UN environment programme

2022 GLOBAL STATUS REPORT FOR BUILDINGS AND CONSTRUCTION

Towards a zero-emissions, efficient and resilient buildings and construction sector

Photo credit: **Junar Eliang**

Global Alliance for Buildings and Construction

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EXECUTIVE SUMMARY

In 2021, construction activities rebounded back to pre-pandemic levels in most major economies, alongside more energy-intensive use of buildings as workplaces reopened but hybrid working remained.

In addition, more emerging economies increased their use of fossil fuel gases in buildings.

As a result, buildings energy demand increased by around 4 per cent from 2020 to 135 EJ – the largest increase in the last 10 years.

CO_2 emissions from buildings operations have reached an all-time high of around 10 $GtCO_2$, around a 5 per cent increase from 2020 and 2 per cent higher than the previous peak in 2019.

Photo credit: Gabriella Clare Marino

DISRUPTIVE TRENDS IMPACTING BUILDING DECARBONIZATION

The COVID-19 pandemic resulted in an unprecedented change across the world in the buildings and construction sector in 2020. This included a major drop in demand for construction across major economies, workplace shutdowns due to lockdown, labour and material shortages, changing work patterns, and energy affordability challenges, which all still persist today. The result was the single largest drop in CO_2 emissions in the last decade, as documented in the last Global Status Report for Buildings and Construction.

In 2021, construction activities rebounded back to pre-pandemic levels in most major economies (section 4.1), alongside more energy-intensive use of buildings as workplaces reopened but hybrid working remained (section 4.2). In addition, more emerging economies increased their use of fossil fuel gases in buildings. As a result, buildings energy demand increased by around 4 per cent from 2020 to 135 EJ – the largest increase in the last 10 years (International Energy Agency [IEA] 2022). The impact of this is that CO_2 emissions from buildings operations have reached an all-time high of around 10 $GtCO_2$, around a 5 per cent increase from 2020 and 2 per cent higher than the previous peak in 2019. When including estimated CO_2 emissions from producing buildings materials of around 3.6 $GtCO_2$ (i.e. concrete, steel, aluminium, glass, and bricks), buildings represented around 37 per cent of global CO_2 emissions in 2021.

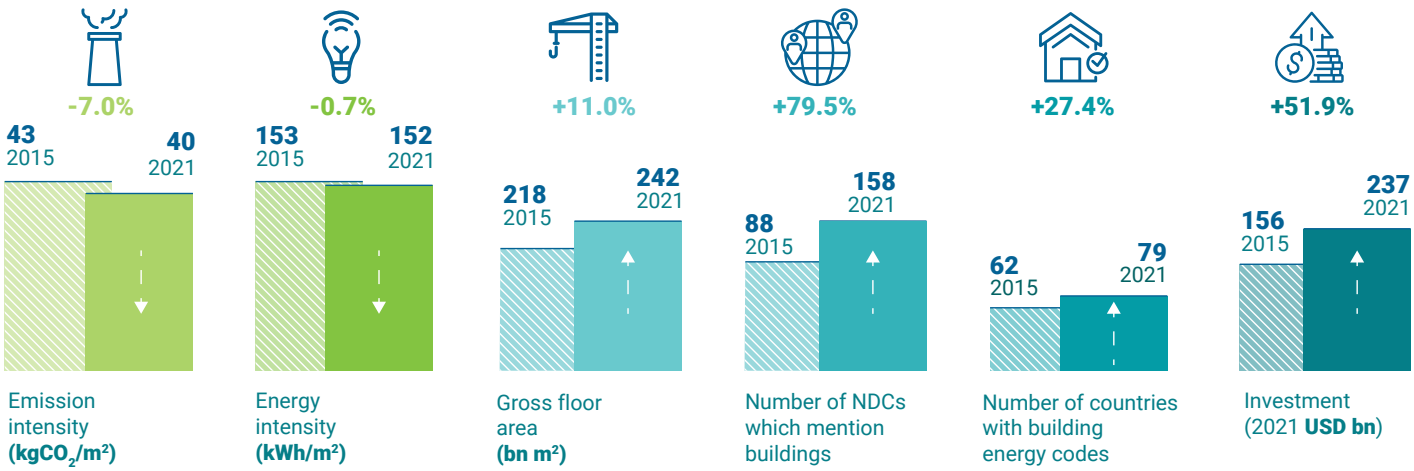
Also in 2021, the goals of the Paris Agreement were reaffirmed at the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP26). The Glasgow Climate Pact agreed at COP26 emphasizes accelerating and rapidly scaling up energy efficiency measures (United Nations Framework Convention on Climate Change [UNFCCC] 2022a). In addition, COP26 saw more than 120 events focused on the built environment and the launch of a number of important buildings initiatives.

Nevertheless, the rebound in CO_2 emissions shows that few structural changes have yet occurred within the buildings sector to reduce energy demand or cut emissions, and that 2020 was merely a pandemic-related outlier in building emissions trends. Overall, the key trends for the Global Status Report for Buildings and Construction highlight that since 2015, some progress has been made on the policy level and with an increase in investments, but there must be greater effort to reduce emissions overall and improve building energy performance alongside the continuing trend of increasing floor area (see figure 1). The 2022 update of the Global Buildings Climate Tracker confirms this observation and shows a growing gap between the actual climate performance of the sector and the necessary decarbonization pathway. This is despite 2021 having seen a growing number of countries committing to energy efficiency and offering extensive details for decarbonization of buildings within their nationally determined contributions (NDCs) (section 5.1), and an approximate 16 per cent increase in global investment in energy efficiency to over USD 230 billion (section 6).

As we move forward through 2022, there are significant risks to the decarbonization trajectory due to the Russian invasion of Ukraine and the ensuing energy crisis in Europe. Further risks are posed by global energy price volatility, along with the cost-of-living crisis facing economies and the implications of interest rate rises on investment in building decarbonization from governments, households and businesses.

The latest assessment report from the Intergovernmental Panel on Climate Change (IPCC) for the mitigation

Figure 1. Global buildings and construction key trends 2015 and 2021[1]



[1] 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, and also deflation factors for USD. The proportional changes between previous years remains similar.

working group (AR6 WGIII) sent a clear message that the buildings and construction industry offer significant global mitigation potential for reaching the Paris Agreement. Opportunities include improving existing buildings efficiency and use, high-performance new buildings, efficient lighting appliances and equipment in buildings, integrating renewables in buildings, and decarbonizing production of building materials. The consensus of the IPCC report is that buildings' operational emissions will need to drop by more than 95 per cent compared to current levels, and that these reductions are cost-effective and beneficial to building occupants and energy security (see section 2.3).

The growing and intersecting economic, energy, security and climate crises both challenge and highlight the progress needed to decarbonize and to improve the resilience of the global buildings sector. Greater political and organizational leadership is needed to further prioritize and implement actions that support the decarbonization and sustainability transition of the built environment and transformation of construction materials production.

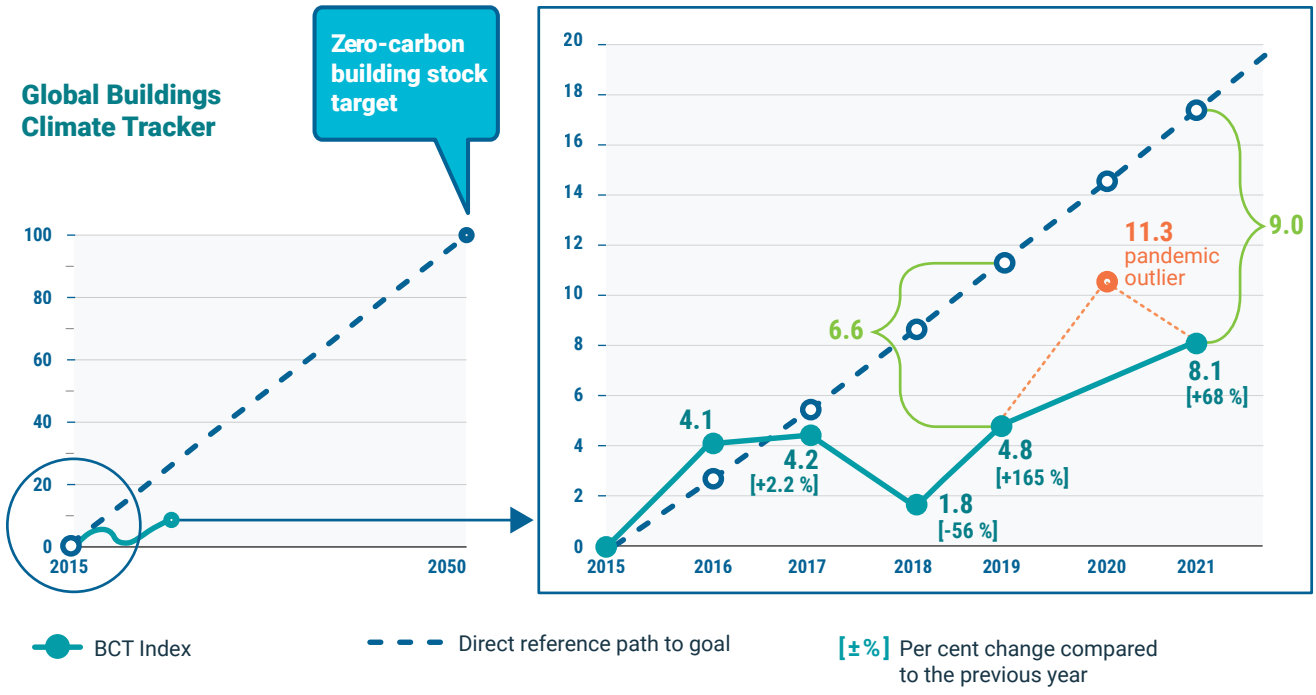
In 2021, many governments continued to act with a clear interest to address climate change and buildings sustainability. The European Union's REPowerEU initiative has sought to improve the energy performance of buildings by boosting the take-up of efficiency retrofits, renewables and heat pumps, and the use of fiscal measures for energy efficiency products for buildings. Similarly, the US Inflation Reduction Act has also made specific reference to supporting energy efficiency and renewable energy in buildings. Multiplying such policy commitments and a focus on sustaining and increasing investment will be critical to bending the emissions trajectory downward in the coming years.

GLOBAL BUILDINGS CLIMATE TRACKER

The Global Buildings Climate Tracker (section 3) indicates that the buildings and construction sector remains off track to achieve decarbonization by 2050. The Global Buildings Climate Tracker monitors the progress of the buildings and construction sector towards achieving the Paris Agreement.

In 2021, the decarbonization level decreased to 8.1 points, from a high point of 11.3 in 2020[2]. The tracker shows that since the pandemic, building decarbonization activities have reverted to their previous speed of change.

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



Source: Adapted by the Buildings Performance Institute Europe.

[2] 2021 Global Status Report for Buildings and Construction showed 17.3 points for 2020. The 2022 report uses updated historic data and indicators, which explains the discrepancies between the numbers in the two reports. For details, see Annex.

Current observations show a negative rebound since 2020 in the decarbonization of the buildings sector, with increased energy intensity and higher emissions. This leads to a growing gap between the observed performance and the desired pathway, as shown in the lower part of figure 2. The gap grew from 6.6 points in 2019 to 9.0 points in 2021.

GLOBAL BUILDINGS AND CONSTRUCTION STATUS

Operational energy demand in buildings (such as space heating and cooling, water heating, lighting and cooking) has grown to around 135 EJ, which is an increase of around 4 per cent from 2020 and exceeds the previous peak in 2019 by over 3 per cent (IEA 2022f). Related to energy demand, the global buildings sector CO_2 operational emissions have also rebounded from 2020 by about 5 per cent to a level of around 10 $GtCO_2$. This increase in emissions exceeds the pre-pandemic all-time high in 2019 by 2 per cent (IEA 2022f) (see Figure 3).

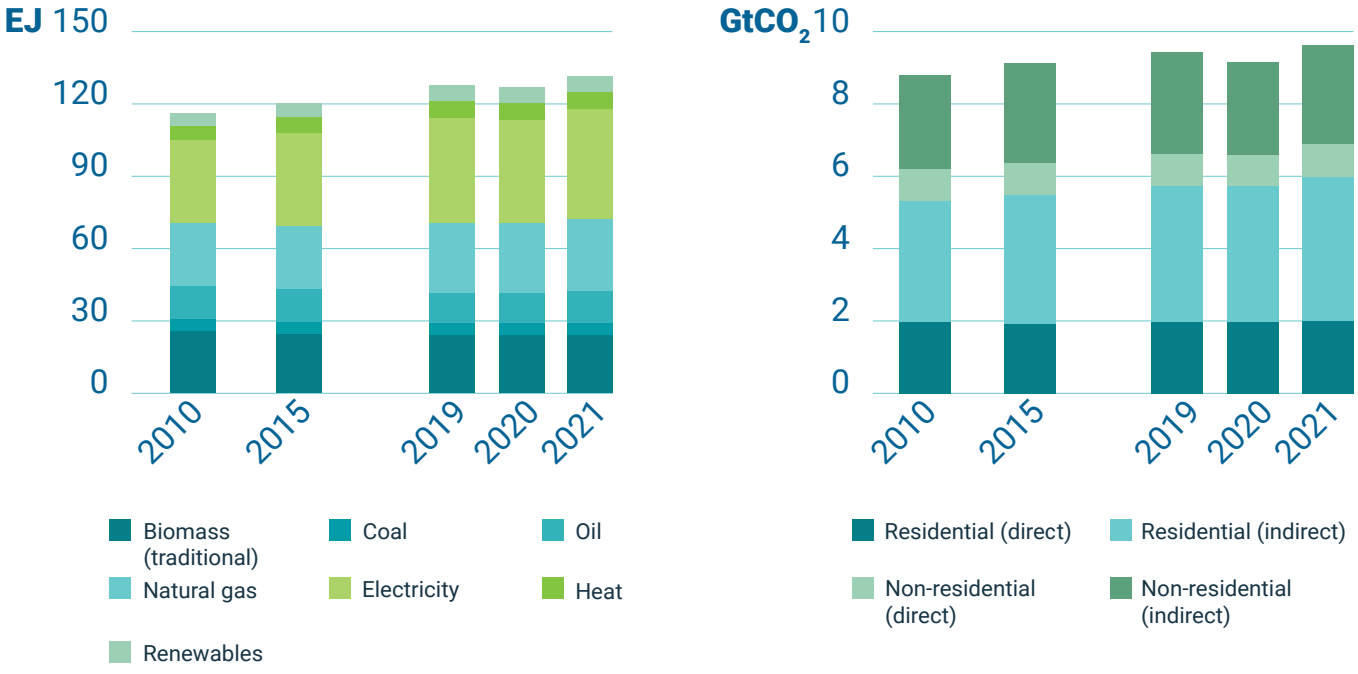
The increase reflects the reopening of the global economy as workplaces began to use more energy, alongside households continuing to work in hybrid mode, and a growth in economies using gas for heating.

The energy intensity of buildings, representing the total final energy consumption per square metre, has remained unchanged over the last three years at around 150kWh/m^2. To achieve the needed pathway toward net zero carbon, the International Energy Agency estimates that intensity needs to drop by around 35 per cent of its current level to around 95 kWh/m^2 (IEA 2022f). Unfortunately, energy intensity has largely been unchanged since 2019 and must improve at a rate of 5 per cent per year by 2030 to achieve these targets. To do so, alongside decarbonization of the grid, the building renovation rate must increase to 2.5 per cent per year (or 10 million dwellings per year) by 2030 in developed economies (IEA 2021b).

SUSTAINABLE BUILDINGS AND CONSTRUCTION POLICIES

Buildings and construction policies saw progress in 2021, with 23 countries revising and updating their NDCs with a greater level of commitment to building efficiency and adaptation, and a greater level of detail. 80 per cent of countries now refer to buildings as part of their NDC action plans, compared to around 69 per cent in 2020 (see Figure 4). This is a positive sign as more governments recognize and make commitments to the role buildings play in their decarbonization actions (see section 5.1).

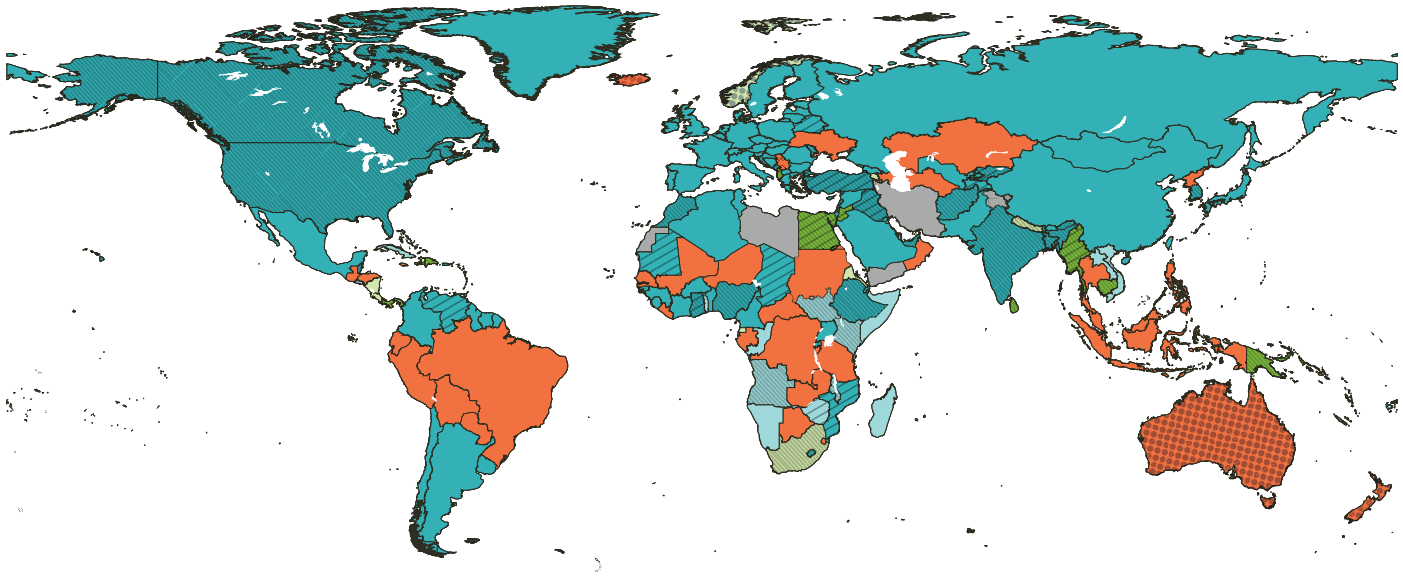
Figure 3. Energy consumption in buildings by fuel, 2010-2021 (left) and CO_2 emissions in buildings 2010-2021 (right)



Source: International Energy Agency (2022). Tracking Clean Energy Progress. Paris.

Figure 4. Mentions of buildings across all countries' latest NDCs

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.



Source: United Nations Framework Convention on Climate Change [UNFCCC].

Notes: Adaptation can refer to any measures to improve resilience to the impacts of climate change, such as improved flood resilience for housing. Regions with fine left-hatching have specific reference to building codes. Regions with dotted hatching have reported actions through the Biennial Report.

Building codes are vital to addressing buildings sector emissions and providing clear guidelines on their features. They can be a main driver for improvements in energy performance. As of September 2022, 40 per cent of countries have mandatory or voluntary regulations or codes for building energy performance (see section 5.2) – this marks an increase of only one country from last year's Buildings Global Status Report, due to Georgia now formally applying the EU directive 2010/31/EU (European Parliament 2010). When looking at countries with mandatory codes or regulations for both residential and non-residential buildings, the proportion falls to 26 per cent. In 2021, seven US states adopted more stringent building codes for enforcement, including Washington and New York states, which have focused on promoting electrification and use of heat pumps, and geothermal heating and cooling systems, while Denmark and France implemented lifetime CO_2 levels for new buildings (see section 5.2 and 5.3).

As a priority, more jurisdictions need to align their building codes to meeting the Paris Agreement. In 2021, several organisations and jurisdictions undertook efforts to align their new building energy codes towards being zero carbon. For example, the new voluntary appendix to the 2021 International Energy Conservation Code (IECC) works towards providing a standard for achieving zero-carbon buildings (IECC 2021), and Washington DC's 2020 energy code includes a net-zero energy appendix for new buildings (Government of the District of Columbia 2017).

As a further tool for promoting building sustainability, green building certification offers a way to adopt and recognize higher standards of building energy performance and broader metrics of building sustainability. Since 2020, there has been a 19 per cent increase in certifications across the world among the tracked systems (section 5.4).

Energy used for equipment and appliances represented around 18 per cent of building energy use in 2021 (IEA 2022f). To further address building emissions reductions, more countries have introduced minimum energy performance standards for equipment and appliances. These cover more than 80 per cent of refrigerators, 75 per cent of lighting and 82 per cent of air conditioners globally by final energy use, and are supported by a growing use of labels to indicate performance levels (IEA 2022f).

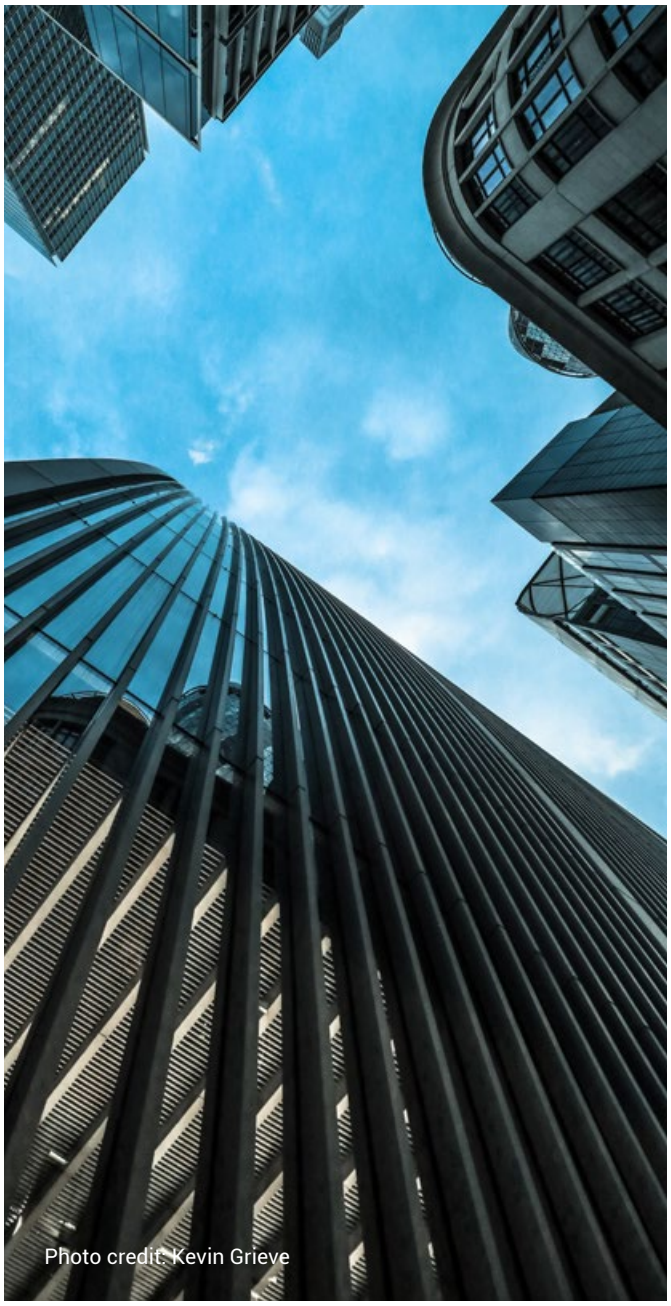


Photo credit: Kevin Grieve

INVESTMENT AND FINANCING FOR SUSTAINABLE BUILDINGS

In 2021, global buildings sector investment in energy efficiency increased by around 16 per cent from 2020 to a total of approximately USD 237 billion (IEA 2022g). This increase occurred primarily among European countries with existing programmes of public investment in efficiency, including Germany, UK and Italy, and sustained investment in USA, Canada and Japan (see section 6).

The growth in construction activities also increased the investment in more efficient new buildings and buildings covered under sustainability or "green" certifications, with an estimated 19 per cent growth in certified buildings compared to 2020.

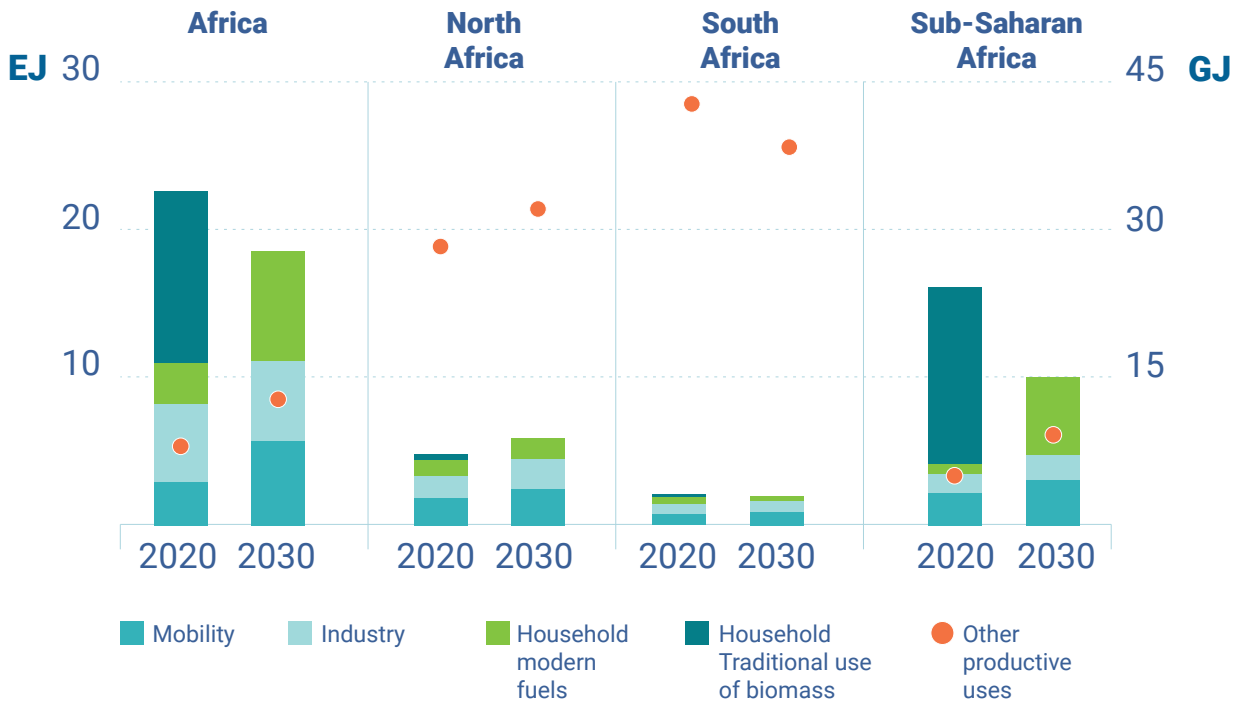
Investment in improving the energy performance of existing buildings and ensuring existing systems are operating as designed is critical to both reducing energy demand and avoiding related CO_2 emissions. Investing in fuel switching to clean fuels, such as through electrification and adoption of heat pumps for space heating and cooling, will play a major role in this transition, with the global heat pump market estimated to have grown by around 15 per cent in 2021 (IEA 2022g).

This increase in investment is welcome news but also highlights the challenge of needing to continue to increase investments in efficiency during a period of inflation that will cause increasing pressure on borrowing costs. Yet in the face of rising energy prices, investing in efficiency is a way to avoid future energy price volatility as well as reducing emissions.

A PATHWAY TOWARDS SUSTAINABILITY FOR AFRICA'S BUILDINGS AND CONSTRUCTION SECTOR

Around 56 per cent of the African population lives in informal housing (UN Habitat 2016). The population across Africa is expected to reach 2.4 billion people by 2050 and 80 per cent of this growth will occur in cities (African Development Bank [ADB] 2019). The need to provide housing now and in the future is a major driver of growth for buildings across the African continent. There are enormous opportunities for these buildings and urban environments to be built to a high-quality and sustainable standard, to be zero carbon (or zero carbon ready) and to be capable of adapting to a changing climate.

Figure 5. Africa's final energy consumption by sector 2020-2030



Source: IEA Africa Energy Outlook 2022 (IEA 2022b).

Notes: TUOB = traditional use of biomass. Other productive uses include services and agriculture. Household modern fuels include fossil fuels, electricity and renewables, such as the use of biomass in modern stoves.

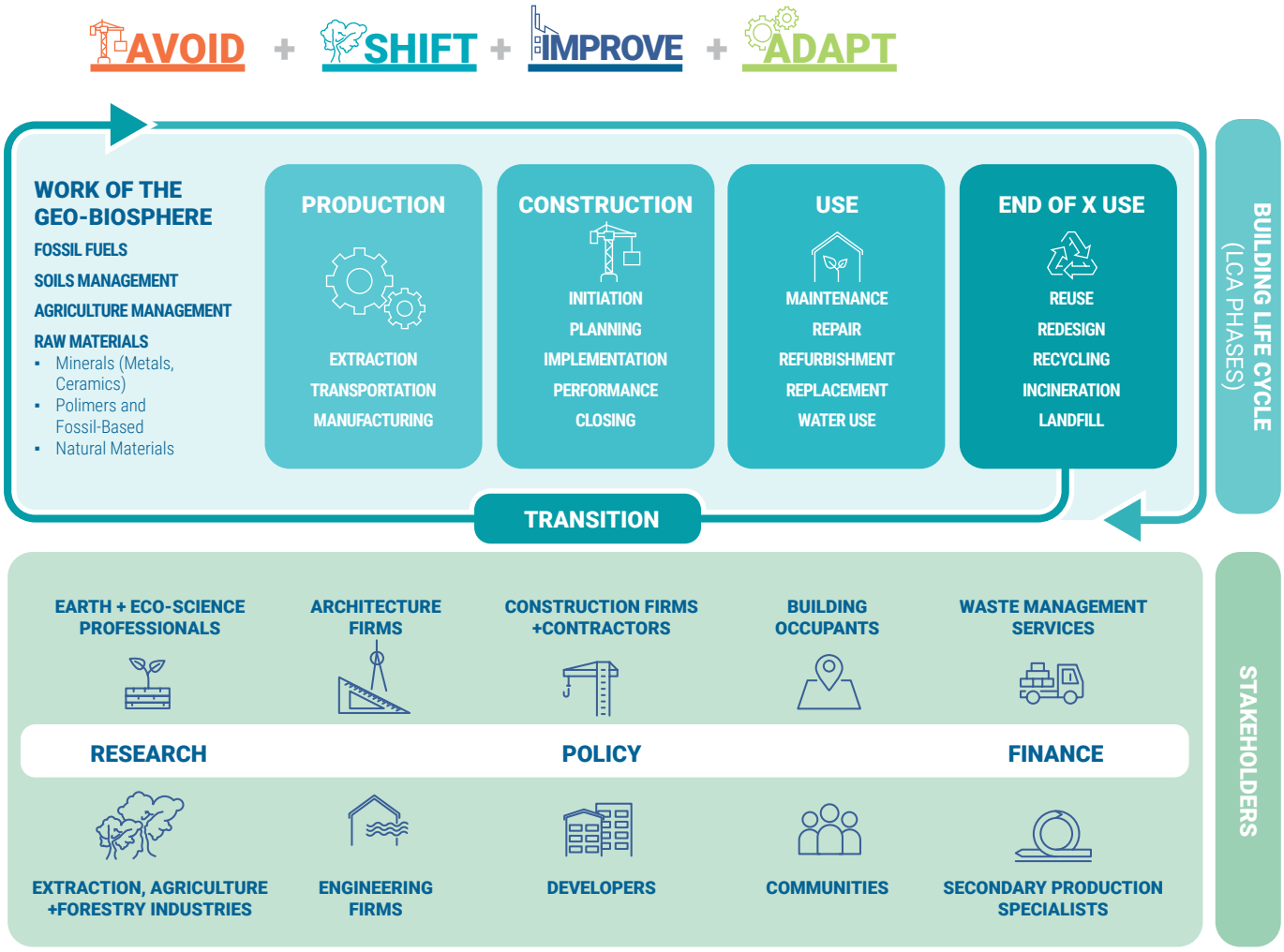
Africa accounts for around 6 per cent of global energy demand and contributed to less than 3 per cent of global greenhouse gas emissions in 2021 (IEA 2022b). Households in Africa accounted for 56 per cent of total final energy consumption in 2021, but only 43 per cent of the continent's population had access to electricity. The IEA estimates that household energy demand by 2030 for cooling and appliances will more than double, though the energy intensity of lighting in the residential sector will decrease due to the movement towards energy-efficient lamps (IEA 2022b). Further, Sustainable Energy for All highlights that of the 54 high-impact and high-temperature risk countries, 24 are on the African continent (Sustainable Energy for All [SEforALL] 2022). This means that the need for cooling is a major future challenge for residential energy demand, with ownership of fans standing at 0.6 units per household and current cooling device ownership standing at only 0.06 units per household (IEA 2022b).

Since the 2021 Buildings-GSR, ten African countries provided further detail within their NDC update regarding commitments to decarbonizing the building stock (see section 5.2 and section 7.2). However, only five African countries (9 per cent) have a mandatory building code (section 5.2). As a priority, it will be critical for those nations that do not yet have mandatory codes to develop both the codes and their regulatory framework and the skills and capacity to implement energy efficient and sustainable building codes that make use of local best practices and traditions. As part of this effort, energy efficient traditional and sustainable construction and building practices, which are a cornerstone of African cultural heritage, should be promoted and formalized in building codes so that housing is constructed within the local context and acts to preserve African culture while being of a high quality and affordable.

CONSTRUCTION WITH WHOLE LIFE CYCLE APPROACHES TO BUILDING MATERIALS

The global consumption of raw materials will almost double by 2060 as the world economy grows and living standards rise, exacerbating the environmental overloading we are experiencing today (Organisation for Economic Co-operation and Development [OECD] 2019). The International Resource Panel has underlined the massive greenhouse gas emissions reduction potential from material efficiency strategies applied across the building stock (Hertwich et al. 2020). In G7 countries alone, material efficiency strategies, including the use of recycled materials, could reduce greenhouse gas emissions in the material cycle of residential buildings by over 80 per cent in 2050.

Figure 6. From data to actionable knowledge: How to get the right information to stakeholders at the right phase of the built environment process life cycle in order to facilitate maximum decarbonization through systems-thinking



Transitioning to a future of low-carbon buildings requires the design of multi-beneficial material strategies that take a whole building life cycle and systems-thinking approach. The longevity of buildings infrastructure needs to be incentivized financially and legislatively to encourage low-carbon adaptation and refurbishment that extends building lifespans without locking in operational energy inefficiencies.

Despite its massive contribution to global greenhouse gas emissions, embodied carbon has previously been under addressed in strategies to reduce building emissions. A (whole) life cycle analysis approach is increasingly being adopted by industry leaders to guide strategies to simultaneously address embodied and operational carbon. These can be clustered in three strategies – "avoid", "shift" and "improve" – all of which lead to "adaptability". Measures range from building less, requiring less material and using low-carbon materials, to circular approaches and improved designs that have a longer lifetime and lower operational emissions during building use.

To decarbonize the building materials sector, all stakeholders need to take greater responsibility to understand the environmental impact of their decisions regarding material selections across the life cycle. Doing so requires getting the right data to the right stakeholders at consequential stages of decision-making (see Figure 6).

Built environment carbon rating systems need to include better rewards for avoiding new construction where possible, for shifting to low-carbon biobased solutions, and for improving production methods for conventional materials. Avoiding carbon emissions by

building better-designed, resource-efficient buildings is key to reducing raw material consumption and related emissions. However, the most urgent priority must be to increase the longevity of existing and new building stock and reuse existing components whenever possible.

CHARTING THE PATHWAY TO SUSTAINABLE, ZERO-CARBON, EFFICIENT AND RESILIENT BUILDINGS THROUGH BUILDING AND CONSTRUCTION ROADMAPS

To support countries and regions in developing a clear set of actions towards enabling a sustainable, zero-carbon and resilient buildings and construction sector, the roadmap development process provides a way to build targets, strategies and partnerships through a collaborative approach.

A growing number of countries and regions are using the roadmap process for charting the path to a sustainable buildings and construction sector. Roadmaps already published include the GlobalABC and IEA's jointly published global, Asia, Africa and Latin America roadmaps along with country and regional roadmaps, including for the ASEAN region, Indonesia and Colombia (see section 9).

In addition, roadmaps are being developed for more than 30 countries and regions, highlighting the importance of national governments and regional cooperation and partnerships in efforts to decarbonize the building sector. Planned roadmaps include Türkiye, Sri Lanka, Burkina Faso, Senegal, Ghana, India, Bangladesh, 22 countries and territories in the Arab League, China's Greater Bay Area (Guangdong–Hong Kong–Macau), Cambodia and Viet Nam.

The GlobalABC provides support through the Roadmap Coordination Hub, which is a group of country and non-state stakeholders working together to "build synergies between the different initiatives […] ensuring that the lifespan of the roadmaps extends well beyond the projects, through local engagement and implementation."

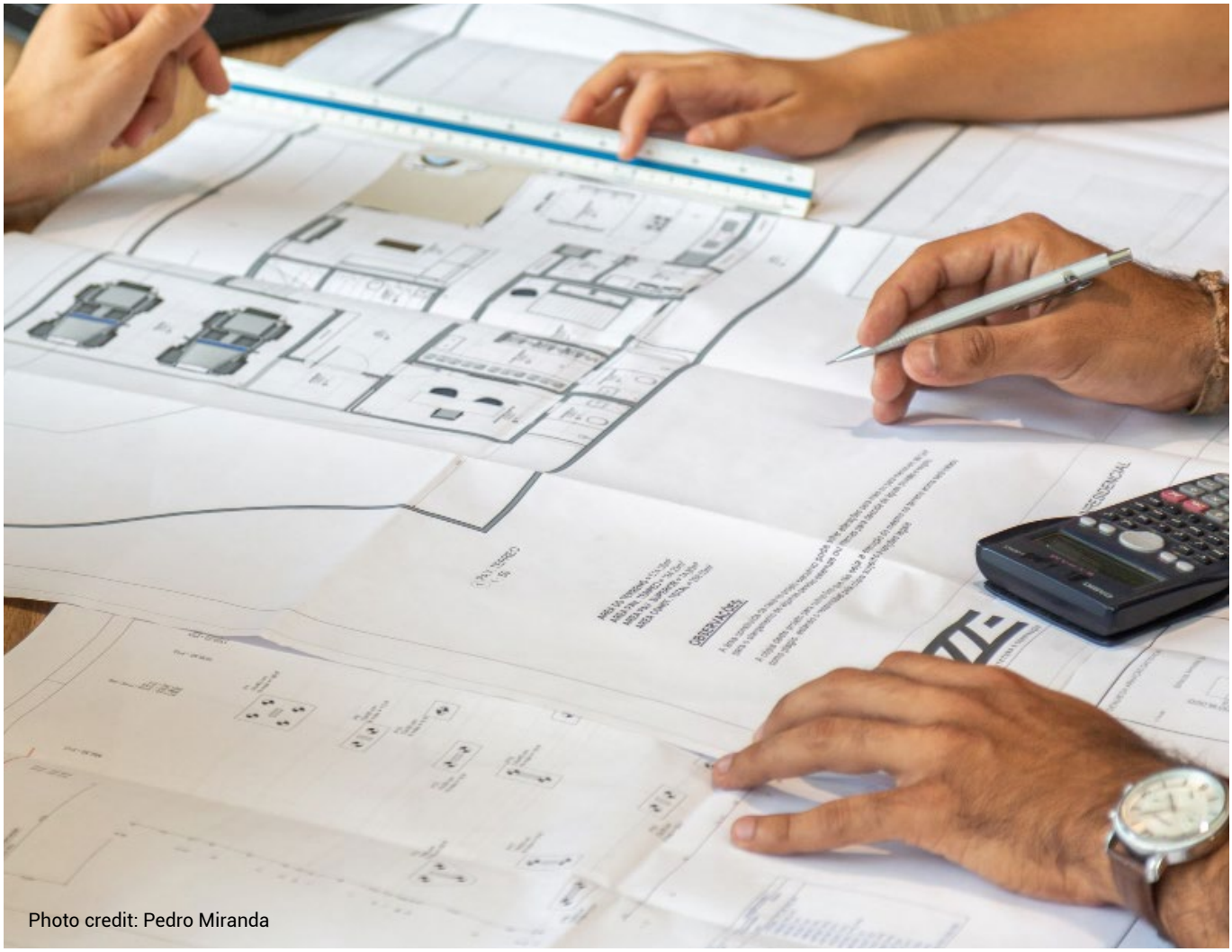


Photo credit: Pedro Miranda

KEY RECOMMENDATIONS FOR POLICY AND DECISION MAKERS

The structural changes needed in the buildings and construction sector are not yet showing, as is clearly documented in the series of Global Status Reports for Buildings and Construction. While the increase in investment in energy efficiency among existing buildings and a greater number of new buildings being constructed to higher energy performance standards are welcome trends, the impact on energy use and energy intensity is not yet showing, nor is there any sign of emissions from the buildings sector being decoupled from energy or construction.

Policymakers and decision makers must urgently implement definitive near-term actions that deliver the needed emissions reductions while achieving the objectives of a sustainable and resilient buildings and construction sector. The buildings sector will continue to grow to meet citizens' needs for safe housing and workplaces, but its growth must be in alignment with the Paris Agreement.

The following recommendations are designed to respond to these challenges:

1. Coalitions of national stakeholders should be developed to **set targets and strategy towards a zero-emission, efficient and resilient buildings and construction sector** through building decarbonization and resilience roadmaps and in line with the Marrakech Partnership Global Climate Action Human Settlements Pathway.

2. National and sub-national governments must put in place mandatory building energy codes and **set out a pathway for their new building codes and standards to be performance based and to achieve zero carbon across a building's life cycle as quickly as possible.** For jurisdictions without building energy codes, these need to be formulated and adopted. Codes should consider the Guidelines for Energy Efficiency Standards in Buildings (United Nations Economic Commission for Europe [UNECE] 2020).

3. Governments and non-state actors **must increase their investment in energy efficiency**. This investment needs to target all businesses and households. Governments will need to use financial and non-financial incentives to encourage investment and provide support for vulnerable households.

4. The construction and real estate industries must **develop and implement zero-carbon strategies for new and existing buildings** in all jurisdictions, in order to effectively support government policies.

5. The building materials and construction industries must commit to **reducing their CO_2 emissions throughout their value chain in line with the Paris Agreement,** supporting government policies towards a carbon neutral building stock.

6. Increased funding is urgently required for public–private research partnerships to **accelerate the development, demonstration and commercialization of innovations to reduce embodied carbon** in building materials.

7. For governments aiming to achieve a net-zero-carbon built environment, regulations and assessment of emissions need to **take a life cycle approach** that considers both materials' embodied carbon emissions and operational emissions.

8. Governments, especially cities, need to **implement policies that promote the shift to circular economies** that replace linear, non-renewable, toxic material processes with sustainable renewable materials that can sequester carbon and be managed sustainably over their life cycles. In parallel, for materials that cannot (yet) be replaced, their use and their carbon footprint should be reduced as much as possible.

9. Fast-growing countries and economies, including in Africa and Southeast Asia, need investment to **build capacity, resources and supply chains** to promote energy-efficient designs and low-carbon and sustainable construction.

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