UN environment programme

Beyond foundations

Mainstreaming sustainable solutions to cut emissions from the buildings sector

Global Alliance for Buildings and Construction

Global Status Report for
Buildings and Construction

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Foreword

The world is not on track to achieve the Paris Agreement goals, a stark fact highlighted by UNEP's Emissions Gap Report 2023. It underscored the urgency of tackling the climate crisis, with recent years seeing a disturbing acceleration in the number, speed and scale of broken climate records.

This troubling state of affairs is reflected in the buildings and construction sector. For yet another year, the Global Status Report for Buildings and Construction tells us that overall energy demand and emissions of the buildings sector continued to grow, rising by about 1 per cent from 2021.

The need to take action has never been greater: about 60 per cent of the buildings that will exist by 2050 have not been built yet and 20 per cent of existing building stock needs to be renovated to zero-carbon-ready by 2030. At COP28, twenty-eight countries launched the Buildings Breakthrough, committing to make near-zero emission and resilient buildings the new normal by 2030.

There is much to do. There is a still a lack of investment in decarbonizing buildings, while current global economic instability is further slowing green building investment. Innovative business models and well-defined metrics to guide decision making are needed, along with digitalization to improve data. The introduction of reporting requirements for the financial sector through regulation will also incentivize green investments.

While energy efficiency measures are a high priority, they must be combined with material efficiency strategies. Embodied carbon emissions still represent more than a quarter of the sector's emissions and are set to grow. The challenges of a changing climate also need to be taken on board – retrofitting existing buildings and designing new ones with climate extremes in mind is essential.

As per article 4.9 of the Paris Agreement, every country must commit to new national climate plans aligned with the 1.5°C limit by 2025. Most National Determined Contributions (NDCs) still lack clear actions and targets towards building energy efficiency and adaptation measures. Let us seize this moment to raise ambition levels in NDCs through actions in the buildings and construction sector.

Dechen Tsering
Director a.i., Climate Change Division

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Abbreviations

BECs	Building Energy Codes
EPBD	Energy Performance of Buildings Directive
ESCos	Energy Service Companies
IEA	International Energy Agency
IDB	Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
GlobalABC	Global Aliance for Buildings and Construction
GBCT	Global Building Climate Tracker
GHG	Greenhouse Gas
MEPS	Minimum Energy Performance Standards
NbS	Nature-based Solutions
NDCs	Nationally Determined Contributions
NZE	Net Zero Emissions
UAE	United Arab Emirates
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNOPS	United Nations Office for Project Services
WorldGBC	World Green Buildings Council
ZEB	Zero Emissions Building

Support statements

Rasmi Hamzeh
Director

Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) / Ministry of Energy and Mineral Resources (MEMR), Jordan

It's concerning that investments in building energy efficiency are declining. The engagement of governments to offer financial incentives and enforce policy regulations is crucial, to accomplish our objectives in this sector. Climate change will raise energy costs, especially affecting Jordanian households. Energy-efficient buildings save individuals from energy poverty and guarantee the stability of their livelihoods. We highly value the Global Status Report and the knowledge base it provides.

Every year, the GSR provides crucial evidence, insights and recommendations that inform stakeholders´ efforts to increase ambition in the buildings and construction sector and to accelerate implementation of the policies and initiatives that will help us achieve our collective climate goals. Germany is very glad to continue to support the GlobalABC´s important work in accelerating the transformation and decarbonization of the buildings sector.

Berthold Goeke
Director General for Climate Action

Federal Ministry for Economic Affairs and Climate Action (BMWK) Germany

Hassan Middib
Director
President of Technical Directorate/ Architect Eng.

Ministry of Construction and Housing & Municipalities Public, Republic of Iraq

Iraq issued codes (The Green Architecture, Thermal Insulation and Natural Lighting). Energy Efficiency in Building Code will be prepared. It has begun implementing sustainable cities, which contain green spaces and take into account thermal insulation in walls, windows, and roofs. It will complete a building that has (PREEAM). Repairing government institutions and making sustainable.

Le Sénégal, s'engage depuis 2017 dans la promotion des bâtiments durables. Depuis un an, notre collaboration avec GlobalABC acte notre détermination à intégrer les meilleures pratiques internationales en matière de bâtiments durables. Le ministère soutient l'initiative Buildings-GSR, essentielle pour structurer le secteur. La collaboration étendue vise à créer un réseau fort pour un impact accru dans la lutte contre le changement climatique.

Amadou Thiam
Directeur Général de la Construction et de l'Habitat

Ministère de l'urbanisme du logement et de l'hygiène publique, Sénégal

Executive Summary

Key messages

The buildings and construction sector contributes significantly to global climate change, accounting for about 21 per cent of global greenhouse gas emissions. In 2022, buildings were responsible for 34 per cent global energy demand and 37 per cent of energy and process-related carbon dioxide (CO_2) emissions. Despite a 3.5 per cent reduction in energy intensity, overall energy demand and emissions rose by about one per cent from 2021.

Policy progress is evident with more comprehensive climate action plans covering buildings and construction in Nationally Determined Contributions (NDCs). However, few align with net-zero operational emissions, and while over 81 countries have building energy codes, many are outdated.

Investment in building decarbonisation exceeded US$285 billion in 2022 but is expected to decline in 2023, largely due to a less favourable investment environment due to rising costs. The necessary increase in investments falls short of the net-zero targets for new and existing buildings by 2030 and 2050, respectively.

The 2022 update of the Global Buildings Climate Tracker (GBCT) paints a concerning picture: the gap between the current state and the desired decarbonisation path is significant. The GBCT indicates that to align with the 2030 milestone, an annual increase of ten decarbonisation points is now required, a substantial jump from the six points anticipated per year starting in 2015.

To reach the goals of net-zero carbon emission buildings for new buildings by 2030 and existing buildings by 2050, stronger policies are needed to enhance energy efficiency and address carbon emissions from building materials and construction. National efforts are crucial, with countries forming coalitions to share best practices and promote low-carbon construction.

Buildings and construction sector in review

Since the 2022 Global Buildings Status Report, the construction sector has seen significant changes. Post-pandemic recovery has spurred construction activities, driven by eased supply chain disruptions and a rebound in housing demand. However, inflation and global interest rate hikes have tempered growth, particularly affecting developing countries like China, Mexico, Indonesia and India.

Geopolitical tensions and conflicts have added to global energy market instability, affecting the construction sector. Despite these challenges, global efforts to mitigate the sector's climate impact have been notable, with initiatives like the Buildings Breakthrough at COP28 aiming for a net-zero, resilient and inclusive buildings sector.

Looking forward to 2024, the focus must be on tangible emission reductions, enhancing building performance, increasing renewable energy use and addressing housing and energy access disparities. Despite the complexities, strategic partnerships can facilitate the shift to an efficient, resilient and whole life net-zero carbon global building stock.

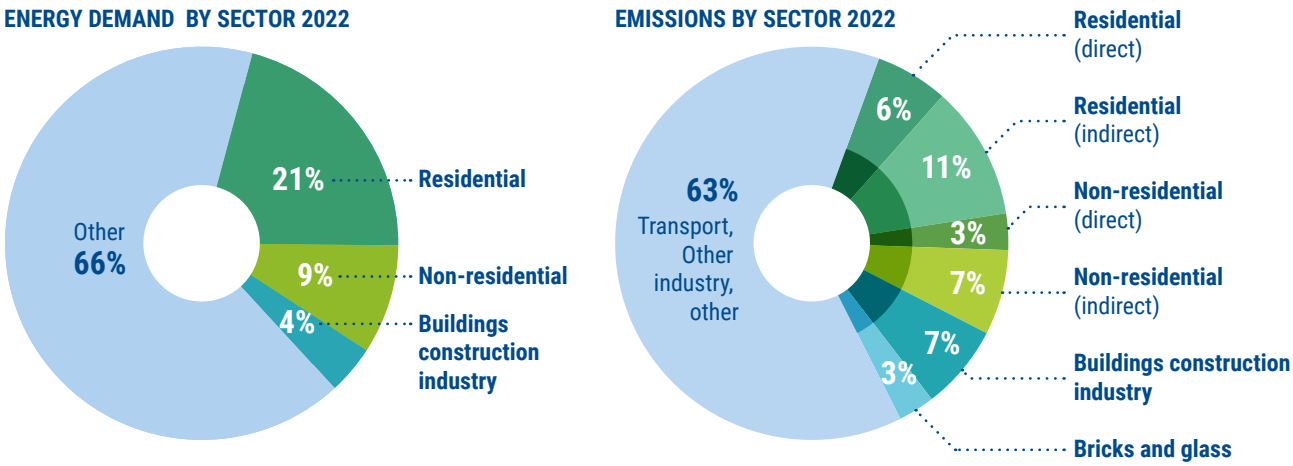
Global buildings and construction status

In 2022, the global buildings sector was a major energy consumer, accounting for 30 per cent of the final energy demand, primarily for operational needs like heating and cooling. Including the energy for producing construction materials, this figure rose to 34 per cent. Energy demand in the sector has grown by just over one per cent annually, with electricity use in buildings increasing from 30 per cent in 2010 to 35 per cent in 2022 of total final energy demand, in parallel with a shift towards renewables.

CO_2 emissions from building operations and construction reached new highs in 2022, making up 37 per cent of total global CO_2 emissions to just under 10 gigatonnes (Gt) CO_2, due to emissions from buildings operations and material production. This reflected a growth in indirect emissions related to electricity use to 6.8 $GtCO_2$, while direct emissions from buildings have declined slightly to three $GtCO_2$. The production of materials used in the construction process for cement, steel and aluminium added a further 2.5 $GtCO_2$, with brick and glass production contributing around 1.2 $GtCO_2$.

Energy intensity per square meter improved by 3.5 per cent from 2021 to 2022, thanks to better building codes and fabric performance, especially in colder climates. However, a significant number of countries are still lack building energy codes. Retrofit rates must increase significantly to meet the Paris Agreement's target of a 50 per cent reduction in carbon emissions by 2030.

Figure 1 Share of buildings in total final energy consumptions in 2022 (left) and share of buildings in global energy and process emissions in 2022 (right)



(Source: IEA 2023a. Adapted from 'Tracking Clean Energy Progress')

Notes: Buildings construction industry refers to materials used in construction, including concrete, steel and aluminium. Other materials shown separately.

Sustainable buildings and construction policies

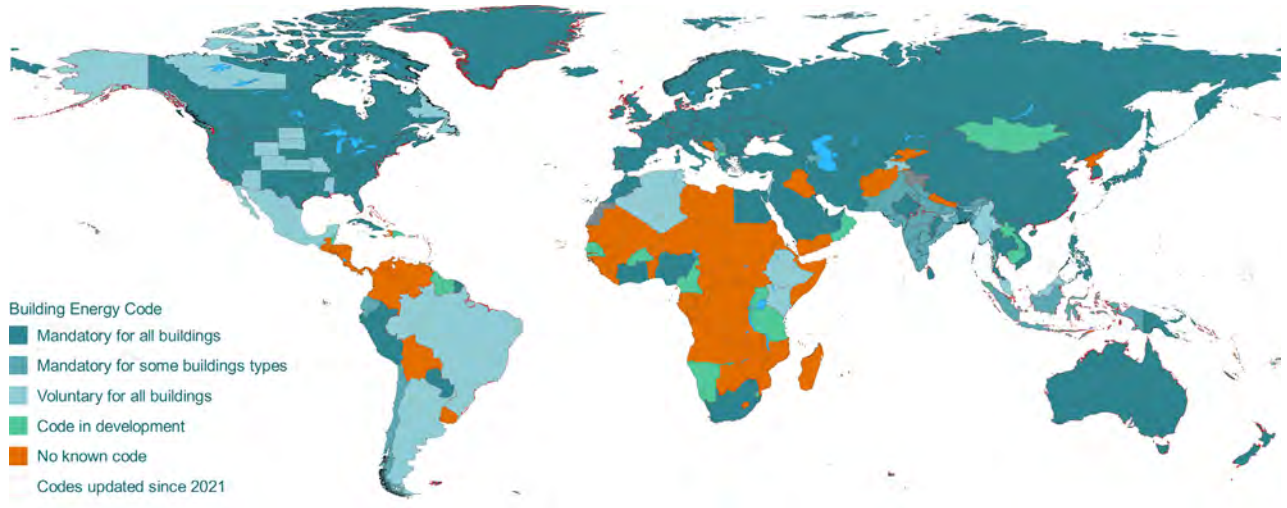
The global policy environment for building sustainability is diverse and evolving. While some nations lack comprehensive strategies for emissions reduction, an increasing number are implementing regulations to not exceed the 1.5°C global temperature increase threshold. The European Union, for instance, has revised its Energy Performance of Buildings Directive (EPBD) to mandate zero emission standards for new buildings by 2030, and plans to phase out fossil fuel boilers by 2040. India, attributing 40 per cent of its CO_2 emissions to buildings, enacted legislation in 2022 to initiate carbon trading and sustainable building codes.

By 2023, the global number of building codes has grown to 81 for residential and 77 for non-residential structures, with 80 per cent being mandatory. However, over 30 per cent of these codes have not been updated since 2015, potentially falling short of high-performance standards. With 80 per cent of floor area growth by 2030 expected in developing economies, many lack stringent energy codes, presenting an opportunity for improved enforcement and alignment with net-zero CO_2 goals.

Recent updates in various countries are aligning with the Paris Agreement and the European Union's EPBD. Examples (see Section 3.2) include France's RE2020, Denmark's 2023 regulations, California's 2022 standards, the United Kingdom 2021 Building Regulations, Singapore's 2021 Code for Environmental Sustainability, China's latest energy performance code, and Sri Lanka's Energy Efficiency Building Code 2020.

Under the Paris Agreement, governments are expected to enhance their commitments every five years through their NDCs. As of December 2023, 194 countries and the European Union have submitted NDCs, with 48 updates since 2022. However, only 11 updates expanded on building-related actions. For example, the United Arab Emirates targets a 56 per cent reduction in building emissions by 2030 through updated codes and renewable energy initiatives. Despite these efforts, G20 nations lack extensive buildings coverage in their NDCs, and overall progress remains modest.

Figure 2 Global building energy codes by type and status



(Source: IEA 2023)

Note: Countries with dark 'red' outline have adopted updated building energy codes since 2021.Investment and financing for sustainable buildings

Transitioning to net-zero buildings necessitates strategic use of policy and financial tools. By using policy tools, such as capacity development, mandates and incentives in collaboration with financial tools, such as grants, equity instruments, risk mitigation tools, contracts, asset finance models and others, investment barriers in energy-efficiency and low-carbon technologies can be overcome.

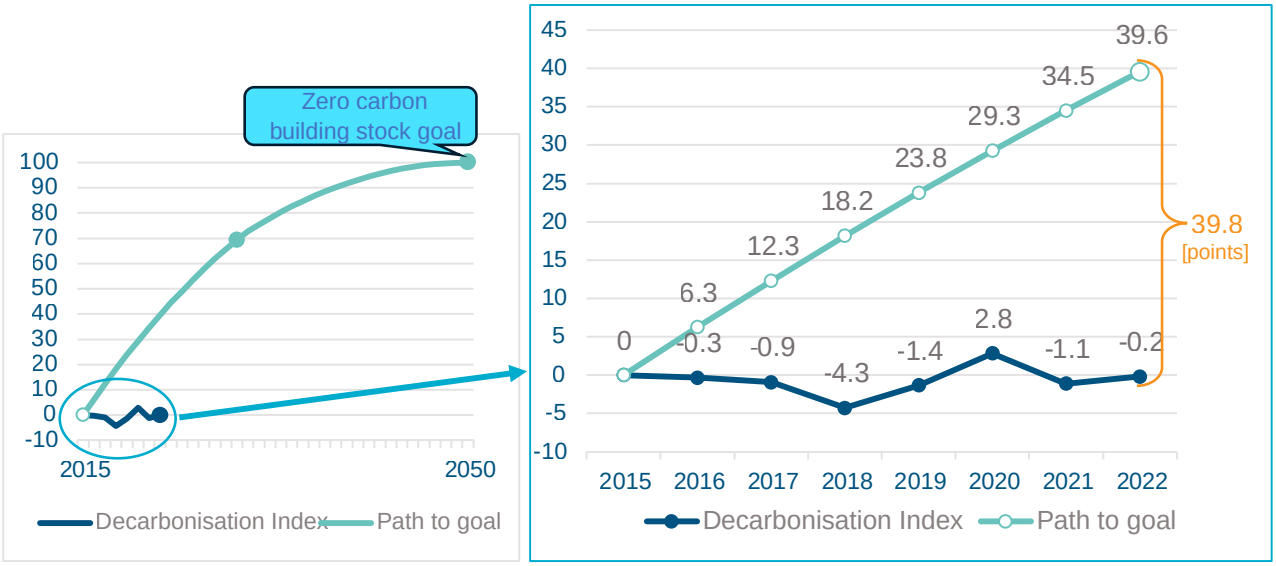
Global investment in building energy efficiency rose by approximately 14 per cent in 2021, to US$285 billion. The increase was largely driven by public investment and Europe's response to energy insecurity. Major markets like the United States of America (USA), Germany and Italy significantly contributed to this increase. However, some countries like China, France and the United Kingdom experienced a decrease in efficiency spending due to a slowing construction sector and changes in government programs. Projections for 2023 suggest a potential slowdown in spending due to increased borrowing costs, economic uncertainty and geopolitical conflicts. The investment is expected to drop to US$270 billion in 2023. Nevertheless, energy efficiency investments offer a way to mitigate risk exposure to energy cost volatility and reduce emissions at the same time. Despite the projected reduction in efficiency spending, investments are increasingly being directed towards technologies that enable net-zero carbon-ready buildings. However, the lack of knowledge around energy efficiency investment remains a barrier to adopting strategies that reduce perceived risks associated with these investments.

Global Buildings Climate Tracker

Launched in 2020, the GBCT assesses progress in the decarbonisation of the building sector from 2015, the year the Paris Agreement was established. The 2022 update of the GBCT paints a concerning picture: The gap between the current state and the desired decarbonisation path is significant, amounting to a gap of 40 decarbonisation points. The observations show that the decarbonisation of the building stock worldwide is lacking significant progress. In fact, the index is at similar levels in 2022 as at its start in 2015. To align with the 2030 milestone, the GBCT requires an annual increase of 10 decarbonisation points to get back on track, a substantial jump from the 6 points anticipated per year starting in 2015.

The GBCT uses a seven-part index to measure decarbonisation efforts against a 2050 target, with a 2030 milestone for interim progress. This index includes CO_2 emissions from building operations and six other indicators, divided into impact (energy intensity and renewable energy share) and action (energy efficiency investments, green building certifications, NDCs for buildings, and building energy codes), with CO_2 emissions acting as a multiplier. A detailed view on the indicators shows that CO_2 emissions from buildings operations have increased by 5.4 per cent since 2015, and the energy intensity reduction is far below the necessary level. Renewable energy use in buildings has only marginally improved, and the uptake of green building certifications is lagging. Policy-wise, only a handful of countries have detailed NDCs for buildings or building energy codes aligned with zero energy building (ZEB) principles. To meet the 2050 decarbonisation goal, it's imperative to accelerate the implementation of effective measures, and to strengthen the reporting, monitoring, and verification of both the measures and the indicators.

Figure 3 **GBCT decarbonisation index. Left: Reference path until 2050. Right: Zoom in for the 2015-2022 period**



(Source: BPIE)

Buildings climate policy gap review

The GBCT has identified a concerning lack of progress in decarbonising the global building stock, a crucial step towards the net-zero carbon goal by 2050. However, opportunities exist to bridge these gaps through targeted policy actions.

The GBCT's analysis compares the 2015-2022 period with a decarbonisation reference path based on the International Energy Agency's Net-Zero Emissions (NZE) scenario. A proposed 'get on track' path suggests an accelerated approach to meet the reference path, provided that efforts are made soon.

Key indicators include CO_2 emissions from building operations, which were 40 per cent above the target of 7.0 $GtCO_2$/year in 2022. To realign, a yearly reduction of approximately ten per cent in CO_2 emissions is necessary until 2030. The energy intensity in the building sector must decrease by 37 per cent from 2015 levels to 96 kWh/m^2 by 2030. As of 2022, there was a modest reduction to 145.3 kWh/m^2, still 15 per cent above the target trajectory.

Renewable energy's share in buildings' final energy consumption was only six per cent in 2022, necessitating an annual increase of 1.5 per cent points to meet the 18 per cent target by 2030. In 2022, the cumulative investment in energy efficiency and high-performance buildings should have been 40 per cent (of the goal value) higher, totalling US$2.7 trillion.

Green building certification growth is also slow, reaching only 9.1 points by 2022, compared to the required 16.3 points. NDCs must incorporate detailed actions for the building sector's decarbonisation. As of 2022, only 3.3 per cent of building energy codes meet zero emission principles, far from the 2030 target of all G20 members and half of the other countries having respective codes in place.

Adaptation and resilient construction methods

As global temperatures rise, the built environment must adapt to more frequent extreme weather events like storms, floods and wildfires. The Intergovernmental Panel on Climate Change (IPCC) emphasizes the importance of resilience and adaptation in both building operations and materials to withstand these climate impacts.

Existing buildings, particularly high-density ones, face an increased risk of overheating as temperatures continue to rise. This is a significant challenge in low-income economies where financial constraints and informal building techniques make it difficult to construct resilient structures.

Furthermore, sea level rise, intense hurricanes and flooding present growing challenges. Buildings in flood-prone areas are particularly vulnerable, with potential damage impacting property values, insurance costs and community resilience.

Poor building practices can contribute to maladaptation, leading to increased energy consumption and greenhouse gas emissions. To mitigate these risks, it's crucial to incorporate sustainable building practices, including passive design measures, energy-efficient materials and strategic design.

Retrofitting existing buildings and designing new ones with climate extremes in mind is essential. Building codes need to be updated to incorporate future warming estimates and past extreme weather events. More guidance for adapting buildings to climate change is needed. Recent European Union guidance outlines the risks and adaptive measures that can be taken for buildings in the face of increased heat, storms, heavy precipitation, flooding, subsidence and drought. It also provides best practice guidance for policymakers and industry actors across these risk domains.

Innovations in business cases for renovation and green building construction industry

The construction sector has among the lowest productivity within the global economy. It needs to boost building decarbonisation to address climate challenges, requiring innovative business models. These models enhance renovation efficiency and cost-effectiveness through central planning and coordination. For instance, an approach in Germany has achieved a deep renovation of a building into a climate-neutral structure in just 22 working days.

Standardizing best practices within building types and climate zones is crucial for scalability and replication. Digitalization, including 3D scanning and printing, is key for understanding and simulating renovation solutions, enabling thorough planning and prefabrication of components, thus saving time, materials and workforce.

Start ups are emerging as centralized solution providers, offering services from 3D scanning to on-site renovation coordination. They also handle the installation of solar-photovoltaic (PV) systems, combining the roles of renovation and traditional energy service providers.

However, these new construction business models need supportive government policies. For example, in the Netherlands, owners can charge tenants a fee for net-zero energy standard renovations when energy bills go down. In Germany, solution providers benefit from feed-in tariffs for installed solar-PV. These innovative models demonstrate a promising path for future renovation practices, proving that innovation in the construction sector is achievable and successful.

Nature-based solutions and biophilic design

Nature-based solutions (NbS) and biophilic design are increasingly used in architecture and urban planning to promote sustainability. NbS aims to harmonize human-made structures with nature, leveraging ecosystem functions for climate regulation, water purification and habitat creation. An NbS approach can enhance air and water quality, support biodiversity, and mitigate urban heat islands. However, the United Nations Environment Programme (UNEP) reports that investments in NbS are still low compared to activities that harm nature. NbS technologies like green roofs and constructed wetlands offer sustainable alternatives to traditional infrastructure, improving urban resilience against extreme weather.

Implementing NbS requires a multidisciplinary approach, with the International Union for the Conservation of Nature setting global standards. Biophilic design, meanwhile, fosters a connection with nature using natural materials, light and ventilation, and by designing spaces for nature interaction. This approach improves well-being, productivity and learning, particularly in healthcare settings. The Biophilic Cities Network and resources like the World Green Building Council's 'Circular Built Environment Playbook' exemplify global efforts to incorporate these principles, aiming to reduce energy, water usage and waste.

Roadmaps for buildings and construction

The Global Alliance for Buildings and Construction (GlobalABC), led by UNEP and in collaboration with United Nations Office for Project Services (UNOPS) and UN-Habitat, is developing tools and guidance to assist governments in creating climate action roadmaps for the buildings and construction sector.

Over 15 national and regional roadmaps have been facilitated with the GlobalABC, with 34 countries adopting strategies for decarbonising the building sector. These roadmaps, delineating short to long-term actions, aim to unify stakeholders and establish achievable goals, thus accelerating inclusive climate action. For example, Costa Rica's National Decarbonization Plan includes a focus on efficient, low-emission buildings, while Chile is formulating a strategy for the sector's carbon footprint.

These roadmaps are anchored in NDCs, guiding national efforts and underscoring the building sector's role in decarbonisation. To further this cause, GlobalABC collaborated with UNOPS and UN-Habitat, to develop a new methodology and tools to support countries and regions. This approach promotes stakeholder collaboration and covers the entire building value chain, addressing carbon emissions, climate adaptation and inclusion.

The methodology encompasses five action areas: Strategic Priorities, Spatial and Urban Development, New Buildings, Existing Buildings, and Construction Supply Chain, ensuring a holistic climate action strategy that encourages circularity. The roadmap development process involves six steps: Mobilisation, Stakeholder Engagement, Baseline Assessment, Prioritisation of Challenges and Opportunities, Actions and Timeline, and Implementation and Monitoring.

The overarching aim is to eliminate obstacles to creating climate action roadmaps for the building and construction sector, aiding the shift towards a decarbonized, sustainable industry.

Buildings Breakthrough

Launched on 6 December 2023, at COP28 in Dubai, the Buildings Breakthrough initiative is a collaborative effort by the French and Moroccan governments and UNEP. This initiative targets the building sector, which contributes significantly to global greenhouse gas emissions, with the goal of achieving near zero emissions and climate resilience by 2030.

As part of the broader Breakthrough Agenda, the Buildings Breakthrough aims to make sustainable solutions and clean technologies affordable and accessible in all regions by 2030. The initiative is co-led by France's Ministry for Ecological Transition and Territorial Cohesion and Morocco's Ministry of National Territory Planning, Land Planning, Housing, and City Policy, with coordination by GlobalABC.

The initiative will be annually assessed by the UNEP/GlobalABC secretariat, the International Energy Agency, and the International Renewable Energy Agency, in alignment with the UNEP/GlobalABC annual Global Status Report for Buildings and Construction. As February 2024, 28 countries, including Armenia, Austria, Canada, China and USA, have pledged their commitment to the Buildings Breakthrough.

The initiative calls for accelerated development and implementation of actions across the building and construction sector, improved coordination among stakeholders, and harmonization of definitions and certifications for near zero emission buildings. It also encourages governments to establish procurement commitments for net-zero buildings, join low-carbon material alliances, and commit to deploying clean, efficient heating and cooling technologies.

Furthermore, the Buildings Breakthrough seeks increased funding for net-zero carbon building construction and renovations, and the creation of a matchmaking platform to serve as a single point of contact for emerging and developing countries. It also promotes collaboration to identify knowledge gaps, align research priorities with policy goals and enhance communication of research and best practices.

Recommendations for policy and decision makers

The 2024 Global Status Report for Buildings and Construction indicates a significant lag in the sector's progress toward the Paris Agreement's net-zero carbon targets by 2050. To address this, the report provides targeted recommendations:

For governments, the urgent need is to develop and enforce climate action roadmaps for buildings and construction, with 161 nations still pending. Building energy codes must be strengthened to enhance efficiency, and despite economic hurdles, investment in building decarbonisation should increase. Policies should also aim to reduce embodied carbon through sustainable practices and materials and promote retrofitting to significantly reduce energy consumption.

Private sector actors are encouraged to integrate climate action roadmaps, channel investments into energy-efficient and net-zero carbon buildings and undertake retrofits to lower emissions. They should also be mindful of their social impact, promoting justice and equity regarding access to and affordability of housing.

Researchers and NGOs play a crucial role in supporting the creation of climate action roadmaps with evidence-based research. They should collaborate in developing data frameworks to support decarbonisation, raise awareness with media and through strategic communications and push for policy changes. Cross-sectoral collaborations are vital to enhance the decarbonisation impact.

These steps are critical for realigning the buildings and construction sector with global climate goals, ensuring a sustainable and resilient future.

01 Buildings and construction sector in review: A reality check

The buildings and construction sector has experienced a tumultuous year since the last Global Buildings Status Report in 2022. Across the world, as economies emerged from the effects of the pandemic, construction activities picked up as supply chain constraints eased and demand for construction of new housing resumed to its pre-pandemic levels, alongside a return to workplaces for many employees and expanding economic demands. Yet as economies reopened, there was a rapid increase in inflation and the release of pent-up demand alongside retained savings from the pandemic (Reinhart and Graf von Luckner 2022), which saw many central banks across the world address inflation by raising interest rates rapidly from near historic lows that are creating challenging conditions for the construction sector (Guénette et al. 2022). This increase in the cost of borrowing has slowed construction activities globally, particularly among major developing economies such as China, Mexico, Indonesia and India. Furthermore, ongoing conflicts and rising tensions continues to cause instability in global energy markets. At the same time, international efforts are underway for the buildings sector to address climate change, with the launch of the Buildings Breakthrough at COP28 and a growing coordination among countries and non-state actors to secure the delivery of an efficient, inclusive, resilient and net-zero buildings and construction sector (UNEP 2023).

The buildings sector's sheer importance in terms of the contributions to climate change cannot be overstated, given it is estimated to be responsible for around 21 per cent of all global greenhouse gas (GHG) emissions (Cabeza et al., 2022). In 2022, energy demand in buildings accounts for around 37 per cent of total global energy demand and 37 per cent of energy and process-related CO_2 emissions for buildings operation and materials production. Although energy intensity has dropped by around 3.5 per cent since 2021, overall energy demand and carbon emissions for energy have increased by around 1 per cent to 132 EJ and around 9.8 $GtCO_2$ in 2022, exceeding the 2018 peak (International Energy Agency [IEA], 2023). The policy landscape has also improved with an increase in the number of Nationally Determined Contributions (NDCs) including more extensive details for climate actions in the buildings sector, but this is not yet translating into policy actions that are aligned to net-zero, such as Building Energy Codes (BECs), as only seven NDCs have a code aligned to net-zero operational emissions. The amount of investment going into decarbonising buildings increased in 2022 to over US$285 billion but is expected to fall across 2023 as households and businesses face higher borrowing costs and builders face higher costs of construction in labour and materials (IEA, 2023g. Overall, however, the Global Buildings Carbon Tracker (GBCT) shows that the rate of change is not fast enough and that the global buildings and construction sector is not on track to realizing sustainable, efficient, whole-life carbon net-zero new buildings by 2030 and an operational net-zero carbon building stock by 2050.

Stronger policies around improving energy performance of new and existing buildings, new policies and practices to address the whole-life carbon emissions from building materials and construction, and an increase in investment in energy efficiency and construction of net-zero carbon buildings are all needed. COP28 saw the launch of the Buildings Breakthrough and the 'Buildings Breakthrough Agenda Report', which highlights that to align with the IEA NZE scenario, operational buildings emissions must decrease by approximately 50 per cent from their 2022 levels by 2030 (IEA et al. 2023). The Buildings Breakthrough has gathered 28 countries, and growing, that have pledged to take effort to deliver near-zero emission and resilient buildings by 2030.

Actions at the national level that support the decarbonisation of the existing and new buildings sector are critical to the delivery of the Building Breakthrough objective and Paris Agreement. There has been growth in efforts that countries are taking to build coalitions of support and networks that enable best practice for improved building performance; this includes advancing design methods that support low carbon building construction, prioritizing the renovation and reuse of buildings and undertaking efforts to improve the resilience and climate adaptation of existing and new buildings. Such efforts are critical given that the buildings sector is expected to expand, especially in emerging and developing economies, and the importance of taking early action to prevent designs that are emission-intensive or maladaptive.

As we move through 2024, policy- and decision-makers across government and industry must urgently prioritize efforts that deliver real-word emission reductions in the buildings and construction sector. There is a need for actions that avoid and shift emissions through improved building performance, adapt buildings to increase their resilience to climate change and expand building renewable energy generation, while also addressing inequalities in access and quality of housing and clean energy. These actions are not straightforward or without competing priorities, but with clear strategies—buildings and construction roadmaps—developed through coalitions, near term change to transition the global buildings stock to being efficient, resilient and zero carbon is possible. As of 2023, the GlobalABC has supported the development of 15 national and regional roadmaps and 34 countries worldwide have adopted a clear strategy for decarbonising the sector.

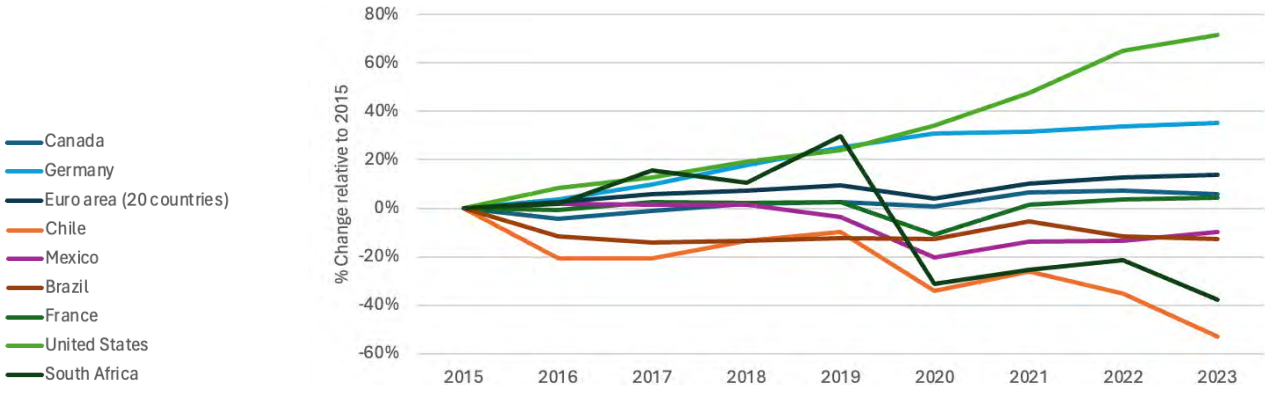
02 Global buildings and construction status

2.1 Building construction trends

Since 2010, the total global area of constructed buildings has grown by over 31 per cent and reaching just over 250 billion square meters (IEA 2023a), with nearly 80 per cent of this being residential (IEA et al. 2023). The increase in buildings floorspace is a driver of energy demand for buildings and construction materials, though as energy intensity continues to improve it is offsetting the increase in total energy demand despite the growth in construction and changes in comfort standards in developing economies, such as in Africa (GlobalData 2023). Between 2021 and 2022, total global buildings floorspace grew by two per cent, while energy demand grew by one per cent.

Buildings construction activities in 2022 and 2023 varied across the globe. Within G20 countries, only the USA showed a continued upward growth in construction (see Figure 4), while many countries across the African region have experienced sustained growth of population and of construction activities for buildings (GlobalData 2023).

Figure 4 Change in construction activities in selected G20 Countries 2015-2023



(Source: Organisation for Economic Co-operation and Development [OECD] 2023)

Among high-income countries, many have seen a slide in their historic overall expenditure in the construction sector, for which buildings comprise the majority of construction in most economies. The European area (20 countries) has seen a considerable slowdown in their expenditure in construction, though some economies such as Germany and France remain relatively steady. China's construction sector was expected to grow by 2.7 per cent, a slowdown compared to previous years, while India's construction industry was expected to grow at a rate of five per cent (Konovalov 2023). Yet, a majority of the world lacks enforcement of regulations—such as requiring labelling that address energy performance—and the result is a growing amount of floorspace built with no energy performance requirements, which leads to a growing energy demand. In 2022, this amounted to around 2.4 billion square metres of floorspace added with no building energy codes — the equivalent of Spain's entire building stock.

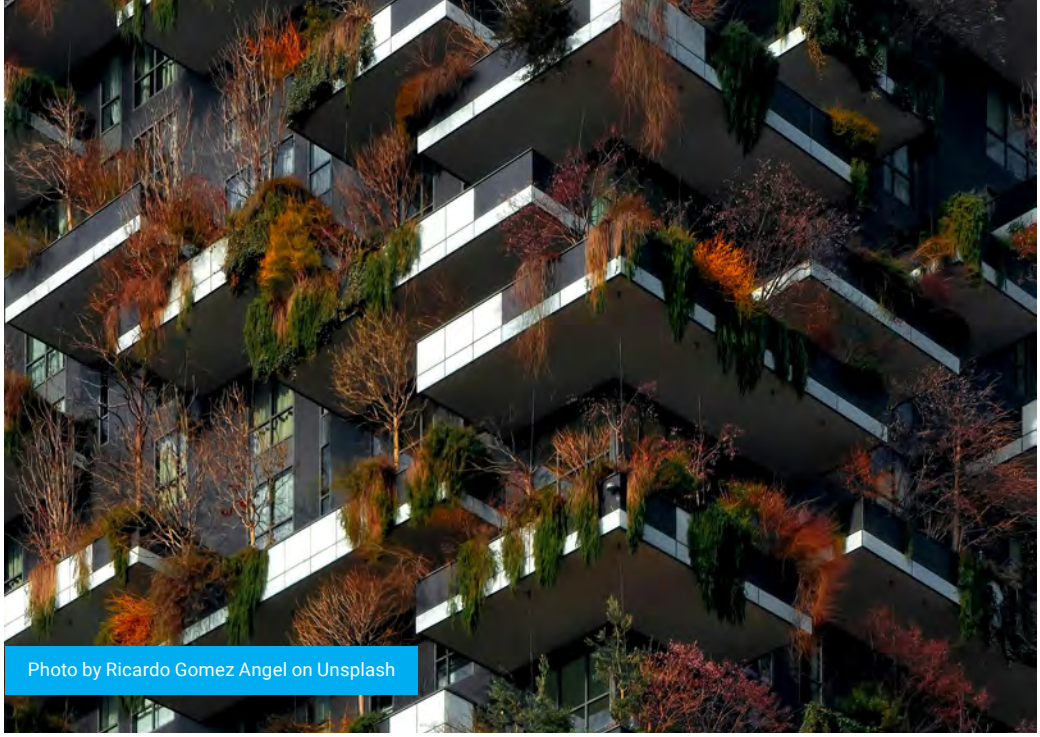
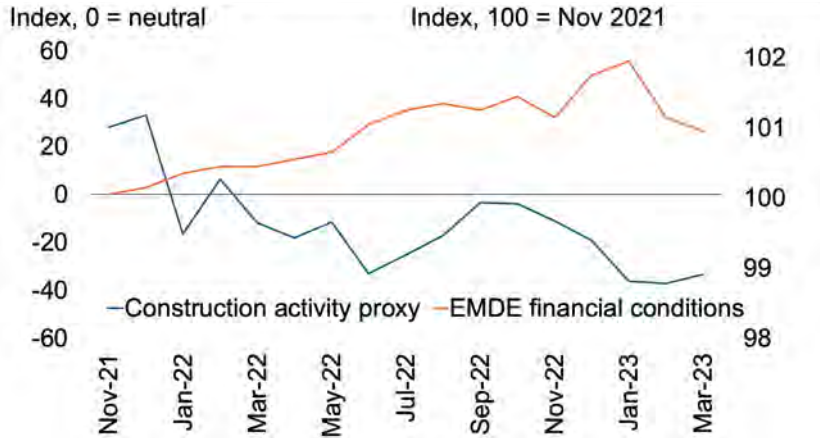


Photo by Ricardo Gomez Angel on Unsplash

Over the last year, the global economy has experienced a slowdown due to rising inflation and stricter financial conditions, which have also limited investment in buildings construction overall. The global construction industry is grappling with high employment and material costs along with a lack of skilled labour, and estimates suggest only a modest increase in global construction output growth from 1.7 per cent in 2022 to 1.8 per cent in 2023 (Global Data 2023), expanding from US$7,080 billion in 2022 and to around US$7,560 billion in 2023 (The Business Research Company 2024). This growth is being challenged by a combination of the increased cost of borrowing—as central banks have increased interest rates at the fastest pace in the last 20 years (World Bank 2023)[1]—and the geopolitical conflict that have resulted in economic uncertainty and constraints, escalated commodity prices and disrupted supply chains. In emerging and developing economies, there has been a marked slowdown in buildings construction economic activities due to the pressures that borrowing costs (see Figure 5).

1 *World Bank (2023). Global Economic Prospects, June 2023. Washington, DC: World Bank. doi:10.1596/978-1-4648-1951-3. License: Creative Commons Attribution CC BY 3.0 IGO*

Figure 5 Emerging and development economies (EMDE) market construction activity and financial conditions



(Source: *World Bank 2023)*

Despite these slowdowns, floor area is projected to increase by a further 15 per cent by 2030 (IEA 2023a), which will add nearly 40 billion square meters and is equivalent to five times the current floor area in Indonesia. It is estimated that more than half of these additions are in regions with hot climates—where space cooling demand is growing—that lack comprehensive implemented building energy codes with enforcement mechanisms (IEA et al. 2023). From an operation carbon perspective, there is a risk that the improvements in energy efficiency in colder climates may be offset by less efficient construction in warmer climates where cooling demand is increasing, and a potential further increase of carbon emissions if those economies electricity grids are not accelerating the rate of renewable generation. From an embodied carbon perspective, regions of the world with increasing construction activities and limited access or use of low-carbon materials risk locking in high embodied carbon and operational emissions for a long duration.

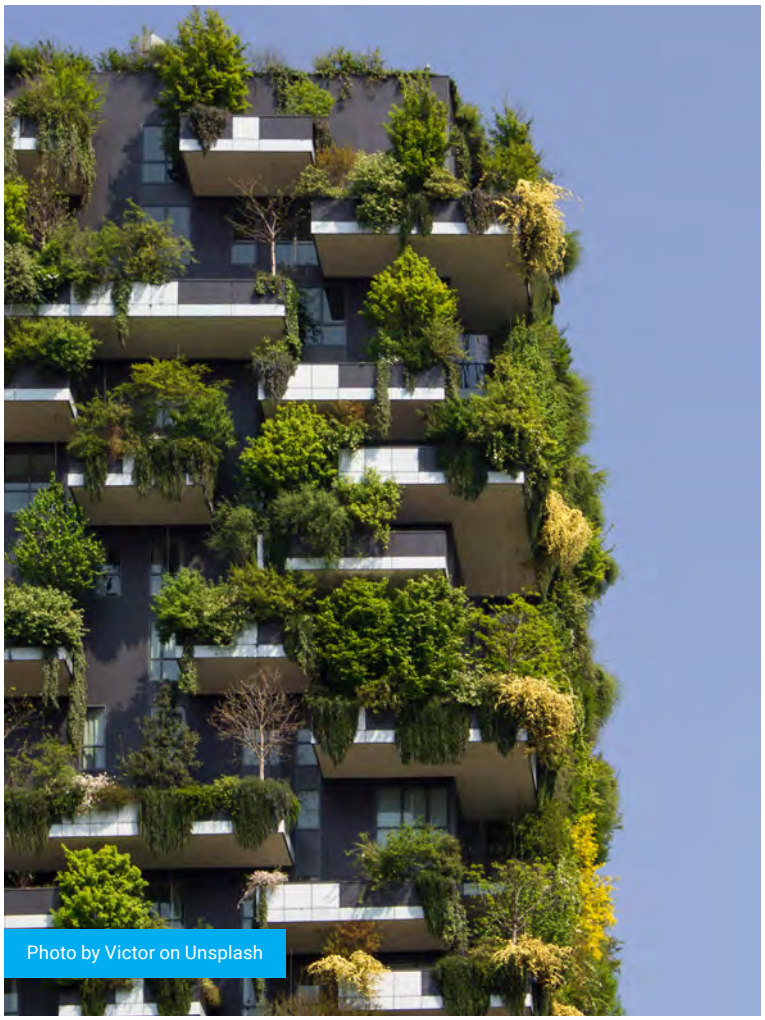


Photo by Victor on Unsplash

Countries around the world continue to take efforts to decarbonise their building stocks through policies and pledges (see Chapter 3), but they will need to adopt approaches that emphasize whole-cycle net-zero carbon emission buildings that are based on energy efficiency (IEA 2022a). At the base are energy-efficient buildings, which boast significant energy savings through optimized construction and systems for heating, cooling, lighting and other services. Low-carbon buildings take this a step further by incorporating low-carbon energy sources, although some may require upgrades to existing equipment to reduce carbon emissions fully. Nearly zero-carbon buildings achieve high energy efficiency and include some form of zero-emission energy, but they fall short of completely neutralizing their energy consumption. Net-zero-carbon buildings rise above this by meeting their energy needs with zero-emission sources over a set period, typically a year. Zero-carbon buildings are similar but ensure that all energy demands are met with zero-emission energy throughout the period. Carbon-negative buildings exceed even this standard by producing more renewable energy than they consume, contributing the surplus to the grid for external use. Lastly, whole life cycle, net-zero-carbon buildings represent the pinnacle of sustainability, maintaining a zero-carbon status while also ensuring that the embodied emissions from their construction materials are net-zero, achieved through either decarbonisation or offsets.

2.1.1 Social Impact across the Built Environment

The built environment plays a central role in shaping social dynamics. Multiple aspects of people's lives, from health and well-being to human rights, are impacted at every stage of the building and construction lifecycle. Yet, the social implications of the buildings and construction sector rarely receive due attention, and the issues being faced lack clarity, recognition and understanding. The buildings and construction sector has a role to play in supporting improvements in social justice and equity through efforts that build equity, which has historically been lacking in representation (see Box 1).

Box 1 Embedding gender equality in the construction sector

The construction sector remains male-dominated globally (Bridges et al. 2020; Zhang et al. 2021). Women currently represent only 4.5 per cent of the construction industry in Malta (Navarro-Astor et al. 2017), 4.6 per cent in Argentina (D'Alessandro et al. 2020; D'Alessandro et al. 2022), 5.47 per cent in Mexico (Government of Mexico 2022), nine per cent in the broader architecture engineering, construction and operations sector in the USA (Morello et al. 2018) and 14.1 per cent in Austria (Navarro-Astor et al. 2017).

Studies have shown that women face significant challenges in participating in the construction sector, including gender pay gaps, gender stereotypes, lack of finance, discrimination, harassment and even violence (Fielden et al. 2000; World Bank Group 2019; Bridges et al. 2020). Among the different sectors within the construction industry, women also tend to be better represented in professional activities than labour activities because of the perceived notions that construction work as a masculine activity.

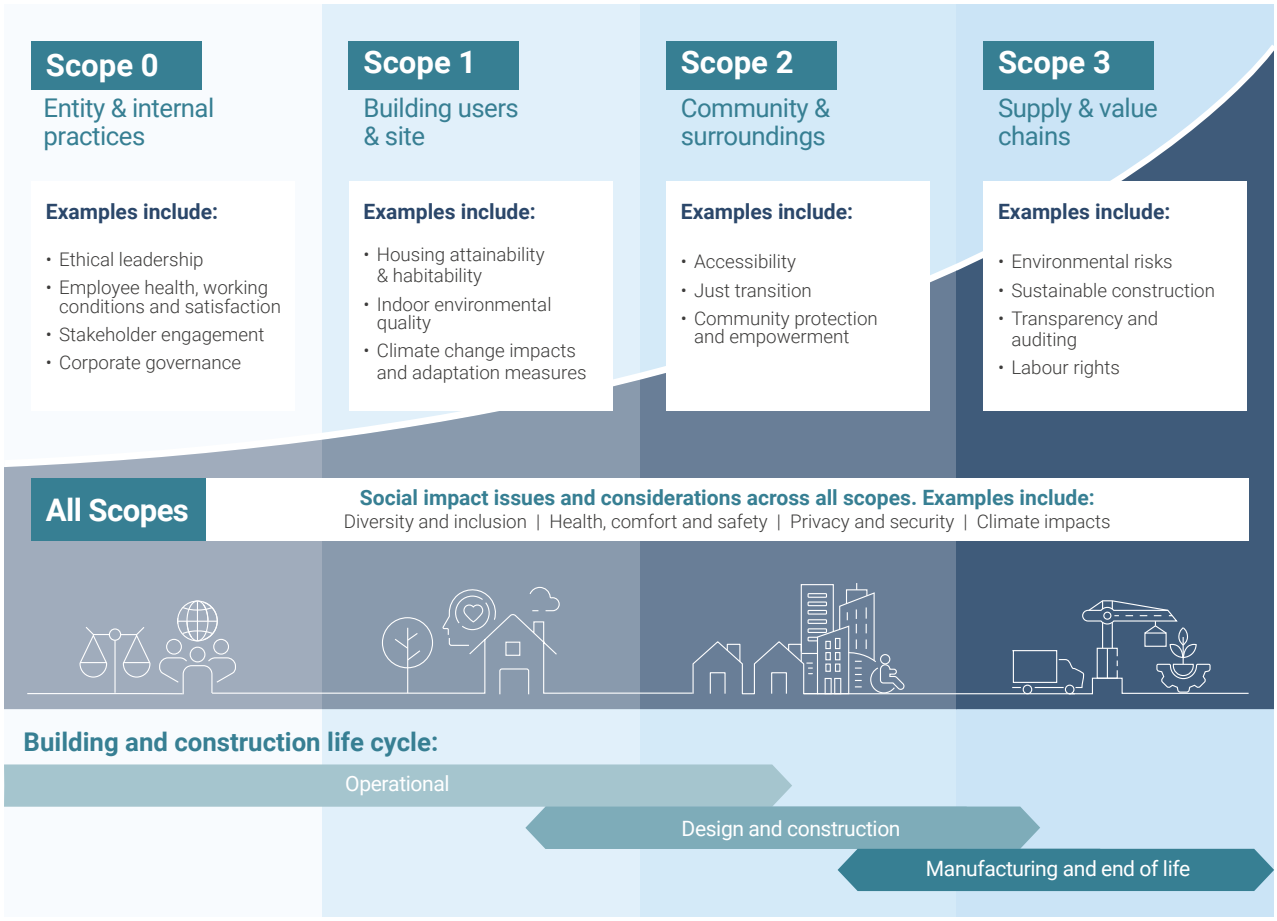
Women participating in the construction sector have actively challenged gender norms and roles (Ness 2012). Various studies have argued for affirmative institutional action to increase gender equality in the construction industry. In the United Kingdom, Dainty et al. (2004) highlight the need for increasing the number of women role models, enhancing construction industry's image, increasing access and staff retention, changing the culture of the industry and monitoring progress. In Mexico, the National Program for Equality between Women and Men (Proigualdad) 2020-2024 provides an overarching roadmap by establishing commitments and policies to generate necessary conditions for the participation of women in all spheres of life. Proigualdad promotes (1) economic autonomy, (2) conditions for recognition, reduction and redistribution of domestic and care work, (3) improved access to well-being and health, (4) combating gender-based violence, (5) equal participation of women in the decision-making in the political, social, community and private spheres, and (6) building safe and peaceful environments for women and girls.

These recommendations provide initial steps needed to improve gender equality in the construction industry. However, further context-specific and evidence-based efforts to encourage and promote women's participation in the construction industry are needed to increase gender equality.

The World Green Building Council (WorldGBC) published at COP28 a new report—'Social Impacts across the Built Environment'—that provides a framework for how the building and construction sector can address social impact across the entire building life cycle (WorldGBC 2023a). The report, which is supported by the UN High-Level Climate Champions, is aimed at stakeholders across the buildings and construction sector to address social impact issues and considerations, and apply solutions across their own practices, reporting and delivery.

The report presents a social impact framework for the building sector, using 'scopes' similar to the Greenhouse Gas Protocol. It introduces scopes 0-3 to guide the industry in addressing social justice and equity. Scope 0 covers internal practices, Scope 1 focuses on building users, Scope 2 on community impact and Scope 3 on the supply chain (see Figure 6). The goal is to integrate social and environmental sustainability in the built environment and improve decision-making and environmental, social and governance (ESG) reporting in the sector.

Figure 6 Social Impact Framework

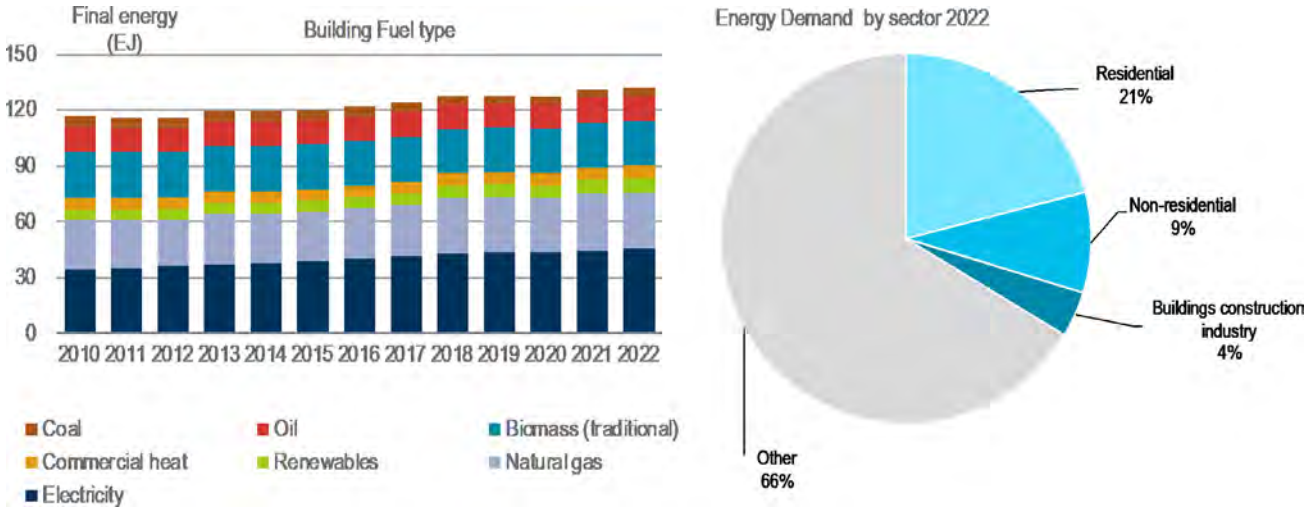


(Source: WorldGBC)

2.2 Energy in the buildings and construction sector trends

In 2022, operational energy demand in buildings (for space heating and cooling, water heating, lighting, cooking and other uses) accounted for around 30 per cent of final energy demand 132 EJ, and when adding energy used to produce materials used in the construction of buildings it amounted to 34 per cent (see Figure 7). The past decade has seen an average annual growth of just over one per cent in energy demand in buildings. Electricity's share in buildings' energy use has risen from 30 per cent in 2010 to 35 per cent in 2022. Despite a shift from fossil fuels to electricity and renewables, fossil fuel use in buildings has grown at an average annual rate of 0.5 per cent since 2010 (IEA 2023a).

Figure 7 Energy consumption in buildings by fuel, 2010-2022 (left) and share of buildings in total final energy consumptions in 2022 (right)



(Source: IEA 2023a)

Notes: Buildings construction industry refers to materials used in construction including concrete, steel and aluminium. Buildings construction industry related energy use not shown in left panel.

In 2022, overall energy use in buildings increased by around one per cent, which was largely driven by the added floorspace in emerging economies and was influenced by the continued increase in space cooling demand, which rose by over three per cent compared to 2021, despite space heating energy consumption decreasing by four per cent, primarily due to a mild winter in several regions (IEA 2023a). While demand for spacing heating is declining due to energy efficiency improvements, cooling demand continues to grow and managing this demand requires the use of sustainable cooling strategies that focus on protecting vulnerable populations at risk to heat, reducing demand and increasing adaptive capacity through passive cooling designs of buildings and cities, shifting demand for cooling through design and use of renewables, and improving cooling performance through more efficient fabrics and equipment (SEforAll 2023).

On a positive note, although total energy demand has increased, the energy intensity per square meter has improved by around 3.5 per cent from 150 kWh/m^2 in 2021 to 145 kWh/m^2 in 2022[2]. This improvement in energy intensity is being led by improved building codes and fabric performance and technology improvements (e.g. updated minimum energy performance standards and heat pumps) in cold climate countries (see Chapter 3). Yet a critical challenge to improving global energy efficiency is the lack of building energy codes in more than 110 countries (see Section 3.2).

2 *Values included for the baselines have been updated from previous versions of the Buildings-GSR due to both historic input data updates for emissions and floorspace. The proportional changes between previous years remains similar.*

Stricter building codes and increased retrofit rates have helped decrease space heating intensity by seven per cent globally since 2015. Efficiency gains have reduced space heating service demand by four per cent in advanced economies since 2010, but this has not offset floor area growth in emerging and developing economies (IEA 2023a). High-performance building envelopes that use low-carbon passive designs and efficient active technologies, which are integrated into good building design, are crucial for reducing thermal needs and ensuring occupants' comfort. Envelope structure and material selection are vital due to buildings' long lifetimes and associated costs. However, more efforts are needed, particularly in warmer regions.

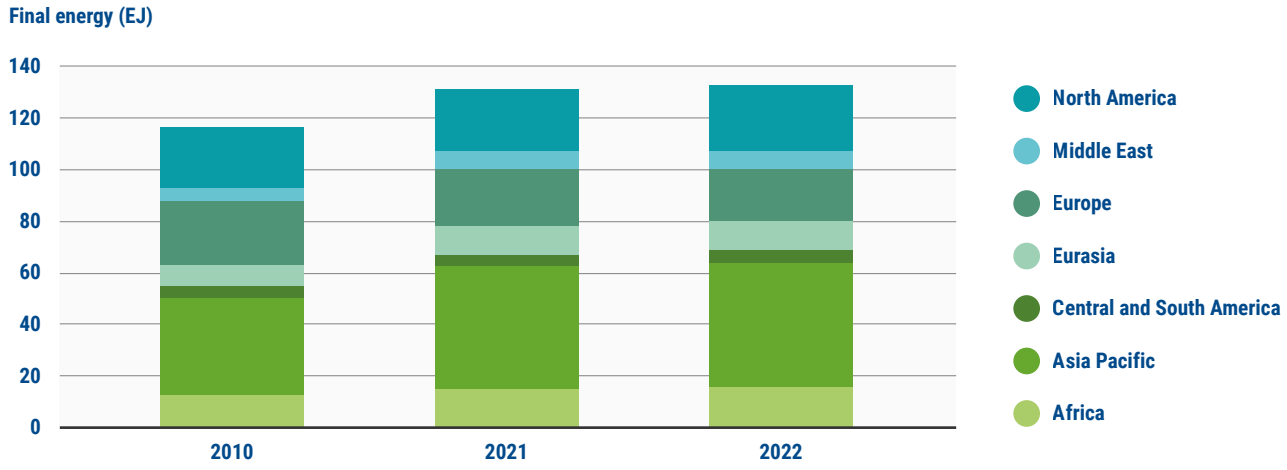
A further challenge is that the rate of retrofit in buildings is well below those needed to achieve a 50 per cent reduction in carbon emissions by 2030. Currently, the average retrofit rate of the building stock is around one per cent per year, with these retrofits typically achieving less than 15 per cent reduction in energy intensity (IEA 2023a). To align with the goals of the Paris Agreement, retrofit rates need to increase to between 2.5 to five per cent and higher by 2030, and these retrofits need to be extensive (IEA 2023a), meaning that building fabrics need insulation and glazing upgrades alongside heating and cooling system improvements, and the adoption of passive and nature-based building solutions that reduce service demands.

In 2023, space heating was responsible for 33 per cent of total final energy demand and has decreased by around four per cent since 2010, while global space cooling service demand has risen by over 45 per cent over the same period. The increase in the demand for cooling was largely driven by changes in expectations for the use of cooling, increased floor area, equipment ownership growth and higher temperatures (and aggressive climate change impacts). This increase is also due to the frequent neglect of cooling-oriented envelope solutions during building design and application of energy building codes. This, along with rising temperatures and improvements in living standards, is expected to increase air-conditioner ownership from 37 per cent of the global population today to over 45 per cent in 2030 (IEA 2023a).

To align to the Paris Agreement goals, energy consumption in buildings needs to drop by around 25 per cent and fossil fuel use by more than 40 per cent by 2030 (IEA 2023a). This necessitates phasing out of fossil fuels and use of traditional biomass, associated with air pollution and health consequences, and achieving universal energy access, Sustainable Development Goal 7.

While global energy demand in buildings has grown by 13 per cent since 2010, regional energy demand has shown diverging trends with considerable growth in demand across Africa (27 per cent), Asia Pacific (27 per cent), Eurasia (26 per cent) and Middle East (32 per cent) and North America having moderately low growth (four per cent), while Europe experienced a 15 per cent decline over this period and half of the reduction occurring over the last three years (see Figure 8).

Figure 8 Total final energy consumption in buildings



(Source: IEA 2023a)

Countries are responding by increasing energy performance requirements for both new and existing buildings. Notable progress has been made in China, Japan, the European Union, and the USA, with policies and industry standards focusing on energy efficiency, zero-energy performance and zero emissions (see Section 3.2).

A positive sign in the buildings sector is a spike in renewable energy use in buildings, which has grown by more than 50 per cent and now comprises around six per cent of total energy use in buildings (IEA 2023a). When accounting for renewables in the grid, it is estimated that renewables contribute to 15 per cent of global building energy (REN21 2023)[3]. Analysis by REN21 shows that Brazil, Canada, France, Italy and Germany lead in renewables adoption in buildings, while other major economies such as India, Russian Federation and the Republic of Korea are lagging. There is a need to increase production of renewable energy systems in order to reduce costs for wide-spread adoption, particularly in emerging economies where such systems can be unaffordable to many building owners (REN21 2023).

3 REN21, 2023. Renewables 2023 Global Status Report

Though there are improvements in energy intensity and continued growth in buildings renewables, the sector needs more rapid changes to align with the Paris Agreement goals. This decade is crucial for implementing measures to ensure all new buildings and 20 per cent of the existing building stock are net-zero carbon ready by 2030. This includes the need for improvements in the energy efficiency of materials used for constructing buildings, which represent four per cent of global energy demand. The challenge lies in accelerating the use of efficient and renewable building technologies, expanding the scope and stringency of minimum performance standards and building energy codes across countries, while also improving awareness through the labelling of energy performance and carbon.

2.2.1 Improvements in building heating and cooling technologies continue to expand

A key technology to addressing both energy efficiency and carbon emissions in buildings is the electrification of buildings with the use of heat pumps. Global heat pump sales grew by 11 per cent in 2022, marking the second consecutive year of double-digit growth, though still only cover ten per cent of global heating demand in buildings (IEA 2023a). Heat pumps are a crucial technology for heat decarbonisation, as the performance levels of domestic heat pumps can be up to 400 per cent efficient or more depending on conditions. Heat pumps have seen a surge in sales in 2022, with Europe experiencing an increase of 40 per cent, the USA around ten per cent and Japan almost 19 per cent from 2021 levels. In 2023, Germany experienced a doubling of heat pumps purchased and sales in the USA exceeded gas furnaces in 2023, though China's sales have largely flattened due to the housing and economic slowdown (IEA 2023a).

The existing installation of heat pumps is primarily concentrated in new buildings and existing single-family homes. For these, a recent collection of case studied showed all-electric are cheaper and have lower emissions than ones which use natural gas (Tan et al. 2023). However, to maintain solid growth, multi-storey apartment buildings and commercial spaces will need to be prioritised. Alongside new construction, retrofitting existing buildings with heat pumps where appropriate will also need to accelerate, alongside the adoption of district scaled low carbon energy systems.

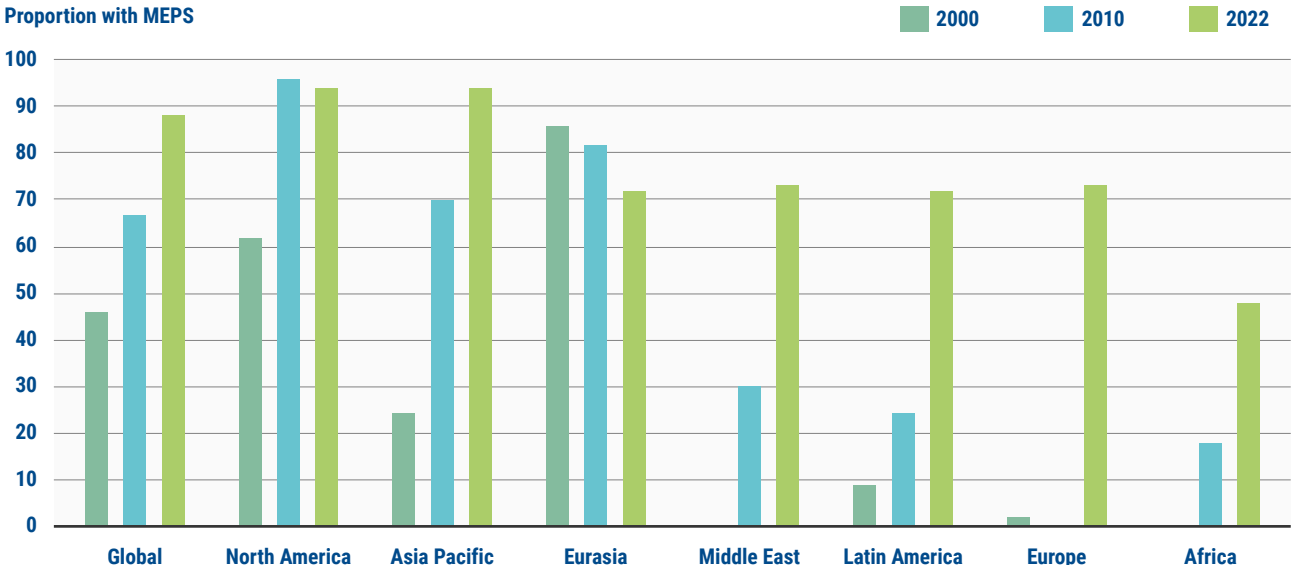
To meet national energy and climate pledges worldwide, the IEA estimate that heat pump installations would need to triple and satisfy nearly 20 per cent of global heating needs in buildings by 2030 (IEA 2023a), which translates to sales needing to increase by over 15 per cent per year this decade. This goal is almost within reach if the growth rate of new installations continues at the current pace, but will need additional policy support and technical innovation, especially by reducing upfront costs, improving energy performance and durability, developing products with lower environmental impact, alongside worker re-skilling.

Energy consumption for space cooling has more than tripled since 1990 (IEA 2023a), leading to increased pressure on electricity grids, higher GHG emissions, and the exacerbation of urban heat islands. A significant portion of the global population lacks access to affordable and sustainable cooling, resulting in heightened risk of heat stress, compromised thermal comfort, reduced labour productivity, and negative health impacts (SEforAll 2023). A major driver of the increase in demand for cooling is changing thermal comfort expectations among building users in countries where heat exposure and maladapted buildings are resulting in conditions where cooling is being sought (IEA 2023a).

Since 2000, energy demand for space cooling has grown at an average rate of four per cent per year, doubling the rate for water heating and in 2022, the number of residential cooling units in operation reached over 1.5 billion, a threefold increase since 2000 (IEA 2023a). This surge in energy consumption for space cooling strains peak electricity demand, particularly during hot days, increasing the likelihood of power outages. To reduce global electricity demand for cooling, there is a need for a rapid shift to best-practice adaptive designs and the use of nature-based solutions with the adoption of high-performance cooling products that are affordable and accessible to markets with emerging cooling demands, such as India, China and across Southeast Asia and Sub-Saharan Africa. Without this shift, electricity demand for space cooling could rise by up to 40 per cent globally by 2030.

The IEA have tracked over 90 countries that have established Minimum Energy Performance Standards (MEPS) for air conditioners (see Figure 9), and more than 95 countries have implemented labelling policies, covering approximately 86 per cent of global space cooling energy consumption in the residential sector (IEA 2023k).

Figure 9 Residential space cooling consumption covered by minimum energy performance standards by region 2000-2022



(Source: IEA 2023k)

Photo by Elifin Realty on Unsplash

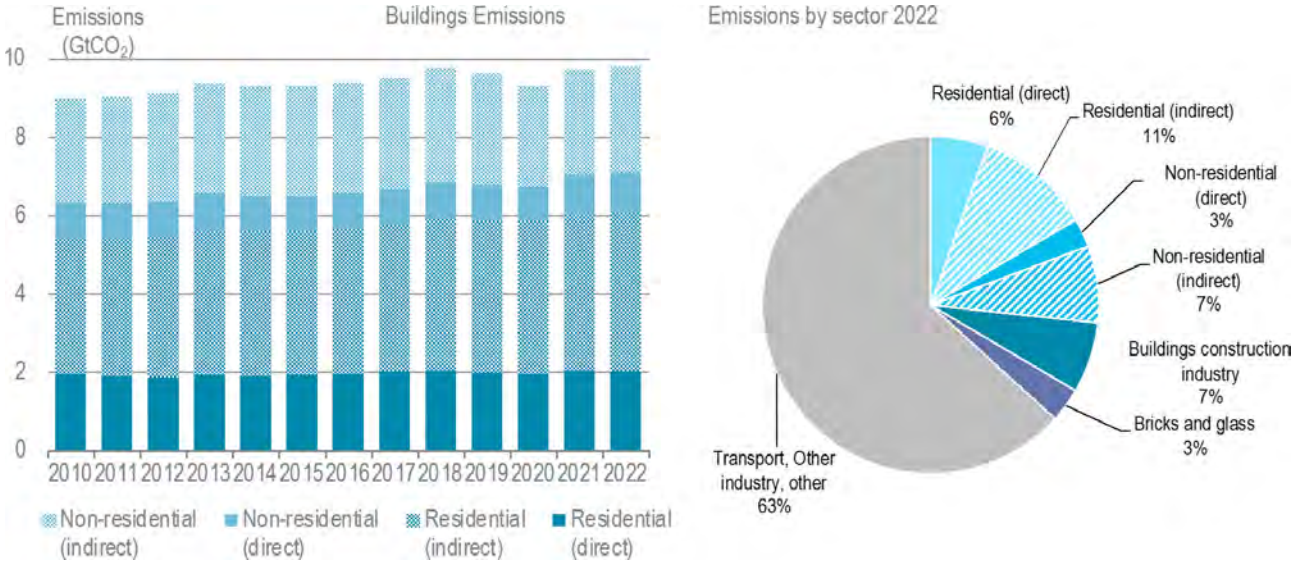
2.3 Emissions in the buildings and construction sector trends

Global operational energy-related CO_2 emissions from buildings grew by around one per cent in 2022 compared to 2021 to just under ten $GtCO_2$, reaching a new global peak (IEA 2023a). Emissions from buildings related energy-demand represents around 27 per cent of total global CO_2 emissions in 2022 (or 21 per cent of global GHG emissions) and a further seven to nine per cent is estimated to be due to the manufacturing of buildings materials (i.e. concrete, steel, aluminium, glass and bricks), bringing the global estimate of energy and process-related emissions for the buildings and construction sector to around 37 per cent. If including other materials used in buildings, such as plastics, foams, fabrics and other soft and hard materials, the proportion of emissions would be even greater.

In 2022, direct CO_2 emissions from buildings operations experienced a slight decrease, reaching three Gt, which contrasts with the average annual growth of nearly one per cent from 2015 to 2021 (IEA 2023a). Meanwhile, indirect emissions from buildings operations increased by approximately 1.4 per cent in 2022, totalling nearly 6.8 Gt and can be attributed to a growing reliance on electricity for building operations (IEA 2023a). Regional differences in emissions trends were observed in 2022.

In addition to direct and indirect emissions from building operations, 2.5 Gt CO_2 in 2022 were associated with building construction, including the manufacturing and processing of cement, steel and aluminium. Estimates for the production of bricks and glass would see a further 1.2$GtCO_2$ emitted (see Box 2). Altogether, emissions from building operations and construction account for over one-third of global energy-related emissions at around 13.6$GtCO_2$. (see Figure 10).

Figure 10 **CO_2 emissions in buildings 2010-2022 (left) and share of buildings in global energy and process emissions in 2022 (right)**



(Source: IEA 2023a)

Notes: Buildings construction industry refers to concrete, steel and aluminium for buildings and infrastructure construction respectively. The boundaries of the emissions (energy and process) account for construction materials include from raw materials preparation and processing and the different steps to produce the materials. For example, for cement this includes the entire manufacturing processes, from obtaining raw materials and preparing the fuel through to grinding and milling. The numbers in the pie chart are rounded values and therefore do not necessarily sum to the total value for a given sector.

Notes: Buildings construction industry refers to concrete, steel and aluminium for buildings and infrastructure construction respectively. The boundaries of the emissions (energy and process) account for construction materials include from raw materials preparation and processing and the different steps to produce the materials. For example, for cement this includes the entire manufacturing processes, from obtaining raw materials and preparing the fuel through to grinding and milling. The numbers in the pie chart are rounded values and therefore do not necessarily sum to the total value for a given sector.

The embodied carbon emissions of materials used in buildings construction are an important area for action due to their being around 50 per cent of the overall carbon emissions in new building (World Business Council for Sustainable Development and ARUP 2023). In addition, addressing materials through improved efficiency and use is vital to reducing construction waste going to landfill, increasing the reusability of materials and enhancing the circularity of buildings construction (WGBC 2023). These actions can be supported by avoiding new building, reusing existing, build smartly and build efficiently. To achieve net-zero goals, collaborative efforts are needed across the entire built environment value chain, focusing on reducing consumption demand and simultaneously lowering carbon intensity in the supply side.

To align with the Paris Agreement goals, buildings and construction sector emissions (direct and indirect) must be reduced by an average of nine per cent per year until 2030, resulting in a more than 50 per cent reduction by the end of the decade. Alongside building operations emissions, embodied carbon emissions need to reduce through improved manufacturing process and use of renewable energy used in their production.

Box 2 Emissions from bricks and glass

Estimates of greenhouse gas (GHG) emissions associated with subsidiary building materials, namely the production of bricks and glass, are challenging for two key reasons. First, due to the global prevalence of informal manufacturing practices, tracking the overall output of bricks by country and year is uncertain, especially in rapidly urbanizing economies. Second, calculations of per-brick or per-tonne of product GHG emissions are themselves uncertain. This is partly due to the absence of a standardized approach to defining the system boundaries of the production techniques, but also similar uncertainties regarding informal production. A 2023 paper examining the energy consumption of brick manufacturing in India points to these challenges (Tibrewal et al. 2023).

The 2022 Global Status Report for Buildings pointed to estimates that global emissions associated with brick and block manufacturing stood at approximately 1.1Gt CO_2e annually, with glass adding an additional approximately 0.1Gt. Tracking changes in these emissions year to year is largely impossible, due the uncertainties outlined above. There has been no evidence published in the past year that would suggest a substantial shift in the portion of new buildings that are built using brick and glass respectively.

By assuming growth in line with global floor space increase between 2021 and 2022 of less than five per cent and an absence of substantial improvements in overall emissions intensity, bricks and glass production would still account for approximately 1.2Gt CO_2e. Until major improvements in brick manufacturing carbon intensity are scaled, it is unlikely that these emissions will be reduced in the near term.

03 Sustainable buildings and construction policies

National and sub-national actions are critical to support the sustainable transition of the buildings sector, and there have been a range of policy developments that are outlined (see Section 3.1). In addition, the Global Status Report tracks both national buildings energy code developments and buildings commitments under the Paris Agreement's Nationally Determined Contributions (NDCs) (see Section 3.3). It also tracks the status of building energy codes and those that are aligned towards net or nearly zero carbon emissions (see Section 3.2).

Recognising the policy gap that currently exists to limiting global warming to 1.5°C, WorldGBC alongside 75 Green Building Councils, launched the 'Global Policy Principles for a Sustainable Built Environment' (WorldGBC 2023b). These principles are structured around seven key focus areas - carbon, resilience, circularity, water, biodiversity, health, equity and access - outlining detailed policy mechanisms to deliver on global goals including the Paris Agreement and the Sustainable Development Goals.

3.1 Leading national policies

Globally, the buildings policy landscape is diverse, with many countries lacking substantive or coordinated policies for addressing sustainability, energy performance or CO_2 emissions in the building sector. However, a small but growing number of countries are developing and committing to buildings energy and CO_2 emissions regulations that are compatible with limiting global temperature increases to 1.5°C. A growing number of governments are furthering their commitments to addressing building energy performance and emission reductions.

Since 2022, there have been several notable advances in nationally relevant policy, including in the European Union where the legislative process to strengthen the Energy Performance of Buildings Directive (EPBD) is entering its final stages (European Commission 2023a). The revised EPBD, agreed upon in late 2023, mandates zero emission standards for new public buildings by 2028 and all new buildings by 2030. European Union countries must cut residential energy use by 2030 or 2035, targeting inefficient buildings first, and enforce MEPS on non-residential buildings from 2030. Funding for new fossil fuel boilers is banned from 2025, with a complete phase out by 2040. The policy also requires calculating and reporting the Global Warming Potential for new buildings by 2030, alongside implementing Whole Life Carbon targets.

In India, the buildings sector currently account for 40 per cent of national CO_2 emissions, but 70 per cent of expected Indian buildings have yet to be constructed (GBPN 2022). In December 2022, India's legislature passed the Energy Conservation (Amendment) Act, 2022, which sets out the parameters of a carbon-trading scheme and allows for the specification by the central government of an energy conservation and sustainable building code for large buildings (Tariq 2023).

In July 2022, Japan revised and strengthened its Building Energy Conservation Act, aiming for compliance with building energy efficiency standards across the building stock by 2025 (Energy Conservation Center Japan 2022). The government of Ireland announced an extension of its renewable heat incentive programme (IEA 2023d), while France and Bosnia Herzegovina have committed funds to supporting energy efficiency measures for public buildings (IEA 2023e). In September of 2023, the United Kingdom announced a £1b in grants for home insulation (UK Government 2023a), but also weakened plans to phase out fossil fuel heating for off-grid homes and scrapped minimum energy efficiency standards for rental homes (Evans et al. 2023).

In Chile, the National Energy Efficiency Plan 2022–2026 aims to reduce thermal energy demand in buildings by 30 per cent by 2026 and 50 per cent by 2050 over 2019 levels, through the promotion of energy focused retrofit, district energy programmes and capacity building (Energy Ministry of Chile 2022). This builds on the 2021 Energy Efficiency Law, which states that new buildings in the residential, commercial and public sectors must have a certified energy label (Energy Ministry of Chile 2021).

Across Latin America and the Caribbean as a whole, opportunities for improving the region's codes to improve the resilience and sustainability of buildings were highlighted in a 2023 report (Alvear et al. 2023). The study compares approaches of regulatory bodies across 26 countries, highlighting mitigation, adaptation and resilience in the region's building stock.

3.2 Building codes

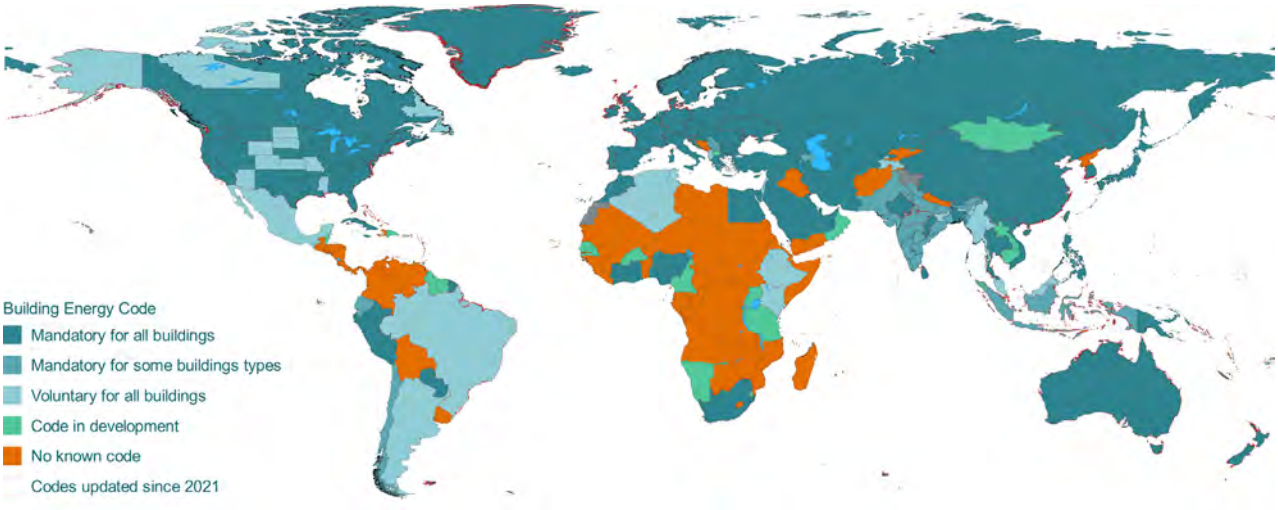
As of 2023, there are now 81 and 77 national buildings adopted codes for the residential and non-residential buildings respectively, of which 80 per cent are mandatory. Twenty of these codes having been updated and adopted since 2021, and 17 adopted codes developed or revised in 2023 alone.

However, despite a growing number of adopted codes and their updates, more than 30 per cent, have not been updated since 2015 and as a result are not likely to be mandating a high-performance standard. Further, it is estimated that around 80 per cent of projected floor area growth by 2030 is expected to occur in developing and emerging economies (IEA 2023a), and most of these countries lack the necessary building energy codes and enforcement to limit the growth of energy demand. This offers a significant opportunity for countries to take efforts to improve and further enforce their adopted codes and align the standards towards achieving a whole-life net-zero CO_2 emission performance for new and retrofit buildings.

Photo by Alexander Abero on Unsplash

Although the number of adopted codes globally are growing, there are still regions around the world that will benefit from attention to developing and adopting more modern codes, such as Africa and parts of South America and Southeast Asia where codes are yet to be developed, remain voluntary or are limited in scope and stringency (see Figure 11).

Figure 11 Adopted global building energy codes by type and status



(Source: IEA 2023a)

Notes: Countries with dark 'red' outline have adopted updated building energy codes since 2021

The past 18 months has seen several countries update their building codes towards alignment with the Paris Agreement and, for those in the European Union, upgrading codes to meet the EPBD.

The French building code, RE2020, sets out rules for energy, environmental and health performance of new building projects and includes a bioclimate indicator that requires a 30 per cent reduction to the previous code, mandates the use of low-carbon energy sources, limiting overheating risks, and aims for a 50 per cent reduction in embodied carbon emissions for buildings by 2030 and their full decarbonisation by 2050. The RE2020 calculates a building's environmental impact based on the emissions created during its whole life cycle, including construction as well as manufacturing and transportation of building materials (Minister for Ecological Transition and Territorial Cohesion of France 2024).

Updated Danish building regulations came into force in 2023 and now require buildings over 1000 m^2 to limit carbon emissions to 12 kg CO_2e per m^2 per year. This limit will be reduced incrementally to 7.9 kg CO_2e per m^2 per year in 2029. Additionally, all new buildings must document their environmental impacts through Life Cycle Assessment (LCA) over a 50-year time span (Danish Ministry of Interior and Housing 2021).

The recently updated California 2022 Building Energy Efficiency Standards has focused on improving energy efficiency and reducing GHG emissions from newly constructed and renovated buildings (California Energy Commission 2022). The California code encourages the use of efficient electric heat pumps for space heating and water heating, introduces the requirements for electric-ready new homes, expands use of solar photovoltaic (PV) and battery storage systems and promotes the use of climate and grid-flexible technologies such as demand response ready appliances. This development occurs against the backdrop of US$1 billion funding for supporting the adoption of building energy codes under the Inflation Reduction Act (Office of State and Community Energy Programs2024).

The updated 2021 British Building Regulations changes to Part L (Fuel and Power) has similarly focused on energy efficiency standards, improved ventilation and new overheating requirements (UK Government 2023b). The code, which contributes to the United Kingdom's net-zero goals, requires CO_2 emissions from new build homes to be 30 per cent lower than the current standards, and emissions from other new buildings, including offices and shops, to be reduced by 27 per cent. A Future Homes and Buildings Standard is due in 2025 and will set the path to achieving net-zero buildings, although the United Kingdom has argued the proposed standards is lower than current levels (UKGBC 2023).

Singapore's , launched in 2021, includes MEPS for new and existing buildings. From 2022, all new buildings are required to be 50 per cent more energy-efficient compared to 2005 levels, which is more stringent in comparison to the previous 30 per cent requirement (Building and Construction Authority 2021). For existing buildings undergoing major retrofitting, the requirement for 40 per cent improvement in energy efficiency compared to 2005 levels applies starting from 2022, also indicating an increase in stringency of requirements from previously 25 per cent. The update also supports a Super Low Energy (SLE) Programme, which aims to promote best-in-class energy efficiency, the use of onsite and offsite renewable energy, and intelligent energy management strategies in buildings.

China's most recent building energy performance code was published in 2021 and sets mandatory energy efficiency standards for new construction, renovation and expansion of buildings to reduce energy consumption and promote sustainable development. It also encourages the integration of renewable energy sources, such as solar and wind power (The Standardization Administration of the People's Republic of China 2021).

Sri Lanka's Energy Efficiency Building Code 2020 was introduced by the Sustainable Energy Authority (SEA) and includes energy efficiency improvements in the design, construction and operation of buildings (Sri Lanka Sustainable Energy Authority 2020). In addition to setting out minimum energy performance requirements for building components (e.g. walls, roofs, windows, lighting systems and controls) it set outs guidelines for heating, ventilation and air conditioning (HVAC) systems to ensure energy-efficient operation and maintenance alongside energy management systems. The code also sets out recommendations for the use of renewable energy technologies, such as solar water heating systems and photovoltaic systems.

3.2.1 Modernisation building energy codes

For countries and states, developing building codes that enable the transition towards a resilient, efficient and zero-carbon building stock requires attention to high standards that promote advanced designs, which encompasses envelopes and technologies that ensure buildings operate with the least amount of energy required to maintain comfortable and productive spaces.

Modern building codes must encompass a comprehensive array of considerations to effectively achieve elevated levels of energy efficiency, bolster sustainability, address climate change and facilitate optimal thermal comfort. Codes need to take an integrated approach to outline stringent guidelines for building envelope insulation, efficient HVAC systems, energy-efficient lighting and the use of renewable energy sources. Additionally, codes must promote passive design strategies that capitalize on natural ventilation where the climate allows, as well as on day lighting and shading techniques to curtail energy demand while ensuring occupant comfort. These codes should also encourage the incorporation of smart building technologies that enable real-time energy monitoring, data-driven optimization and adaptive controls and enable building-to-grid interactivity.

Countries that have already adopted building energy codes should look to include energy efficiency requirements that seek higher levels of performance of the building envelope, glazing and more efficient building services system performance requirements, in line with enhanced MEPS.
For countries without building codes, separate standards for new buildings can be enacted (or embedded in forthcoming codes) to set fabric performance requirements for all or most building types. It is also crucial that building energy codes set out a pathway towards net-zero carbon and therefore have a timeline to become more stringent over time.

Modernised building codes might include, but are not limited to:

Stringent energy efficiency requirements for building envelopes and electricity consuming systems, with some level of the overall building energy performance supplemented by prescriptive compliance options that favour passive demand reduction measures. Where possible, this should be done for both new and existing buildings to ensure efficient design, maintenance, operation and renovation of buildings.

Zero emission-aligned whole-life carbon targets, addressing both operational and embodied CO_2 emissions, aligned to national and international decarbonisation targets for the sector.

Requirements for buildings to be equipped with smart meters, user appropriate controls (including demand response controls, such as demand response thermostats, demand response lighting controls and demand response HVAC controls), sensors and communication technologies.

Requirements for buildings to be equipped with smart devices, where appropriate, and make use of intelligent analytics to improve operation.

Prescriptive requirements for on-site renewable energy systems.

Grid-ready requirements for buildings (pre-wiring, space requirements for future installations of PV systems, electric vehicle (EV) charging and energy storage).

Smart EV charging requirements, where appropriate.

Requirements for thorough testing and commissioning prior to occupancy.

Requirements for post-occupancy energy use monitoring based on the smart meter data.

Energy codes provide an immediate strategy to improve building performance through energy efficiency measures. Building energy codes should be part of a comprehensive and enforced policy package supporting high-performance buildings.

The importance of building codes, particularly in developing countries, is critical to managing future energy demand and avoiding carbon emissions. Developing countries often exhibit rapid urbanisation and construction growth that can lead to substantial increases in energy consumption and related carbon emissions unless efficiency is enacted as buildings are constructed, alongside expansion and improvements of a low-carbon grid. Building codes provide an essential framework to guide the expansion of the buildings stock towards a sustainable trajectory. By mandating energy-efficient construction practices, developing countries can pre-emptively mitigate the rise in energy demand and carbon emissions that would otherwise accompany urbanisation. Codes can also be used to increase the adoption of renewable energy solutions and innovative technologies, fostering self-reliance and resilience in energy systems. Implementing and enforcing building energy codes in emerging economies can help mitigate the impacts of climate change, improve energy security and reduce the carbon footprint of the building sector (see Box 3).

Codes also play an important role in addressing resilience to climate change and for buildings to withstand the impact of extreme climate conditions, including heat waves, on buildings and their occupants (Building Energy Codes Working Group 2023). Building energy efficiency emerges as a crucial strategy for enhancing climate resilience and ensuring thermal comfort and safety during extreme conditions in buildings. It is estimated that between 2000 and 2019, over 7,000 weather-related natural hazard events affected over four billion people, causing significant economic losses and loss-of-life (Centre for Research on the Epidemiology of Disasters, United Nations Office for Disaster Risk Reduction 2020). Resilient buildings are identified as key assets in dealing with extreme weather events, reducing stress on the grid and enhancing survivability during power outages.

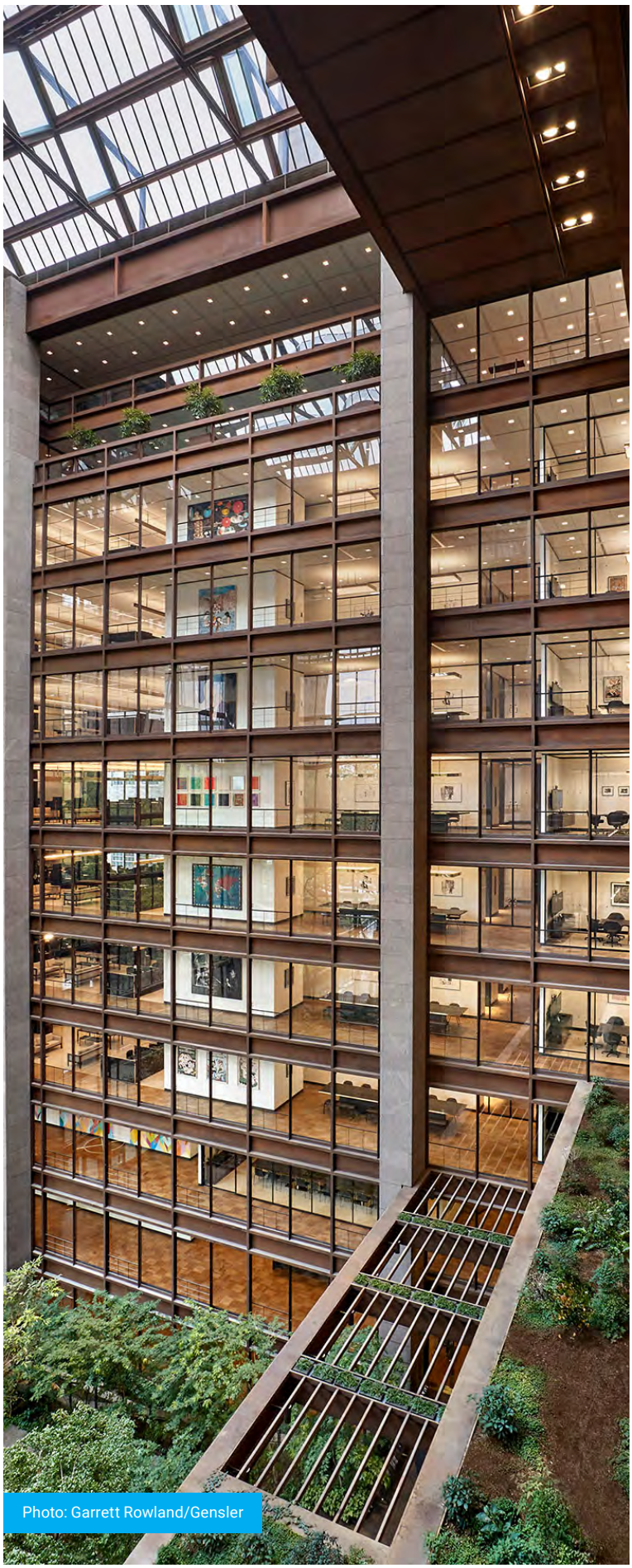


Photo: Garrett Rowland/Gensler

Box 3 Climate action and the path to net-zero: New York City and Tokyo

New York, USA and Tokyo, Japan are two of the world's most famous megacities, with around 8.5 million and 14 million inhabitants respectively. Both are pursuing measures to decarbonise their building stock in line with the goals of the Paris Agreement. Each of these cities has diverse urban morphologies and architectural vernaculars and they are pursuing different policy approaches to building decarbonisation.

In New York City, Local Law 97 (LL97) was passed in April 2019 as part of the Climate Mobilization Act, and aims to reduce buildings emissions, which account for two-thirds of the city's total (Urban Green Council 2023a). The law targets buildings over 25,000 square feet (approximately 2322 m^2), whether they are individual structures or part of a larger complex exceeding 50,000 square feet (approximately 4645 m^2) (Urban Green Council 2023b). The law is set to roll out with new energy efficiency and greenhouse gas emission limits, starting in 2024, with even stricter standards slated for 2030. The goal is a 40 per cent reduction in emissions from the city's largest buildings by 2030, with a net-zero reduction target by 2050 (Urban Green Council 2023b).

Non-compliance with LL97 comes at a substantial cost – a fine of US$268 per ton of CO_2 equivalent over the limit, based on 2024 energy usage and emissions. This approach underscores the city's plan to use a regulatory stick to achieve its climate objectives. A study commissioned by the Real Estate Board of New York (REBNY) in January 2023 revealed a significant challenge ahead – over 3,700 properties could be out of compliance, potentially facing penalties exceeding US$200 million annually, despite substantial investments aimed at meeting the new standards (REBNY press 2023).

Meanwhile, Tokyo is aiming at building decarbonisation through the Zero Emissions Tokyo Strategy. This strategy targets a 30 per cent reduction in GHG emissions on year 2000 levels by 2030, 38 per cent energy use reduction over the same period, and an increase of renewable power to 30 per cent. By 2050 all buildings must be zero emissions (Tokyo Metropolitan Government 2020).

These efforts take place in the context of the Tokyo Cap-and-Trade Program (TCTP), which launched in 2010 (Tokyo Metropolitan Government 2019). This program allows buildings which surpass their targets to sell their offset carbon to other properties, incentivising further reductions. Progress to date shows the greatest gains have come from high efficiency heating and LEDs replacing inefficient lighting (Tokyo Metropolitan Government 2022). In 2020, the city's Green Buildings Program of building performance disclosure was expanded to cover buildings larger than 2000 m^2.

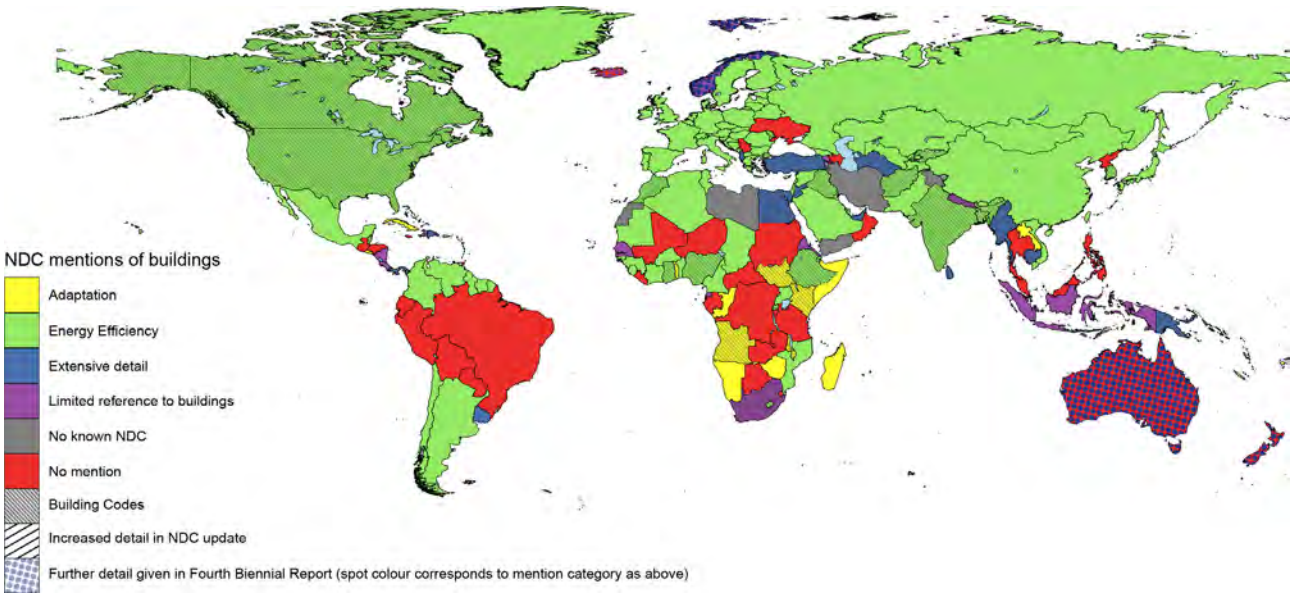
As both cities emerge fully from the COVID pandemic, empty office space remains. Tokyo's central districts have vacancy rates of over 6 per cent (Matsuno 2023) and as much as 100 million square feet of real estate space in New York City is empty (Goldberg and Sakaguchi 2023). This may present a unique opportunity to reform lease agreements and implement retrofits at scale to safeguard the low carbon future both cities are striving for (McKinsey & Company 2022).

3.3 Nationally Determined Contributions updates

NDCs outline government climate mitigation plans under the Paris Agreement. While countries are requested to update and strengthen their NDC commitments every five years, engagement with the process varies considerably.

As of December 2023, 194 countries plus the European Union have submitted NDCs to the United Nations Framework Convention on Climate Change (UNFCCC) repository, with 48 submitting updates since the 2022 Buildings Global Status Report, including the 27 members of the European Union which submit the same NDC (UNFCCC 2024a) (see Figure 12). Notably, the Holy See submitted an NDC for the first time, but it did not make mention of buildings other than listing heating related GHG emissions. Overall, there has been very limited increase in the detail of buildings actions (and clear reference of measuring the aimed achievements), with only 11 of the 48 submissions increasing the level of coverage of buildings relative to previous NDC submissions. Table 1 summarises these changes, incorporating the highest level of commitment that a country has included relating to buildings from its NDC submissions. The current level of commitments is shown in .

Figure 12 Mentions of buildings in Nationally Determined Contributions (NDCs)



(Source: GlobalABC)

Note: This map is without prejudice to the status of or the sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Table 1
Mentions of buildings in NDCs at the time of publication of the Buildings — Global Status Report

GLOBAL STATUS REPORT YEAR	2021	2022	2023
Adaptation only	17	20	17
Energy efficiency	94	103	106
Extensive detail	10	15	19
Limited reference to buildings	14	16	15
No known NDC	5	3	3
No mention	56	39	37
Total mentioning buildings	135	158	161
TOTAL	**196**	**196**	**197**

Despite the limited progress on commitments to buildings action in the NDC in the past year, several countries have submitted plans with extensive detail. The Bahamas aims to drive buildings emissions mitigation through the adoption of a revised building code, the adoption of which could prevent 22kt CO_2e emissions by 2030. Bahamas' NDC also lays out plans for energy audits of government buildings, hotels and industrial facilities, as well as replacing lighting with low-energy LED lighting and rolling out a public information campaign aimed at reducing energy consumption. The updated NDC of Türkiye points to the adoption of a 2022 by-law on energy performance in buildings, which requires buildings over 2000 m^2 to have an EPC of at least class B and at least 10 per cent of their energy to be supplied by renewable energy. The Turkish NDC also commits to the renovation of existing buildings by 2030 and to use district heating in areas of high population density. The broader decarbonisation roadmap for Türkiye's building sector was developed Zero Carbon Building Accelerator (ZCBA) project in 2023 (Bayraktar et al. 2023).

The United Arab Emirates NDC reported buildings emissions of 62 Mt CO_2e in 2019, with a target to reduce these by 56 per cent by 2030. This will be achieved through the National Energy and Water Demand Side Management Programme 2050, which requires periodically updated building codes to improve the efficiency of new buildings, improved retrofit rates and increased uptake of roof-top solar PV and water heating (Government of the United Arab Emirates 2023). Within the Emirates themselves, Dubai aims to retrofit 30,000 buildings by 2030.

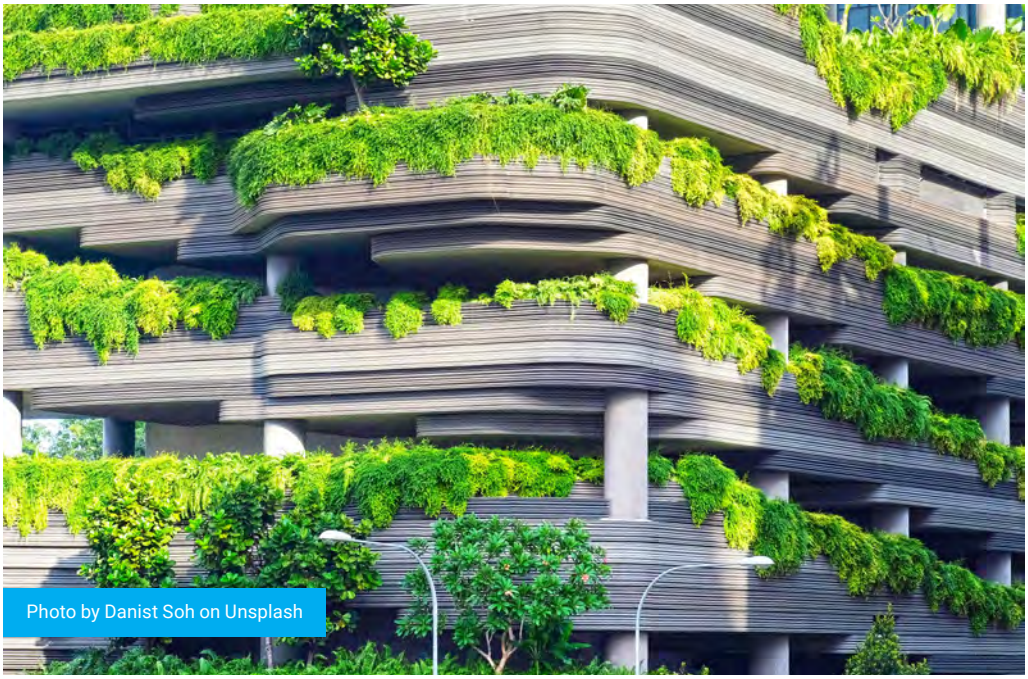


Photo by Danist Soh on Unsplash

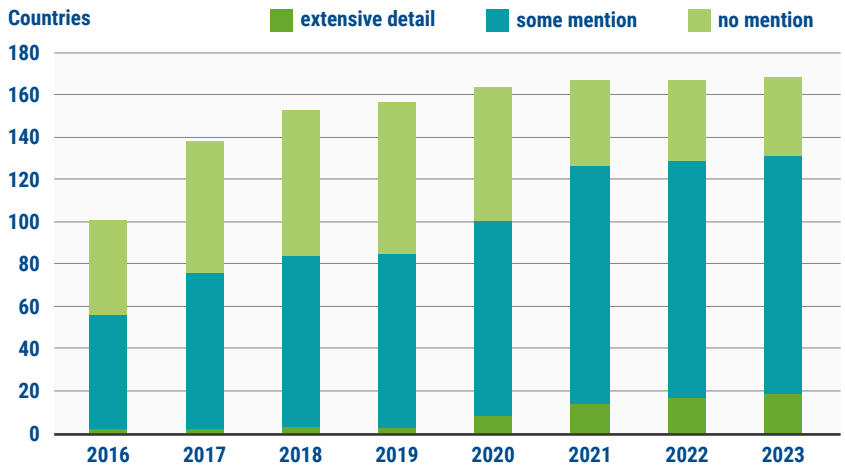
This year, the buildings Global Status Report also reveals how detail in the NDCs with respect to buildings has changed since the signing of the Paris Agreement. The first major tranche of submissions occurred in 2016, with 100 submissions occurring in that calendar year (see Table 2). Since then, the number of countries issuing NDCs with some consideration of buildings has increased steadily, but the number of those with extensive coverage is still lower (19) than those with no mention of buildings (37). Crucially, no G20 economy includes extensive reference to buildings in their NDC. Despite this, countries such as New Zealand, Norway, Australia and Iceland have published more detailed roadmaps in their respective Biennial Update Reports (UNFCCC 2024b) and Long-Term Low-Carbon Development Strategy documents (UNFCCC 2024c). As of December 2023, there have been a total of 168 unique submissions, covering 194 parties to the Paris Agreement (see Figure 13).

As countries move towards updating and submitting/resubmitting their NDCs for the subsequent reporting period in 2025, along with the development of the Low-Carbon Development Strategy documents, greater attention to the buildings sector and decarbonisation and adaptation details need to be added to bolster efforts to address buildings sector emissions and climate resilience.

Table 2
Changes over time of mentions of buildings in the NDCs

CALENDAR YEAR	Extensive detail	Some mention	No mention	Unique country submissions to date
2016	2	54	45	101
2017	2	74	62	138
2018	3	81	69	153
2019	3	82	71	156
2020	8	92	63	163
2021	14	112	41	167
2022	17	112	38	167
2023	19	112	37	168

Figure 13
Number of unique NDCs mentioning buildings by level of detail



(Source: GlobalABC)

3.4 Building certification systems

The World Green Building Council (WorldGBC) in its Global Policy Principles for a Sustainable Built Environment report (WorldGBC 2023), recognized the role of voluntary green building standards and certifications as an information policy lever to support the elimination of both operational and embodied carbon emissions across buildings' lifecycle and the prioritisation of buildings renovation. With growing interest, the WorldGBC network has evolved to represent 80 countries across global regions.

More than 60 international and local building certification systems exist worldwide. Unfortunately, the limited availability and transparency of the data openly published by building certification entities remains a barrier. Only 13 certifications systems are included in the analysis of the GBCT. These include BEAM Plus, BREEAM, CASBEE, DGNB, EDGE, GREEN STAR, GRIHA, LEED, Miljobyggnad, MINERGIE, Passive House, Saaf, and WELL. These certification schemes vary from local certification schemes operating in one country to schemes operating in 180 countries. In recent years, certifications such as LEED, DGNB, Passive House and EDGE have increased their coverage, including new countries where their certification scheme is being implemented (see Box 4).

Box 4 Green Building Certificates in specific regions

Green building certification in the UAE

Since COP28 took place in the United Arab Emirates in 2023, a brief analysis of the certifications systems in the region was conducted. Due to limited availability of data, only four of the certification systems existing in the region are discussed.

According to the information presented by the Emirates Green Buildings Council (EmiratesGBC publication launch webinar: Advancing deep retrofit in the UAE 2020), as of 2020, the Dubai Green Building Regulations and Specifications (replaced by Al Sa'fat – Dubai Green Building System in 2020) had accumulated 19,046 certified buildings and 15,532 villas; PEARL Building rating system had certified 461 buildings and 9972 villas; and Barjeel had accumulated 59 certified buildings and 289 villas. Saaf, which is part of the analysis for the GBCT tracker, has accumulated 4641 projects until 2022.

Green building certification in Latin America

Since Latin America is a region with a broad variety of cultures, climates, energy prices and local policies and construction practices, there is also a difference in the level of development of green building standards and certification schemes between countries. However, since the Paris Agreement in COP21, signatory countries have developed local certification schemes to promote green building, energy efficiency and decarbonisation, and its benefits to the environment, health and well-being of people and communities.

Such examples are ***GBC Casa***, ***GBC Condomínio*** and ***GBC Life*** and ***Zero Energy*** in Brazil; ***CVS*** and ***CES in Chile***, ***Casa Colombia***, ***Casa Guatemala***, CREAS in Argentina, MAS in Uruguay, and ECOCASA in Mexico (Alvear et al. 2023). A relevant example of certification may be the Torre Rise project in Mexico, which is expected to be the tallest skyscraper in the region once completed. This project is applying different certification schemes such as LEED, WELL, bEQ and the local norm for minimum criteria and environmental requirements for sustainable buildings in Mexico, NMX-164. The project can be seen as an example to promote best practices based on foreign and national standards, opening the way to sustainable innovations in the building sector.

To incentivize the demand for building certificates, certification schemes should be leveraged as a tool to access funding and investment schemes. Moreover, certification schemes are more frequently including lifecycle assessments and zero carbon emission principles within their evaluations (IEA et al. 2022). These new characteristics should be linked to the obligation of housing associations, building portfolio managers and mortgage credit institutions to report lifecycle emissions, and to the requirement of new buildings to be zero carbon emissions. Certification schemes considering embodied emissions, combined with the inclusion of embodied emissions into public procurement decisions, can also help create demand for material efficient designs (Huynh et al. 2023; IEA 2023f).

Certification schemes should also recognize the local context and tailor their assessments to encourage and facilitate their rollout according to the local circumstances, especially in developing countries. Furthermore, certification schemes can gradually consider options to promote not only sustainable constructions but also resilient buildings, for which a lack of resilience is recognized as an ever-increasing risk to the building stock (Felicioni et al. 2023).

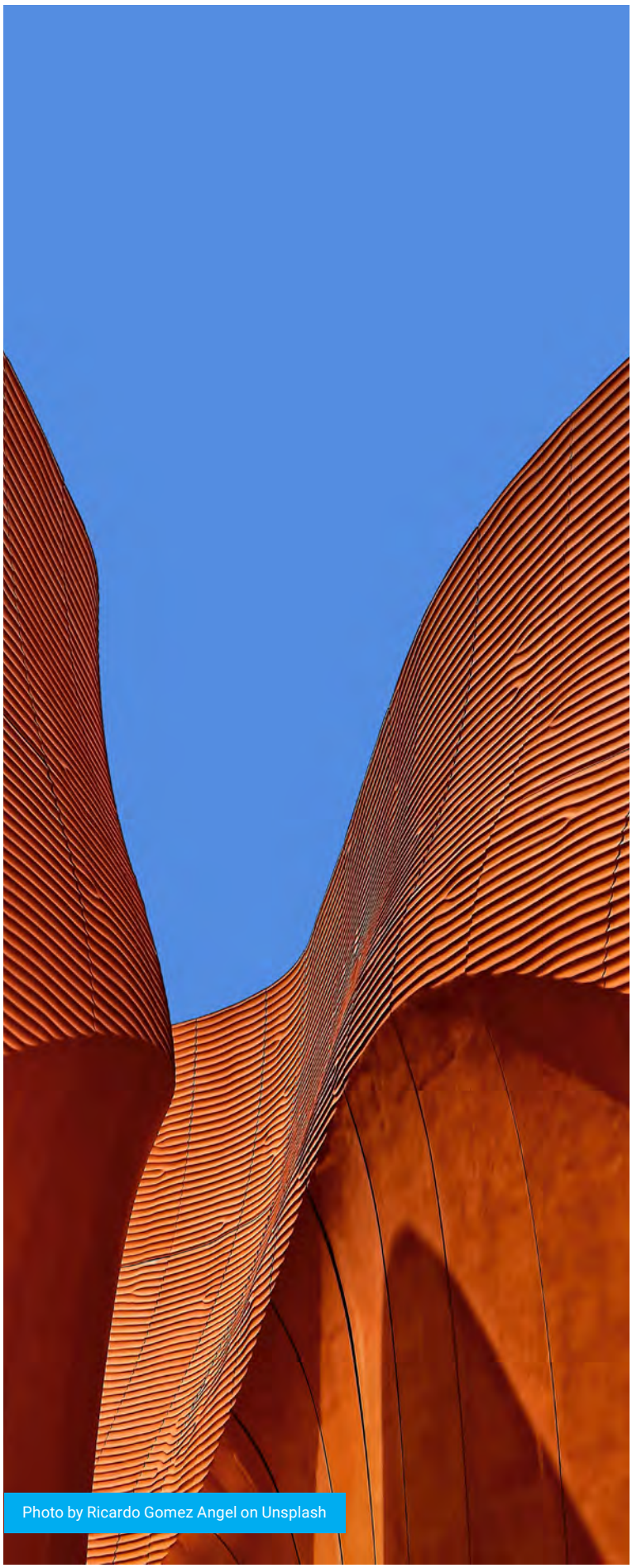


Photo by Ricardo Gomez Angel on Unsplash

04 Investment and financing for sustainable buildings

The transition to net-zero buildings is a complex process that requires strategic use of both policy and financial instruments. These instruments must be designed to promote investment in energy-efficient and low-carbon building technologies by overcoming financial barriers and supporting long-term cost savings from energy efficiency improvements.

A recent report looking at the interdependencies between policy and finance showed that policy instruments (e.g. capacity development, mandates and incentives) have strong interdependencies with financial instruments (Micale et al. 2023). Capacity development and fiscal tools bolster mandates and incentives, improving local workforce skills, including sustainability knowledge of public engineers and architects. Mandates, like data disclosure by building owners and standard setting, are crucial for transition. Financial instruments often include grants, fiscal instruments, equity instruments, risk mitigation instruments, business models and contracts, debt instruments, asset finance models, and structured finance strategies. These instruments play varied and often complementary roles in the transition to net-zero buildings.

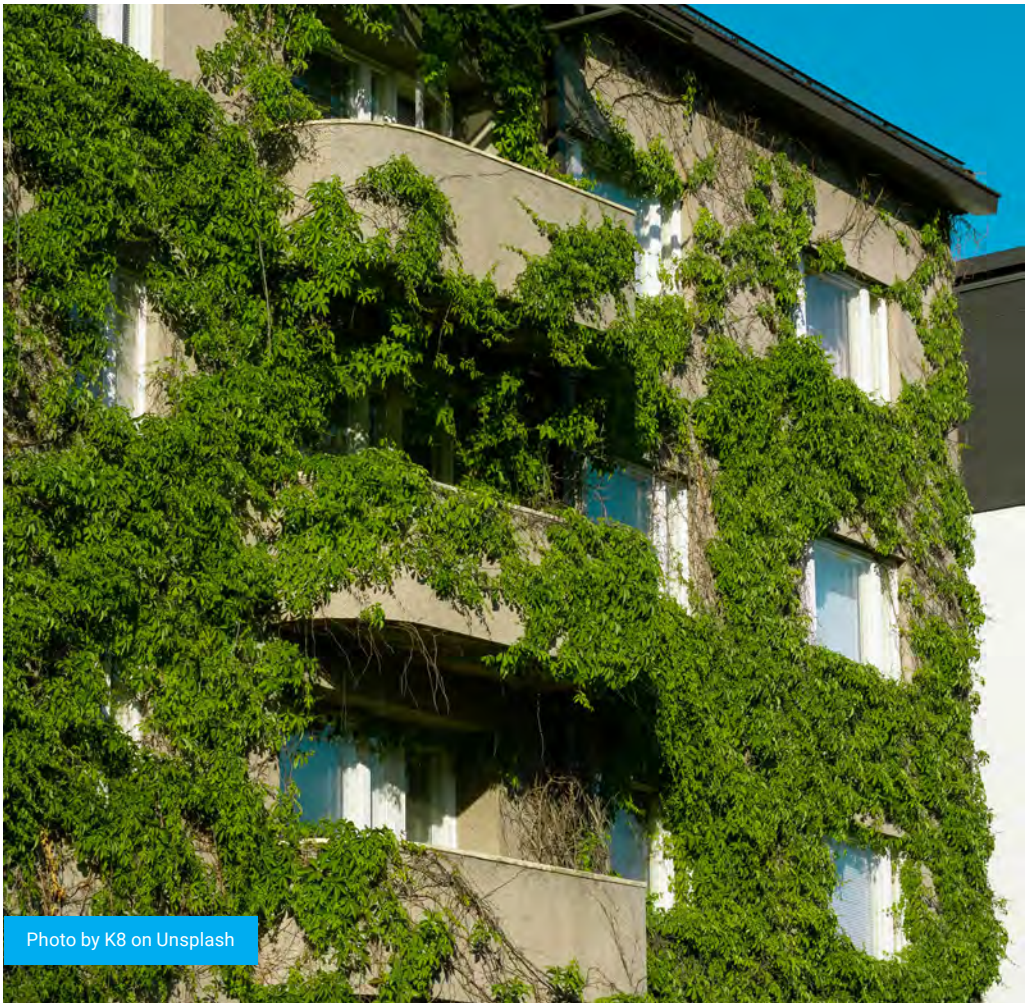


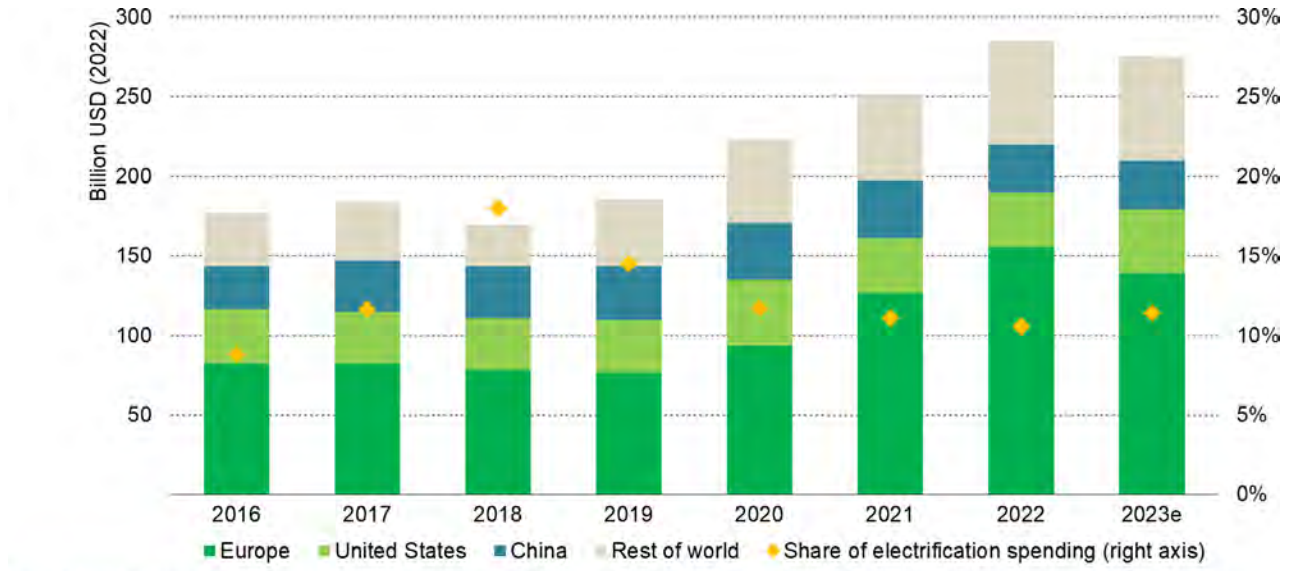
Photo by K8 on Unsplash

4.1 Energy efficiency investment in buildings

Global investment in the energy efficiency of buildings increased by around 14 per cent from 2021 to US$285 billion in 2022 (IEA 2023g) (see Figure 14). Investments in 2023 are estimated to fall to 270 billion due to the impact of rising borrowing costs and economic instability, which are slowing construction activity. Investment in energy efficiency and construction of sustainable buildings represents less than five per cent of total global investment in the buildings sector. Global increases in the cost of living will put pressure on borrowing costs, but energy efficiency presents a means of moderating energy cost volatility as well as reducing emissions.

The growth in global investment was driven by direct public investment and Europe's response to energy insecurity amidst the cautious reopening of the global construction sector. However, projections for 2023 indicate a potential slowdown in spending due to increased borrowing costs, economic uncertainty and the ongoing conflicts.

Figure 14 Investment in energy efficiency in buildings and construction



Notes: Spending on electrification (e.g., Heat pumps) is included in the total spending, and represented as a share of total spending on the right axis; 2023e = estimated values for 2023

(Source: IEA 2023a)

The 2022 increase in efficiency investment was largely attributed to spending in major markets such as the USA, Germany and Italy. There was also an increase related to the expansion of global floorspace with more newly constructed buildings reaching higher than minimum building code standards, such as those meeting green or sustainable certifications (see Section 3.4).

In the USA, over US$33.7 billion was invested through Department of Energy efficiency programmes and utility demand-side management. This spending is estimated to have increased by an additional US$970 million in 2023 through the newly created State and Community Energy Office under the Inflation Reduction Act. In Germany, efficiency spending moderated to around US$51 billion in 2022, accompanied by changes in support programmes. In Italy, the Superbonus programme led to a near doubling of the investment in energy efficiency from US$23 billion in 2021 to around US$57 billion in 2022. However, recent changes to the Italian Superbonus programme have created uncertainty about spending beyond 2023.

China's construction sector experienced a 10 per cent reduction in investment in 2022, alongside a slowing delivery of green buildings. Similarly, France and the United Kingdom saw a decrease in efficiency spending due to a slowing construction sector and changes in government programmes. Conversely, some developing markets, such as India, saw an increase in construction activities and investment in building energy efficiency. Japan's focus on achieving zero energy housing (ZEH) has resulted in an increase in the proportion of green new buildings.

Overall, most countries experienced a modest increase in 2022, primarily due to the recovery of construction activities from pandemic-induced lows. Europe saw a modest increase in investment of around three per cent, while Central and South America experienced an increase of around five per cent in construction sector spending and related investment in energy efficiency.

International financial institutions continue to support investment in the global building stock through concessional finance. For instance, the European Bank for Reconstruction and Development committed over US$73.5 million to Lithuania for energy efficiency renovations in residential buildings and US$43 million to Albania for improving school building efficiency.

Investments are increasingly being directed towards technologies that enable net-zero carbon ready buildings, such as heat pumps (see Section 2.2.1). In 2022, around 3 million heat pumps were installed in buildings across Europe, marking an increase of almost 40 per cent compared to the previous year and is estimated to be worth US$14 billion (Global Market Insights 2023).

However, the winding down of pandemic-related stimulus and the projected reductions in government and private sector spending due to increased borrowing costs suggest that 2023 may see a reduction in efficiency spending. Investment in global energy efficiency is projected to drop by up to 10 per cent due to construction market uncertainty in Asia, South America and Europe, and changes in several large European programmes. This potential shift in investment trends in the buildings sector energy efficiency is concerning, given that further energy price rises will strain households and businesses. The lack of knowledge around energy efficiency investment is a barrier to adopting strategies—such as shared-risks and preferential terms for energy efficient technologies—that reduce perceived risks associated with these investments.

Photo by Iva Rajović on Unsplash

4.2 Financing of energy efficiency and zero carbon buildings: a case study of the European Union

Addressing the risks and challenges posed by climate change in the buildings sector requires the mobilisation of substantial capital, with the construction and real estate sector facing a substantial investment gap needed to decarbonise. In the European Union alone, to achieve the proposed 55 per cent climate target by 2030, around US$300 billion of additional investment in building renovation is needed every year (European Commission 2020). Part of this investment is aimed to be met by the European Union's US$733 billion Recovery and Resilience Facility (RRF), which has dedicated 37 per cent of its funds to climate-related expenditure between 2021-27. However, as mobilising capital through public investment is not sufficient, the financial services sector must also play its role.

To overcome existing sectoral and systemic barriers, the European Union has taken several legislative initiatives that are increasingly impacting the construction and real estate sector. To support sustainable investments, the European Union has developed a classification system to enable the identification of activities that are environmentally sustainable and to help investors navigate the transition to a low-carbon economy.

The EU taxonomy , entered into force on 1 July 2020, creates a common language for investors, issuers of green bonds, companies and policymakers through technical screening criteria in relation to six environmental objectives (European Commission 2023b):

1. Climate change mitigation
2. Climate change adaptation
3. Sustainable use and protection of water and marine resources
4. Transition to a circular economy
5. Pollution prevention and control
6. Protection and restoration of biodiversity and ecosystems

To be classified as an environmentally sustainable or green activity according to the EU taxonomy, an economic activity should make a substantial contribution to at least one of the above environmental objectives while not doing significant harm to the other five. In addition, "minimum social safeguards", such as the UN Guiding Principles on Business and Human Rights, need to be met. To date, three taxonomies have been fully developed and adopted for buildings sector-related activities: climate change mitigation, climate change adaptation and transition to a circular economy. The finance legislative context in the European Union is further explored in a recent WorldGBC report 'Ahead of the wave: financing the transition to a decarbonised built environment' (Emmrich et al. 2023).

The climate delegated act of the taxonomy has outlined that the primary energy demand (PED) of new constructions has to be at least 10 per cent lower than the nearly zero energy building (NZEB) threshold, whereas for building renovation to be considered a sustainable economic activity, it needs to achieve 30 per cent energy saving and comply with minimum energy performance requirements.

While the use of the EU taxonomy is predominantly voluntary at this stage, the introduction of reporting requirements as of 2022, mandating the disclosure of eligibility and alignment with the taxonomy, has rendered the regulation more relevant and influential in the sector. One of these initiatives is the Sustainable Finance Disclosure Regulation (SFDR) (European Commission 2022), which was developed with the aim to improve transparency in the market about the way how financial actors, i.e. asset managers, institutional investors, insurance companies and pension funds, incorporate sustainability risks. A distinctive part of the SFDR concerns the so-called classification requirement of financial products as a:

- Financial product without a sustainability ambition
- Financial product that promotes environmental or social characteristics, so-called light green products
- Financial product that has both environmental and social investment as its objective, so-called dark green products

The more ambitious the product, the stricter the disclosure requirement. To meet SFDR sustainable investment definitions, reporting of the full lifecycle environmental impacts is required, including extraction of raw materials to the construction phase, use and finally demolition and disposal.

Current focus is on usability of the EU taxonomy, as in practice many real estate actors seem to be struggling to collect the required data to establish and prove taxonomy alignment. Collecting sufficient data to measure against the EU taxonomy is considered valuable in anticipation of its future expansion, offering insights into the proportion of portfolios that already have a reduced environmental impact and the steps that can be taken to improve the more carbon-intensive assets.

Tightening the climate change mitigation thresholds of the current taxonomy will be imminent to bring it in line with the forthcoming and more ambitious recast of EU's Energy Performance of Buildings Directive. This will also be an opportunity to emphasize the importance of renovations of existing buildings over new constructions[4], as well as introduce whole life carbon benchmarks and limit values, and other mechanisms such as carbon fine demolition and carbon credits for reuse of buildings. In any case, these developments are already driving investor action and unparalleled levels of transparency when it comes to reporting.

4 *The energy efficiency renovation of buildings is currently classified as a 'transitional activity, and as such cannot be included in a 'dark green' fund under the SFDR. The present environmental taxonomy may have the unintended consequence to suggest that investing in renovation is less sustainable than demolishing a replacing an existing building with a high energy performance new construction.*

The implementation of green taxonomies is growing around the world. By the end of 2022, there were over twenty taxonomies in place or being developed (The Sustainability Institute by ERM 2022). For instance, in Latin America, Colombia launched its Green taxonomy in 2022, and Mexico is (see Section 10.3). Countries in other regions that have recently launched their green taxonomies include Canada, South Africa, Indonesia and Singapore. While some of these differ from the EU taxonomy to prioritise their local context, countries such as Canada and South Africa are predominantly built on the EU taxonomy (The Sustainability Institute by ERM 2022).

It is important to increase international cooperation to pursue alignments across taxonomies. The large diversity of them may hinder stakeholders operating across borders since their activities may be classified differently across regions (Thür 2022). The European Union in its proposal to regulate its green bonds (TANG 2022) indicates that to encourage the development of high-quality sustainable taxonomies in third-country jurisdictions, European Union bond proceeds allocated in a third country should be able to use a sustainable taxonomy from that third country provided that that taxonomy has been deemed 'equivalent' to the EU taxonomy.

Another prominent enabler being implemented in multiple regions is the carbon exchange and trade markets. More than 60 countries, cities, states and provinces have implemented or are planning to implement carbon trading systems (IEA 2020). Alignments like these should be further pursued. Trading systems can stimulate technological innovations, support climate risk quantification and multilateral co-operation, create synergies with energy and environmental policies, among other benefits (IEA 2020).

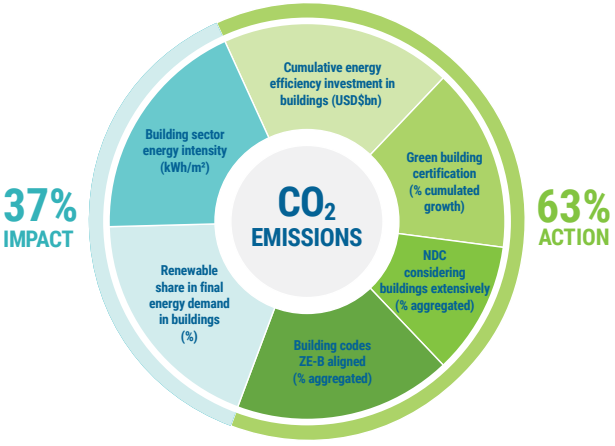
05 Global Buildings Climate Tracker

First published in 2020, the Global Buildings Climate Tracker (GBCT) monitors the progress towards the decarbonisation of buildings worldwide. The GBCT is a seven-part composite index that provides a snapshot of the decarbonisation efforts of buildings from 2015 (when the Paris Agreement was established) until today (this year's edition includes data until 2022). For the first time, the progress is being measured against a reference scenario, which envisions decarbonisation the building sector by the year 2050.

As shown in Figure 15, the GBCT integrates the CO_2 emissions associated with building operations[5]. Additionally, it includes two indicators to monitor the impact of decarbonisation efforts and four indicators to monitor the actions taken towards the decarbonisation of buildings. The impact of the decarbonisation efforts is represented by the indicators monitoring the building stock energy intensity and the renewable share in final energy demand. Meanwhile the indicators monitoring the energy efficiency investments, green building certification, NDCs considering buildings, and building energy codes measure the actions taken towards decarbonisation. The CO_2 emissions indicator is used as a multiplier while the other six indicators are aggregated using a weighted sum, with weights established in the first edition of the GBCT: impact indicators 37 per cent and action indicators 63 per cent.

5 *It is important to consider the role of embodied carbon emissions in the building sector. Unfortunately, these are not being currently included in the GBCT due to the lack of a data set covering this portion of the emissions in the sector worldwide and through the timespan of the tracker.*

Figure 15 GBCT's indicators weights



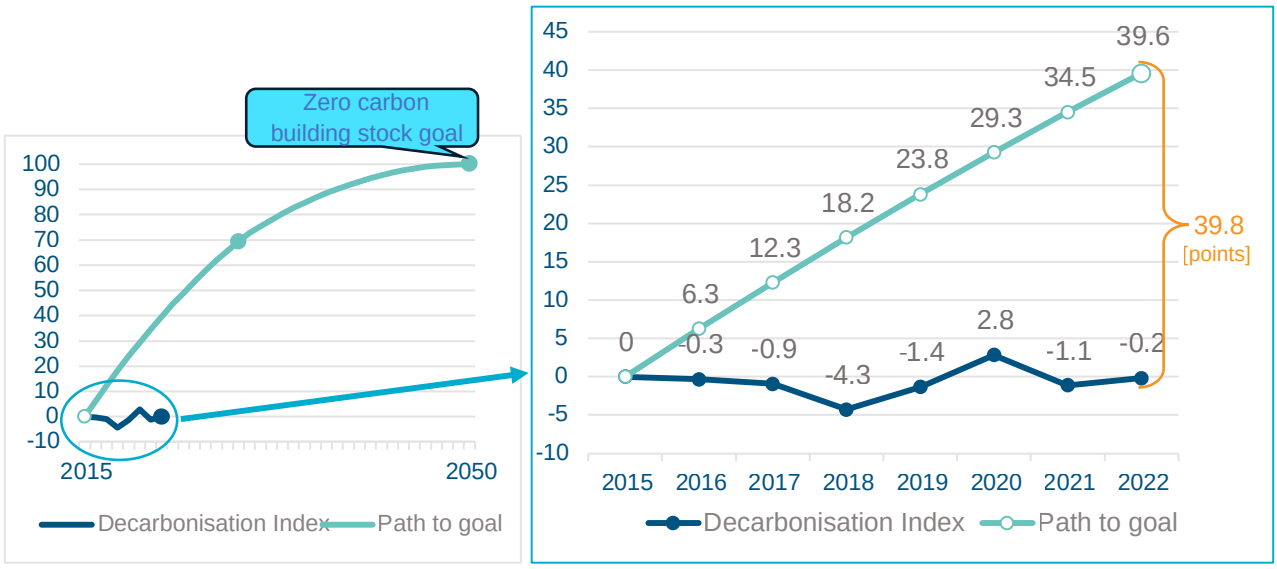
(Source: Building Performance Institute of Europe [BPIE])

In this edition of the GBCT, the goals for all the indicators were adjusted to a reference scenario to increase the consistency among them and with the final decarbonisation goal of the composite index. The IEA's Net Zero Emissions (NZE) scenario (IEA 2023h) was used as the reference scenario. For each indicator a 2030 milestone and the 2050 final goal are introduced. The milestone in 2030 reflects the near-term actions required to pave the way towards the long-term goal by 2050. Other updates include the change in the methodology for the energy efficiency investments, which shifted from monitoring annual investments to cumulated investments. Additionally, the methodology for the NDCs and building energy codes was adjusted to assess the relevant aspects included in them more thoroughly. A detailed description of the updates of the goals and methodologies can be found in.

Figure 16 (left) presents the reference path of decarbonisation for the building stock, starting in 2015 until 2050. The path is the result of combining the reference paths for the seven indicators. For each indicator, it is considered to follow a linear path from the starting point in 2015 to the milestone in 2030, and then to the goal in 2050. The reference paths of the indicators are aggregated using a weighted sum according to the weights previously described and then multiplied by the CO_2 emissions indicator.

Figure 16 (right) zooms in to present the period 2015-2022. The observations show that the decarbonisation of the building sector is far off track. By 2022, the gap between the observed status and the reference path is 39.8 decarbonisation points[6]. After a noticeable increase observed in 2020—most likely related to the COVID-19 pandemic restrictions—and its rebound in 2021, the decarbonisation index increased by 0.8 points in 2022, reaching -0.2 points. The observations of the first seven years of the implementation of the Paris agreement show that the decarbonisation of the building stock worldwide is lacking significant progress. By 2022, the decarbonisation index is at similar levels of the reference starting point in 2015. From a global perspective, progress to mitigate the climate change impact of buildings and construction is stagnating.

Figure 16 GBCT decarbonisation index. Left: reference path until 2050. Right: zoom in for the 2015-2022 period.



(Sources: BPIE

6 *Please consider that the results from the previous editions of the GBCT differ from the results presented this year due to the changes implemented in the methodology and goals of some of the indicators, for more details please refer.*

This lack of progress can be obser ved in most of the indicators comprising the GBCT. Table 3 summarises the observations for the selected indicators, including the starting point in 2015 and the observations in 2022.

Table 3 GBCT's indicators observations summary, 2015-2022

INDICATOR	Starting value in 2015	Observed value in 2022	Observed change from 2015 to 2022	Necessary change from 2015 to 2022
EMISSIONS				
Buildings sector energy related emissions	9.3 [$GtCO_2$/year]	9.8 [$GtCO_2$/year]	+5.4 [%]	-24.6 [%]
IMPACT				
Building sector energy intensity	153.1 [kWh/m²]	145.3 [kWh/m²]	-5.1 [%]	-17.3 [%]
Renewable share in final energy demand in buildings	5 [%]	5.9 [%]	+0.9 percentage points	+6.1percentage points
ACTION				
Cumulative energy efficiency investment in buildings	161 [US$bn]	1,642 [US$bn]	+1,481 [US$bn]	+2,531 [US$bn]
Green building certification (cumulative growth)	1.0 point	9.1 points	+8.1 points	+15.3 points
NDC considering buildings extensively (aggregated)	0.7 [%]	5.7 [%]	+5.0 percentage points	+34.7 percentage points
Building codes ZEB-aligned (aggregated)	0 [%]	3.3 [%]	+3.3 percentage points	+35.0 percentage points

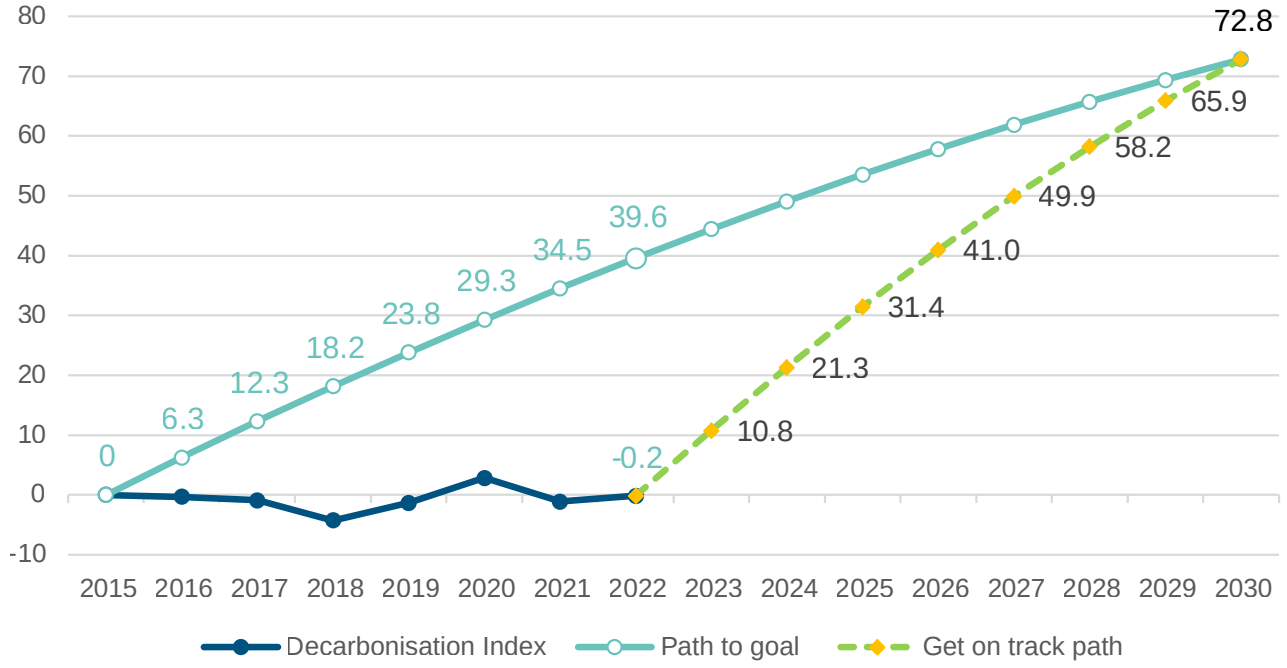
By 2022, the GBCT shows that the CO_2 emissions associated with the operation of buildings have not reduced since 2015. By 2022, the CO_2 emissions from buildings are 5.4 per cent higher than those observed in 2015. Moreover, the indicators measuring the impact of the decarbonisation efforts show that, since 2015, the energy intensity in buildings has decreased by only 5.1 per cent falling short of the necessary 17.3 per cent reduction. Additionally, the renewable energy share in buildings' final energy demand has increased by only 0.9 percentage points from 2015 to 2022, instead of the required 6.1 percentage points.

Conversely, in terms of the indicators measuring actions taken towards decarbonisation, the GBCT shows that the cumulated 2015-2022 energy efficiency investments were US$1,050 billion less than is needed to be on track. The cumulative growth of green building certifications increased 8.1 points, around seven points below the necessary value. With respect to policy progress, by 2022 only 17 countries have NDCs have extensive details for the building sector (see Section 3.3) and only three countries have established building energy codes that are aligned with ZEB principles (see Section 3.2), making these two indicators very low values 5.7 per cent and 3.3 per cent, respectively[7].

7 *Consider that the number of countries is not translated directly into percentages for these two indicators. It is considered that advanced economies may reach net-zero emissions in advance of others, i.e. it was considered that by 2030 all the G20 members and 50% of the remaining countries should include a detailed strategy for the building sector within their NDCs and have building energy codes including ZEB principles. For more details on the methodology for these two indicators please refer to Annex: Global Buildings Climate Tracker method.*

The low progress or even worsening observed in the GBCT's indicators explain the large gap shown in Figure 16 between the current status of the decarbonisation of the building stock and the reference path. The representation of a path to get on track by the end of the decade towards the long-term goal in 2050 in presented in Figure 17 (the reference path is shown only until 2030 to facilitate the reading of the figure).

Figure 17 GBCT observations and path to get on track by 2030



(Source: BPIE)

It is important to notice, that starting in 2015, around six decarbonisation points were required every year to follow the reference path. However, due to the slow progress achieved until 2022, around ten decarbonisation points are now necessary every year to correct the current situation and get on track by 2030.

To get on track towards the final goal in 2050, it is necessary not only to accelerate and strength the implementation of effective measures to boost the progress of each of the areas covered by the indicators comprised in the GBCT, but also to strengthen the reporting, monitoring and verification of the measures and indicators themselves. The following section provides more insights regarding the development of the indicators, the gaps in their progress until 2022, and the opportunities to get on track.

06

Buildings climate policy gap review

The lack of progress in the decarbonisation of the global building stock, evidenced by the GBCT, is the result of gaps in progress across the monitored indicators. These gaps, and the opportunities that exist to close them, can get the sector back on a trajectory to aligning to the net-zero carbon goal in 2050 by the end of this decade. The following policy gap analysis outlines the actions needed to address both the emissions indicators and the impact and action indicators.

The gap analysis covers the period 2015-2022 and compares against a reference path that could be followed to achieve the decarbonisation of the global building stock. The reference path is defined according to the milestones and goals of each indicator, which were established based on the IEA's Net-zero Emissions scenario (IEA 2023h). For more details on the milestones, goals and methods for the GBCT's indicators please see Annex: Global Buildings Climate Tracker Method.

In addition to the observations and reference paths, a 'get on track' path shows the accelerated actions trajectory to reach the decarbonisation reference path, which assumes that necessary efforts to bridge the gap for each indicator are deployed in the upcoming years and that the indicators get on track by 2030. From 2030 onwards, the progress of each indicator follows the reference path until 2050. Hence, the reference path is only presented until 2030 to facilitate the visualisation in the figures.

Note that although the GBCT is normalised and the final index is dimensionless (i.e. no units)[8], the indicators in this section are presented in terms of their absolute values to facilitate the analysis and interpretation of the results.

8 *For more details please see Annex: Global Buildings Climate Tracker Method*

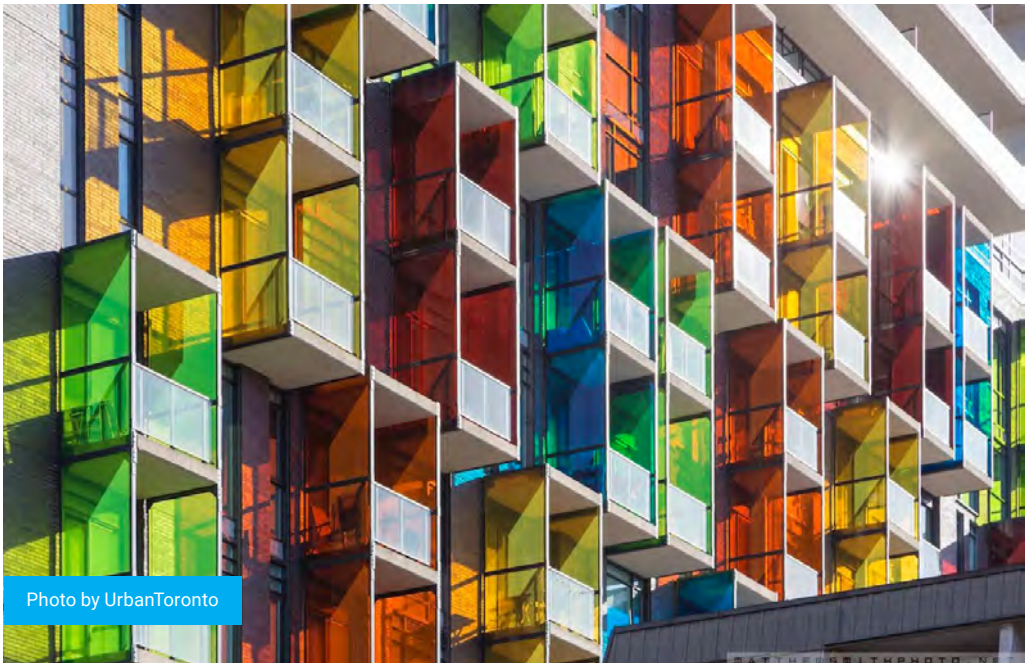


Photo by UrbanToronto

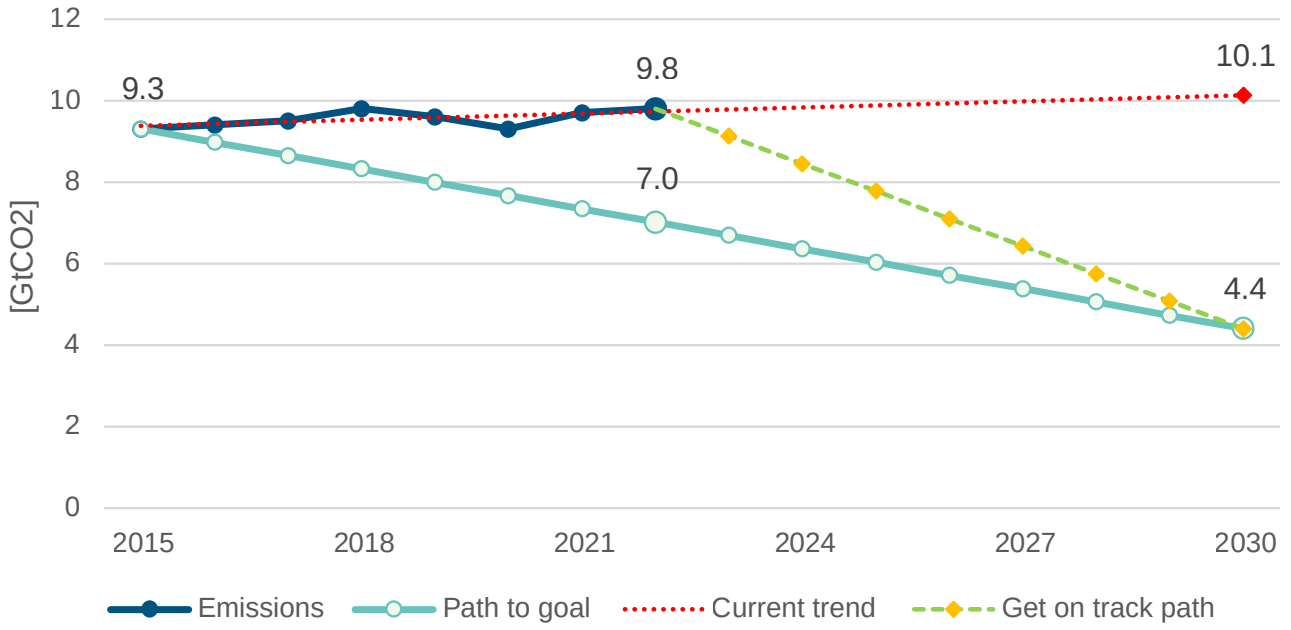
6.1 Emissions

6.1.1 Buildings sector energy related emissions

This indicator monitors the CO_2 emissions (direct and indirect) resulting from the operation of buildings. The reference path towards the long-term goal of zero $GtCO_2$/year by 2050 has a milestone of 4.4 $GtCO_2$/year in 2030.

In 2022, the CO_2 emissions from buildings' operation reached 9.8 $GtCO_2$/year (see Section 2.3 Emissions in the buildings and construction sector trends), which is 40 per cent higher than the reference value. If the trend from previous years continues, the CO_2 emissions from buildings' operation may keep growing, exceeding twice the required value for 2030. To get on track, the CO_2 emissions should reduce in average by around ten per cent every year until 2030 (Figure 18).

Figure 18 Observations of the CO_2 emission of the global building stock's operation and path to get on track



(Source: BPIE)

The actions required to accelerate the rate of decarbonisation include setting out stronger policies that set targets for reducing building emissions; upgrading and adopting building energy codes that align to net-zero carbon; shifting towards mandatory performance certificates and labelling as well as whole life cycle reporting frameworks; adopting 'upper third' best available technology MEPS; setting maximum operational and embodied carbon emissions; and adopting zero carbon public procurement requirements (IEA 2023f; WorldGBC 2023b).

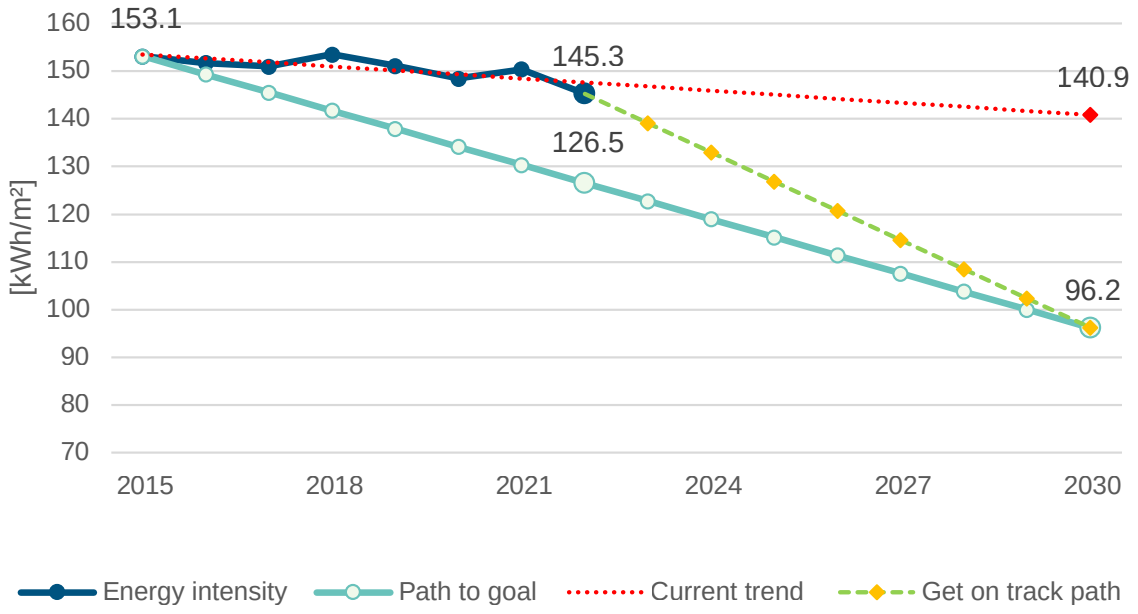
Even though the tracker does not include embodied emissions due to the lack of data, it is important to highlight that it is necessary to address not only operational but also embodied emissions. An example of efforts to in this regard is France's RE2020 regulation, which caps buildings' embodied carbon emissions (IEA 2023f). Mechanisms to collect and report data regarding embodied carbon emissions should be deployed, especially in regions where new construction is expected to increase considerably in the coming years. Green labelling and certification related to embodied emissions, as well as factoring embodied emissions into public procurement decisions, can also help create demand for material efficient designs (IEA 2023f).

6.2 Impact

6.2.1 Building sector energy intensity

To meet the reference path, global building energy intensity needs to reduce by around 37 per cent compared to 2015, reaching a 96 kWh/m^2 milestone by 2030. In 2022, building energy intensity reduced by around 3 per cent compared to 2021, reaching 145.3 kWh/m^2. Yet, this indicator is 15 per cent higher than the necessary value to be on track. If this trend continues, the energy intensity would be almost 50 per cent higher than the needed value in 2030. To get on track, the energy intensity should reduce by around 5 per cent every year to 2030, almost seven times faster that during the 2015-2022 period (Figure 19).

Figure 19 Observations of the building sector energy intensity and path to get on track



(Source: BPIE)

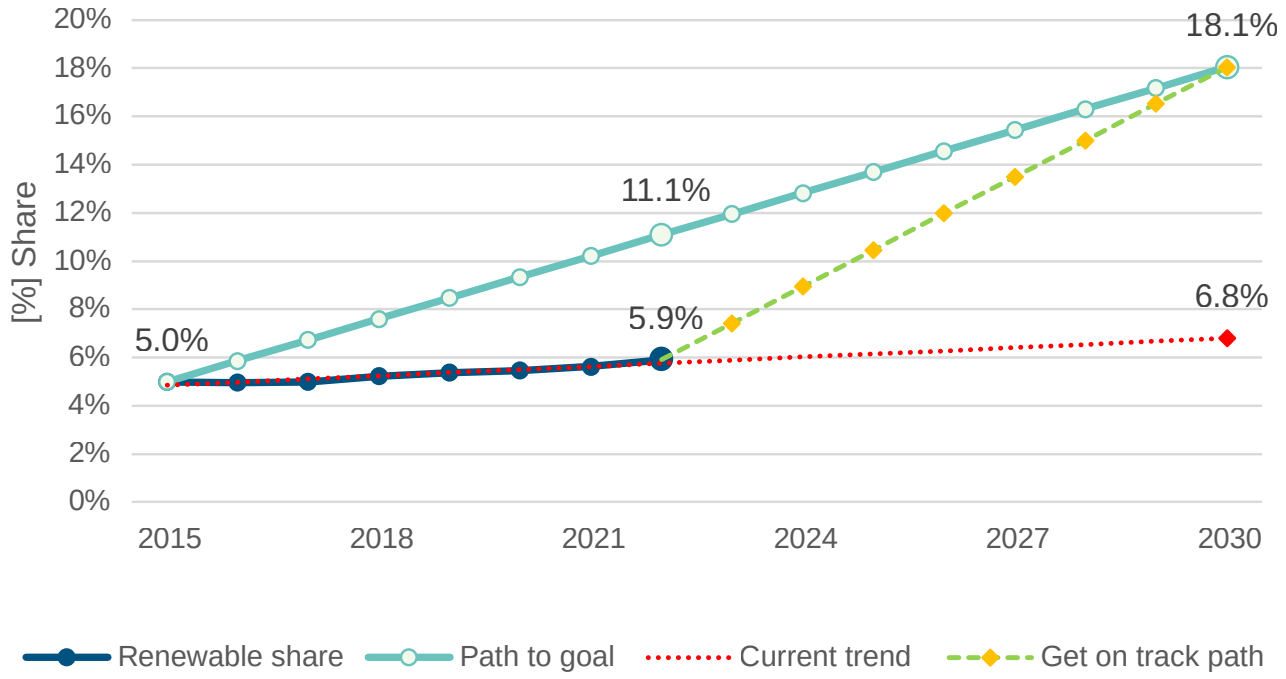
Reducing the energy consumption in buildings through higher energy performance standards for new buildings and efficient retrofits of existing buildings is key to achieve the reduction of CO_2 emissions. In developing regions like Latin America, moving from strategies beyond technologies towards approaches at the systems level, such as combining buildings materials and passive technologies with efficient end uses, can enable achieving higher savings (IEA 2023a). Moreover, it is imperative to highlight the role of sufficiency measures to reduce energy consumption. The Intergovernmental Panel on Climate Change (IPCC) in its 2023 report highlights the role of sufficiency measures to limit the demand for energy and materials over the lifecycle of buildings and appliances (IPCC 2023).

Recent examples of the types of policy actions needed include China's new General Code for Building Energy Efficiency and Renewable Energy Utilization, implemented in 2022, which requires all new, expanded or renovated buildings to be designed with energy efficiency principles (IEA 2023i). In Europe, the recast of the Energy Performance of Buildings Directive (EPBD) is expected to increase the support for the transition towards a more efficient building stock in the region. In the Republic of Korea, the 'Energy Cashback' pilot programme, launched in 2022, incentivises households to reduce energy consumption through behaviour change in improving energy efficiency. Meanwhile, Australia's updated 2022 National Construction Code has strengthened energy efficiency requirements for new homes and apartments.

6.2.2 Renewable share in final energy demand in buildings

The share of renewable energy in the final energy consumption of buildings needs to reach 18 per cent by 2030 to align to the reference pathway. In 2022, renewable energy use in buildings was only six per cent. If this trend continues this use would only reach seven per cent by 2030. To get on track, the share of renewable energy in the final energy demand of buildings should increase by 1.5 per cent every year until 2030 (Figure 20).

Figure 20 Observations of the renewable share in final energy demand in buildings and path to get on track



(Source: BPIE)

Although the amount of renewable energy used in buildings increased by 30 per cent from 2015 to 2022 (IEA 2023i), this increase has not displaced conventional fuels. But so long as the electricity grid also continues to decarbonise, building emissions would fall at the needed rate.

Policy actions that see building codes adopt minimum renewable energy requirements for end-uses such as hot water heating, alongside onsite renewable energy generation and storage, will support the increase of renewables used in buildings. Moreover, adopting requirements for renewable energy procurement can also accelerate the decarbonisation of the energy supply in buildings.

An example of a supporting framework for renewable energy procurement is the Zero Code Renewable Energy Procurement Framework (Architecture 2023, 2024). Decarbonising heat through the use of heat pumps alongside a decarbonising electricity grid will further reduce emissions and can be mandated through building codes and bans on fossil fuel heating systems. For example, the California building code sets out performance targets that effectively require the use of heat pumps in new building construction by requiring heating from 'clean energy' or having to meet much more stringent fabric performance requirements (NRDC 2021).

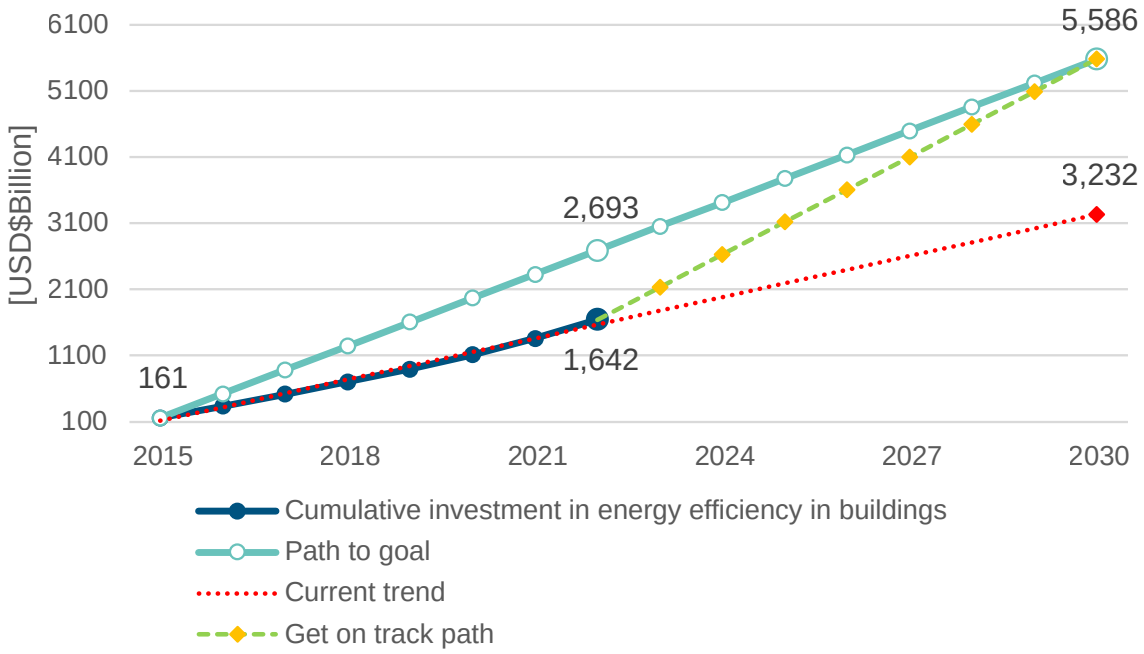
6.3 Action

6.3.1 Cumulative energy efficiency investment in buildings

Global investment in energy efficiency and high-performance buildings are at an all time high, with US$285 billion in 2021 and US$270 billion in 2022, making the total accumulated investment of around US$1,642 billion. Yet, to meet the reference pathway, total accumulated spending would need to be 40 per cent (of the reference value) higher at US$2,693 billion (Figure 21). Without considerable efforts to increase the investment levels in energy efficiency and shifting construction practices to sustainable buildings, the trend will be 58 per cent lower than needed in 2030.
This scenario is worrying as global investments in energy efficiency in the building sector were projected to drop by up to five per cent in 2023 due to both construction market uncertainty in Asia, South America and Europe, and changes to several large European programmes (IEA 2023g).

To get on track, the annual investment level should increase gradually around 12 per cent every year until 2030. Investments not made during this period will lead to a more inefficient building stock, increasing the magnitude of the efforts that would be required in the future.

Figure 21 Observations of the cumulative investment in energy efficiency in buildings and path to get on track



(Source: BPIE)

The Breakthrough agenda report indicates that in some cases the main challenge is not attracting more finance but rather using the existing funds more effectively. The lack of awareness of funding options and limited access to affordable finance instruments is one of the main barriers in developing regions (Beavor et al. 2023). Developing frameworks, such as Mission Efficiency (2024), to match and support partners and recipient countries through the whole process, from project ideation to completion, can increase capacity for investment in efficient buildings. Models that have worked well in sectors such as power and road transport include having a dedicated matchmaking platform to bring partners and stakeholders together (IEA et al. 2022).

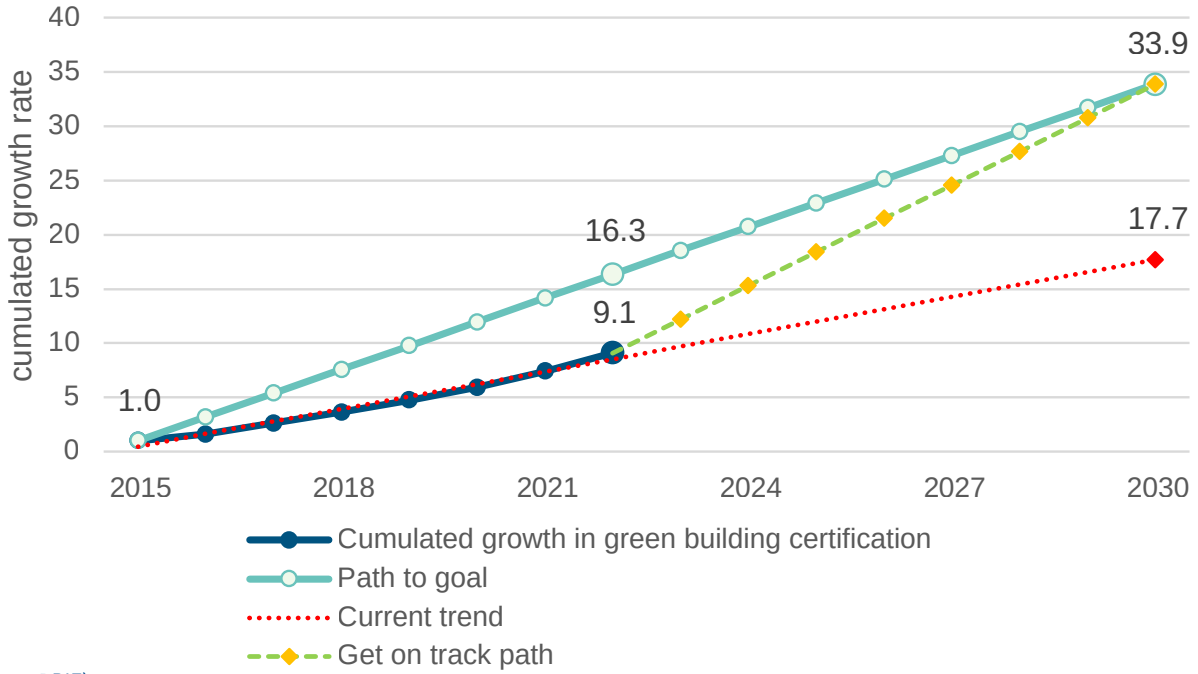
Investing in energy efficiency means investing in youth employment, especially in developing regions. The increase in demand for workers can enable greater inclusion of historically underrepresented groups (IEA 2023a).
A previous survey by the Inter-American Development Bank's (Ravillard et al. 2021) identified a higher participation of women in emerging sectors in Latin America, including energy efficiency.

6.3.2 Green building certification

This indicator, which tracks the cumulated growth of green building certification, uses available data from 13 certification systems around the world (see Section 3.4). The total annual number of certifications issued by each of these systems is aggregated using weights assigned to each system based on the total number of certifications cumulated and the number of countries where the certification system is being implemented.

Even though the number of certifications itself has grown continuously since 2015, by 2022, the cumulated growth of building certifications reached only 9.1 points, instead of the necessary 16.3 points (see Figure 22). If the trend from previous years continues, by 2030 the accumulated growth of building certifications would be only 17.7, half of the necessary value. To get on track, the accumulated growth of building certifications should increase by 3.1 points every year until 2030.

Figure 22 Observations of the growth in green building certifications and path to get on track



(Source: BPIE)

Green certification of buildings offers a way of understanding the leading edge of sustainable building construction and broader recognition of the importance of sustainability across the sector. Unfortunately, transparency of the data openly published by building certification entities remains a barrier. Although many of the certification systems are voluntary, having comprehensive and transparent information about the number of certified buildings around the world helps build a clearer picture of the status of the building stock in terms of their sustainability. Better reporting practices should be deployed. An example of a sustainability-related voluntary scheme with clear reporting strategies is the Science Based Targets initiative, which shows companies how much and how quickly businesses need to reduce their GHG emissions to prevent the worst impacts of climate change, leading them on a clear path towards decarbonisation (WRI, 2023).

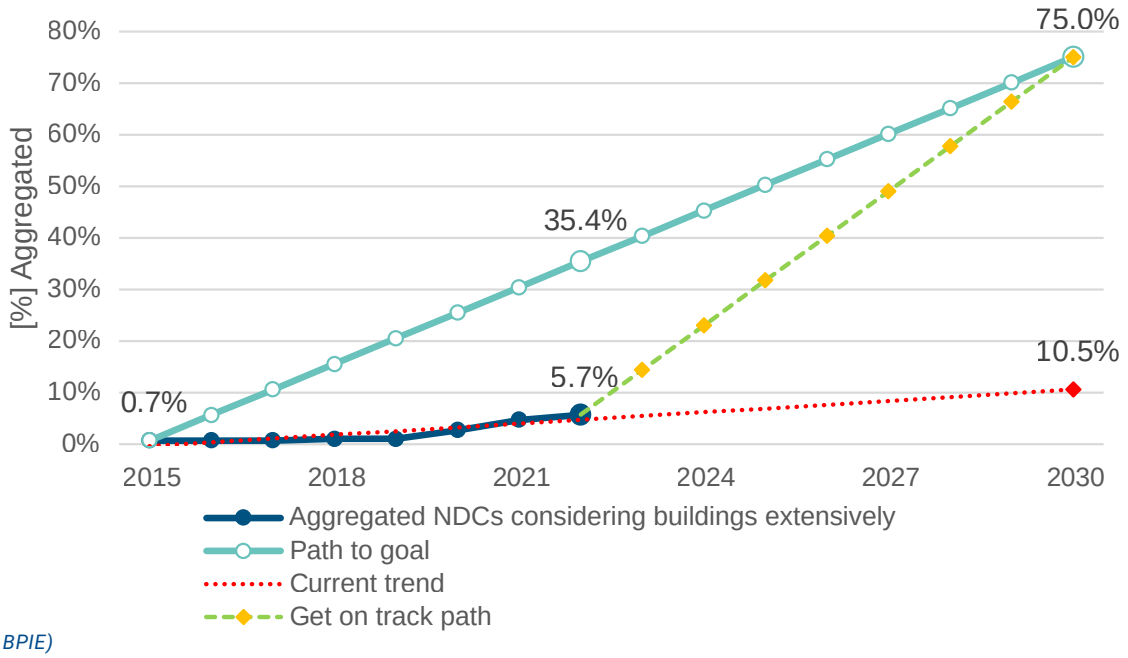
To further support the advancement of sustainability standards, harmonisation across systems should be encouraged to facilitate international cooperation and deployment of funding in regions with low levels of green building investment. The lack of coordination among certification schemes, or the minimum levels within the standards, presents a barrier to international investment (IEA et al. 2022). Certification systems should also acknowledge the circumstances and context of each region where they are being implemented. For instance the EDGE certification system now offers a zero-carbon certification (recognising the challenges for developing countries), which requires zero operational emissions and partially considers embodied carbon (IEA et al. 2022).

6.3.3 NDC considering buildings extensively

NDCs must include clear actions to tackle the decarbonisation of the building sector, through extensive strategies for energy efficiency, mitigation and adaptation. This indicator expects that advanced economies should reach net-zero emissions more rapidly given they are responsible for around 80 per cent of emissions. This indicator therefore needs that all G20 members and 50 per cent of the remaining countries would include a detailed strategy for the building sector within their NDCs by 2030. For 2050, the goal is defined as all countries having an NDC including a detailed strategy for the building sector.

As of 2022, the aggregated NDCs considering buildings in detail is very low and only 5.7 per cent, around 30 per cent less than the necessary value (Figure 23). Only 17 countries have included extensive actions for the building sector in their NDCs as of 2022. If this trend continues, aggregated value of extensive NCDs would be only 10.5 per cent, more than 60 per cent below what is necessary. To get on track, all G20 members should include a clear and detailed strategy for the building sector in their NDCs before 2030, and the number of other countries with extensive NDCs should almost quadruple.

Figure 23 Observations of NDCs considering buildings extensively and path to get on track



(Source: BPIE)

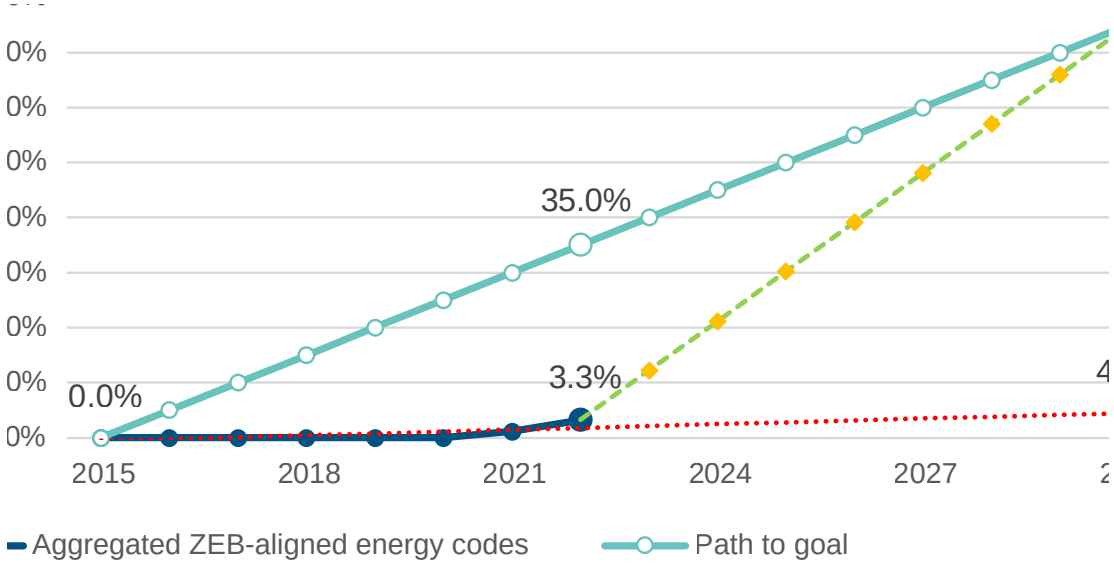
6.3.4 Building codes ZEB-aligned

Building codes must rapidly be updated to be aligned to zero emission principles. Both countries with existing codes to be upgraded and countries that lack building energy codes to set out a pathway to adopting efficient zero emission standards. While doing this update, the breakthrough agenda (IEA et al. 2022) highlights the urgency of not only limiting operational carbon emissions but also the embodied emissions.

The reference pathway for building codes is that by 2030 all the G20 members and 50 per cent of the remaining countries should have implemented building energy codes that are aligned with zero emission principles. For 2050, the goal is defined as all countries having building energy codes that are net-zero buildings, both operationally and in embodied carbon.

As of 2022, the proportion of building energy codes aligned with ZEB principles only reached 3.3 per cent, more than 30 per cent lower what is needed (Figure 24). Only three of the existing codes worldwide in 2022 were aligned with ZEB principles (see Section 3.2). If the trend continues, this indicator would be only 4.5 per cent, more than 70 per cent below the necessary value in 2030.

Figure 24 Observations of aggregated ZEB-aligned energy codes and path to get on track



(Source: BPIE)

To get on track, all G20 members and at least 50 per cent of the remaining countries should set out and implement building energy codes that are aligned with ZEB standards before 2030. Examples of such efforts include Japan reviewing its buildings regulations in 2022 to require zero energy performance for all new buildings by 2030, and for all existing buildings by 2050. Türkiye also tightened regulations in 2023 to require all new buildings to be nearly zero energy, with thicker insulation and at least five per cent of demand met by renewable energy sources (IEA 2023i).

Developing regions, where the building stock is expected to grow considerably in the coming years, require international support to establish clear roadmaps and local building energy codes. For instance, in Nigeria where there is a housing shortage of 17 million units (Realty 2021), one of the main barriers is the lack of building regulations, standard technologies and information standards and labelling (Beavor et al. 2023). The inclusion of ZEB principles in the building practices in these regions plays a key role in guaranteeing that the emerging building stock is aligned with the decarbonisation goals of the sector worldwide.

07 Deep dive – Adaptation and resilient construction methods

As global temperatures increase and extreme weather phenomena such as storms, floods and wildfires become more frequent, adaptation and resilience in the built environment will become increasingly important. These climate impacts can manifest in risks that affect both building operations and the resilience of building materials under extreme and intense climate conditions. The Intergovernmental Panel on Climate Change (IPCC) has defined adaptation as actions taken to "adjust to the actual or expected climate and its effects" and resilience as the "capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance" (Mach et al. 2014).

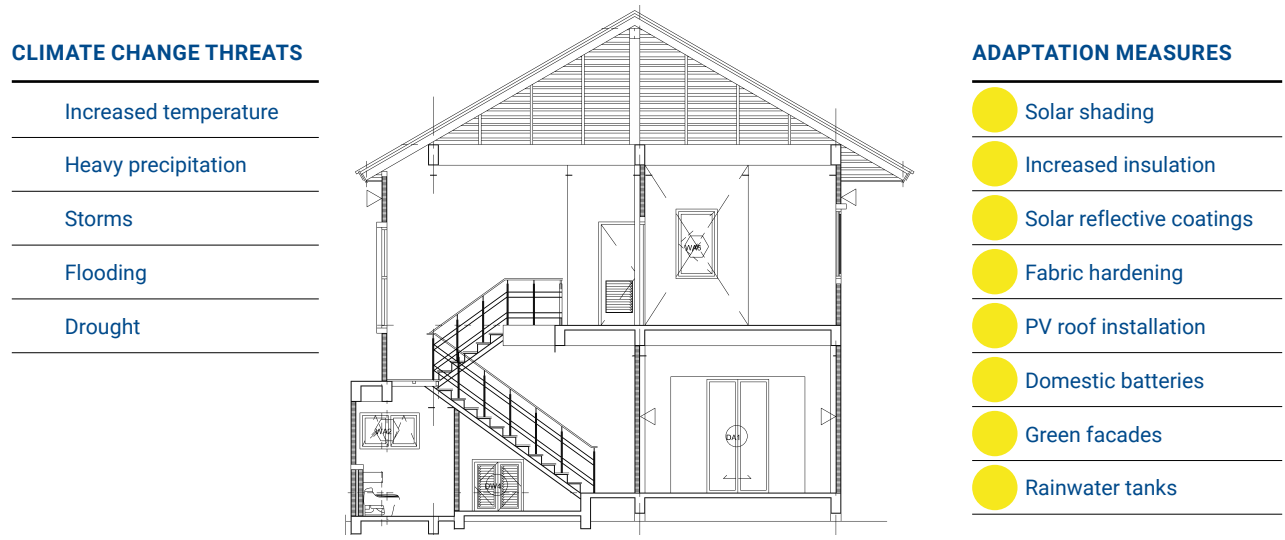
Depending on their specific location and design, existing buildings will face increasing risk of overheating as global temperatures continue to rise throughout the 21st century. This is particularly true for higher density buildings (e.g. high-rise), buildings with low ventilation rates and buildings with high levels of glazing. Increasing prevalence of high wind and storms in many regions will also necessitate increased rates of repair and the need to improve building materials and methods to withstand such events (Carlin et al. 2023). This is challenging in low-income and emerging economies, where lack of funds and informal building techniques makes high resilience buildings difficult to build.

Sea-level rise, more intense hurricanes and flooding also present increasing challenges for the built environment in the years ahead. For example, following hurricane Otis in Acapulco, Mexico, the recovery and reconstruction efforts cost US$3.4 billion (Garrison and O'Boyle 2023). The coastal setting of many of the world's major cities is inherent in their vulnerability to climate change (Faraud and Fathi 2023). Buildings situated in flood-prone zones are vulnerable to water incursion, which can compromise foundations, structural integrity and electrical systems (EPA 2023).

The intersection of building practices and the risk of maladaptation to climate change is a critical consideration for establishing sustainable and resilient urban environments. Inadequate building practices can inadvertently contribute to maladaptation, particularly in the form of overheating, and lead to increased energy consumption. Buildings with poor insulation, suboptimal orientation and insufficient ventilation may succumb to overheating during heat waves, amplifying health risks and escalating energy demands for cooling, and consequently increasing the greenhouse gas (GHG) emissions. Inappropriately designed structures may also rely heavily on energy-intensive air conditioning systems, exacerbating carbon emissions from regions without decarbonised electricity grids. Glass-dominated facades without solar control properties in many modern urban architectures can lead to excessive solar heat gain.

To address these risks, passive design measures incorporated alongside sustainable building practices become imperative; this includes well-designed water-sensitive green roofs, energy-efficient materials and strategic design that incorporates solar shading and natural ventilation. Proactive measures in building design and construction can mitigate maladaptation risks, fostering climate-resilient structures that not only withstand the challenges of a changing climate but also contribute to reduced energy consumption and overall environmental sustainability (see Figure 25). Appropriate adaptation to increasing temperatures also has the potential to address 'cooling poverty' – the condition where marginalised communities are forced to make use of inefficient and often dangerous methods appliances to keep cool (Mazzone 2021). Further strategies are outlined in the World Green Building Council '***Climate Resilience in the Built Environment***' Guide (WorldGBC 2022).

Figure 25 Threats to buildings under climate change and available adaption measures



(Source: Harry Kennard)

Retrofitting existing buildings to maximise resilience in the face of increasing environmental hazards will require multiple policy instruments to ensure sufficient action. Resilient retrofits can be categorised into three types: first, structural hardening, which protects against damage in the event of increased weather stressors and flood risk; second, resource conservation measures aimed at reducing the amount of energy a building needs – this can be achieved through installing solar shading, natural ventilation and night-vent cooling, green roofs, or by improving insulation; finally, measures to improve building energy supply resilience such as local renewable energy generation and storage measures (Williams-Eynon 2022).

New buildings will also need to be built with new climate extremes taken into consideration throughout the design and construction period. Population projections currently point to increases of around 1.5 billion in the next thirty years. This expansion will occur predominantly in the warmest countries on earth, leading to large expansions of the building stock in places where much of current housing is provided through informal building practices. The role of building codes to guide this expected expansion of building stock is central to maximising the adaptive capabilities of buildings (C40 Cities Climate Leadership Group 2024). Buildings serve as the primary means through which the harmful effects of the environment are modified.

Building codes need to be updated in the face of a changing climate. At COP27 in Egypt, the Global Resiliency Dialogue launched guidelines enshrining 15 core principles aimed at advancing resilience in buildings through building codes and standards (International Code Council 2022). Emphasizing occupant health and safety as the primary purpose of codes and standards, these guidelines distinguish building resilience as crucial for communities to recover from weather-related natural hazards. The principles underscore the role of science in predicting likely climate scenarios, designing for them and adapting building codes accordingly, advocating an approach to minimum requirements, which avoids one-size-fits-all solutions.

The development and enforcement of building codes offer a crucial means to integrate safety, environmental considerations and adaptability to a changing climate into the built environment. While building codes traditionally rely on historical climate data, there is a growing imperative to incorporate estimates of future warming, learn from past extreme weather events and overcome challenges such as climate data scarcity to update and enhance these codes (Gupta et al. 2021).

Broader policy guidance is slowly being developed as awareness adaptation in the built environment becomes more salient. In 2023, the European Commission published the best practice technical guidance for adapting the European Union building stock to climate change (European Commission 2023c), which outlines the risks and adaptive measures that can be taken for buildings in face of increased heat, storms, heavy precipitation, flooding, subsidence and drought. Crucially, it also summarises best practice guidance for policy makers and industry actors across these risk domains.

7.1 Building a water-resilient future for everyone, everywhere

Alongside the challenges of climate change, the global water crisis is an escalating problem that demands urgent attention. With global water use, storage and distribution estimated to contribute 10 per cent of global GHG emissions (Water Research Foundation 2023), and the buildings and construction being responsible for around 15 per cent of freshwater use (Ding 2014; Baynes et al. 2018; Heravi and Abdolvand 2019; Sustainable Facilities Tool 2024), it is imperative to evaluate the role of the built environment in contributing to and mitigating the water crisis.

This urgent challenge has been highlighted in a recent report 'Building a water-resilient future' (Montano-Owen and Brady 2023), which presents the magnitude of the global water crisis and outlines the role of the built environment as a contributory sector. The magnitude of the global water crisis can be summarised in four challenges:

- Scarcity: Today, nearly four billion people are affected by water scarcity (Mekonnen and Hoekstra 2016) and predictions suggest this number will only rise as global water demand is projected to increase by 55 per cent by 2050 (OECD 2024).
- Equity, access and quality: Nearly two billion people live without access to safe water (Mekonnen and Hoekstra 2016).
- Greenhouse gas emissions: Generated during the water supply process due to energy requirements for pumping, treating, desalination, distribution and waste management.
- Resilience and climate change: 90 per cent of natural disasters are weather-related (Centre for Research on the Epidemiology of Disasters [CRED] et al. 2015).

The built environment provides the physical infrastructure that forms the basis of our societies and economic development, yet the lack of water protection and preservation practices has meant the built environment has both caused and exacerbated the global water crisis. Tackling the above challenges, as well as providing safe water to the world's growing population, is a key responsibility for the building and construction sector – in line with the urgency to decarbonise the industry by 2050.

The need for change from the sector can be seen across all stages of the value chain, and is reflected across four geo-spatial scales of water use in the built environment industry (see Figure 26):

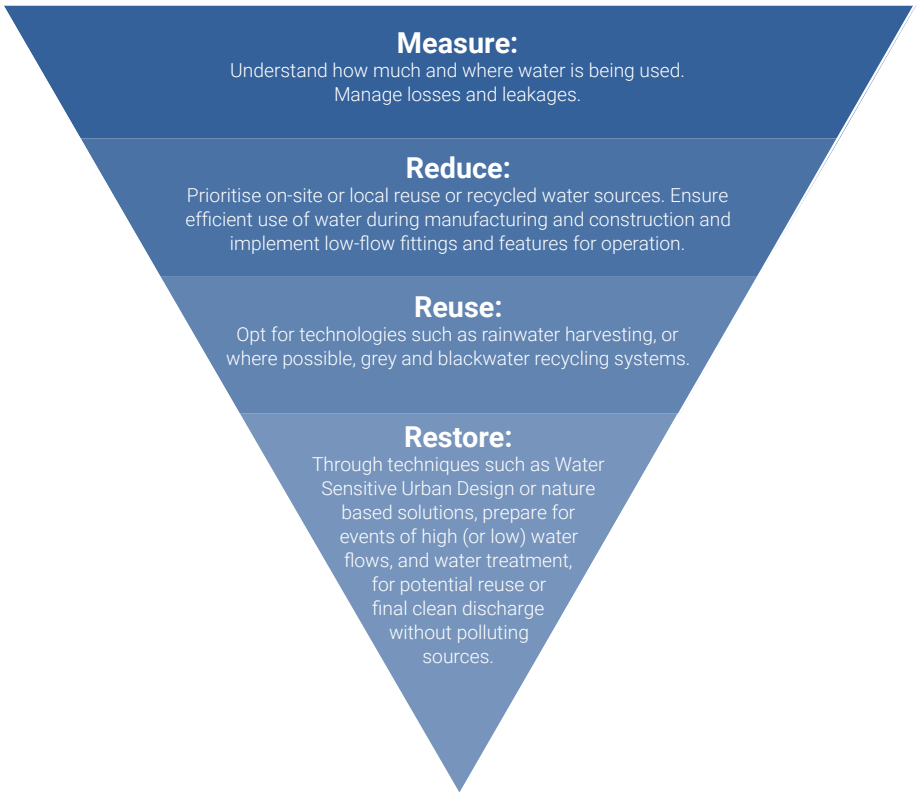
- Supply chain: The industrial sector is the second largest water user in the supply chain. Most of the water used during manufacturing processes cannot be directly reused for other purposes – and may also present a risk to local water sources from contamination (Gerbens-Leenes et al. 2018).
- Construction processes: Water is used abundantly in dust control (particularly in demolition projects), earthworks and cement plastering. Although the tracking of water consumption has not been a common practice, some studies have estimated this consumption in the range of 500 to 3,500 l/m^2 (Garg et al. 2023).
- Buildings use: The consumption and conservation of water within individual buildings can have significant environmental, economic and social impacts. Key challenges include lack of monitoring, inefficient fixtures and systems, inadequate maintenance, and lack of awareness or incentives.
- Cities and communities: Urban centres often face problems related to insufficient infrastructure, water consumption and loss, wastewater management, and water drainage.

Figure 26 Scales of water use in the built environment

(Source: WorldGBC)

All stakeholders in the value chain, from suppliers to regulators, have a responsibility to enable sustainable and equitable development and social justice. The buildings and construction sector must recognise the urgency of the water crisis and realise where the greatest risks and opportunities are. By following the principles of water management, i.e. Prevent, Measure, Reduce, Reuse and Restore (see Figure 27), it is possible for the buildings sector to help address the global water crisis alongside the efforts to adapt to a changing climate and to decarbonise the buildings sector.

Figure 27 Principles of water management for the built environment



(Source: WorldGBC)

7.2 Resilience in Building Codes in Latin America and the Caribbean

The Inter-American Development Bank (IDB), in collaboration with the Chile Building Institute (IC), EBP Chile and Chile Green Building Council, issued in December 2023 the report 'Resilience and Sustainability in Building Codes in Latin America and the Caribbean' as a technical note that provided a regional comparison and called on strengthening opportunities regarding resilience in the construction sector across the region (IDB 2023)[9]. The analysis identified that the region's progress in seismic and wind codes is much greater than that for floods, which is still a threat that countries face reactively. Likewise, the region has been taking accelerated steps to incorporate sustainability aspects in construction projects (homes and buildings), although this is not necessarily reflected in building codes. On the other hand, regarding sustainability aspects, it was identified that issues related to energy savings are more advanced than other aspects such as the efficient use of water, the quality of the indoor environment and the identification of climatic zones (IDB 2023). Specific strategies for earthquakes, wind, floods and sustainability are described in further detail in the ***report***.

9 *IDB (2023), Resiliencia y sostenibilidad en los códigos de construcción de América Latina y el Caribe: análisis regional comparativo y oportunidades de fortalecimiento. http://dx.doi.org/10.18235/0005377*

08 Deep Dive - Innovations in business cases (renovation and green building construction industry)

The construction sector has among the lowest productivity within the global economy (Mckinsey Global Institute 2017; van Sante 2022). To meet the global climate challenge, building decarbonisation must accelerate significantly. Relying only on common construction and renovation practices will not be sufficient. Innovative business models offer an approach to further strengthen the sector's capacities to take on that challenge. Increasing renovation depends on a variety of factors, not least strong policy instruments and access to finance. This chapter focuses on innovative business models for renovation and construction sector by highlighting selected to illustrate the growing interest in certain business models.

8.1 Addressing root causes: central planning and coordination of the renovation

Construction and renovation typically rely on a highly fragmented value chain. Streamlining, standardizing, replicating and thus scaling up renovation solutions require different business models compared to current practices (de Wilde 2019).

A better coordination of the whole renovation process is a key success factor for innovative business models. Optimized renovation requires less time and interference at the construction site and less workforce, ultimately making renovation less costly. Different to conventional renovation business models, those projects need a central solution provider planning upfront and coordinating the construction process without the need to commission individual trades one after another.

A recent example from Germany proved that a deep renovation of a building is possible in just 22 working days: an old semi-detached house was transformed into a climate-neutral including the building envelope, new windows, heat pump with photovoltaic (PV) system, plus completely new building services (under-floor heating, plumbing, electrics, ventilation), new floors, interior doors and so on. An hourly-clocked construction schedule was the basis for this 'renovation sprint' (Bauingenieurbüro Ronald Meyer 2023). Also, in other parts of the world, the optimisation of communication between and coordination of involved parties in the construction process is seen as key to speed up renovation and make it cheaper (Dixit 2022).

8.2 Completely digitalised and standardised renovation processes

The next step in accelerating decarbonisation of the existing building stock is to standardise good practice examples within a building typology and climate zone so they are easily replicable and scalable. While standardisation of processes is possible without, increasingly, digitalisation is seen as a key to do so (Dixit 2022; Kai-Stefan Schober 2023; Zhang et al. 2023).

Digitally scanning the building helps to better understand and simulate building renovation solutions and allows for a thorough upfront planning of renovation. An end-to-end digitised renovation process allows for prefabrication of facades and roofs to minimize further the work at the construction site, saving more time, material, workforce and stress. There is an increasing number of start-ups that took this step and act as a centralised solution provider: 3-D-scanning the building, planning renovation, commissioning prefabricated insulation elements including technical building equipment, and coordinating the renovation process on site (Ecoworks 2023; Renowate 2023; Saint-Gobain 2023). As part of their business models, these companies are often also contracting the PV installation that will supply the building with all electricity needed to heat the building with the heat pump and satisfy the needs of consumers. In this way, the start-ups not only act as a provider of renovation solutions, but also combine this with the role of a traditional energy service provider.

Yet these models rely on a supportive governmental framework. In the Netherlands, homeowners are allowed to receive a fee from their tenants if they renovate their building to a net-zero energy standard, in Germany, solution providers make use of the feed-in tariffs for solar-PV they install on the roofs. However, the business models showcase a possible way forward for future renovation practices and show that innovation in the construction sector is possible and can be successful.

8.3 Reducing risks of investments: buildings performance contracting

Energy Service Companies (ESCos) have been shifting the business models for building energy performance by introducing energy efficiency measures and financing these investments through the resulting energy cost reductions. Buildings Performance Contracting builds on this idea. In a performance contract, the residual value of buildings and installations is being determined by measurement. Those suppliers who guarantee the highest residual value of a building, e.g. through proper maintenance, life-enhancing measures or re-use of building materials will be contracted. This model is being used in the Belgian region Flanders.

Buildings Performance Contracting acknowledges the problems that are caused by the separation of construction and maintenance of a building. If those being responsible for construction do not take care of the maintenance after the construction, it prevents learning from failures in planning and construction. An incentive framework is needed for parties to collaborate to improve the building over its lifetime. An energy service contract usually has a term of 15 years in order to generate sufficient income to refinance the investment. The business model proposed by Buildings Performance Contracting is aimed at contracts with a maximum term of 10 years. The business case results from a higher residual value of the building through the promotion of measures that are of long duration, e.g., renovation. This residual value at the end of the project is guaranteed by the contract, which includes performance indicators for energy performance and comfort. The status quo of the building and the components are being checked through regular maintenance throughout the 10-year-long contract period.

A way of further institutionalising the role of a single service provider is the set up of so called one-stop shops for renovation (European Commission et al. 2021), which accompany the whole customer journey of an energy renovation. There are privately, publicly or semi-publicly led one-stop shops (Pardalis et al. 2022), some consist of a single actor, others are working in teams or stable cooperation (Laffont-Eloire et al. 2017). One-stop shops are putting in place a variety of business models, some of them are similar to an Energy Service Companies, other one-stop shops focus on facilitating the renovation and others offer an all-inclusive renovation package (Cicmanova et al. 2020).

An example of a one-stop shop that organises financing is Oktave in France, supported by the French region Grand-Est (Oktave 2021). The organisation has set up a EUR€1.5 million advance payment fund to pre-finance grants for homeowners to renovate their homes. With this budget, the group provides advance payments that will be covered by other grants (e.g. national subsidy schemes, regional or local grant schemes) that the homeowner is only entitled to receive after an initial investment has taken place. The aim of these programmes is to support owners by providing administrative, financial and technical support for the renovation process.

One-stop shops are increasingly being set up in Europe and also beyond. Organisations in the USA and Australia are pushing for the development of more integrated renovation services, often with a special focus on low-income households (Johnston 2021; ACEEE 2022; Kresowik and Reeg 2022). These efforts promote the opportunities that renovations have in supporting building decarbonisation alongside enhancing asset value and improving building quality.

09

Deep dive – Nature-based solutions and biophilic design

In an effort to increase sustainable and environmentally-friendly architectural solutions, nature-based solutions (NbS) and biophilic design are two approaches that enhance sustainability by placing nature at the heart of architectural and urban planning through local knowledge and engagement with natural designs and construction.

NbS approaches aim to create a harmonious, symbiotic relationship between the built environment and the natural world. They have been defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits'' (International Union for Conservation of Nature (IUCN) 2024). NbS are inspired by nature and use the intricate workings of natural ecosystems to offer a range of services, from indoor climate conditioning and water purification to carbon sequestration and bio-diverse habitat provision. NbS can improve air and water quality, mitigate biodiversity loss, sequester carbon and reduce urban heat island effects (Matthews et al. 2022; Marvin et al. 2023).

Underpinned by a holistic understanding of ecosystems, NbS recognise the complexity and the interconnections between different natural and built systems, and see nature as a resource. At present, this resource is being heavily depleted. Total investments in NbS have been estimated at US$200 billion per year, which is less than three per cent of the US$7 trillion in finance flows that have been assessed to have a direct negative impact on nature in a recent UNEP report (Birch et al. 2023).

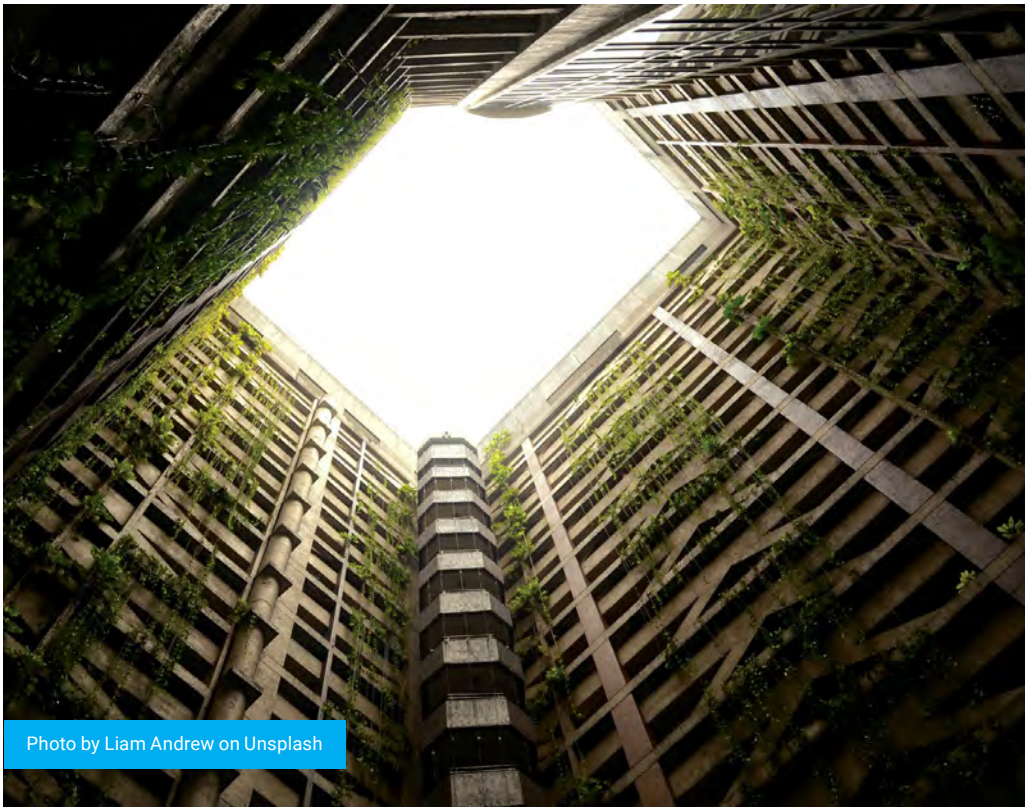


Photo by Liam Andrew on Unsplash

9.1 Exploring NbS technologies

Nature-based Solutions (NbS) technologies attempt to mimic or enhance natural processes to provide ecosystem services, such as green roofs and walls, permeable pavements, rain gardens and constructed wetlands. They utilize natural materials and processes, making them more sustainable and less disruptive than conventional infrastructure.

Green roofs and walls, for instance, provide insulation, reduce urban heat island effects, improve air quality and create habitat for wildlife. Permeable pavements allow rainwater to infiltrate into the ground, reducing runoff and recharging groundwater. Rain gardens and constructed wetlands filter pollutants from storm water, enhancing water quality and providing habitat.

Adopting NbS has the potential to offer a range of benefits including helping to mitigate climate change by sequestering carbon, enhancing biodiversity by creating habitats for various species, and promoting water and air quality by filtering pollutants. NbS can also increase the resilience of cities to extreme weather events and climate change by improving storm water management and reducing heat stress.

Integrating NbS into buildings and cities involves rethinking the design process from site selection and analysis through design and construction, to maintenance and monitoring. It requires a multidisciplinary approach, involving architects, landscape architects, engineers, ecologists and other stakeholders. These complexities have led to the observation that their cost effectiveness is often uncertain, and that inadequate financing can limit the effectiveness of NbS (Seddon et al. 2020). Despite its great potential for benefit, it has been argued that NbS requires social and environmental safeguards to ensure it achieves the positive community and biodiversity impacts it aims to achieve (Melanidis and Hagerman 2022).

In response to these concerns, the International Union for the Conservation of Nature has published a global standard aimed at yielding a consistent and verifiable implementation of NbS (IUCN 2020). This allows for the full costs and benefits of NbS projects to be assessed, and ensure transparency, inclusivity and effective management going forward.

9.2 Biophilia and biophilic design

While NBS seek to integrate nature into built environment design, biophilic design seeks to integrate nature by creating a sense of connection and engagement. This can involve the use of natural materials and patterns, the creation of views and access to nature, the incorporation of natural light and ventilation, and the design of spaces that facilitate interaction with nature.

While it incorporates many aspects of traditional building practice, biophilic design is an emerging field. Its design principles are centred on the idea of creating a direct and meaningful connection with nature. This can be achieved through various strategies, including the incorporation of natural light and ventilation, the use of natural materials and patterns, the creation of views and access to nature, and the design of spaces that facilitate interaction with nature. Examples of biophilic architectural aspects include living plants, living walls, natural textures and materials, and views of natural spaces.

The benefits of biophilic design include a greater connection to nature that has the potential to enhance well-being and productivity, reduce stress and promote creativity and learning. In healthcare settings, it has been found to be beneficial (Zhao et al. 2022). A study from the University of Oregon found that some employee absences could be attributed to office environments that lacked a view of nature (Elzeyadi 2011).

Choice of construction material is also important for achieving biophilic design principles. A recent analysis of circularity in wood construction found it has inherent advantages such as lower lifecycle emissions and energy consumption compared to non-wood materials (UNECE 2023). This is particularly relevant in Africa, which is undergoing a rapid expansion of urban environments. A comprehensive review of the potential of wood and natural materials for circularity in Africa was published in early 2023 (Westerholm 2023).

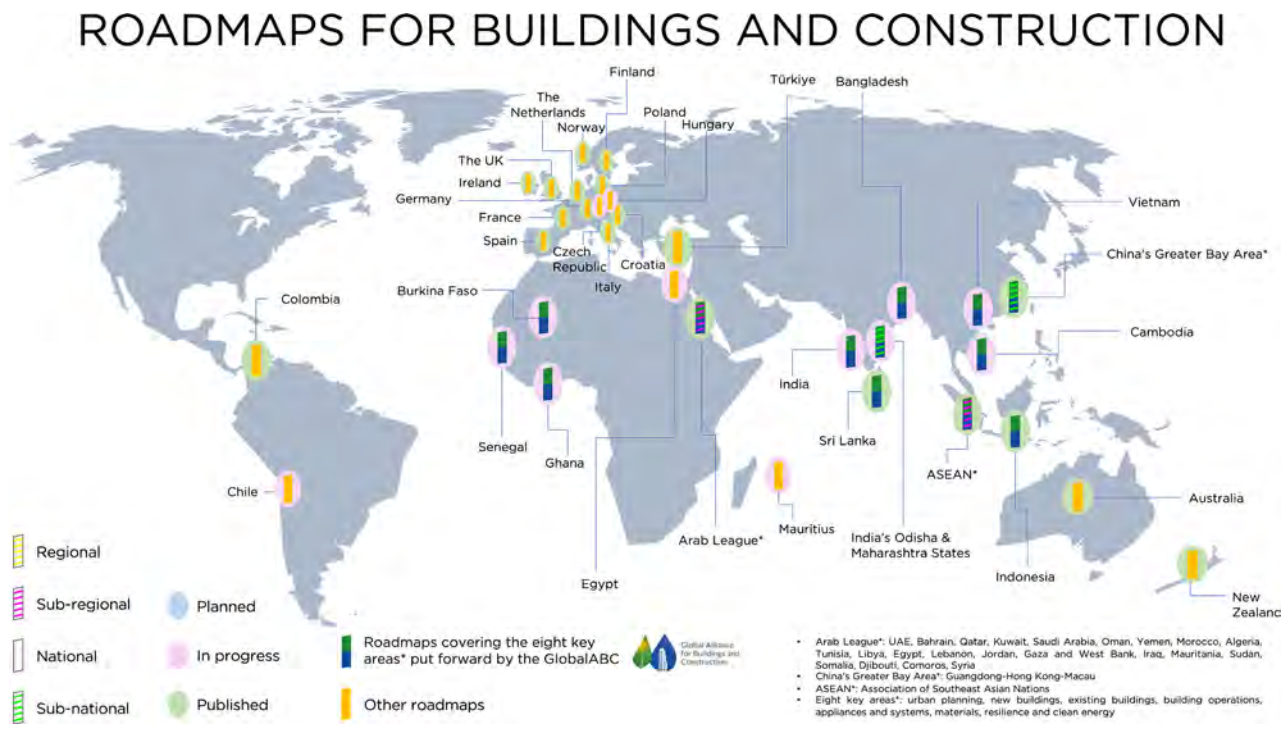
The Biophilic Cities Network is a global network of cities that are committed to becoming more biophilic. These cities are implementing a variety of strategies, from creating green networks and corridors to promoting urban agriculture and biodiversity. Cities like Singapore and Copenhagen are starting to use the principles of biophilic design to create better living environments. By incorporating natural elements into the built environment, biophilic design has the potential to reduce energy consumption, water usage and waste production. Further information around biophilic design, including case studies, can be found at the World Green Building Council's ***'Circular Built Environment Playbook' (WorldGBC 2023c).***

10 Roadmaps for buildings and construction

The GlobalABC, under the lead of UNEP and in partnership with UNOPS and UN-Habitat, is developing guidance and tools to support national and sub-national governments in creating their climate action roadmaps for the buildings and construction sector. The guidance and tools are being piloted in Ghana, Senegal, Bangladesh and India, and they will be made available more broadly during the fourth quarter of 2024.

Climate action roadmaps defining short, medium and long-term actions have the capacity to accelerate inclusive climate action for the sector by bringing stakeholders together and setting clear and achievable goals. The 'Human Settlement - Climate Action Pathways' report, which defines how to achieve the Paris Agreement, calls for all countries to develop their buildings and construction roadmaps by 2030 (GlobalABC 2021). As of 2023, the GlobalABC has supported the development of 15 national and regional roadmaps and 34 countries worldwide have adopted a clear strategy for decarbonising the sector (see Figure 28).

Figure 28 Global roadmaps for buildings and construction



(Source: UNEP GlobalABC)

There are efforts to develop and align national climate actions across Latin America. In addition to the case study of Colombia (see section 11.2), Costa Rica developed a ***National Decarbonization Plan 2018-2050*** (Government of Costa Rica 2018), with a specific section addressing the development of buildings subject to high efficiency standards and low emission processes. These are set to be implemented under specific milestones for years 2025, 2030 and 2050, including new materials, low emission technologies and electrification, renewable energies, and resilience. At subnational level, Costa Rica Green Building Council, with the support of WRI and the WorldGBC, has developed four roadmaps for the municipalities of Santa Ana, Belen, Curridabat and Moravia.

Chile is also currently developing a national strategy for the carbon footprint of the building sector in response to the lack of mandatory regulations or incentives regarding environmental reporting and carbon emissions. Chile aims to develop an alignment strategy with the national policies supporting carbon neutrality by 2050.

Crucially, even if there are no specific laws or regulations for the buildings and construction sector, the roadmaps highlight NDCs as a commitment by the national government (see Chapter 3). These NDCs serve as a foundation for decision-making when setting specific milestones and goals. In this context, the roadmaps serve as a strategic document to implement this commitment, emphasizing the significance of including the building sector as a key aspect of the economy in achieving national decarbonisation goals. Additionally, as part of the Zero Carbon Readiness Framework project (WorldGBC 2024a), the GlobalABC and the WorldGBC support regions such as the Americas, Asia-Pacific and the Middle East and North Africa (MENA) in taking enabling actions to create national roadmaps.

In Europe, WorldGBC's BuildingLife project has seen twelve national Green Building Councils develop decarbonisation roadmaps for the sector, supplemented by a regional European Union Policy roadmap (WorldGBC 2024b). The Green Building Councils are now working with industry and policy makers on implementing the recommended actions and increasing accountability across the sector to deliver on short, medium and long-term goals.

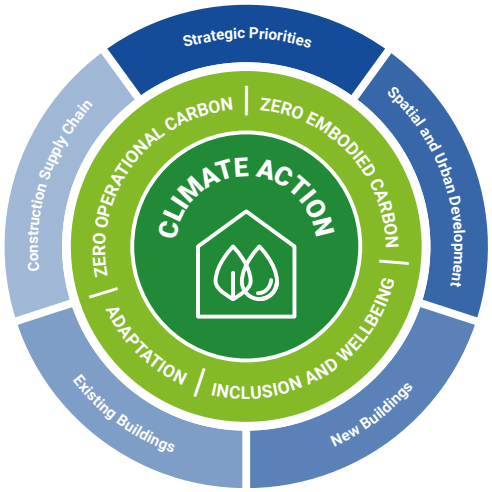
To accelerate roadmap development and achieve the Climate Action Pathways, GlobalABC has partnered with UNEP, UNOPS and UN-Habitat to design and pilot a new methodology and supportive tools, to help countries and sub-national governments in this endeavour. UNOPS was mandated to develop the methodological approach and UN-Habitat is piloting it in Ghana, Senegal and Bangladesh. A local social enterprise, Development Alternatives, is piloting it in two states in India. The methodology seeks to enhance stakeholders' collaboration and follow a step-by-step approach based on the new iteration of the GlobalABC framework. The final guidance document and the tools will be made available during the fourth quarter of 2024.

10.1 A new framework for Buildings and Construction Roadmap development

Supported by UNEP, the GlobalABC and UNOPS are developing a collaborative and step-by-step approach based on the new iteration of the GlobalABC framework to guide governments in designing their climate action roadmaps to turn their ambitions into action.

The new GlobalABC framework (see Figure 29 GlobalABC Roadmap Action Framework) aims to offer a more holistic approach to decarbonisation by better considering the entire building value chain and the carbon emissions related to material manufacturing and building construction, as well as integrating climate adaptation and inclusion as central pieces of any decarbonisation strategy. The new GlobalABC framework comprises four objectives that cut across five action areas. The four objectives are (1) Embodied Carbon; (2) Operational Carbon Reduction; (3) Adaptation; and (4) Wellbeing and Inclusion to align with the Paris Agreement and the Climate Action Pathways. Introducing objectives into the GlobalABC framework aims to facilitate goal setting and monitoring.

Figure 29 GlobalABC Roadmap Action Framework



(Source: GlobalABC)

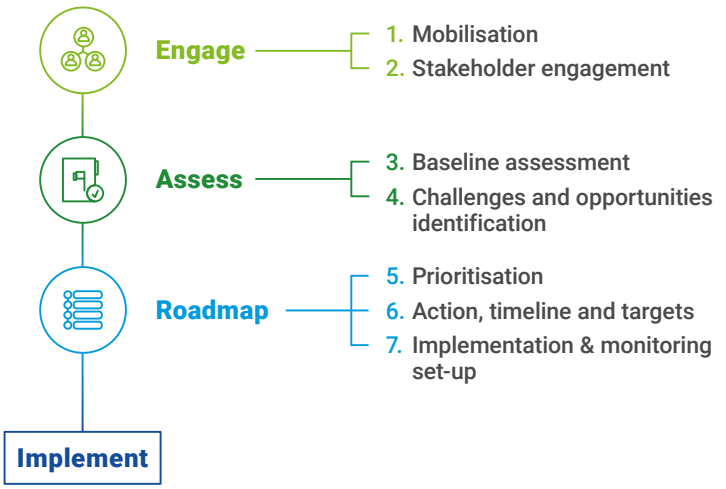
The framework considers the following five action areas:

- Action Area 1 – Strategic Priorities: refers to national, regional and local development planning processes that define development objectives, their prioritisation and implementation. This action area recognises the importance of embedding inclusive climate action in the buildings and construction sector at the highest level of governance to give a clear direction and mandate to line ministries and local governments for its implementation.
- Action Area 2 – Spatial and Urban Development: refers to how people occupy the land at a country, regional and urban scale and the supportive regulations and processes, including land use regulations, urban development planning (i.e. Master plan), urban project implementation, and natural environment protection. Many spatial planning decisions impact the capacity to mitigate carbon emissions and ensure the adaptation and resiliency of the building and construction sector and the inclusion and wellbeing of the population.
- Action Area 3 – New Buildings: includes all phases of planning and delivering a new building – from project preparation to procurement, design and construction. It also considers material, system and appliance choices. Construction planning and delivery are critical phases for climate action. During those phases, designers, architects, engineers and developers have the opportunity to make inclusive, sustainable and resilient choices for the future.
- Action Area 4 – Existing Buildings: considers all building management phases, including operation, maintenance, renovation, refurbishment and decommissioning. It also includes how materials, systems and appliances are used and selected during the building's use life. This action area considers, more specifically, the reduction of operational carbon emissions, the adaptation of the building stock and circularity.
- Action Area 5 – Construction Supply Chain: includes raw material extraction, system, appliance and material manufacturing, commercialisation, importation and the norms regulating the supply chain. This action area is critical to reducing the building's embodied carbon by acting upstream, implementing circularity principles and sustainable production as well as ensuring equity and well-being for the industry workforce and the community.

The five action areas were defined to cover the entire building and construction value chain and lifecycle to ensure climate action is comprehensive, leverages synergies and promotes circularity. In addition, the five action areas were set so each area could be considered independently and adopted by a group of stakeholders.

The GlobalABC Roadmap guidance follows a step-by-step approach (see Figure 30 Roadmap implementation process) that is underpinned by easy-to-use tools that seek to standardise and simplify the roadmap creation process and to promote knowledge and evidence-based decision making.

Figure 30
Roadmap implementation process



(Source: GlobalABC)

The approach includes the following six steps:

- Step 1. Mobilisation: This phase initiates the roadmap development by identifying stakeholders and setting the stage for successful completion and implementation. Most importantly, the mobilisation step is an opportunity to define the roadmap scope and objectives and take stoke on existing government commitments toward decarbonisation as the initial point for the goal-setting exercise accompanying the roadmap development.
- Step 2. Stakeholder engagement: Engagement is critical throughout the roadmap development. The GlobalABC roadmap guidance emphasises a collaborative approach and offers opportunities for co-creation. This approach will ensure the roadmap is based on an accurate and shared understanding of the context and that stakeholders agree with the roadmap and engage in its implementation. Furthermore, during this phase, stakeholder groups are established and the engagement plan is developed and agreed upon.
- Step 3. Baseline assessment: The purpose is to develop a comprehensive understanding of the buildings and construction sector. The baseline assessment looks at both (1) the physical environment through a quantitative data-driven approach and (2) the enabling environment using qualitative data. The assessment measures the gaps between business-as-usual projections and the government targets and identifies challenges and opportunities in achieving the four GlobalABC objectives. This holistic and innovative methodology lays the ground for a knowledge and data-driven approach to designing the roadmap.
- Step 4. Prioritisation of challenges and opportunities: The purpose is to identify the logical links and interactions between the challenges and the opportunities and how they impact the achievement of the four GlobalABC objectives. This step leverages a root-cause analysis and mind-mapping approach that will support the identification of key actions and their prioritisation during the following step.
- Step 5. Actions and timeline: Building on the above steps, the central piece of the roadmap aims to define the theory of change, the actions and their timeline for the sector's decarbonisation. Those elements are defined collectively during workshops. The guidance provides examples of good practices to inspire stakeholders to identify actions.
- Step 6. Implementation and monitoring set up: The purpose is to define action plans and assigns responsibilities for the roadmap implementation. It also defines how progress will be measured.

This standardised approach seeks to overcome the barriers impeding the widespread development of climate action roadmaps for the building and construction sector and support the call to action for the transition towards a decarbonised and sustainable construction sector.

10.2 National implementation: Colombia national roadmap to net-zero buildings

The National Zero Carbon Building Roadmap was launched in Colombia in June 2022, as a building pathway to achieve net-zero carbon emissions from the buildings sector by 2050, in line with the country's 2050 strategy. The roadmap sets specific targets to scale net-zero in terms of operational carbon and embodied carbon for new buildings and for existing buildings. In addition to the main targets, the roadmap proposes 67 specific goals and 163 transformative actions that must be carried out by the different actors of the public and private sector, in the short (2030), medium (2040) and long term (2050), to ensure that all buildings are net-zero by 2050. These goals are grouped into six action categories: (i) corporate practices; (ii) urban planning; (iii) materials; (iv) new buildings; (v) existing buildings; and (vi) informal settlements.

After the roadmap was launched, the implementation process began with specific strategies with the national government, with local governments and with the private sector. Those strategies are summarized below:

- Joint actions with the national government: To begin the implementation of the roadmap, a prioritisation exercise involving the Ministry of Environment and Colombia Green Building Council (GBC) was conducted to understand the specific actions that should be implemented immediately during the current governmental term. Based on those actions, a work plan for each national government stakeholder was initiated. These work plans include contributions to public policies and the identification of opportunities for articulation with current initiatives, specifically with the Ministry of Housing, the Ministry of Energy, the Ministry of Industry and the Department of National Planning.
- Joint actions with local governments: Leader cities such as Bogotá and Cali that already had issued city action plans to net-zero buildings, have developed local regulations and incentives to advance towards net-zero. Cali recently adopted the Sustainable Construction Manual for the city and Bogotá issued the Eco urbanism and Sustainable Construction Policy. Other local governments such as Envigado and Medellín have been working on incentives for energy efficiency, and resources have been allocated to start a five-year project called 'Energy Efficiency for the Transition to Carbon Neutral Cities in Colombia' that will be implemented by the Development Bank of Latin America and the Caribbean (CAF) and the Inter-American Development Bank (IDB) and executed by Colombia GBC to assist Cali, Barranquilla and Pasto to accelerate decarbonisation.
- Joint actions with the private sector: The private sector has been a major driver of sustainability in Colombia; therefore, it has to play a major role in the implementation of the roadmap. To articulate the actions of the value chain, Colombia GBC is leading a round table with 14 industry associations that includes the Construction Chamber, the Concrete, Plastic, Still, Glass, Ceramic, Envelop, Plumbing association and the financial institution association. In addition, Colombia GBC has published the Decarbonisation Guide for Companies in the Construction Sector for each company to develop its own roadmap to decarbonisation.
- Allocation of resources to implement medium-term actions from the roadmap: As part of the 'Energy Efficiency for the Transition to Carbon Neutral Cities in Colombia' project, several actions from the roadmap will be implemented during the following years, including labelling of buildings and effective implementation of energy and water saving regulations, dissemination and education.

These actions represent significant progress in the path towards carbon neutrality of buildings and it is expected that other actions will be leveraged from this starting point.

10.3 Regional Roadmap for Buildings and Construction in China's Greater Bay Area

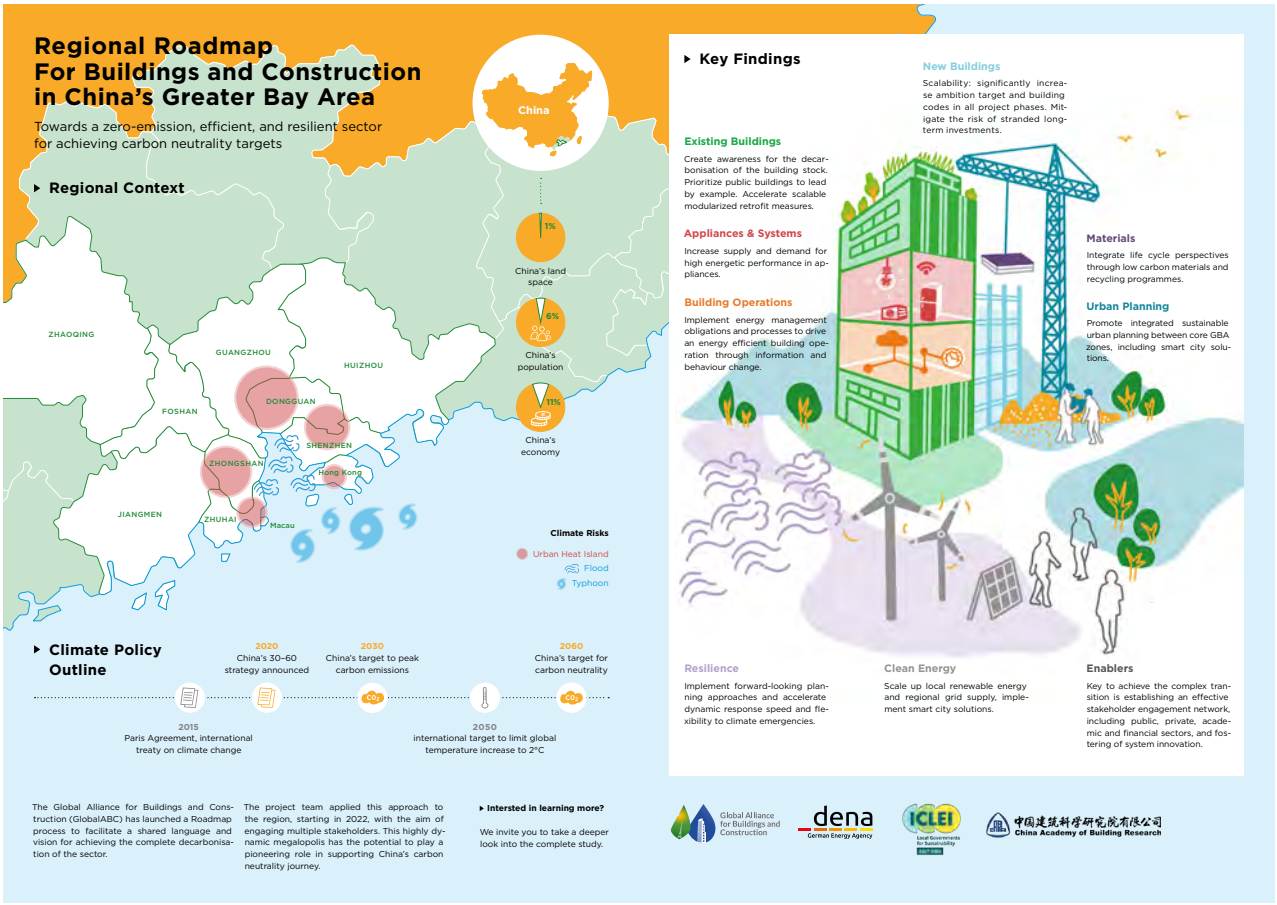
Located in the southern coastal region of China, the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) stands as a formidable megalopolis. Despite occupying less than one percent of the country's land area, it holds a prominent position as China's economic and innovation powerhouse, contributing approximately 11% to the nation's economy. By undertaking comprehensive measures to enhance the sustainability, efficiency, and resilience of buildings within this megalopolis, a substantial stride can be made toward China's ambitious goal of achieving carbon neutrality by 2060.

To facilitate the Greater Bay Area's transition towards a low-carbon and resource-efficient buildings and construction sector, the German Energy Agency (dena) took the initiative to develop a comprehensive regional roadmap which was launched in May 2023. The Regional Roadmap for Buildings and Construction in China's Greater Bay Area incorporates recommendations for eight key action areas, aligning with the UNEP Global Alliance for Buildings and Construction (GlobalABC) framework (dena, 2023). To ensure practicality and incorporate local perspectives, the project has actively engaged a diverse group of stakeholders, with prominent partners including the China Academy of Building Research (CABR), the ICLEI East Asia Secretariat, and international members of the GlobalABC.

Key findings:

- Urban Planning: Promote integrated sustainable urban planning between core GBA regions, including smart city solutions.
- New Buildings: significantly increase ambition target and building codes in all project phases, whilst mitigating the risk of stranded long-term investments.
- Existing Buildings: Create awareness for the decarbonisation of the building stock. Prioritize public buildings to lead by example. Accelerate scalable modularized retrofit measures.
- Building Operations: Implement energy management obligations and processes to drive an energy efficient building operation through information and behaviour change.
- Appliances & Systems: Increase supply and demand for high energetic performance in appliances.
- Materials: Integrate life cycle perspectives through locally sourced and processed low carbon materials and recycling programmes.
- Resilience: Implement future proof planning approaches and accelerate dynamic response speed and flexibility to climate emergencies.
- Clean Energy: Scale up local renewable energy and regional grid supply, implement smart city solutions.
- Enablers: Key is to establish and run an effective stakeholder engagement network (including public, private, academic and financial sectors) and foster system innovation.
- Considering the complexity of the building sector and its interlinked activity fields highlighted in this roadmap, the selection of focus areas by local stakeholders could be the reasonable next step. To that end, authors suggest that stakeholders choose their respective actions, focusing on applicable ownership, implementation, and monitoring.

Figure 31 Regional Roadmap for Buildings and Construction in China's Greater Bay Area



(Source: dena)

10.4 Building national coalitions for decarbonising buildings in Mexico

According to the National Institute of Statistics, Geography and Informatics (INEGI 2024), there are around 35 million dwellings in Mexico. Nearly 8.5 million dwellings require renovations and/or an extension of their spaces to address existing deficiencies. A particular challenge for undertaking these renovations and the construction of energy efficient and low-carbon buildings is that municipalities across Mexico, who have the responsibility of regulating building construction, lack capacity to direct these actions. This highlights the need for improved capacity at local levels.

National coalitions are critical to creating a multi-stakeholder approach to supporting the decarbonisation of the buildings and construction sector. Such approaches can build multi-institutional and multi-jurisdictional support around efforts to improve the design and construction of buildings and bring in communities of practice and civil society.

The Mexican Chapter of the Global Alliance for Buildings and Construction carried out a mapping of the key stakeholders currently working in Mexico on sustainable construction and the various activities they are engaged in to support improving buildings quality, energy and environmental performance and resilience.

In 2023, more than 20 institutions, including multilateral banks, NGOs, government agencies, international cooperation and implementing agencies, worked on topics that included: green financing, gender and social inclusion, capacity building, advancing the regulatory framework, and digitalisation. The activities were conducted in different regions of the country, implemented at national and local level (see Box 5).

Box 5 Buildings sustainability and decarbonisation activities across Mexico

The following are international initiatives currently in implementation throughout Mexico: the USAID Partnership for Net Zero Cities (RTI 2023), the World Resources Institute's Efficient Buildings Challenge (WRI 2024), the International Finance Corporation's ***Market Accelerator for Green Construction Program***, the ***CEELA project*** by the Swiss Agency for Development and Cooperation (Swiss Confederation 2024), the Programme for Energy Efficiency in Buildings (PEEB) (2024), the Energy Partnership Programme by the ***Danish Energy Agency*** (Climate and Energy Cooperation 2024), and the ***Energy Efficiency Refurbishment of Social Housing in Mexico*** (GIZ 2024).

The World Resources Institute in Mexico (WRI México) coordinates the Building Efficiency Accelerator (BEA) in 11 subnational jurisdictions, supporting them on implementing energy efficiency public policies and pilot projects (WRI 2019). In 2023, WRI México implemented the second year of the Building Challenge in Mexico City, the state of Sonora and the first edition in the municipality of Monterrey, with the participation of 30 companies registering 50 buildings to achieve ten per cent of energy consumption reduction by implementing energy efficiency measures.

As an example of the national collaborations being scaled across Mexico, the DKTI Vivienda programme, implemented by the German Technical Cooperation (GIZ) from 2018 to 2023, on behalf of German Federal Ministry for Economic Cooperation and Development (BMZ), increased the energy efficiency of more than 7,300 homes, improving the comfort and living conditions of more than 29,500 people (GIZ 2023a). With a total estimated mitigation of 8,850 tCO_2eq, capacity building, digitalisation and social inclusion were at the centre of the refurbishment solutions. Led by the Ministry of Agrarian, Territorial and Urban Development (SEDATU), the programme worked with multiple partners in the country, including: the Integrated Systematic Savings Programme (ASI FIPATERM), Habitat for Humanity Mexico, the National Workers' Housing Fund Institute (***INFONAVIT***), the National Housing Commission (***CONAVI***) and the National Coordination for Self-produced Housing.

The technical and financial feasibility of building improvement solutions were tested in different climate zones through 62 pilot refurbishment projects of both commercially and self-constructed dwellings. Measures included thermal insulation, high performance windows, shading devices, replacement of household appliances, photovoltaic systems, solar water heaters and controlled mechanical ventilation with heat exchangers. The pilot projects served to update national housing programmes and provide policy recommendations that ensure the continuity and scalability of the measures. The programme's projected annual impacts estimate the energy efficiency rehabilitation of 2,000 dwellings and an average mitigation of 4,000 tCO_2eq (GIZ 2023b).

In addition, digital literacy was promoted using user friendly web and mobile apps for informing households on energy use and bioclimatic design choices (Gobierno de México 2024a) through ***massive open online courses*** (INAFED 2022) and the instrumentation of dwellings with sensor and data processing equipment for monitoring energy use. The DKTI Vivienda programme effectively combined the social and technological dimensions of housing renovation by simultaneously utilising a bottom-up participatory approach and also by designing constructive solutions through technical support in the field following a whole house approach (Gobierno de México 2024b).

Supporting efforts to decarbonise Mexico's building sector, the Ministry of Finance and Public Credit (SHCP) released Mexico's Sustainable Taxonomy in March 2023 (SHCP 2023). The construction sector is one of the six economic sectors for which technical assessment criteria were defined. Metrics and thresholds were specified for ten economic activities within the construction sector including: new construction and renovation of residential buildings, new construction and renovation of commercial buildings, construction of industrial warehouses, air-conditioning systems, and two civil works activities.

The publishing of the Sustainable Taxonomy triggered the creation of financial instruments by commercial banks such as green mortgages. Technical assistance provided by the International Finance Corporation (IFC) was key for developing ***green mortgages*** (IFC 2023a) and promoting broader adoption of certified sustainable construction by providing a partial credit guarantee for the issuance of a green bond for 800 million Mexican pesos (IFC, 2023b).

Photo by Mark Boss on Unsplash

11 Buildings Breakthrough

On December 6, 2023, at COP28 in Dubai, the Governments of France and Morocco, along with the UN Environment Programme (UNEP), launched Buildings Breakthrough, an initiative that aims to transform the building sector—a sector responsible for 37 per cent of energy and process-related CO_2 emissions and 21 per cent of global GHG emissions—towards near zero emissions and climate resilience by 2030 (UNEP 2023).

Buildings Breakthrough is part of the Breakthrough Agenda, a framework for countries, businesses and civil society to strengthen their actions in key emitting sectors. The initiative is co-led by the Ministry for Ecological Transition and Territorial Cohesion of France and the Ministry of National Territory Planning, Land Planning, Housing and City Policy of the Kingdom of Morocco, and coordinated by GlobalABC (Climate Champions 2022).

Buildings Breakthrough aims to make clean technologies and sustainable solutions the most affordable, accessible and attractive option in all regions by 2030. The UNEP/GlobalABC secretariat, the IEA and the International Renewable Energy Agency, along with the High-level Climate Champions, will undertake an annual assessment of global progress in the sector. This assessment will be closely aligned with the UNEP/GlobalABC annual Global Status Report for Buildings and Construction. As of February 2024, 28 countries have pledged their commitment to the Buildings Breakthrough initiative.

The 28 countries that have pledged their commitment to Buildings Breakthrough are: Armenia, Austria, Canada, China, Côte d'Ivoire, Egypt, Ethiopia, Finland, France, Germany, Ghana, Guinea-Bissau, Japan, Jordan, Kenya, Liberia, Mauritania, Mongolia, Morocco, Netherlands, Norway, Senegal, Sweden, Tunisia, Türkiye, the United Kingdom, the USA and Zambia, along with the European Commission.

The Buildings Breakthrough Agenda outlines the actions that need to be taken and calls for the acceleration of the development, strengthening and implementation of actions across the buildings and construction sector. The initiative stresses the need for improved coordination among countries and stakeholders at national, regional and international levels to harmonise definitions, assessment frameworks and certifications for near zero emission and resilient buildings.

The Buildings Breakthrough Agenda highlights that governments should collaborate to agree on definitions, performance metrics and certification schemes for whole life net-zero carbon emission and resilient buildings, with regional differences, and on shared international mechanisms for data sharing of exemplary projects. National and sub-national governments should collectively establish procurement commitments for net-zero buildings, join low-carbon material alliances and set up commitments on deploying clean, efficient heating and cooling technologies.

The Agenda seeks for countries to increase funding for net-zero carbon building construction and renovations and improve coordination by creating a matchmaking platform, supported by various stakeholders, to serve as a single point of contact for emerging and developing countries. In addition, countries and companies should collaborate to identify knowledge gaps, align research priorities with policy goals, expand and strengthen networks across all relevant actors, enhance communication of research and best practices, assist developing countries in enhancing building energy codes, and deliver training using government projects as a model.

12

Key recommendations for policy makers and decision makers

The 2023 Global Status Report for Buildings and Construction shows the global buildings and construction sector is not on track towards aligning with the Paris Agreement goals and transitioning to an efficient, resilient and net-zero carbon buildings stock by 2050.

To support the buildings and construction sector to accelerate progress towards meeting the 2023 Global Status Report highlights a set of actor specific recommendations.

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For policy makers and government decision makers

- Develop and implement climate action roadmaps: As of 2023, 161 countries still need to develop and implement their climate action roadmaps for the buildings and construction sector. Policymakers should prioritise the creation of these roadmaps at national and sub-national scales that define short, medium and long-term actions to decarbonise the sector.
- Strengthen building energy codes: A majority of the world lacks regulations addressing energy performance in buildings. Policymakers should work towards implementing stricter building energy codes, aligned with net-zero targets, to improve the energy performance of both new and existing buildings.
- Increase investment in decarbonising buildings: Despite an increase in investments in 2022, the amount is expected to fall in 2023 due to higher borrowing costs and increased construction costs. Policymakers should provide clear market signals to drive innovation and explore ways to incentivise and increase investment in energy efficiency and the construction of whole life net-zero carbon buildings.
- Develop and implement policy and regulatory approaches to reduce embodied carbon in the sector through reuse, circularity and natural or bio-based materials.
- Promote retrofitting of existing buildings: The current retrofit rate of the building stock is around 1 per cent per year, with these retrofits typically achieving less than 15 per cent reduction in energy intensity. Policymakers should promote and incentivise extensive retrofitting to improve energy efficiency and reduce emissions by targeting accelerating efficiency improvement to between five to ten per cent per year.

For private organisations

- Adopt climate action roadmaps: Private organisations, particularly those in the construction sector, should adopt and implement climate action roadmaps to guide their decarbonisation efforts and incentivise market-place innovation of building products, technologies and systems.
- Invest in energy-efficient and net-zero carbon buildings: Organisations should prioritise investment in energy-efficient and whole life net-zero carbon buildings for their own assets and investment portfolios, contributing to the overall decarbonisation of the sector.
- Promote and implement high performance retrofitting: Private organisations should focus on retrofitting their existing buildings to improve their energy efficiency and reduce their carbon footprint and taking advantage of incentives for best available low or zero carbon technologies.
- Understand their social impacts: Organisations involved in the buildings and construction sector need to frame their role in supporting justice and equity within their scopes of influence for the sector and seek to empower a diversity of communities through their work.

For researchers and NGOs

- Support the development of evidence: Researchers and NGOs can provide valuable input and support in the development of climate action roadmaps through research and analysis to provide an evidence base around whole life zero carbon technologies, materials, reuse and renovation designs, along with evaluation and feedback to ensure policies and roadmaps are comprehensive, achievable and effective.
- Build the information set for buildings decarbonisation: Researchers, government and private organisations need to partner to develop and deploy processes for building the information set, data and data-frameworks, to support building decarbonisation, such as Building Passports (Hartenberger ***et al.*** 2021).
- Raise awareness and advocate for policy change: NGOs can help raise awareness about the importance of decarbonising the buildings and construction sector and advocate for policy changes to support this goal such as through more inclusive designs and sustainable design approaches.
- Promote and strengthen cross-sectoral collaborations from the buildings and construction sector with inter-dependent sectors, such as health, agriculture and cultural heritage.

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Annex: Global Buildings Climate Tracker (GBCT) method

The GBCT was developed to monitor the progress towards the decarbonisation of the building stock worldwide. The tracker is a composite indicator comprising seven indicators, described as a 'decarbonisation index' for buildings. The index monitors the progress towards the final goal of decarbonizing the building sector by 2050.

The process to calculate the final index comprises four steps: data collection and processing, normalization, weighting and aggregation, composite index calculation and analysis. To monitor the status of the seven indicators included in the index, the GBCT relies on extensive data research using global data sets that are consistently evaluated to ensure their quality. The most recent available data allows analysing the decarbonisation progress during the 2015-2022 period. During the normalisation step, all the indicators are translated to a common scale by dividing the observations by the total range between their value at the starting point in 2015 and their goal value in 2050. Once the indicators are normalised, the CO_2 emissions indicator is used as a multiplier while the other six indicators are aggregated using a weighted sum, with weights established in the first edition of the GBCT: impact indicators 37 per cent and action indicators 63 per cent. Then the final composite index is obtained and contrasted with the reference path towards the whole life zero carbon goal in 2050.

The first edition of the GBCT was released in 2020 as part of the Global Status Report for Buildings and Construction that year. In this third edition of the tracker, the goals for all the indicators were revised to increase the consistency among them and the final decarbonisation goal of the composite index. The Net Zero Emissions (NZE) scenario (IEA 2023h) developed by the IEA is used as the reference scenario to define the goals. The goals outlined by the NZE scenario for the building sector are aligned with the transition of the global energy sector to achieve net-zero CO_2 emissions by 2050. Moreover, this scenario is consistent with limiting the global temperature rise to 1.5 °C, in line with emissions reductions assessed by the Intergovernmental Panel on Climate Change (IPCC).

The final goal for the GBCT remains to be the decarbonisation of the building sector by 2050. However, the individual goals for the different indicators were adjusted according to the NZE and internal analyses. The goals for all the indicators, including 2030 milestones, are summarized in Table 4 GBCT's indicators goals. The goals and methodology for each indicator are described in the following subsection.

Table 4 GBCT's indicators goals

INDICATOR	2030 milestone	2050 final goal
EMISSIONS		
Buildings sector energy related emissions ($GtCO_2$/year)	4.4	0
IMPACT		
Building sector energy unit intensity (kWh/m²)	96.2	55.8
Renewable share in final energy demand in buildings (%)	18.1	25.0
ACTION		
Cumulative energy efficiency investment in buildings (US$bn)	5,586.2	28,374.8
Green building certification (cumulative growth)	33.9	96.5
NDC considering buildings extensively (% aggregated)	75	100
Building codes ZEB-aligned (% aggregated)	75	100

Adjustments to indicators

In this third edition of the GBCT, the goals for the buildings sector energy related emissions, energy unit intensity, and renewable share in final energy demand in buildings were modified to correspond to the values established by the NZE. The NZE scenario considers that all CO_2 emissions (direct and indirect) from the operation of buildings need to reduce from the current levels to reach 4.4 $GtCO_2$/year by 2030 and 0 $GtCO_2$/year by 2050 (IEA 2023i). The NZE scenario considers that the energy consumed per square meter in buildings needs to reduce to 96.2 kWh/m² by 2030, around 35 per cent less than in 2022 (IEA 2023i). The NZE scenario considers that energy intensity of the buildings sector should be 55.8 kWh/m² by 2050 (IEA 2021a). Moreover, the energy supply of the building sector should transform to progressively shift from fossil fuels to other energy sources, considering the increase of electrification and aiming at the share of renewable energy in the building sector (in the demand side) to increasing to 18.1 per cent by 2030 (IEA 2023j), and reaching 25 per cent by 2050 (IEA 2021b). It is important to notice that the scenario considers that the remaining supply for energy in buildings will be covered by 2 per cent from fossil technologies and around 73 per cent by the electricity sector, which is expected to increase its share of renewable energies from 29 per cent in 2020 to nearly 70 per cent in 2050 (IEA 2021c).

For the energy efficiency investments in buildings indicator, the methodology and the goal were modified. The approach was shifted from employing annual investments to utilising cumulative investments beginning in 2015. This change enables to highlight the cumulative shortfall in investments that have accrued over time, with the shortfall defined as the difference between the actual annual investments made and the annual investments required to stay on track towards achieving climate neutrality. The goal for this indicator was then established based on the NZE scenario, which considers that the investments in energy efficiency should be US$537.7 billion annually by 2030 (IEA 2023i). This value was used as a reference to calculate the cumulative goal as follows: It was considered that the investments grow linearly from the starting point in 2015 until reaching US$537.7 billion in 2030, then the cumulative path was calculated by summing up the investments every year to obtain the cumulated 2030 milestone, US$5,586.2 billion.

For the goal value in 2050, it was considered that the annual investments from 2030 to 2050 follow the same ratio than the investments from 2015 to 2030 but adjusted for 20 years (2030-2050). Then the cumulative goal for 2050 was calculated by summing up the investments every year, obtaining US$28,374.8 billion. The impact of using cumulative instead of annual investments in the GBCT remains relatively modest for the years spanning 2015 to 2022. However, in the future, the cumulative unfulfilled investments will accrue and widen the gap on the path toward climate neutrality unless these missed investments are addressed and made up for.

For the cumulative growth of green building certification indicator, the goal was defined based on the growth of the global building floor area. The building floor area is expected to grow (starting in 2015) 34 per cent until 2030, and 97 per cent until 2050 (IEA 2022b). Hence, it is considered that the indicator for the cumulative growth of building certifications should reach 33.9 points by 2023, and 96.5 points by 2050.

For the indicator monitoring the number of countries with NDCs considering the building sector in their efforts, the methodology and goal were adjusted. To render the assessment of each country's building stock decarbonisation efforts more precise and focus on relevant aspects, the approach shifted from simply counting the number of NDCs mentioning Buildings to counting the number of NDCs that include a detailed strategy addressing the building sector. Moreover, it was also considered that advanced economies may reach net-zero emissions in advance of others, i.e. it was considered that by 2030 all the G20 members and 50 per cent of the remaining countries should include a detailed strategy for the building sector within their NDCs; by 2050, it is considered that all countries have defined an NDC including a detailed strategy for the building sector.

For the indicator monitoring the countries with established building energy codes, the methodology and goal were also adjusted. Similarly, to the NDCs indicator, a more thorough analysis of the existing building energy codes was pursued. The methodology shifted from simply counting the number of countries with an established building energy code to counting the number of building energy codes aligned with ZEB principles. The purpose of this change is to reflect the need for countries to consider a life cycle oriented approach for the construction and renovation of buildings. The new approach also aims at reflecting the fact that by 2030 all new buildings are expected to be zero emissions in the NZE scenario. It was also considered that advanced economies may reach net-zero emissions earlier than others, i.e. it was considered that by 2030 all G20 members and 50 per cent of the remaining countries should have building energy codes aligned with ZEB principles; by 2050, all countries should have building energy codes aligned with ZEB principles.

The adjustments previously described were incorporated into the GBCT. The methodology for the final composite index remains the same. The observations, results and analysis for the composite index and the individual indicators are presented in Chapter 5: Global Buildings Climate Tracker and Chapter 6: Buildings climate policy gap review.

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