Thought Leadership

Under one roof

Public and private roles to catalyze sustainable building

A report by the UBS Sustainability and Impact Institute
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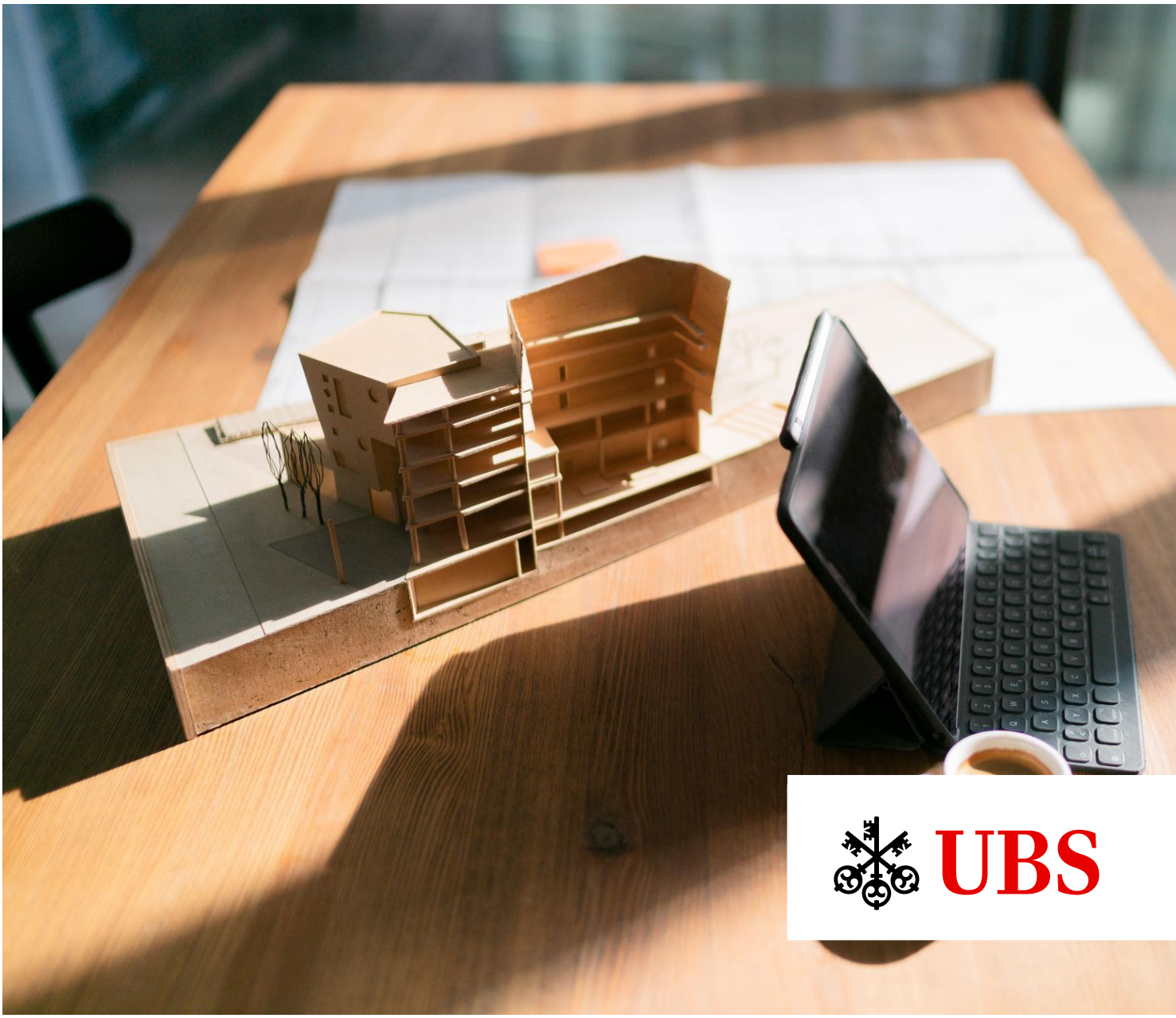

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Executive Summary

"When one has finished building one's house, one suddenly realizes that in the process one has learned something that one really needed to know in the worst way—before one began." Friedrich Nietzsche

The Paris Agreement implicitly signed up the global building sector for full decarbonization by 2050. This translates to a seemingly reasonable annual reduction of 3.6%, but the sector's emissions instead rose by 3% in recent years. Bending this curve could require investment in solutions of around USD 1tn per annum between now and 2050—at face value a large sum, but one that would yield significant benefits, and which equates to only 9% of total annual investment in the sector today.

The sector has the concepts and technologies to make substantial progress on decarbonization now. However, entrenched market barriers create hurdles: inadequate rewards for better buildings, insufficient penalties for worse buildings, and information transmission failure.

Private and public stakeholders can take complementary actions today to overcome these hurdles and accelerate decarbonization. For instance, private finance could provide some three quarters of total investment required, due to the investibility of decarbonization solutions, the sheer level of capital required, and the complicated nature of the sector. Current market barriers create an irreplaceable role for public authorities, who have both the incentives (working in the public interest) and the tools (taxes, subsidies, and regulations) to shape the rules and tilt markets toward society's goals.

This report provides seven actions for public and private stakeholders to bend the curve on buildings' emissions. The take-home messages are:

- **Incentives are needed:** Current building markets provide low incentives to act. Across different metrics, trends are going the wrong way; retrofit rates remain a third of what they need to be, and markets continue constructing new buildings that will be standing in 2050, when climate targets come due, but today aren't zero-carbon ready (i.e., fully electrified). Public incentives are needed: "carrots" in the form of grants to reduce upfront capex, "sticks" that ensure that capex is spent. Any carrots must be targeted to avoid wasteful uses of public money. Private institutions can highlight roadblocks and create common metrics, guiding scarce public incentives to where they have the most "bang for buck".
- **New approaches to sharing risks are key:** The high upfront costs and long payback times associated with buildings means the sector is naturally slow-moving, in direct contrast to the demands of its climate targets. New partnerships across public and private institutions can help share the risks that prevent the innovation, commercialization, and deployment of solutions today.

Find more insights in our latest white paper:
"Rethink, rebuild, reimagine—Laying the foundation for better buildings".

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1. Smoke still rising

At a glance

- With its direct emissions still rising—3% over the last few years—the global building sector's decarbonization efforts have yet to gather momentum.
- Decarbonizing the global building sector at the rate demanded by climate targets requires collaboration between diverse stakeholders performing complementary roles.

The impact of some sectors on the climate is easy to spot: the iconic image of coal power plants emitting dark plumes, or the smoking tailpipes of today's oil-fueled transport. Other sectors have less visible climate impacts, but their contribution to global warming remains no less significant.

The building sector's outsized climate impact can sometimes fly under the radar. Considering only their direct emissions, buildings generated 9% of global carbon dioxide emissions in 2022, but this quickly increases if we consider their wider impacts. For instance, including their indirect emissions (such as from power consumption) and the emissions embodied in their bones—concrete, aluminum, steel, glass, and brick—increases the sector's total share of global emissions to 37%.[1] Through this lens, buildings become one of the highest sources of emissions, ahead of industry (24%) and transport (21%).[2]

By ratifying the Paris Agreement, governments implicitly signed the sector up for Net Zero by 2050, making decarbonization a megatrend that will shape buildings for decades. However, while an annual 3.6% reduction in emissions between now and 2050 feels temptingly easy, the sector's contribution to climate change is still on the rise—globally, its direct emissions increased 3% between 2020 and 2022[3]—and left unchecked, its emissions could double by 2050.[4]

While no sector is decarbonizing at the required rate, two features of real estate make a U-turn on emissions uniquely difficult compared to other sectors:

- **Buildings change slowly, creating friction between the realized and required speed of decarbonization:** Once constructed, buildings tend to stay as they are. Turnover in the stock is naturally low and slow, with assets' lives in developed markets reaching over 80 years on average. Construction is also a capital-intensive process, requiring high upfront investment with long payback periods. Building markets tend to be highly regulated; a thicket of performance and design regulations create multiple hoops that new projects must jump through before spades go into the ground.

[1] Global Alliance for Buildings and Construction (2022), *2022 Global Status Report for Buildings and Construction*.
[2] International Energy Agency (2023), *Net Zero Roadmap: A global pathway to keep the 1.5°C goal in reach – 2023 update,* P198 Table A.4; Note these figures should be treated as directionally correct rather than exact because they are from different sources, and the exact share of emissions from buildings (and other sectors) depends a lot on where analysts draw the boundaries on emission scopes (such as whether to include embodied emissions or not).
[3] Ibid.
[4] The Economist (2022), *The construction industry remains horribly climate-unfriendly*.

- **Highly localized submarkets mean universal solutions don't pass muster:** The global building market is a jigsaw of highly localized submarkets. Each faces a unique transition pathway, the result of geographical, economic, technological, and social factors, which in turn requires a tailored combination of solutions. For instance, cities in Western Europe, with their established and carbon-intensive building stock, are likely to reduce emissions by focusing on retrofitting existing buildings through energy-efficient heating, cooling, and lighting, as well as smart technologies and on-site renewables. Similar strategies may be inappropriate for rapidly expanding cities in many non-advanced economies,[5] which will overwhelmingly drive growth in global total floor area over the coming decades.[6] Their focus will be on building sustainably from the start.

Decarbonizing the global building sector at the rate demanded by climate targets requires a diverse set of stakeholders performing complementary roles. Public institutions (governments and development finance institutions) seem best positioned and appropriately incentivized to address holistic market failures, making them irreplaceable on the road to Net Zero. But the sheer level of capital necessary to decarbonize buildings, and the required innovation in key technologies, creates variegated and similarly vital roles for stakeholders across the private sector. Real estate markets will be a key tool to deliver, organize, and deploy solutions on a global scale. Equally, they need guidance from public institutions to ensure they do so in a desirable way.

[5] Large cities in countries across China, East and South East Asia, and Africa, are growing outward and upward at higher frequencies than those in Europe and North America; see Mahatta, R. et al. (2019), *Building up or spreading out? Typologies of urban growth across 478 cities of 1 million+*, Environmental Research Letters.

[6] International Energy Agency (2023), *Net Zero Roadmap: A global pathway to keep the 1.5°C goal in reach – 2023 update,* P85.

2. From Paris to present

At a glance

- The building sector's decarbonization journey until now is the result of four trends: the Paris Agreement, a growing vocabulary on climate change's impacts, technological advancements, and recognition of the commercial implications of decarbonization.
- Existing market barriers could limit further decarbonization, creating important roles for public institutions to provide incentives that move the needle.
- The level of capital required, and the need for innovation on upstream industrial technologies, creates an important role for private institutions as well.

2.1. Roles and responsibilities: Where to begin?

The building sector's decarbonization journey so far can be understood through four trends:

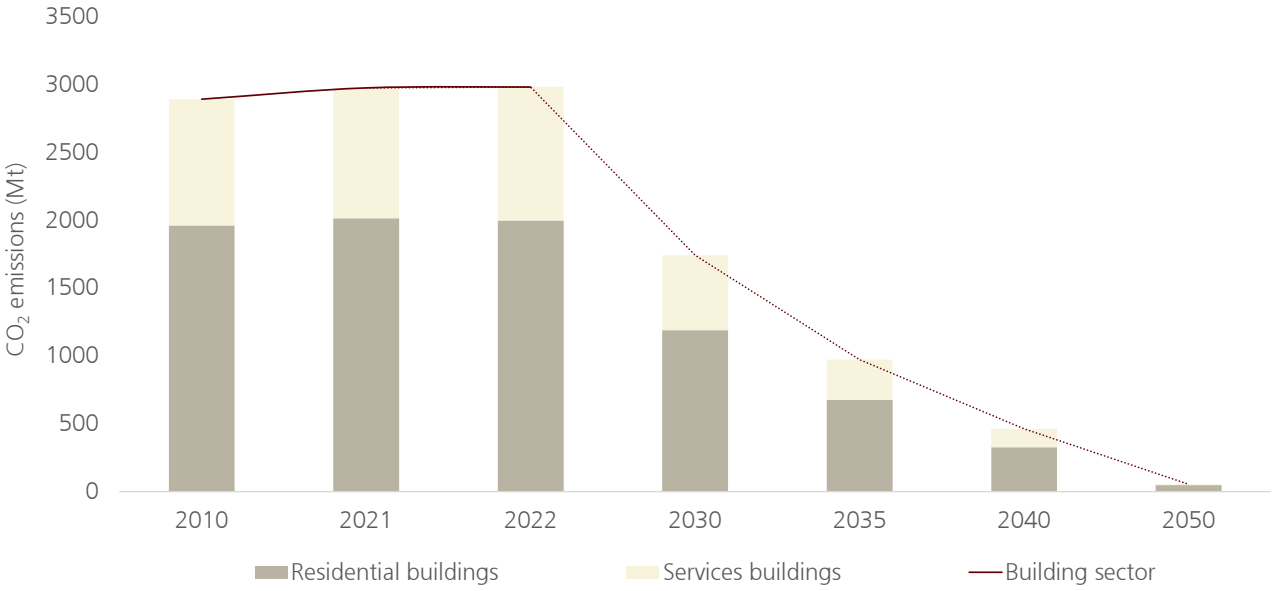
- **The Paris Agreement** sets clear goals and outlines the road for the global building sector;
- **Climate-related risks and opportunities** remain relatively new concepts in the sector, but the language is developed enough to form a coherent theoretical bedrock to begin understanding the commercial implications of the Paris Agreement;
- **Decarbonization technologies** that address buildings' *direct* emissions, such as insulation and heat pumps, are mostly commercialized and market-ready, while those at the industrial level remain in the pipeline; and,
- **The required financing** to deploy decarbonization technologies is increasingly understood by practitioners, underpinned by a recognition of the carbon emissions, but also an appreciation of the financial costs and benefits of solutions.

The Paris Agreement: A starting point

The Paris Agreement, established in 2015, set clear goalposts for the world to reach net-zero emissions by 2050. It means the world has a finite "carbon budget" it can burn through over the next three decades. Distributing this budget on a sector level creates a clear flight path for the building sector (Figure 1), which, according to the latest analysis on the feasibility of limiting mean surface temperature increases to 1.5º Celsius, translates into an annual reduction in the sector's emissions of 13% compared to 2022 levels until 2050. All sectors need to decarbonize, but the building sector faces a tougher lift (Figure 2); by 2050 its share of relative emissions needs to drop by two-thirds, comparably more than other sectors such as transport, whose relative share of global emissions in a Net Zero scenario rises over time.

Figure 1: Net Zero demands a departure from the building sector's rising emissions

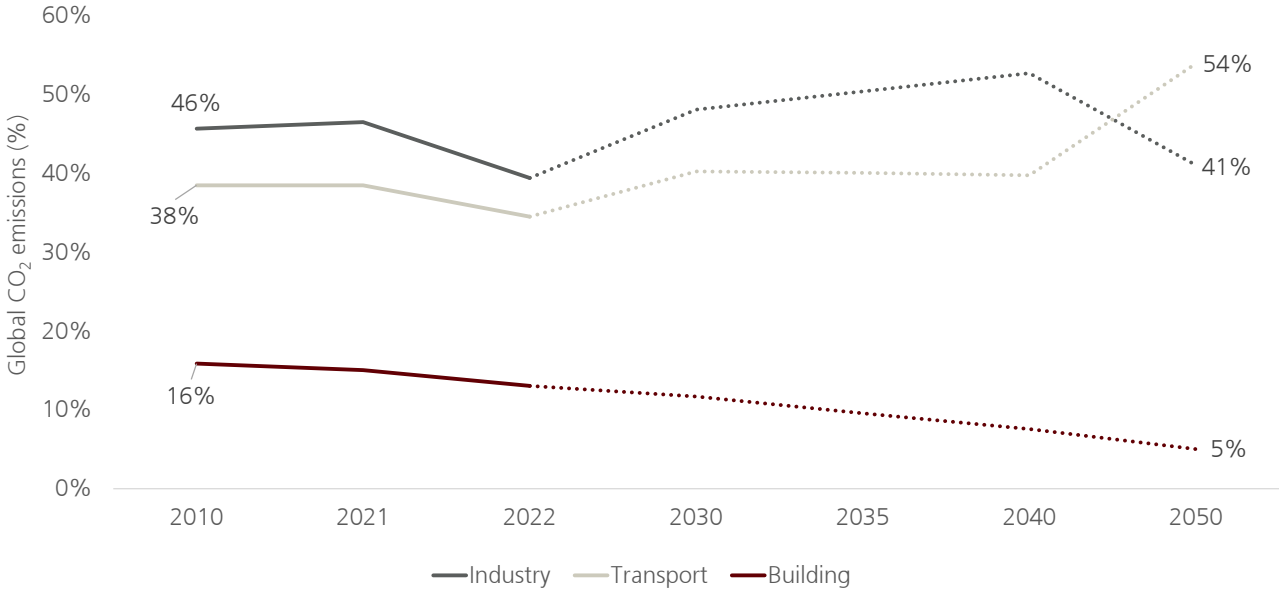
The building sector needs to achieve a compound annual reduction rate in its emissions of –6.5% by 2030 and –13% by 2050 compared to 2022.



Sources: IEA (2023), Net Zero Roadmap: A global pathway to keep the 1.5°C goal in reach – 2023 update, Table A.4, based on the Net Zero Scenario, UBS

Figure 2: Building sector has more roadblocks to clear

The sector also sees a heavier relative lift, with its proportional share of global emissions falling two-thirds by 2050, considerably more on a relative basis than other sectors.



Sources: IEA (2023), Net Zero Roadmap: A global pathway to keep the 1.5°C goal in reach – 2023 update, Table A.4, based on the Net Zero Scenario, UBS

With a budget and route map in hand, the focus shifts to allocation. Decarbonizing a sector requires knowledge of where exactly emissions emerge, so that the sector can target strategies and solutions at the highest emitting portions of the value chain, or the largest "bang for buck" solutions. For instance, over 75% of the sector's global emissions are linked to the operation of individual buildings—and while this will vary substantially by the asset and market—it suggests an outsized role for the downstream end of the value chain in reducing total emissions.[7]

Why is this important? The Paris Agreement provides a crucial framework to understand what decarbonization entails on a sector level. It was the starting point for subsequent work to understand how emissions are generated at each link in the building value chain, from upstream production of construction materials to downstream demolition of buildings. In turn, this enables stakeholders to discuss roles and responsibilities vis-à-vis decarbonization, based on who in the value chain "owns" which part of the sector's emissions.

Climate-related risks and opportunities: Enabling conversations

The impacts of climate change are difficult to grasp, given they occur over long timeframes (often beyond the asset life of many buildings). They are also novel, with no historical precedent for how buildings will be affected by rising temperatures and changing weather patterns. As David Carlin highlights, society tends to wait till crises break before taking preventative action (Interview 1).

The sector increasingly uses new concepts to make sense of these uncertainties. The most significant are a nuanced understanding of *physical* risks, such as the increased risks of flooding and heatwaves, as well as *transition* risks, such as rising regulatory standards and changes in consumer preferences (Figure 3). While they can feel obvious—of course, a building is impacted by flooding—they form a valuable common language between stakeholders on climate-related risks and opportunities, facilitating conversations across the value chain on the implications of climate change and decarbonization.

Figure 3: Physical and transition risks create a shared language to understand climate-related risks and opportunities

Transition and physical risks provide a conceptual framework for the sector to understand how decarbonization could affect individual buildings.

Transition risks		**Physical risks**
Policy and legal	Markets	Acute
• Increased pricing of GHG emissions • Enhanced emissions-reporting obligations • Mandates on and regulation of existing products and services • Exposure to litigation	• Changing customer behavior • Uncertainty in market signals • Increased cost of raw materials	• Increase severity of extreme weather events such as cyclones and floods (causing damages on facilities, reduction or disruption in production capacity)
Technology	Reputation	Chronic
• Substitution of existing products and services with lower emissions options • Unsuccessful investment in new technologies • Upfront costs of transition to lower emissions technology	• Shift in consumer preferences • Stigmatization of sector • Increased stakeholder concern or negative stakeholder feedback	• Changes in precipitation patterns and extreme variability in weather patterns • Rising mean temperatures • Rising sea levels (causing damages on facilities, increased operating costs, impacts to workforce management and planning

Sources: Taskforce on Climate-related Financial Disclosures (2016), UBS

[7] UNEP and Global Alliance for Building and Construction (2022), *2022 Global status report for buildings and construction*, P42.

Interview 1

Sustainability and the building sector—David Carlin, Head of Climate Risk and TCFD, United Nations Environment Program Finance Initiative

What are the most significant risks to real estate from a sustainability perspective?
The real estate sector faces both physical and transition risks. The physical risks are predominantly location dependent and include damages from flooding, fires, heat, and storms, but also changes in the availability of water and other key resources. On the transition side, the shift to Net Zero and a more sustainable economy will demand retrofits to energy-inefficient buildings, new materials in construction, and rethinking of buildings' environmental footprints. All these risks have impacts on the desirability of assets as well as their operating and construction costs, meaning they have implications for valuations. In addition, the availability and cost of insurance will be a key consideration in valuing properties in a changing world.

Does the speed and severity of those risk vary by submarket? The speed and depth as well as the kind of risk are somewhat dependent on the individual market. However, I would argue these risks are already visible in many places. On the physical risk front, we have seen major insurers pull out of the California residential insurance market due to worsening fire-related losses. On the transition risk side, research by the Bank of England has shown that less energy-efficient properties have lower values and higher default rates.

Do you think the ecosystem is paying attention to these risks?
Some in the ecosystem are paying attention and there has been some good research on the role of climate information in financial markets. However, the extent to which climate and transition risks are integrated into decision-making processes remains limited. Unfortunately, we tend to wait for a crisis and then look back and come up with ways to prevent that crisis from recurring. This leaves us exposed to novel risks and those outside the historical experience, and climate change almost definitionally is about unprecedented change.

How do you see the role of capital providers, asset owners, and corporates changing in response to climate-related risks in the sector?
You are starting to see some signals in insurance markets. As mentioned above, certain areas are becoming uninsurable. This development can have a knock-on effect for valuations. Among investors, Net Zero commitments have gone mainstream, and some smaller funds focus on climate solutions. That said, much of the industry appears at the beginning of its journey towards sustainability and resilience.

In your opinion, what does 'good' and 'less good' look like for the market by 2030?
It's a tough question since it is somewhat contingent on outside factors such as the pace of the transition, the strength of climate impacts, and other macroeconomic and geopolitical factors. I believe leading firms in 2030 will be both creators and users of transparent reporting throughout their value chains. Analytics will improve the energy efficiency and climate resilience of their assets, at the same time providing crucial information for the business case to roll out decarbonization solutions.

New analytical tools and lines of question build on these concepts and the groundwork laid by prior initiatives.[8] For instance, the initially EU-funded Carbon Risk Real Estate Monitor (CRREM) tool assesses the alignment of buildings in different real estate submarkets against the Paris Agreement. It builds on the concept of transition risks to define conditions under which a building may drift into asset stranding territory based on its climate impact and submarket, enabling investors to assess the materiality of transition risks across their portfolios. Practitioners increasingly use these and other tools to study whether market values for buildings reflect transition risk—the so-called green premium. These studies generally find a positive association between green credentials and value of between 5 to 15%, although divergent methods, proxies for green, and measures of value make them hard to compare.[9]

These tools and analyses provide organizations across the value chain with a framework to understand the risks and benefits of decarbonization, enabling an increasingly nuanced understanding of their potential role in decarbonization. While the field is relatively young, the concepts in Figure 2 facilitate a deeper recognition of the commercial implications of climate change, and its potential winners and losers.

Decarbonization technologies: Focus on deployment and innovation

The building sector lacks some crucial technologies to decarbonize, but it can address a substantial chunk of its carbon footprint with the ones available today. For the most part, it can reduce its emissions linked to buildings' operation—roughly 60–80% of the sector's total emissions by some estimates, depending on the region and grid intensity—through existing, market-ready technologies.[10][11] These can be classified into energy efficiency and fuel switching categories. Although they sit across the affordability spectrum, some are "no regrets" through their solid business case and financial benefits (Box 1). Thus, the building sector can make substantial progress on the Paris Agreement with today's toolkit, particularly in the downstream end of the value chain (Figure 4).

However, deployment is clearly not straightforward; otherwise, "no regrets" decarbonization technologies would be used in every building already. Each technology faces unique deployment barriers, which vary based on the combination of asset owner, building, and submarket—rooftop solar, itself a mature technology by most standards, still faces common project-level hurdles (Box 2). As practitioners install technologies and learnings accrue, deployment frictions will ease.

The reliance on electrification highlights the vital role other sectors play in enabling the building sector to decarbonize, requiring systems thinking. For instance, reducing a building's emissions via electrification is only possible with a reliable and clean electricity supply, and through the better integration of buildings with grids. However, today's electricity grids are not developed enough to facilitate 100% electrification. A zero emissions system requires transmission and distribution grids to expand by roughly 2 million km a year until 2030,[12] the equivalent of adding eight times South America's coastline, annually.

[8] Such as the work of the EU Commission and UNEPFI-convened Energy Efficiency Financial Institutions Group (EEFIG) linking financial risk and improvements in energy efficiency; see EEFIG (2022), *The quantitative relationship between energy efficiency improvements and lower probability of default of associated loans and increased value of the underlying assets,* European Commission.
[9] LaSalle (2023), *Focus: What is the value of green? Looking at the evidence linking sustainability and real estate outcomes.*
[10] Boston Consulting Group (2023), *Seizing the net zero opportunity for buildings.*
[11] Direct emissions from residential and non-residential buildings constitute around 24% of the sector's emissions, based on UNEP and GlobalABC (2022).
[12] International Energy Agency (2023), *Net Zero Roadmap: A global pathway to keep the 1.5°C goal in reach – 2023 update,* P198 Table A.4.

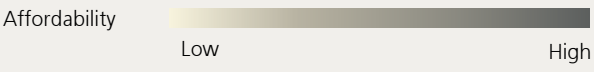
Box 1: Mature technologies already exist to reduce emissions from building operations

The direct and indirect emissions from buildings' operation account for a sizable 28% of global emissions, largely generated from heating and power consumption.[13] Fortunately, the sector does not have to wait for innovations. Facilitated by today's technologies, the sector can pull two levers:

- **Energy efficiency**, such as more efficient lighting, heating, and cooling, plus insulation; and
- **Electrification/fuel switching**, such as replacing fossil-fuel-powered boilers in individual properties with a district heating system.

The technologies within these categories are equally diverse. Classifying them by their end use is a helpful way to get a sense of this (below). Each technology faces barriers to deployment, some higher than others; each presents different costs, and some may reduce emissions by only a small amount, even if widely deployed. Some technologies are market-specific, such as district heating, which is growing in German markets but remains underdeveloped in the US.[14] A broader issue is the need for clean electricity for any solution within the electrification bucket to maximize its emissions reductions. Regardless, all of them are commercialized and available in the market today, and electrification is still likely to reduce emissions in the short term and increasingly as grids decarbonize.

	Energy efficiency	Electrification/fuel switching	Global potential
	Example of mature technologies that exist today		Abatement
Heating	Smart heating controls Heat recovery Insulation Heat pumps*	District heating Electric boilers Solar thermal Heat pumps*	
Appliances and other	Efficient appliances	-	
Cooking	Efficient stoves	Electric stoves	
Space cooling	Efficient air conditioning Smart cooling controls	District cooling	
Lighting	LED lighting Smart lighting controls	-	

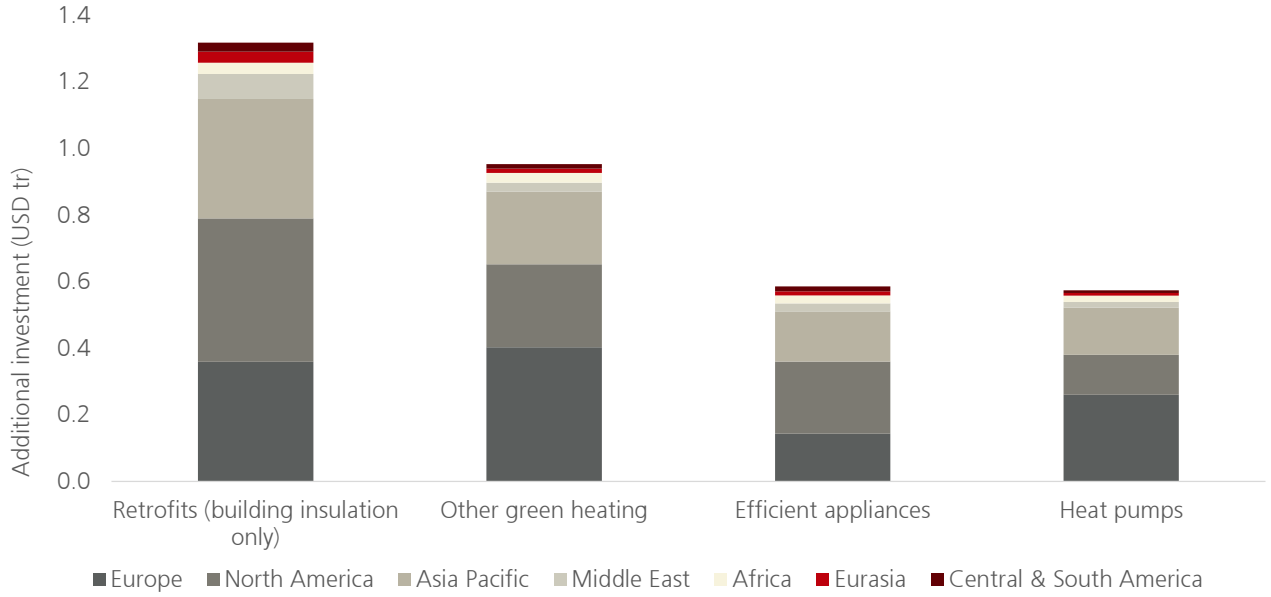


* Heat pumps address both the energy efficiency and electrification levers.
Note: Abatement and affordability potential inferred from BCG analysis.
Source: Boston Consulting Group (2023); UBS

[13] See UBS Sustainability and Impact Institute (2023), *Rethink, rebuild, reimagine: Laying the foundation for better buildings.*
[14] See country summaries in Vivid Economics (2017), *Annex: International comparisons of heating, cooling and heat decarbonization policies: Report prepared for The Department of Business, Energy and Industrial Strategy.*

Figure 4: Most of the investment in buildings will pour into existing technologies

Additional investment (net of historical investment) required in building technologies to reach Net Zero by 2030.



Sources: IIGCC and Vivid Economics (2022), *Climate Investment Roadmap*, P45, UBS

Box 2: Rooftop Solar still presents complexities despite being a mature technology

When installing rooftop solar, due to the nature of the technology, common project-level issues arise, such as:

- **The supporting infrastructure** around a building also matters. For instance, solar panels can sell electricity back to the grid in most markets, but an additional building-to-grid connection may be needed. This can incur high additional costs, as well as take a long time in markets where existing grid connection queues extend into years.
- **Flow of benefits:** Landlords may not have the incentive to install solar panels if the benefits only accrue to the tenant. For instance, rental yield may not increase just because a building has solar panels on, and despite landlords incurring installation and maintenance costs.[15]
- **Misalignment of tenancies and payback periods:** Anecdotally, tenancies in commercial buildings tend to be shorter than the payback period of rooftop solar panels (which generally fall as energy prices rise).[16] If tenants move from the building before they make a return on the assets, they are unlikely to invest in the first place.[17]

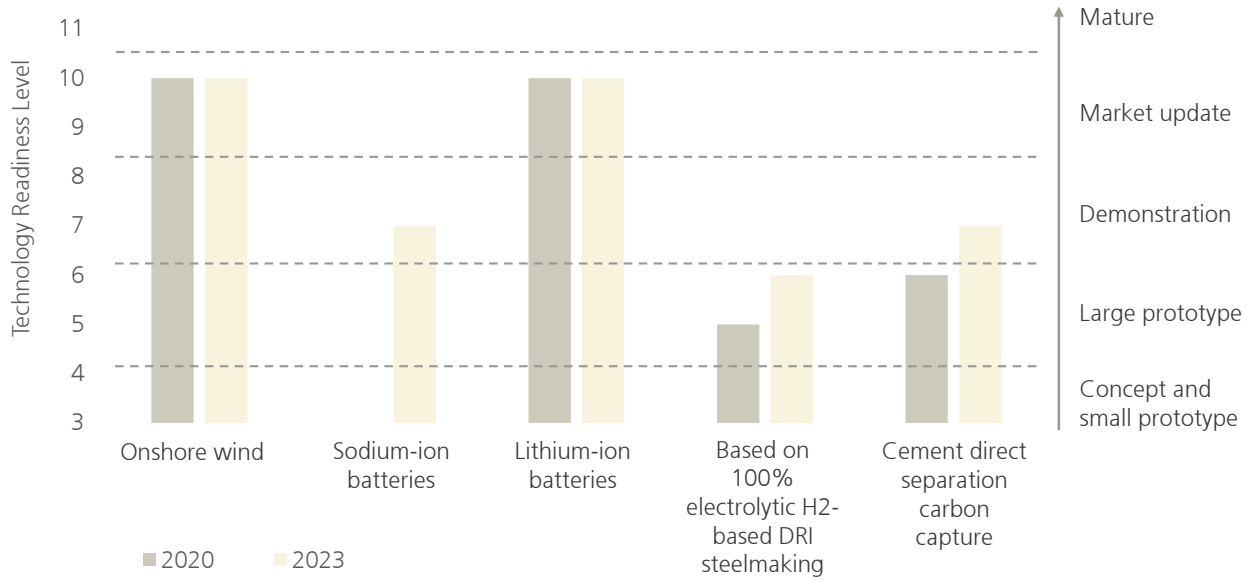
More innovation is required to commercialize decarbonization technologies in the upstream end of the value chain. Here, technologies focus on reducing emissions created through industrial processes to produce building materials like cement and steel. For instance, two key technologies for reducing the emissions from both cement and steel production remain in the demonstration stage, lagging other decarbonization technologies (Figure 5). This is also reflected in their current market shares, which generally remain less than 1% today despite needing to increase to around 10% by the early 2030s (Figure 6).

[15] Hammerle, M. et al (2023), *Solar for renters: Investigating investor perspectives of barriers and policies,* Energy Policy.
[16] Energy and Climate Intelligence Unit (2022), *19 years of free electricity from solar panel payback—analysis.*
[17] The exact barriers can depend on the commercial context for installation, such as whether it is installed by a building owner, a developer under an arrangement with the owner, or the tenant directly; for more information see Lang, K. (2023), *The solar roof-top revolution, a landlord and tenant perspective,* Landlord & Tenant Review.

The state of decarbonization technologies says two things about the roles and responsibilities across the value chain. For the upstream end, emphasis should be on innovation and creating proof-of-concepts. Without them, the lofty forecasts of the required market share of low-carbon building materials look idealistic. Capital is required to fund early-stage demonstrations, creating a key role for public incentives or early-stage financiers. For the downstream end, deployment of existing solutions where they are feasible and practical is crucial for reducing emissions today. As innovation in the upstream end gathers pace, the downstream end needs to send price signals for low-carbon materials to "pull" them into the market.

Figure 5: Techniques for lowering emissions in key building materials lag other low-carbon technologies

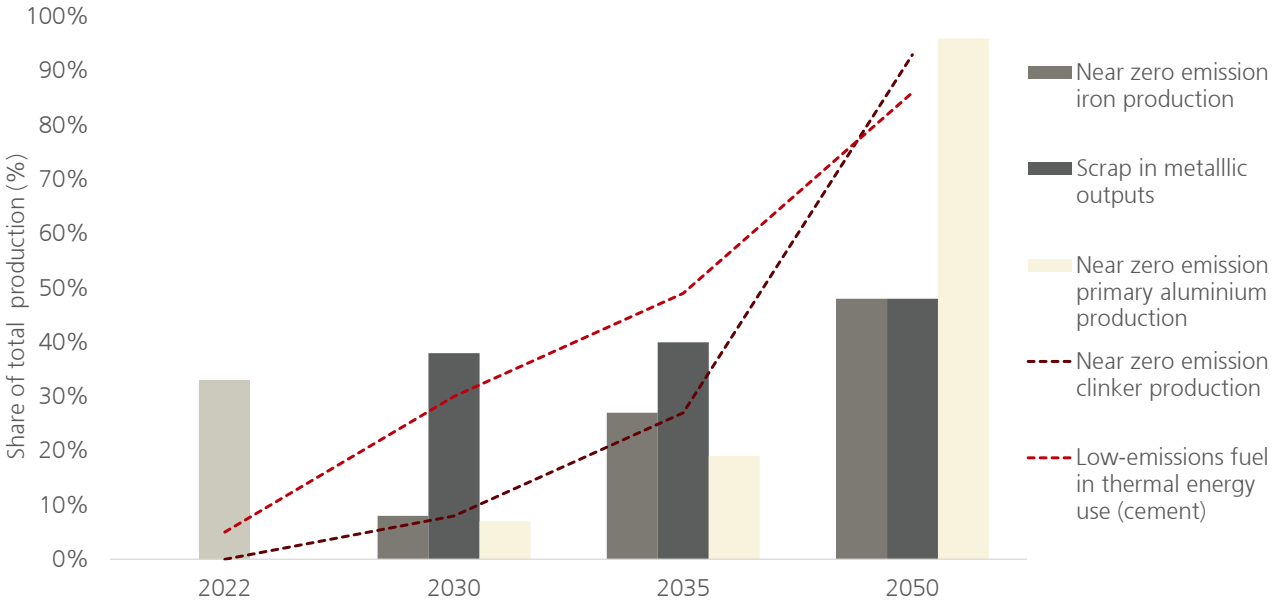
Compared to innovation rates in renewable energy and electrified transport, cement and steelmaking remain in the prototype and demonstration stage.



Note: Technological Readiness Level (TRL) is a framework for rating technologies based on their maturity, from concept to commercialization.
Sources: IEA (2023), UBS

Figure 6: Near Zero emission cement, steel, and aluminum need to commercialize by the 2030s

Lowering the embodied emissions of building materials in line with a 1.5°C path requires rapid innovation and subsequent deployment in low-carbon materials, far above levels today.



Note: Columns relate to steel and aluminum production, lines to cement; absent columns in 2022 are zero values.
Sources: IEA (2023), UBS

Required financing: Achievable and led by private capital

The building sector is capital-intensive, requiring a lot of investment upfront. Real estate is the largest asset class on earth, with a global value of USD 380tr.[18] Excluding other assets within real estate like land, buildings alone represent over a third of global investible real assets.[19] Buildings themselves tend to be the biggest investment people make over their lifetimes. It shouldn't come as a surprise then that the capital required to decarbonize buildings on a global scale is significant.

While detailed forecasts on how to get the sector to Net Zero are possibly too complicated to produce,[20] some analyses attempt to put high-level numbers against it by aggregating the costs associated with key decarbonization technologies. On average, they suggest it could take roughly USD 1tr a year to 2050 to decarbonize the global building sector (Figure 7).[21] At face value this is a large sum but building out energy efficiency would provide localized benefits and paybacks over its useful lifetime, such as cost savings and comfort improvement.[22]

[18] Savills (2023), *Total global value of real estate estimated at $379.7 trillion—almost four times the value of global GDP.*

[19] McKinsey Global Institute (2021), The rise and rise of the global balance sheet: How productively are we using our wealth? Dwellings and non-residential buildings were 31% of global real assets in 2020.

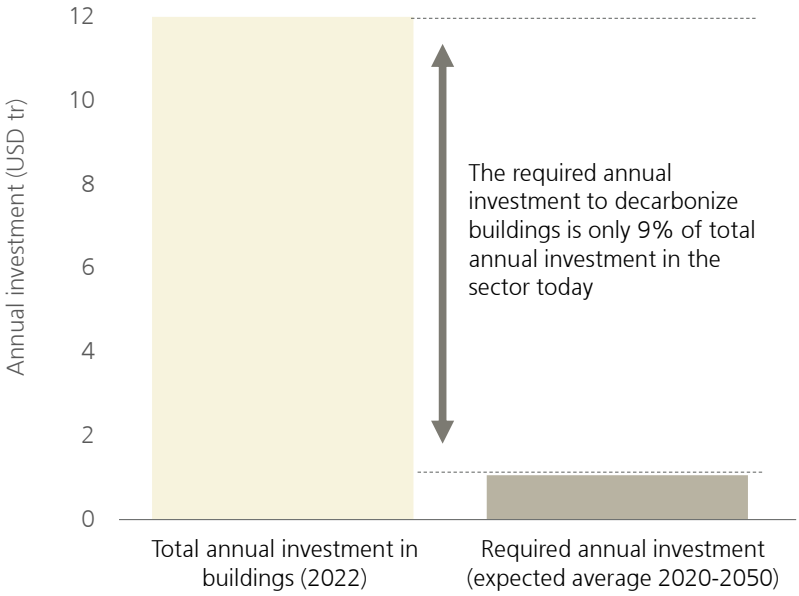
[20] A good overview of the modelling challenge comes from the Energy Transition Commission (ETC), see Appendix A1.3 in ETC (2023), *Financing the Transition: How to make the money flow for a net-zero economy,* P90.

[21] The USD 1tr a year figure is the average annual investment required to decarbonize the building sector between now and 2050, calculated as the mean of a UBS review of five recent Net Zero investment forecasts, from IIGCC, the IEA, McKinsey, IRENA, GFANZ, and the Energy Transitions Commission; we assume the forecasts are comparable, noting each had a slightly different base year (but all within a few years of 2020) as well as different technology mixes used to define the building sector.

[22] UBS Sustainability and Impact Institute (2023), *Retrofit revolution: Why the world needs one and how we can achieve it.*

Figure 7: Required annual decarbonization investment is only a small proportion of sector's total investment

Estimates vary on the required investment to decarbonize existing buildings. The ones included here average at around USD 1tr a year until 2050, which is less than 10% of total investment in buildings today.



Notes: Total annual investment in buildings today is from the Energy Transitions Commission (2023).
Sources: IIGCC (2022); IEA (2022), McKinsey (2022), IRENA (2023), GFANZ (2021), Energy Transitions Commission (2023), UBS

While significant, this figure feels achievable when put into context. It is under one-tenth of total investment in buildings today. Indeed, the case for investing becomes stronger when considering the potential downside of not decarbonizing the building stock; while uncertain, by most estimates the cost of accelerated climate change and low adaptation will be larger than the mitigation costs.[23] Similarly, greener buildings generate other, non-climate benefits. For instance, they tend to be cheaper to run due to significant operational savings, reducing water and energy use by 20 to 40% on average, which can offset any higher upfront capital over the building's lifetime.[24]

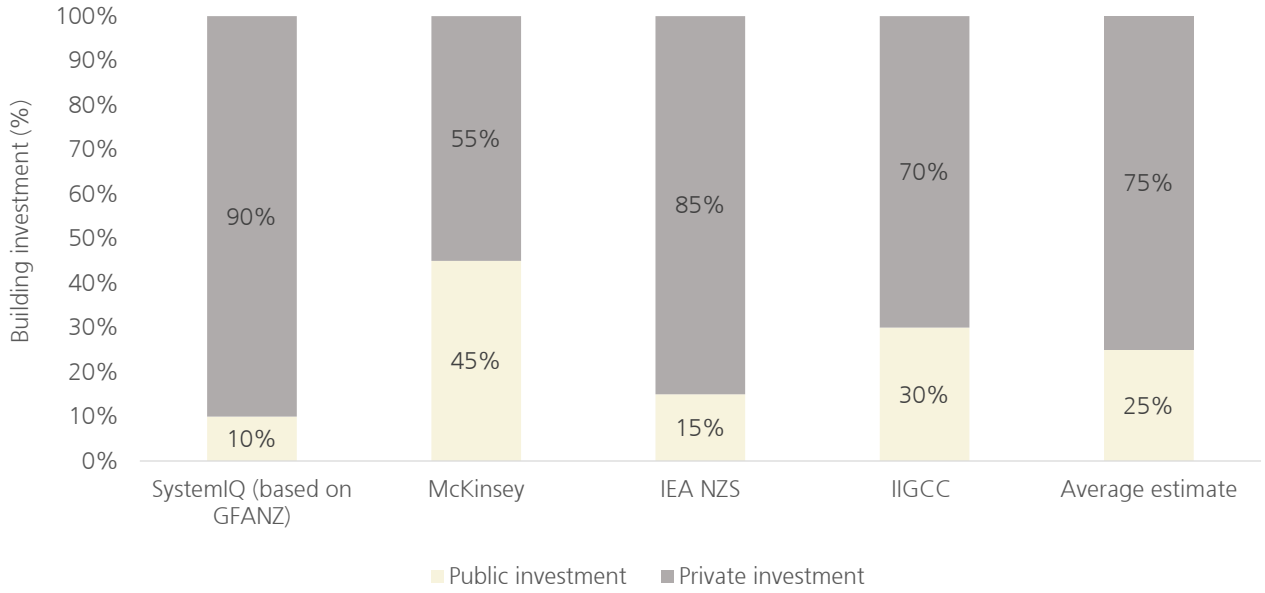
A looming question is, of course, "Who pays"? The building market includes a wide range of stakeholders and assets—from individuals and their houses to companies and their offices and municipal authorities and their public estates. Included in this are stakeholders who do not necessarily own buildings but sell products and services that enable their decarbonization. Across these stakeholders, the motives to decarbonize and the capacity to fund it vary enormously.

Similarly, deploying USD 1tr each year requires an equally diverse set of channels to distribute and price capital across the value chain. The role of private institutions is irreplaceable here, both to provide capital—analyses suggest private organizations could provide 55 to 90% of the capital required to decarbonize buildings (Figure 8)—as well as to develop innovative products and services to meet the sector's diverse capital requirements.

[23] Dietz, S. et al. (2018), *The economics of 1.5°C climate change,* Annual Review of Environment and Resources.
[24] International Finance Corporation (2019), *Building green—The business case.*

Figure 8: The private sector can do the heavy lifting on financing decarbonization in the building sector

Estimates of the private sector's ability to finance the decarbonization of buildings vary between 55 to 90%.



Sources: SystemIQ (2023) based on GFANZ (2021); McKinsey (2023); IEA (2021), as mentioned in IIGCC (2022); UBS

2.2. What's next?

With over 90% of GDP covered by Net Zero targets,[25] governments have implicitly signed the sector up for full decarbonization by 2050. Traditionally a slow-moving area, recent surveys show stakeholders across the sector view decarbonization as an essential commercial driver, despite significant barriers.[26] This sentiment is gradually translating into new products and services; estimates put the potential "value pool"[27] of green products and services in the built environment between USD 800bn and USD 1.2tr out to 2035.[28] Even so, while the direction of travel seems clear, existing market barriers throttle its pace, keeping the sector's emissions far off a 1.5°C trajectory:

- **Information transmission failure** up and down the value chain, from building-level carbon emission assessments to nuanced Paris-aligned trajectories for buildings across submarkets;
- **Insufficient rewards for better buildings** (positive externalities), held back by too few incentives to create better buildings, from public "carrots" to preferential market treatment;
- **Inadequate penalties for worse buildings** (negative externalities), which mean buildings that produce negative environmental, economic, and social impacts remain broadly as acceptable in the market as those that avoid them.

Overcoming these barriers is only possible through a whole-value-chain approach (Figure 9). Diverse solutions needed at the building level, and the incentives and capacities of stakeholders to decarbonize across the value chain, make single-shot or telescopic solutions unlikely to work. For instance, a building in one location can face a very different set of challenges to decarbonize than a similar one elsewhere, from the required technologies to the scale of upfront investment. Those occupying and owning buildings have varying capacities and incentives to decarbonize; some owners

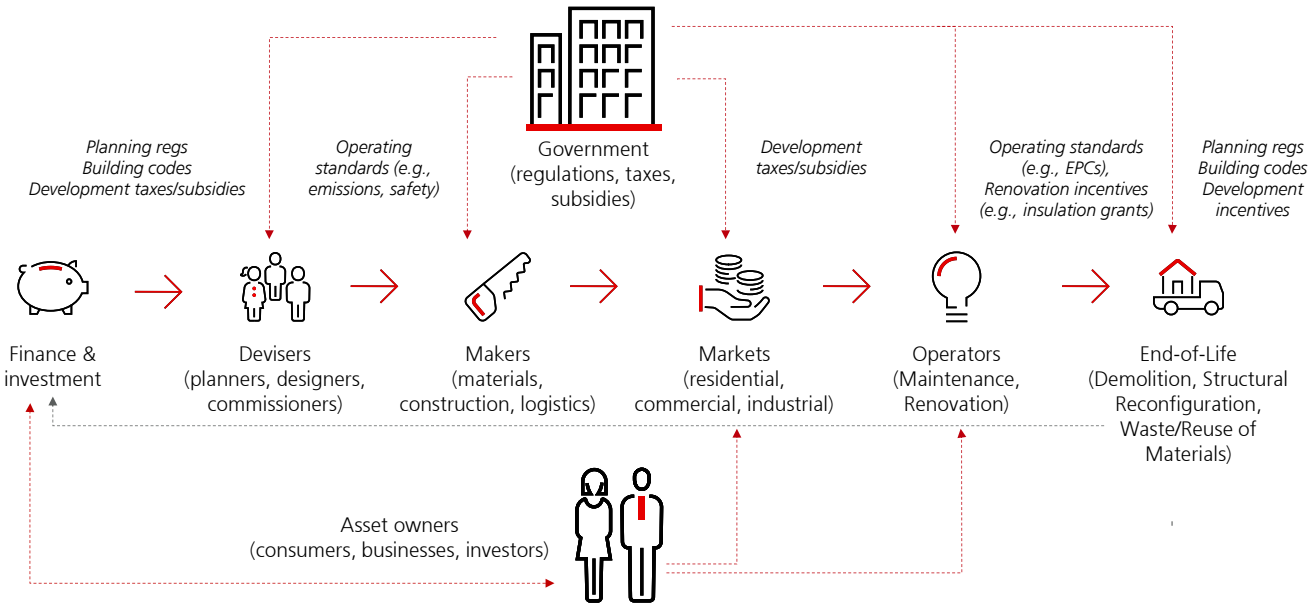
[25] Net Zero Tracker (2023), *Net Zero stocktake 2023.*
[26] Shell and Deloitte (2023), *Decarbonizing construction: Building a low-carbon future,* Page 9; 80% of respondents identified decarbonization as a top three business priority.
[27] Defined as the theoretical potential for new revenues and avoided costs.
[28] McKinsey (2022), *Accelerating green growth in the built environment.*

may lack capital, requiring tailored financing solutions or public incentives, while others may simply ascribe little value to expensive energy efficiency upgrades when the benefits instead flow to their tenants ("split incentives").

However, it is overly simplistic to merely call for a more holistic approach. The real challenge lies in delivering it. Coordinating actions across a complicated global building sector, which spans highly localized submarkets, regulatory regimes, and sets of stakeholders, and deals with assets that last as long as a human life, is beyond any individual link in the chain. Decarbonization scenarios and pathways look increasingly idealistic with every passing year, while sectoral emissions continue rising. The role of public and private institutions will be indispensable for promoting coordinated action, across submarkets and over time, to deliver a decarbonized building sector.

Figure 9: A whole-value-chain approach is critical to decarbonizing the building sector

The diverse solutions needed at the building level, and incentives and capacities to decarbonize across the value chain, necessitate a whole-value-chain approach.



Source: UBS

3. Enabling tomorrow's buildings

At a glance

- The building sector has a large group of stakeholders, who can shoulder the burden of transition together and complement each other.
- The public sector needs to apply its toolbox of subsidies, taxes, and regulation wisely to shape incentives. The private sector can provide the investment needed to finance the transition.
- Seven actions can ensure the private and public sector, individually and working together, bend the curve on building sector emissions.

Across the global building sector, public and private stakeholders can perform core functions to enable decarbonization. These will vary depending on the country—different incentives, policies, regulations, and stakeholders—but generally they apply across submarkets. This section sums up the role of public and private stakeholders, concluding with seven ambitions for the sector to pursue.

Public stakeholders have the authority to address failure

Left alone, the global building sector is unlikely to tackle today's market barriers by generating accurate and reliable sustainability data, or re-pricing buildings along their sustainability credentials, although in some places it is making efforts to do so (Box 3). Typically, only governments and regulators have the incentives (working in the public interest) and the tools (taxes, subsidies, and regulations) to shape the rules and tilt markets toward society's goals.

Public authorities and development finance institutions (DFIs) may need to pragmatically support the most exposed to transition risks, particularly in the residential sector. Any support should be targeted and tracked to avoid wasteful use of scarce public funds. For instance, the owners of commercial buildings that are uneconomic to retrofit may require public incentives to retrofit, convert, or demolish. Otherwise, emissions reductions will go unrealized. Similarly, pricing residential homes against their energy efficiency could hit a wide range of income brackets, making it politically difficult.

Private stakeholders have the capacity to deliver

Private stakeholders in a broad sense have the capacity to deliver decarbonization on a scale that public authorities cannot match. For instance, the scale of capital required to decarbonize the sector means private financial markets will play a central role in decarbonization through long-term, sustained investment. Similarly, most of the world's buildings sit in private hands, so the decision to deploy existing solutions largely rests with stakeholders across the private sector. Private sector deployment of decarbonization solutions, organized and enacted through markets, will be pivotal to achieve Net Zero targets. Although there are no silver bullets, catalyzing the building sector's

decarbonization journey requires private and public stakeholders to perform complementary functions. We propose seven actions for these stakeholders, individually as well as together, to implement these functions.

Box 3: The green premium: Directionally correct but noisy

The green premium in real estate is the idea that tenants and buyers prefer buildings with better green credentials, leading to higher capital values, higher rental yields, and higher occupancy rates. Yet, it is not without complexity and variability. Several reasons combine to blur the picture:

- Studies typically use the green certification of buildings as a proxy for sustainability. The mainstream certifications take a broad definition of green, using multiple factors to define sustainability, including waste, health, water, and transport. This can be useful, but it also blurs the role of specific building traits, such as its climate impact. Some certifications are responding by moving toward more "performance-based" schemes with a focus on climate and energy, which could, over time, provide more nuanced data.[29]
- Most studies focus on central business districts, and so remain focused on offices to the neglect of other building types, such as residential.
- The studies use econometric methods to identify and unpick the factors that drive pricing, which themselves are complicated and dependent on the quality of the inputs.

The conclusion is directional but noisy. Recent studies find a positive association between a building's green credentials and value with wide bands, of between 5–15% for rents, and 5–25% for capital values.[30] It seems positive and clearly non-zero.

3.1. Seven steps to catalyze sustainable building

The whole value chain

1. Form new partnerships to spread the risks of decarbonization:

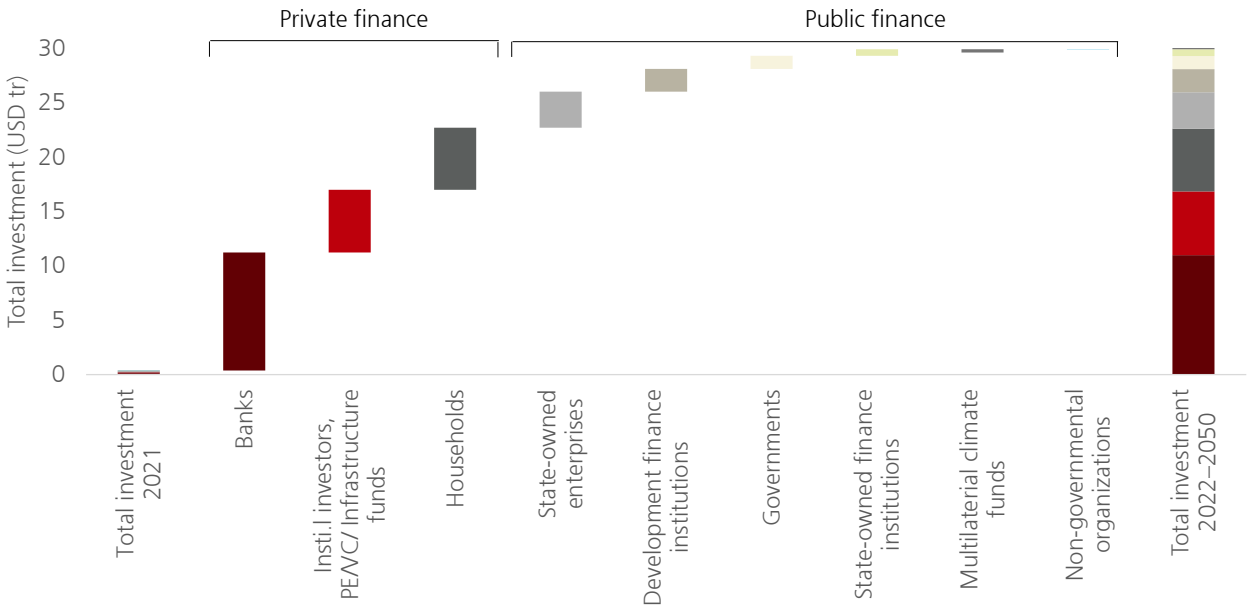
While the private sector will contribute most the capital required to decarbonize buildings, these stakeholders have a range of risk appetites, some of which will be unsuitable for certain decarbonization technologies—requiring different flavors of capital (Figure 10). For instance, institutional investors tend to prefer reliable investments with steady returns, which are better aligned with debt investments. The required innovation on certain early-stage low-carbon building materials naturally presents risks, which might be better suited to early-stage investors, such as venture capitalists or those willing to accept below-market returns (e.g., philanthropists).

The level of funding and speed of deployment required to keep pace with the building sector's decarbonization trajectory means investment needs to be "crowded in" wherever possible, leveraging the sector's already diverse instrument pool (Figure 11). Mortgage-lending banks will play an outsized role here, as the providers of the USD 11tr mortgage market that underwrites an outsized share of buildings finance in many global markets. Work on developing mechanisms like voluntary Mortgage Portfolio Standards has the potential to accelerate the alignment of private institutions with the goals of the Paris Agreement.[31]

[29] JLL (2022), *How are green building certifications moving with the times?*
[30] LaSalle (2023), *What is the value of green? Looking at the evidence linking sustainability and real estate outcomes.*
[31] As mentioned in IEA (2021), *Energy Efficiency*, P38, and the extensive work of Climate Strategy and Partners, such as Sweatman, P. (2021), *Underwriting the renovation wave with Mortgage Portfolio Standards for Energy Efficiency.*

Figure 10: A diverse set of capital providers are needed to meet the demands of end-users

Private financial institutions could finance 55% of total investment in decarbonizing buildings. This is conservative, considering other estimates are as high as 90%.



Note: Based on McKinsey (2023) Transition Investment Model of average annual investment on low-emission assets for 2022 to 2050; Assumptions are made over financiers' risk-return preferences (based on historical investing activities), and these are matched with modeled technology costs pathways under a Paris-aligned scenario; Total investment is based on a meta review of existing studies that cover the building sector.
Sources: McKinsey (2023); GFANZ (2021), IRENA (2023), Energy Transition Commission (2023), IIGCC (2022), UBS

Figure 11: New instruments for channeling capital to green buildings are still emerging

Banks, expected to be the largest capital providers for decarbonizing buildings, could increasingly test new and innovative tools, particularly in partnership with other stakeholders, in addition to their more established levers.

	Traditional and well-established	Tested and growing	New and innovative
Non-repayable rewards	Grants and subsidies Tax incentives	Energy efficiency obligations	Grants and subsidies
Debt financing	Soft loans Leasing	Energy performance control Energy services agreements Revolving funds Commercial loans	Energy efficient mortgages Crowdfunding Property assessment clean energy On-bill finance Guaranteed renovation loans
Equity financing		Energy performance contracts Energy service agreement	Crowdfunding

Sources: Adapted from Bertoldi et al (2020), UBS

Partnerships can facilitate this by spreading the risk, enabling investors with diverse risk-return appetites to invest in projects typically outside of their scope. Three types of partnership exist today, with leading examples in the sector:

- **Public-private partnerships** are typically formed when private capital considers a project unprofitable but the inclusion of public institutions shifts the economic calculus, through either direct funding (grants or tax cuts) or guarantees. Blended finance approaches following this model show promise to overcome capital barriers for retrofitting; a recent example is the Milano Transformation Fund.[32] On average, estimates suggest private capital markets could provide 77% of the investment required to decarbonize buildings (Figure 10). This will not happen organically; the modeling that sits behind this figure assumes governments implement incentives over time to guide investment, such as targeted subsidies for retrofits and steadily rising carbon taxes.
- **Private-private partnerships** can operate through organizations co-delivering a decarbonization product or service based on each organization's specialty, such as banks providing loans for residential retrofits in conjunction with the installers.[33] Another example is energy efficiency "one-stop-shops", which combine offerings from several partners to cover the entire customer journey for retrofitting, from information and technical assistance to finance and monitoring of savings.[34]
- **Public-public partnerships** are useful in situations where governments may not have the expertise or resources to implement energy-efficiency programs but others, such as DFIs, do. A good example is the role development banks play in developing countries through providing expertise and capital where private markets may deem projects unprofitable. For instance, the International Finance Corporation (IFC, a member of the World Bank Group, Box 4) partnered with the UK Government to provide concessional finance to financial institutions in developing countries for green construction and mortgages through a program called the "Market Accelerator for Green Construction."[35] The program includes technical assistance training for local bank officers and their developer clients.[36] By building expertise on the ground, the program promotes self-sustaining growth in local markets.

  Public authorities should use their scarce resources to strategically guide the direction of markets—enabling them to fund, organize, and deliver decarbonization. When doing so, they also need to keep an eye on undesirable outcomes and side effects beyond the pure economic realm. For example, a "green premium" and "non-green discount" that reprices mortgages could be highly regressive, where (typically) the lowest income brackets live in properties with the lowest green credentials. Given these concerns, retrofitting in the residential market is a good candidate for direct public support.

2. Encourage innovation upstream

Significant innovation is required on technologies to reduce embodied emissions. Forward-looking scenarios assume these technologies commercialize enough to earn double digit market share in the 2030s—low innovation rates in the upstream means no Net Zero for the building sector. As conceptualized in Figure 12, the journey from basic research to diffusion throughout markets is a difficult gap to bridge and rarely linear. Public and private stakeholders plug in throughout, from subsidizing early stages ("technology push"), to public-private pilots during demonstration, to final market demand ("market pull").

Evidence from other low-carbon technology success stories suggest several processes are critical to scaling, including: efficient innovation drivers (such as early-stage grants); efficient learning processes that recycle knowledge and drive costs down the learning curve over time (such as industry forums); clear system frameworks that provide economic incentives (such as public or private guarantees of

[32] Braune, A. et al (2021), *White Paper: How blended finance can catalyse building renovation,* Climate KIC.
[33] A product offered by BNP Paribas in conjunction with EDF. Similarly, several leading Dutch banks have interesting offerings combining green mortgages with home energy efficiency assessments, offered by partnership with external providers.
[34] Boza-Kiss, B. and Bertoldi, P. (2018), *One-stop-shops for energy renovations of buildings,* JRC Science for Policy report.
[35] IFC (2023), *Market Accelerator for Green Construction Program.*
[36] International Finance Corporation (2022), *IFC's Provides $200 Million Loan to Help Scale up Green Finance in Colombia.*

purchase); and facilitative market dynamics (such as ease of integration with business models).[37] These processes lead to the classic "hockey stick" growth charts, which can already be plotted for some building decarbonization technologies in the downstream value chain like heat pumps.[38] Complete decarbonization of the sector requires a similar story in the upstream end.

Box 4: Rusmir Musić, Climate Finance Expert and Operations Officer, IFC, on the role of DFIs in decarbonizing the global building sector.

Development finance institutions such as IFC act like the financial backbone in many markets, providing crucial support where standard capital markets may fall short. Imagine a bank wondering how to green its local loan book, but lacking the technical know-how, or remaining hesitant due to unfamiliarity with green certification; or a business looking to retrofit its multi-story office, but the economics just not stacking up due to interest rates in the double-digit percentages.

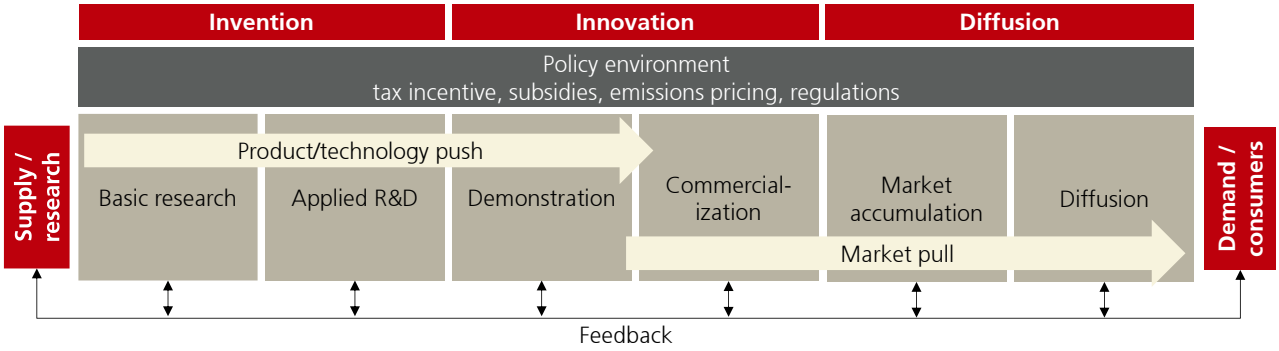
Here's where Institutions like the IFC step in, bridging the gap with tailored financial solutions and products, ensuring projects like these get off the ground. In Colombia, IFC helped create a market transformation, where the market grew in just a few years from almost no green buildings to 26% of all new real estate construction now being certified as green. The intervention was a combination of investments—first direct investments in demonstration projects and then more sweeping programs through local banks; partnership with CAMACOL, the local Chamber of Construction, for business case awareness; and public policy which created tax incentives for certain green technologies. IFC's EDGE green buildings program provided the basis for developers to assess their buildings for green criteria, and then certify them in order to comply with green finance.

The developing country story can sometimes get neglected when it comes to discussion on decarbonizing buildings. Most developers and building owners believe green buildings are something only for rich countries or top-end properties, but not available for their countries or to the residential sectors. IFC is working hard to educate them about the business case for green buildings, partnering with groups like Sustainable Hospitality Alliance to talk about the hotels sector or the Center for Affordable Housing Finance in Africa to talk about residential. The fundamental economics of green building makes a lot more sense in these markets too, given energy costs are a higher proportion of household and company budgets, so saving on energy bills creates a lot of economic value. In areas where the IFC works, energy efficiency upgrades aren't just a nice-to-have for the climate; they can have substantial economic and social impacts. In Pakistan, where electricity prices and temperatures both skyrocketed recently, clients are eager to retrofit because they face store closures if their utility bills for space cooling become too high.

So, in essence, development finance institutions are not just financiers; we're enablers of a sustainable future, ensuring that every corner of the globe has access to the resources needed for greener, more efficient buildings.

[37] Markard, J. et al. (2015), *The technological innovation systems framework: Response to six criticism,* Environmental Innovation and Societal Transitions.
[38] LCP Delta (2023), *Are heat pumps at the inflexion point on a hockey stick-shaped growth curve?*

Figure 12: Getting from idea to market involves traversing a risky and long path.



Sources: Adjusted from Grubb, M. et al (2014), UBS

Actions the public sector can take

3. Offer public incentives where they push the needle

Public authorities should use their scarce resources to strategically guide the direction of markets—enabling them to fund, organize, and deliver decarbonization. This is particularly important in fiscally-restricted developed markets, where public authorities also have lower technical and labor capacities—a key gap partly filled by DFIs (Box 5). When doing so, they also need to keep an eye on undesirable outcomes and side effects beyond the pure economic realm.

An example of undesirable social outcomes sits in the potential effects of repricing buildings in the residential sector. A 'green premium' that reprices mortgages could be highly regressive, where (typically) the lowest income brackets live in properties with the lowest green credentials. Given these concerns, retrofitting in the residential market is a good candidate for direct public support.

Box 5: The European Bank for Development and Reconstruction (EBRD): Sharing risks and providing due diligence

The EBRD is a multilateral development bank originally founded in 1991 to build market economies in the former Eastern Bloc. On green buildings, the bank undertakes:[39]

- **Advanced due diligence:** EBRD specializes in advanced due diligence in the countries in which it operates, providing skillsets that international capital providers may lack. One example is assessing building performance in a way that is comparable across country-specific buildings codes (e.g., kWh / per floor area).
- **Direct and intermediated financing solutions** to promote green buildings, including new construction and refurbishment. In 2022, more than 85% of all EBRD's financing to buildings was "green", which is buildings performing above and beyond national standards and international benchmarks. As part of its financing work, EBRD develops green standards by engaging with national and local authorities, such as through its Green Cities program, helping to parachute international standards into local markets.

Another examples is the inelasticity of today's 'retrofit supply chain'. As demand rises for retrofit solutions, the supply chain is likely to keep pace, particularly on labor supply. Take the UK, it would need 27,000 trained heat pump engineers to meet its installation targets for 2028, nine times the 3,000 currently trained.[40] Public incentives can clearly play a role to push the needle here,

[39] EBRD (2020), *Innovative financing for green building.*
[40] Nesta (2022), *How to scale a highly skilled heat pump industry.*

complementing market repricing, such as training schemes to increase the supply of trained retrofitters for key decarbonization technologies, or favorable fiscal measures.[41]

4. Foster market certainty

Decarbonizing the building stock places big asks on asset owners to look at their investment decisions partially through a climate lens. Confidence in the direction of travel is fundamental to convince the sector that transition risks should be taken seriously in the present, rather than in a few decades. Public stakeholders, including public authorities[42] and DFIs, can foster this confidence by defining the direction of travel and sending signals about its pace. Signals take a variety of forms, from soft power through dialogue to hard signals in the forms of longer-term regulation and policies that set a specific date for a key action, such as rising energy-efficiency standards.

The key to market certainty is sending consistent signals. This can take different forms, from "hands slightly off" approaches like encouraging disclosure, to "hard start" ones like mandatory standards. For instance, high levels of disclosure and data sharing creates a sense of direction in the market. Australia achieves this through its NABERS scheme, which requires asset owners to disclose energy performance to tenants or buyers. Chicago takes this a step further: Large buildings must disclose their performance data publicly online, while prominently displaying their certification labels.[43]

Other countries foster certainty through sticks, such as mandatory energy-efficiency standards for elements of the commercial sector. This is the case in the Netherlands, which expects offices to have an energy label rating "C" today (a standard 50% are estimated to fall below), rising to "A" by 2030, or they cannot be rented or used.[44] As a result, ABN Amro and ING both launched Mortgage Portfolio Standards in the country, which apply a rising minimum energy-efficiency standard to banks' loan books.[45]

5. Create common metrics

Public institutions can help promote comparability of data and concepts by lending credibility to common understandings and promoting their uptake in the market through regulation and other means. For instance, governments can promote the use of a single standard by linking it to regulations, such as energy-efficiency standards, or within grant or loan structures, where the distribution of funds is linked to achieving a specific certification. The EU taxonomy for sustainable activities, while not perfect,[46] is a good example of efforts to create convergence around a coherent idea of a green building. The effect is to amplify the best concepts that exist today, so that they rise to the top, rather than drown in the noise.

Private institutions can also rally behind specific certifications and disseminate their use throughout markets through common groups, such as industry collaborations. For instance, fixed income green bonds promote green buildings, given that they include fairly transparent terms on the use of proceeds (i.e., the funds must be used for greening buildings) and reporting requirements. Underlying many of these bonds are common green building certifications, which combine climate and non-climate factors to produce ratings. Climate-focused capital providers and issuers could look to use certifications that are more climate- and energy-focused. One such standard is EDGE, whose thresholds are explicitly linked to climate and energy (e.g., achieve a 20% improvement in energy efficiency versus the local market baseline), reflecting a building's climate impact more explicitly than certifications that include multiple, non-climate factors.[47]

[41] In the UK, VAT applies to retrofitting but not new builds; see Farey, P. (2022), *Use tax relief on retrofits to cut carbon,* AECOM.
[42] Including governments, subnational authorities like cities, and regulators.
[43] City of Chicago (2023), *Chicago energy rating.*
[44] McAllister, P. and Nase, I. (2023), *Minimum energy efficiency standards in the real estate sector: a critical review of policy regimes,* Journal of Cleaner Production, 393; EIB (2021), *Stimuleringsmaatregelen verplicht energielabel voor kantoren* as mentioned in McAllister and Nase (2023).
[45] Sweatman, P. (2021), *Underwriting the renovation wave with Mortgage Portfolio Standards for energy efficiency.*
[46] Some classification issues remain, such as difficulty accessing the required data and divergences in how European countries have implemented EU-wide standards; see WGBC (2023), *Energy Performance Certificates (EPC): Implementation of the EU Taxonomy in the built environment.*
[47] Thomas, S. et al. (2020), *Why did an international bank create a green building system?*

Actions the private sector can take

6. Offer products and services that make decarbonization easy

If demand for decarbonization increases, such as after the introduction of targeted subsidies, emissions will only be reduced if the market can elastically respond by supplying key solutions, from heat pumps to surveys. Avoiding supply-side frictions requires a diverse ecosystem of solution providers. These are hard to summarize completely.[48]

A promising but relatively old model for simpler retrofit projects, which typically means the residential sector, is the creation of "one-stop-shops." A provider bundles retrofit products and services from across the market into a single contract, such as financing from banks, and installation services from utilities, to make retrofitting an easier experience for the owners of buildings. The contracts can also include terms guaranteeing energy savings and minimum quality of the retrofit, alleviating uncertainty over the benefits of retrofitting. [49] One-stop-shops can also provide flexibility on the financing barriers to retrofitting (high upfront costs) through partnerships. For instance, rather than an individual paying back a standard loan, repayments could be gathered through energy bills (in partnership with utilities) or through local property taxes (in partnership with local authorities).

7. Deploy solutions

While there are solid arguments for spreading the costs and risks of decarbonization between private and public stakeholders—given tackling emissions is a public good—eventually the responsibility for decarbonizing these assets lies with their owners or, depending on the asset, their occupiers.[50] Indeed, deployment is often about practicality as well as cost; for instance, most investment is required in building insultation and heating, both of which are major projects that often require occupiers to shift their use of buildings. While public incentives can ease the cost of moving away from fossil fuel heating or make it increasingly costly to avoid doing so over time, the decision on how and when to install one, in most cases, lies in private hands.

Some analyses suggest building green from the start incurs slightly higher marginal building costs due to factor like higher appliance costs and design fees.[51] However, the business case for green buildings is compelling, especially in commercial and residential markets in developing countries, where energy savings tend to be substantial proportion of income.[52]

[48] For a summary of the most promising solutions from a value creation perspective, see McKinsey & Company (2023), *Building value by decarbonizing the built environment,* Exhibit 3.
[49] For a recent review see Pardalis, G. et al. (2022), *Comparing public- and private-drive one-stop-shops for energy renovations of residential buildings in Europe,* Journal of Cleaner Production.
[50] Baker McKenzie (2023), *United Kingdom: Green Leases—Less talk, more action.*
[51] Chegut, A. et al (2019), *The price of innovation: An analysis of the marginal cost of green buildings,* Journal of Environmental Economics and Management; this fact is particularly presented in the IFC's work on the business case for green buildings in developing countries.
[52] The IFC has done extensive work on the business case for green buildings here, see IFC (2019), *Green Buildings: A financial and policy blueprint for emerging markets;* IFC (2023), *Building green: Sustainable construction in emerging markets.*

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