that align with global sustainability targets. This ensures that real estate investments contribute positively to the global imperative of achieving net-zero emissions.

Table 1: Summary of transition risk methodologies for buildings (UNEP FI & PwC, 2024).

#	Methodology	Definition	Requested Input	Outcome / Metrics	Pros	Cons
1	**Temperature score analysis**	Alignment with a temperature pathway in a defined period.	Actual and estimated GHG emission intensity for the period.	°C in alignment with the associated global warming path.	Easy to communicate and to conceptualise	No standardised methodology
2	**Stranding analysis**	Year in which a building would become a stranded asset by exceeding the defined decarbonisation path.	Specific energy consumption or specific GHG intensity	Year in which a building would not be aligned with a climate scenario	Easy to communicate; High-resolution scenario data available	Data gaps for current specific energy consumption/EPC ratings
3	**Net-zero pathway analysis**	Measures to align a building with 1.5°C of global warming	Baseline energy consumption and appropriate decarbonisation measures	Target alignment over time (i.e. short-, medium- and long-term)	Well-recognised methodology	Data-intensive process

3. Collaborative strategies for achieving 1.5°C: Roles and perspectives in the net-zero transition



Credit: unsplash.com/@maximalfocus

To achieve the ambitious targets of net-zero carbon emissions for existing buildings by 2050, a robust collaboration across various sectors is crucial. Yet, **there is a notable deficiency in the rate of retrofitting across the world**. For instance, a study by 3Keel reveals that even the best-performing G20 countries are retrofitting at rates significantly below what is necessary to meet their national climate goals and achieve net-zero by 2050. Its Global Retrofit Index evaluates G20 countries' progress towards net-zero building stock, examining existing stock, retrofit performance, and policies. The analysis finds that the top six performing countries are in Europe; however, as Figure 14 illustrates, their standout performance is largely attributed to strong retrofit policies, including public funding mechanisms to support climate-friendly building transitions, rather than actual stock or retrofit performance (3Keel, 2023).

Rank	Country	Existing stock (/25)	Retrofit performance (/25)	Retrofit policy (/50)	Total score (/100)
1	Germany	6.0	18.8	36.8	61.5
2	Netherlands*	8.0	20.0	28.3	56.3
3	France	9.0	16.3	30.3	55.5
4	UK	8.0	16.3	28.5	52.8
5	Croatia*	6.0	20.0	26.0	52.0
=12	United States	7.0	7.5	14.3	28.8

Figure 14: Global Retrofit Index 2022 scores of countries analysed (3Keel, 2023).

Enhancing energy efficiency and tackling carbon emissions from building operations demand **a concerted effort that bridges the expertise and resources of surveyors, financial institutions, standard-setting bodies, policymakers, and governments**. Chapter 3 delves into the multifaceted roles of these key stakeholders, examining how their integrated efforts and perspectives contribute towards aligning with the 1.5°C goal. Through exploring these collaborative dynamics, this chapter aims to highlight effective strategies and frameworks for catalysing the transition towards sustainable and net-zero compliant buildings.

3.1 Roles of regulations, governments and surveyors

3.1.1 Regulatory landscape and policymaker engagement in retrofitting

As the urgency to address climate change intensifies, countries around the world are enacting **regulatory updates to enhance energy efficiency within the building sector**. These initiatives are critical for reducing energy consumption and greenhouse gas emissions. Some examples are as follows:

- **The EU** has been at the forefront of integrating energy efficiency into its legislative framework. In 2023, the recast Energy Efficiency Directive was adopted, setting a legally binding target to reduce the EU's final energy consumption by 11.7 per cent by

2030 compared to the 2020 scenario (EU, 2023). Complementing this directive, the Energy Performance of Buildings Directive is also pivotal in achieving the EU's long-term goals for the building sector. Aiming for a fully decarbonised building stock by 2050, this directive underscores the critical role of the building sector, which accounts for around 40 per cent of energy consumption in the EU and over a third of its energy-related greenhouse gas emissions (EU, 2024).

- **Germany**'s recent legislative advancement, the Federal Act on the Increase of Energy Efficiency (Energieeffizienzgesetz—EnEfG), has set stringent energy efficiency requirements, particularly targeting companies and data centres. This law aligns with European directives and introduces significant efficiency measures and detailed reporting obligations to push for higher energy efficiency standards across various sectors (Allen Overy, 2023).
- **The United States** emphasises the adoption and enforcement of state building energy codes as outlined in the 'Energy and Environment Guide to Action—Chapter 4.3: Building Codes for Energy Efficiency'. These codes require that new constructions and major renovations adhere to minimum energy efficiency standards, which aim to reduce building life-cycle costs and to mitigate peak energy demand (EPA, 2023).

Amid the regulations on building sectors, recent years have also seen **significant strides in regulatory measures concerning climate-related disclosures**. In the EU, a notable example is the introduction of the Corporate Sustainability Reporting Directive (CSRD), which has broadened its reach to encompass almost 50,000 companies (UNEP FI, 2024). This directive mandates detailed reporting within the environmental domain, including specifics on real estate assets. Specifically, two questions within the section on climate change are of high relevance:

- The proportion of stranded assets until 2030 and for the period of 2030 to 2050.
- The carrying value of real estate assets by energy efficiency class (note: where no actual data are available, estimates should be used).

The former dimension is especially relevant for **assets for which no retrofit strategy is established.** This is because the CSRD asks for significant locked-in GHG emissions, which are most relevant for assets with fossil-based heating systems and no alternative retrofit pathway defined.

The second reporting dimension outlined above shows **strong parallels to the Capital Requirements Regulation (CRR)**, which provides a template for companies subject to the reporting requirements (EBA, 2022). The template provides a table (see Table 2 below) that also clusters the real estate assets into six buckets by a defined range of specific energy consumption. The CRR reporting splits loans by commercial and residential properties as well as collateral and also asks for the share of proxies used to determine the required specific energy consumption.

Table 2: CRR Template with six categories of specific energy consumption (EBA, 2022).

#	Area	Level of energy efficiency (Energy performance score in kWh/m^2 of collateral)				
		0; <=100	>100; <=>200;	<=*300	<=*400	<=400, >500
1	Total EU area					
2	Of which Loans collateralised by commercial immovable property					
3	Of which Loans collateralised by residential immovable property					
4	Of which Collateral obtained by taking possession: residential and commercial immovable properties					
5	Of which Level of energy efficiency (EP score in kWh/m^2 of collateral) estimated					

The convergence of these regulatory requirements with the existing data gaps underscores the importance of **transparent and reliable proxies for reporting purposes**. This need will persist until initiatives such as the Energy Performance of Buildings Directive bridge these gaps through comprehensive databases that might, for example, contain the latest EPCs for individual addresses. These enhanced regulatory frameworks are designed not only to provide a clearer picture of the current state of building efficiency; they also serve to **spur necessary actions** such as retrofitting. In this way, financial institutions and real estate stakeholders can align more effectively with accelerated climate goals.

Given these regulatory enhancements, it is crucial for policymakers to **continue advancing and enforcing robust energy efficiency regulations** within the building sector. There is a clear call to action for regulators to intensify efforts to integrate ambitious and enforceable energy efficiency measures into broader climate policies. This will ensure that the building sector can align more effectively with global climate goals and contribute to a resilient, sustainable future. The regulatory framework is a necessary condition but probably not sufficient. Further success factors include **adequate skilled labour (both in terms of quantity and quality) to perform the retrofits** and **appropriate financing options** (see section 3.1.2 and 3.2.1), among others.

3.1.2 Governmental incentives and support for retrofit initiatives

Governments and local authorities are pivotal in driving the retrofitting of buildings to meet energy efficiency targets. They are in a unique position to provide foundational support and incentives necessary for property owners and residents to undertake such projects. Despite controlling or influencing a significant portion of greenhouse gas emissions within their jurisdictions, local governments often find their direct impact confined to municipal buildings and operations. Retrofitting, especially in older, less efficient homes, presents a complex and costly challenge, necessitating individualised insulation and heating or ventilation solutions. Achieving widespread retrofitting requires decisive leadership and commitment at every level of local government (Local Partnerships, 2023).

To support retrofit initiatives, governments have a range of tools at their disposal. For instance, the UK Green Building Council outlines several government-led options for promoting domestic energy efficiency improvements as displayed below (UK Green Building Council, 2013):

Cashback and grants	Variable tax schemes	Minimum energy efficiency standards
Offering financial incentives for households to install energy-saving measures	Adjusting property taxes based on energy efficiency or offering rebates for retrofitting efforts	Mandating energy efficiency upgrades in the residential sector
Low-interest loans	**Energy efficiency feed-in tariffs**	**Salary sacrifice schemes**
Making retrofitting more financially accessible to homeowners	Encouraging the development of renewable energy through favourable pricing for energy producers	Allowing employees to invest in home energy improvements through pre-tax salary deductions (CREDS, 2023)

European examples include Germany, France, Croatia, and Italy, each with distinctive funding models that have proven effective. Italy's super bonus scheme, which offers a tax credit of 110 per cent for retrofit expenses, stands out as one of the most ambitious (The Guardian, 2022). Outside the EU, Canada is recognised for its retrofit funding options, including support for heat pump installations (3Keel, 2023). In the UK, a recent commitment of GBP 6 billion towards enhancing energy efficiency underscores the government's role in facilitating retrofits, with funds earmarked for insulating social housing and supporting local authority-led schemes (Ames, 2023).

This integrated approach, **combining direct financial support with regulatory measures and incentives**, is essential for scaling up retrofitting efforts and achieving energy efficiency and carbon reduction targets across the board.

3.2 Roles of financial institutions

Financial institutions play distinct roles in addressing climate risks, influenced by their business models and the regulatory environments within which they operate. While some are guided by voluntary initiatives as detailed in Chapter 2.3, others face growing regulatory pressures to integrate climate risks into their risk management frameworks.

3.2.1 Banks: Financing retrofit and energy transformation

Banks play a pivotal role in the retrofit market, primarily through the adaptation of their lending practices to account for environmental sustainability. As the understanding of physical risks associated with climate change deepens (e.g. Nguyen et al. (2022), Duan and Li (2024)), banks are increasingly aware of the financial implications of transition risks. These are risks that emerge from adjusting to a low-carbon economy, influenced by regulatory changes, fluctuations in energy prices, or shifts in emission costs (Schütz, 2020).

The regulatory landscape is shifting to **require consideration of the environmental impacts of properties in the lending process**. This has led banks to **develop green loan products**, as highlighted in the European Banking Authority's December 2023 report. This report notes the proliferation of green loans guided by frameworks, such as the Green Loan Principles and the EU Taxonomy. However, these frameworks often set rigorous standards, such as an energy reduction threshold of 15 per cent or an EPC rating of A/A+. These potentially exclude properties that still significantly contribute to energy reduction. Despite this, standardising these definitions could create a more level playing field and integrate these financial products into banks' risk management strategies more thoroughly. The EBA also outlines **environmental targets for mortgages** that encourage retrofitting, typically necessitating a reduction of at least 30 per cent in primary energy demand or equivalent reductions in greenhouse gas emissions, or a two-step improvement in the EPC rating. These standards not only promote energy efficiency but also protect asset values from potential depreciation due to outdated energy standards (EBA, 2023).

Research by Schütz (2020) has shown that properties with lower energy efficiency ratings (D to H) could see value decreases ranging from 18.5 per cent to 30.1 per cent, depending on retrofit costs. These potential devaluations highlight the **financial risks to banks of not engaging proactively in the retrofit market**. Additionally, banks face heightened financial risks if more stringent environmental policies are enacted, potentially doubling the losses compared to those driven by rising energy costs alone.

In this changing landscape, banks have a critical opportunity to drive progress towards sustainable building practices through targeted green financing initiatives. By offering tailored loan products for energy retrofits, banks can **specifically encourage property owners to upgrade their buildings to meet higher energy standards**. These financial products can be structured to include lower interest rates or extended repayment terms for projects that achieve significant energy savings or improved EPC ratings. Additionally, banks can **integrate energy performance criteria into their loan assessment processes**, making financing contingent on meeting certain environmental benchmarks.

Banks can also play a crucial role in **raising awareness about the benefits of retrofitting**, both in terms of environmental impact and potential cost savings. Through partnerships with clients in the real estate sector, local governments, and the energy service industry, banks can help facilitate access to reliable contractors and the latest energy-efficient technologies (BMO, 2024). This engagement helps to elevate the standard of retrofit projects and brings innovative solutions into wider use.

Furthermore, surveyors play an important role to the real estate market, as they assess property values based on thorough inspections and detailed property documentation. By **working closely with surveyors**, banks can ensure that their financing options support properties that not only meet but surpass the prevailing standards for energy efficiency. This collaboration will enable the implementation of energy standards and will support the enhancement of property values through improved energy performance.

3.2.2 Investors: Balancing asset value with regulatory compliance

Investors in the real estate market are increasingly confronting the realities of transition risk. In its 2022 report, "Managing Transition Risk in Real Estate", UNEP FI revealed significant stranding risks within a sub-portfolio in the Asia-Pacific region. It predicted that approximately 60 per cent of assets would be stranded by 2030, with nearly all buildings facing similar risks by 2050. In North America, the scenario was even more dire, with the majority of assets becoming stranded at the outset of the analysis (UNEP FI, 2022).

This report also emphasised the significant role of **carbon pricing schemes as a major determinant of value**, although only a minority of investors acknowledged their impact. This gap between perception and reality about the financial effects of carbon pricing highlights a critical area where investor understanding needs to deepen. Additionally, JLL's 2023 market research indicated **a substantial mismatch between the demand and supply of sustainable buildings**, with the former three times higher than the latter (JLL, 2023). This imbalance underscores the pressing need for investors to consider sustainability attributes in their investment decisions, as properties lacking these may face increased risks of becoming stranded.

The risk management of transition risks is becoming increasingly sophisticated, as evidenced by frameworks like the discounted cash flow model proposed by the Urban Land Institute and C Change. This model categorises transition risks into quantifiable and non-quantifiable risks, including (ULI, 2023):

Cost of decarbonisation	Energy costs	Embodied carbon	Obsolescence and depreciation
Minimum energy performance standards	Carbon price	Tenant voids	Exit yield

These risks reflect both direct financial impacts, such as energy costs, and broader market dynamics, such as tenant preferences for sustainable spaces, which can significantly influence asset value. Besides, **non-quantifiable risks, often aligned with TCFD risk categories**, include reputational risks associated with failing to meet market expectations set by initiatives like the Glasgow Financial Alliance for Net Zero. These risks are not only pertinent to financial evaluations but also influence broader stakeholder perceptions and can affect access to capital and insurance (ULI, 2023).

Moreover, investors encounter **substantial data challenges**, especially regarding tenant information, which can complicate their strategies for asset climate management. Utilising open-source and accessible proxy data can mitigate these issues by enhancing data reliability and market comparability (UNEP FI, 2022b).

To effectively navigate the complexities of transition risks and capitalise on the increasing demand for sustainable buildings, investors need to adopt specific, actionable strategies. First, **integrating advanced analytics and sophisticated risk assessment tools** is crucial. These tools should not only evaluate long-term sustainability and financial viability but should also consider risks associated with energy efficiency, regulatory changes, and market demand for green buildings. Additionally, investors should actively **participate in shaping industry standards and policies** by advocating for robust sustainability benchmarks and supporting transparent reporting practices, as exemplified by initiatives like the Net-Zero Asset Owner Alliance and the Net Zero Asset Managers initiative (UNEP FI, 2022a). By leading efforts to standardise metrics for energy efficiency and sustainability, investors can help create a level playing field that enhances investment decision-making and drives the broader adoption of green building practices.

3.2.3 Insurers: Adapting asset allocation to climate risk

Insurers play a unique role in the real estate market, significantly influenced by their substantial investments in property assets. In Europe, **insurers allocate approximately 8 per cent of their total investments to real estate**, with notable regional variations—for example, Dutch insurers allocate about 17 per cent of their assets to this sector (De Nederlandsche Bank, 2022). These investments are particularly susceptible to transition risks, which can arise from fluctuations in market demand for specific energy efficiency classes or through regulatory mandates affecting energy performance (EIOPA, 2022).

The European Insurance and Occupational Pensions Authority (EIOPA) highlights **two primary mechanisms through which energy efficiency can impact property valuation:**

- **Rental income uplift:** Properties with higher energy efficiency may command higher rents, as tenants often view such properties as more cost-effective over time.
- **Resilience to price shocks:** For property owners, energy-efficient buildings can provide a buffer against energy price fluctuations, preserving income stability during such events (as seen during the natural gas price spikes in Europe in 2022). Moreover, these properties are likely to recover more swiftly in value after a market downturn, thanks to their appeal in a more carbon-conscious market environment.

Supporting these observations, De Nederlandsche Bank (2022) notes that future energy and carbon pricing will disproportionately affect less energy-efficient buildings, enhancing the business case for retrofitting. The indirect effects also include increased financing needs within an aging market, potentially impacting the liquidity and risk positions of real estate investors. Like other financial entities, insurers face **challenges in accessing reliable and comprehensive data**, which are crucial for effective climate risk management (Parente, 2023).

Given their substantial investments in real estate and unique risk profiles, insurers are strategically positioned to influence sustainability in the building sector. They can **leverage risk-adjusted pricing models that offer adjusted insurance premiums for energy-efficient properties,** incentivising upgrades that contribute to energy efficiency. This approach encourages property owners to undertake retrofitting initiatives and aligns the insurers' investment strategies with long-term sustainability goals. **By collaborating with developers and governmental bodies**, insurers can also help facilitate the development of new energy-efficient projects or the retrofitting of existing structures. By leveraging insurers' financial resources and risk management expertise, these partnerships prove vital to driving the adoption of sustainable development practices across the real estate sector.

4. Conclusion

Credit: unsplash.com/@redcharlie

This report underscores that financial institutions have begun to recognise the nuanced **risks and opportunities that the transition to a low-carbon economy presents, particularly within the real estate sector**. The nature and degree of these risks vary markedly between banks, investors, and insurers. For banks, the direct financial implications of a building's energy performance might seem minimal but can become significantly adverse in default situations, an aspect that has not received due attention as yet. Conversely, investors and insurers face direct transition risks to their investment portfolios, with this review identifying a diverse array of potential impacts.

Entities committed to net-zero targets, such as those participating in initiatives like the Net-Zero Banking Alliance or the Net Zero Asset Manager Initiative, are increasingly adopting "manage to green" strategies. Such approaches recognise the importance of **acknowledging and addressing the risks of asset stranding and the need for strategic retrofitting**, thereby highlighting the operational repercussions of these indirect effects.

The evolution of climate risk assessment methodologies provides financial institutions with **valuable tools to gauge the transition risks** to their real estate assets or portfolios, laying the groundwork for informed retrofitting decisions. To catalyse this transition, a **concerted effort from a broad spectrum of stakeholders**—including surveyors, financial institutions, regulators, and government bodies—is essential.

A key challenge across the sector is the scarcity of reliable and readily accessible data. Although initiatives like the EPBD represent significant progress towards making EPCs easily accessible through a centralised database, it will take time to bridge the current data gaps. Until then, **leveraging proxy data based on key building characteristics**—such as construction year, building type, floor area, and the timing of the last energy retrofit—offers a viable interim solution to enhance the existing data landscape. An overview of current open-source data proxies for retrofit analysis is available in Appendix II for reader reference.

Plans to develop a comprehensive database, driven by a collaboration between UNEP FI, PwC, and the financial sector, are already formulated but await implementation. Addressing the urgent need for improved data accessibility and reliability is paramount for all stakeholders. **Effective collaboration, the fostering of innovation, and a committed approach to enhancing data quality and sharing** are critical to successfully navigating the complexities of this transition.

Appendix

Credit: unsplash.com/@pueblovista

Appendix I: Retrofit analysis methodology

The retrofit analysis within Climate Excellence uses a generalised building model that builds on the heat transfer coefficients of individual building components and their surface area. Figure 15 illustrates the split of a building in the components bottom plate, outer wall, windows and rooftop, with their corresponding heat transfer coefficients (u-value) as well as their surface area. Conceptually, it is assumed that the heating energy provided by the heating system is transferred to the environment proportionally through the buildings components depending on the building's surface area and the components' heat transfer coefficient.

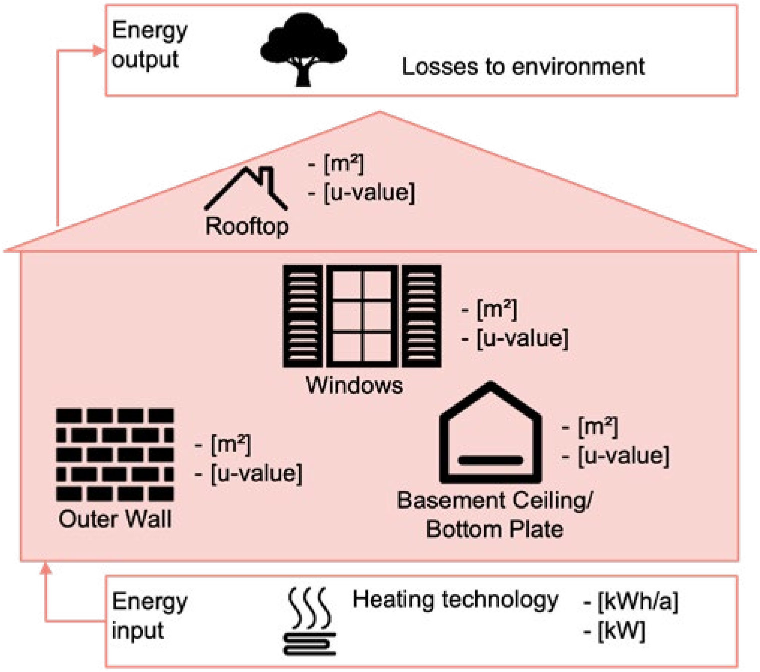


Figure 15: Simplified building model in Climate Excellence (PwC, 2024).

When applying retrofit measures to individual building components, the u-value of these components is improved and the heat loss is reduced. In consequence, the final energy consumption declines. This may affect the sizing decision when the heating system is retrofitted. For each of the retrofit measures, the specific costs (e.g. EUR/m^2) are included in Climate Excellence's database. This enables the calculation of the total investment costs per selected measure.

In addition to the already described measures, it is also possible to install photovoltaic systems on buildings either with or without additional battery storage systems. Figure 16 illustrates the steps involved in selecting a photovoltaic system as well as analysing the contribution towards reducing energy consumption from a public grid and the consequent reduction in CO_2 emissions. Firstly, it is assumed that the maximum technical rooftop potential is allocated towards photovoltaics. Secondly, the annual generation is taken into consideration by postcode. Depending on the annual generation and the annual electricity demand, a suitable storage size is selected if this option is to be applied. Finally, a dispatch algorithm simulates the hourly energy flows. This ultimately leads to an updated electricity demand that is drawn from the public grid, affecting annual CO_2 emissions but leaving the specific energy demand unaffected.

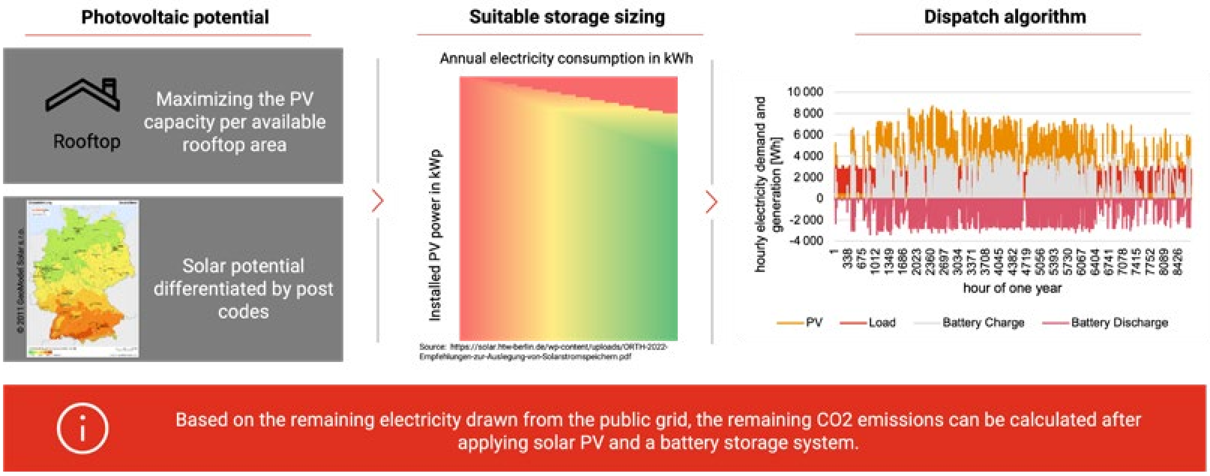


Figure 16: Conceptual illustration of the photovoltaic assessment within the retrofit analysis of Climate Excellence (PwC, 2024).

Appendix II: Overview of open-source data proxies for retrofit analysis

Table 3 below provides an overview of available open-source data proxies used primarily within the European context for retrofit analysis. This list is not exhaustive and generally includes data at the regional or country level. The accuracy and relevance of data inputs can vary, necessitating periodic updates to enhance the precision and meaningfulness of the analysis. This situation underscores the need for the development of a more robust and comprehensive database to support more effective retrofit evaluations.

Table 3: Existing online sources for retrofit analysis inputs (UNEP FI & PwC, 2024).

#	Name of database	Type of resources	Scope of coverage	Link
1	**BSO—EU Building Stock Observatory**	Building information and classification	EU	building-stock-observatory.energy.ec.europa.eu/database/
2	**Episcope and Tabula building topology**	Building information and classification	EU	episcope.eu/welcome/
3	**EUBUCCO**	Building information and classification	EU and Switzerland	eubucco.com/data/
4	**Points for Energy Renovation (PointER): A LiDAR-Derived Point Cloud Dataset of One Million English Buildings Linked to Energy Characteristics**	Building information and classification & EPC databases	16 English districts	mediatum.ub.tum.de/1713501
5	**Episcope and Tabula building topology**	National EPC databases	UK	episcope.eu/welcome/
6	**Statistik Austria database of energy performance certificates**	National EPC databases	Austria	statistik.at/en/databases/address-buildings-and-dwellings-register/database-of-energy-performance-certificates
7	**Енергетски пасоши**	National EPC databases	Serbia	crep.gov.rs/PregledPilotPasosa.aspx
8	**ΑΡΧΕΙΟ ΣΤΑΤΙΣΤΙΚΩΝ ΑΠΟΤΕΛΕΣΜΑΤΩΝ**	National EPC databases	Greece	bpes.ypeka.gr/?page_id=21
9	**Database Integrato per la Pianificazione Energetica dei Distretti Edilizi**	National EPC databases	Italy	portale4e.it/centrale_dettaglio_pa.aspx?ID=1
10	**Building typology database**	National EPC databases	Egypt, Jordan, and Lebanon	buildings-mena.com/typologies

References

Credit: unsplash.com/@jonnyauh

v3Keel (2023). Global Retrofit Index, 3keel.com. Available at: 3keel.com/wp-content/uploads/2022/10/Global_Retrofix_Index.pdf (Accessed: April 15, 2024).

Allen Overy (2023). Update—*Germany tightens energy efficiency requirements: New challenges for companies and data centers*. Available at: allenovery.com/en-gb/global/news-and-insights/publications/update-germany-tightens-energy-efficiency-requirements-new-challenges-for-companies-and-data-centers (Accessed: April 19, 2024).

Ames, E. (2023). GBP 6bn allocated for energy efficiency schemes, localgov.co.uk. Available at: localgov.co.uk/6bn-allocated-for-energy-efficiency-schemes/58531 (Accessed: April 15, 2024).

Architecture 2030 (2024). *Why buildings—architecture 2030*, Architecture2030.org. Available at: architecture2030.org/why-the-built-environment/why-buildings/ (Accessed: April 15, 2024).

AWD (2024). AWD—Dreischeibenhaus, Awd-ingenieure.info. Available at: awd-ingenieure.info/projekt/dreischeibenhaus-duesseldorf/ (Accessed: April 15, 2024).

Binsted, M. et al. (2020). *Stranded asset implications of the Paris Agreement in Latin America and the Caribbean*, Environmental research letters, 15(4), p. 044026. doi: 10.1088/1748-9326/ab506d.

BMO (2024). BMO partners with Canada infrastructure bank to help Canadian clients finance energy retrofits in a sustainable finance first, PR Newswire. Available at: newswire.ca/news-releases/bmo-partners-with-canada-infrastructure-bank-to-help-canadian-clients-finance-energy-retrofits-in-a-sustainable-finance-first-857136794.html (Accessed: April 19, 2024).

Caldecott, B., Tilbury, J. and Ma, Y. (2013). *Stranded Down Under? Environment-related factors changing China's demand for coal and what this means for Australian coal assets*, ox.ac.uk. Available at: ora.ox.ac.uk/objects/uuid:27d52eb8-0c8b-44a6-b395-31c660e32855/files/m99d7256c12b93de67f402fb975d63c17 (Accessed: April 15, 2024).

CBRE (2022). *Building Performance Standards aim to reduce carbon emissions across the U.S*, cbrecommunications.com. Available at: cbre-ea.com/public-home/ea-insights/2022/11/03/building-performance-standards-aim-to-reduce-carbon-emissions-across-the-u.s (Accessed: April 15, 2024).

CDP Worldwide and WWF International (2020). *Temperature Rating Methodology*, Sciencebasedtargets.org. Available at: sciencebasedtargets.org/resources/legacy/2020/09/Temperature-Rating-Methodology-V1.pdf (Accessed: April 15, 2024).

CREDS (2023). *Catalysing netzero retrofit: feasibility of an innovative salary sacrifice scheme*, creds.ac.uk. Available at: creds.ac.uk/publications/catalysing-netzero-retrofit-feasibility-of-an-innovative-salary-sacrifice-scheme/ (Accessed: April 15, 2024).

CRREM (2023). *Embodied Carbon of Retrofits: Ensuring the ecological payback of energetic retrofits*, crrem.eu. Available at: crrem.eu/wp-content/uploads/2023/09/Report-Embodied-carbon-vs-operational-savings_Sep23.pdf (Accessed: April 25, 2024).

De Nederlandsche Bank (2022). *Real estate and climate transition risk: A financial stability perspective*, dnb.nl. Available at: dnb.nl/en/publications/research-publications/occasional-study/nr-2-2022-real-estate-and-climate-transition-risk-a-financial-stability-perspective/ (Accessed: April 15, 2024).

Department for Energy Security and Net Zero (2023). *Domestic private rented property: minimum energy efficiency standard—landlord guidance*, gov.uk. Available at: gov.uk/guidance/domestic-private-rented-property-minimum-energy-efficiency-standard-landlord-guidance (Accessed: April 15, 2024).

Duan, T. and Li, F. W. (2024). *Climate change concerns and mortgage lending*, Journal of empirical finance, 75(101445), p. 101445. doi: 10.1016/j.jempfin.2023.101445.

EBA (2022). Annex I—Templates for ESG prudential disclosures, europa.eu. Available at: eba.europa.eu/sites/default/files/document_library/Publications/Draft%20Technical%20Standards/2022/1026172/Annex%20I%20-%20Templates%20for%20ESG%20prudential%20disclosures.xlsx (Accessed: April 15, 2024).

EBA (2023). EBA Report in response to the call for advice from the European Commission on Green Loans and Mortgages, europa.eu. Available at: eba.europa.eu/sites/default/files/2023-12/e7bcc22e-7fc2-4ca9-b50d-b6e922f99513/EBA%20report%20on%20green%20loans%20and%20mortgages_0.pdf (Accessed: April 15, 2024).

EBRD (2023). Annexes to Implementing the Green Economy—Technical Guide, ebrd.com. Available at: ebrd.com/get-technical-annexes.pdf (Accessed: April 15, 2024).

EEA (2023). Buildings and construction, europa.eu. Available at: eea.europa.eu/en/topics/in-depth/buildings-and-construction (Accessed: April 15, 2024).

EFRAG (2022). *Draft European Sustainability Reporting Standards—ESRS E1—Climate Change*, efrag.org. Available at: efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2FSiteAssets%2F08%2520Draft%2520ESRS%2520E1%2520Climate%2520Change%2520November%25202022.pdf (Accessed: April 15, 2024).

EIOPA (2022). *Discussion paper on the Prudential Treatment of Sustainability Risks, European Insurance and Occupational Pensions Authority*. Available at: eiopa.europa.eu/consultations/discussion-paper-prudential-treatment-sustainability-risks_en (Accessed: April 15, 2024).

EPA (2023). *Energy and environment guide to action*—Chapter 4.3: Building codes for energy efficiency. Available at: epa.gov/statelocalenergy/energy-and-environment-guide-action-chapter-43-building-codes-energy-efficiency (Accessed: April 19, 2024).

EU (2023). *New Energy Efficiency Directive* published, Energy. Available at: energy.ec.europa.eu/news/new-energy-efficiency-directive-published-2023-09-20_en (Accessed: April 19, 2024).

EU (2024). *Energy performance of buildings directive*, Energy. Available at: energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en (Accessed: April 19, 2024).

European Commission (2024a). *Certificates and inspections*, Energy. Available at: energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/certificates-and-inspections_en (Accessed: April 15, 2024).

European Commission (2024b). *EU Building Stock Observatory*, Energy. Available at: energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en (Accessed: April 15, 2024).

European Commission (2024c). *Long-term renovation strategies*, Energy. Available at: energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/long-term-renovation-strategies_en (Accessed: April 15, 2024).

European Union (2012). IEE project TABULA, episcope.eu. Available at: episcope.eu/iee-project/tabula/ (Accessed: April 15, 2024).

Firdaus, N. and Mori, A. (2023). *Stranded assets and sustainable energy transition: A systematic and critical review of incumbents' response*, Energy for sustainable development: the journal of the International Energy Initiative, 73, pp. 76–86. doi: 10.1016/j.esd.2023.01.014.

Gabrielli, L. (2020). Stranding Risk 1st Panel: Climate change impact on real estate- uncertainty and solutions, Crrem.eu. Available at: crrem.eu/wp-content/uploads/2020/09/Panel_1b_gabrielli.pdf (Accessed: April 15, 2024).

German Energy Agency (2016). *Gebäudereport Statistiken und Analysen zur Energieeffizienz im Gebäudebestand*, dena.de. Available at: dena.de/fileadmin/user_upload/8162_dena-Gebaeudereport.pdf (Accessed: April 15, 2024).

German Federal Environment Agency (2017). Klimaneutraler Gebäudebestand 2050, Umweltbundesamt.de. Available at: umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2017-11-06_climate-change_26-2017_klimaneutraler-gebaeudebestand-ii.pdf (Accessed: April 15, 2024).

GlobalABC (2022). *Global Alliance for Buildings and Construction's contribution to the mitigation rountable*, unfccc.int. Available at: unfccc.int/sites/default/files/resource/GST_Mitigation (Accessed: April 25, 2024).

JLL (2023). How can investors manage transition risks amid the push to low carbon economy?, Jll.de. Available at: jll.de/en/trends-and-insights/investor/how-can-investors-manage-transition-risks-amid-the-push-to-net-zero (Accessed: April 15, 2024).

KPMG (2022). *Considerations for climate stranded assets*, kpmg.com. Available at: kpmg.com/us/en/articles/2022/considerations-for-climate-stranded-assets.html (Accessed: April 15, 2024).

KPMG (2024). *Corporate Sustainability Reporting Directive*—KPMG Netherlands. Available at: kpmg.com/nl/en/home/topics/environmental-social-governance/corporate-sustainability-reporting-directive.html (Accessed: April 15, 2024).

Local Partnerships (2023). *Local Partnerships Domestic Retrofit Handbook*, gov.uk. Available at: localpartnerships.gov.uk/wp-content/uploads/2023/07/Local_Partnerships_LA_Domestic_Retrofit_Handbook_July2023.pdf (Accessed: April 15, 2024).

Netherlands Enterprise Agency (2023). Building regulations, gov.nl. Available at: business.gov.nl/regulation/building-regulations/ (Accessed: April 15, 2024).

Nguyen, D. D. et al. (2022). *Climate change risk and the cost of mortgage credit*, Review of finance, 26(6), pp. 1509–1549. doi: 10.1093/rof/rfac013.

NRC (2023). Now open for project applications: Second call under the Greener Neighbourhoods Pilot Program—supporting demonstration projects for deep building retrofits, Government of Canada. Available at: canada.ca/en/natural-resources-canada/news/2023/06/now-open-for-project-applications-second-call-under-the-greener-neighbourhoods-pilot-program--supporting-demonstration-projects-for-deep-building-r.html (Accessed: April 15, 2024).

Parente, F. (2023). *Climate and environmental risks in the insurance sector*, eurofi.net. Available at: eurofi.net/wp-content/uploads/2023/11/eurofi_climate-and-environmental-risks-in-the-insurance-sector_santiago_september-2023.pdf (Accessed: April 15, 2024).

PCAF, CRREM, GRESB (2023). *Accounting and Reporting of GHG Emissions from Real Estate Operations*, carbonaccountingfinancials.com. Available at: carbonaccountingfinancials.com/files/downloads/ghg_emissions_real_estate_guidance_1.0.pdf (Accessed: April 15, 2024).

PlanRadar (2023). *Unlocking the value: Benefits of retrofitting existing buildings*. Available at: planradar.com/ae-en/benefits-of-retrofitting-buildings-for-sustainable-urban-development/ (Accessed: April 15, 2024).

PricewaterhouseCoopers (2024). *Climate excellence for real estate*, PwC. Available at: pwc.de/en/sustainability/climate-excellence-making-companies-fit-for-climate-change/climate-excellence-for-real-estate.html (Accessed: April 15, 2024).

RICS (2024). *The future of real estate valuations: The impact of ESG*, Rics.org. Available at: rics.org/news-insights/wbef/the-future-of-real-estate-valuations-the-impact-of-esg (Accessed: April 15, 2024).

RMI (2023). *Transforming existing buildings from climate liabilities to climate assets*, RMI. Available at: rmi.org/insight/transforming-existing-buildings-from-climate-liabilities-to-climate-assets/ (Accessed: April 15, 2024).

Schütz. F. (2020). *Transition Risk an Opportunities in Residential Mortgages*, DIW Discussion Papers. Available at: diw.de/documents/publikationen/73/diw_01.c.802032.de/dp1910.pdf (Accessed: April 15, 2024).

Science Based Targets initiative (2023a). *Building sector science-based target-setting guidance*. Version 0.2.1—Draft for Pilot Testing, Sciencebasedtargets.org. Available at: sciencebasedtargets.org/resources/files/SBTi_Buildings_Guidance_Draft_for_Pilot_Testing.pdf (Accessed: April 15, 2024).

Science Based Targets initiative (2023b). *SBTi Buildings Target-Setting Tool* Version 0.2, Sciencebasedtargets.org. Available at: sciencebasedtargets.org/resources/files/SBTi-Buildings-Sector-Tool-draft-for-pilot-testing.xlsx (Accessed: April 15, 2024).

Science-Based Targets initiative (2023c). *The SBTi Financial Institutions Net-Zero Standard: Conceptual Framework and Initial Criteria: Consultation Draft*, sciencebasedtargets.org. Available at: sciencebasedtargets.org/resources/files/The-SBTi-Financial-Institutions-Net-Zero-Standard-Consultation-Draft.pdf (Accessed: April 15, 2024).

Science Based Targets initiative (2024). *Net-zero for financial institutions, Science Based Targets*. Available at: sciencebasedtargets.org/net-zero-for-financial-institutions (Accessed: April 15, 2024).

Semieniuk, G. et al. (2022). *Stranded fossil-fuel assets translate to major losses for investors in advanced economies*, Nature climate change, 12(6), pp. 532–538. doi: 10.1038/s41558-022-01356-y.

The Guardian (2022). Italy's superbonus 110% scheme prompts surge of green home renovations, The guardian, 13 April. Available at: theguardian.com/world/2022/apr/13/italys-superbonus-110-scheme-prompts-surge-of-green-home-renovations (Accessed: April 15, 2024).

UBS (2024). *Under one roof, Sustainability and impact*. UBS. Available at: ubs.com/global/en/sustainability-impact/sustainability-insights/reports/under-one-roof.html (Accessed: April 15, 2024).

UK Green Building Council (2013). Task Group Report, ukgbc.org. Available at: ukgbc.org/wp-content/uploads/2017/09/13070520Retrofit20Incentives20Task20Group20-20Report20FINAL_1.pdf (Accessed: April 15, 2024).

ULI (2023). *Transition Risk Assessment Guidelines*, uli.org. Available at: europe.uli.org/wp-content/uploads/2023/07/Transition-RIsk-Guidelines-2023-Final.pdf (Accessed: April 15, 2024).

UNEP (2024). *2023 Global Status Report for Buildings and Construction: Beyond foundations—Mainstreaming sustainable solutions to cut emissions from the buildings sector*. United Nations Environment Programme.

UNEP FI (2022a). *Call to Action to Private Market Asset Managers*, unepfi.org. Available at: unepfi.org/wordpress/wp-content/uploads/2022/11/NZAOA_Call-to-Action-to-Private-Market-Asset-Managers_final.pdf (Accessed: April 19, 2024).

UNEP FI (2022b). *Managing Transition Risk in Real Estate: Aligning to the Paris Climate Accord*, unepfi.org. Available at: unepfi.org/wordpress/wp-content/uploads/2022/03/Managing-transition-risk-in-real-estate.pdf (Accessed: April 15, 2024).

UNEP FI (2023a). *Climate Target Setting for Real Estate Sector Financing*, unepfi.org. Available at: unepfi.org/wordpress/wp-content/uploads/2023/12/NZBA-Real-Estate-White-Paper.pdf (Accessed: April 15, 2024).

UNEP FI (2023b). Database: The climate risk dashboard, unepfi.org. Available at: unepfi.org/themes/climate-change/the-climate-risk-dashboard/ (Accessed: April 15, 2024).

UNEP FI (2023c). *The 2023 Climate Risk Landscape*, unepfi.org. Available at: unepfi.org/themes/climate-change/2023-climate-risk-landscape/ (Accessed: April 15, 2024).

UNEP FI (2023d). *The 2023 Climate Risk Landscape: Technical Supplement*, unepfi.org. Available at: unepfi.org/themes/climate-change/2023-climate-risk-landscape-technical-supplement/ (Accessed: April 15, 2024).

UNEP FI (2024). *Climate Risk Landscape Report 2024*, unepfi.org. Available at: unepfi.org/themes/climate-change/2024-climate-risk-landscape/ (Accessed: April 15, 2024).

UNFCCC (2015). The Paris Agreement, unfccc.int. Available at: unfccc.int/process-and-meetings/the-paris-agreement (Accessed: April 15, 2024).

UN environment programme

finance initiative

UNEP Finance Initiative brings together a large network of banks, insurers and investors that collectively catalyses action across the financial system to deliver more sustainable global economies. For more than 30 years the initiative has been connecting the UN with financial institutions from around the world to shape the sustainable finance agenda. It has established the world's foremost sustainability frameworks that help the finance industry address global environmental, social and governance (ESG) challenges. Convened by a Geneva, Switzerland-based secretariat, more than 500 banks and insurers with assets exceeding US$100 trillion work together to facilitate the implementation of UNEP FI's Principles for Responsible Banking and Principles for Sustainable Insurance. Financial institutions work with UNEP FI on a voluntary basis and the initiative helps them to apply the industry frameworks and develop practical guidance and tools to position their businesses for the transition to a sustainable and inclusive economy.

unepfi.org

unepfi.org

info@unepfi.org

/UNEPFinanceInitiative

UN Environment Programme Finance Initiative

@UNEP_FI