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FOR A BETTER URBAN FUTURE

Expert Group and Intersessional Thematic Meeting on:

Housing Sustainability

ANNEX

Background

1.1. The Housing Challenge

Housing is essential to provide households with a safe and secure place to live, and it creates opportunities for enhancing social capital outcomes, such as health and well-being. Evidence shows that a lack of adequate housing hinders access to education, healthcare, and employment opportunities. The United Nations 1948 Universal Declaration of Human Rights enshrines the importance of housing and the right to adequate housing. However, despite continuous global economic growth, technological advancements, and significant progress in human development—as reflected in improved life expectancy, education, and income—access to adequate housing remains a persistent global challenge. Globally, over 150 million people are homeless, and around 1.6 billion people live in inadequate housing, facing issues such as overcrowding, poor construction, or lack of services. An estimated 1.2 billion people currently live in slums or informal settlements, often under insecure tenure and hazardous conditions. If current trends continue, UN-Habitat projects that up to 3 billion people—nearly 40% of the global population—could be living in slums by 2050.

Urbanization adds to these challenges. By 2050, nearly 70% of the world's population is expected to live in urban areas, up from 57% in 2024. To accommodate this growth, an estimated 60% of the buildings needed by 2050 have yet to be constructed[1], representing both a significant challenge and a transformative opportunity to guide urban development in ways that are inclusive, sustainable, and climate resilient.

1.2. The Climate Challenge

Climate change is accelerating, posing an urgent and multidimensional threat to societies across the globe. According to the Intergovernmental Panel on Climate Change[2], the Earth is already approximately 1.1°C warmer than pre-industrial levels, and without decisive action, this could exceed 1.5°C as early as the 2030s. The frequency and intensity of extreme weather events are increasing. Over

[1] Global Alliance for Buildings and Construction (GlobalABC), 2021 Global Status Report for Buildings and Construction, UNEP, 2021
[2] IPCC (2023) – Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

the past two decades, climate-related disasters have doubled, affecting over 4 billion people globally between 2000 and 2019[3]. By 2050, climate change could displace up to 1.2 billion people due to drought, flooding, and other environmental pressures[4].

In this context, housing is both a contributor to and a casualty of the climate crisis. Resilient, sustainable housing solutions are therefore critical for both climate adaptation and mitigation.

The housing climate challenge manifests in two ways: first, the building and construction sector accounts for approximately 37% of global energy-related CO_2 emissions[5] primarily through energy use in buildings for cooling, heating, lighting, and powering appliances. Materials used in the construction of buildings represent an estimated 9% of overall energy-related CO2 emissions. Heavy material extraction and consumption also contribute to deforestation, biodiversity loss, and overexploitation of freshwater resources.

On the other hand, housing is vulnerable to the impacts of climate change, whereby homes in low-lying areas are prone to flooding, while others experience excessive heat due to heat waves. Rapid urban growth in developing economies has led to unprecedented demand for housing, much of which is being met informally through unregulated construction. Communities residing in informal settlements and other housing structures with low resilience, characterized, for instance, by poor drainage or weak structural integrity, are highly vulnerable to climate change-related disasters. Furthermore, climate-related events are increasingly being associated with displacements that force people to migrate to temporary, unsafe shelters, exposing them to the vagaries of the disasters and thereby forming a vicious cycle. Over the past 10 years, weather-related disasters have caused 220 million internal displacements, a figure equivalent to about 60,000 displacements per day.[6]

1.3. Environmental Sustainability of Housing

Sustainable housing is a cornerstone of equitable urban development and environmental resilience. More than just eco-friendly construction, sustainable housing integrates **environmental, social, and economic dimensions** to ensure that homes are not only green and efficient, but also affordable, secure, and inclusive. From an environmental standpoint, sustainable housing aims to minimize resource consumption and greenhouse gas emissions through energy-efficient design, use of sustainable materials, and climate-resilient infrastructure. Socially, it prioritizes inclusiveness—ensuring access to adequate housing for all, including marginalized and low-income groups. Economically, it supports affordability and long-term viability, enabling households to live with dignity without excessive financial strain.

This multidimensional approach is reflected in international definitions. UN-Habitat emphasizes sustainable housing as "adequate housing that is **environmentally sound, socially inclusive, and economically affordable**".[7] The OECD adds that it must meet “the needs of current and future

[3] United Nations Office for Disaster Risk Reduction (UNDRR) (2020) – Human Cost of Disasters: An Overview of the Last 20 Years (2000–2019).
[4] Institute for Economics & Peace (2020) – Ecological Threat Register 2020.
[5] GlobalABC & UNEP (2022) – 2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector.
[6] IDMC, GRID, (2024), Global Report on Internal Displacement, IDMC, GRID, Geneva, Switzerland, 2024
[7] UN-Habitat – Sustainable Housing for Sustainable Cities: A Policy Framework for Developing Countries (2012)

generations,"[8] while UNECE frames it as essential to inclusive and green economic growth[9]. Together, these perspectives show that sustainable housing, therefore, is not a single model but a guiding principle that links housing policy to broader goals of climate action, poverty reduction, and social justice.

Sustainable housing provides a healthy environment for inhabitants; it is durable, safe, and secure; it is affordable; it is built with low-energy, affordable materials and technology; it is resilient to natural disasters and climate impacts; it is has access to safe and affordable energy, water, sanitation, and recycling facilities; it uses energy and water efficiently; it does not pollute the environment; it is well connected to economic opportunities and social amenities (education, health, and other services); and it is integrated into local neighbourhoods.

Sustainable housing provides a resilient built environment against climate change hazards. Achieving housing sustainability involves making the building and construction sector sustainable by rethinking the entire life cycle of buildings, from the extraction of raw materials to waste management, encompassing all associated environmental, social, cultural, and economic processes. It means shifting from a system that harms the natural environment, exacerbates social inequalities, and threatens biological and cultural diversity to one that benefits communities and ecosystems, allowing both human and natural environments to thrive.

Enshrined in international frameworks like the UDHR and ICESCR, adequate housing is defined by the seven elements that characterise it. Environmental sustainability can be proposed as an 8th element.

2. Environmental Impacts of Housing

The environmental footprint of the building and construction sector is increasingly recognized as one of the most significant contributors to global greenhouse gas (GHG) emissions. The built environment is responsible for an estimated 21% of total global GHG emissions and 40% of global CO_2 emissions, with around 70% from building operations.

[8] OECD (2021) – Policy Toolkit for Affordable and Green Housing
[9] UNECE (2015) – Guidelines on Sustainable Housing

2.1. Housing lifecycle

- **Housing Construction:** Currently, 30% of global raw material extraction is attributed to housing development. Building materials pose different environmental impacts in their entire lifecycle (from extraction, processing, transport, use, and end-of-life). These materials include sand, stone, wood, metals, and water. Approximately 12% of the world's freshwater is used to produce concrete, bricks, and other construction materials. After water, concrete (which comprises sand, aggregate, water, and cement) is the most widely used substance on Earth, with more than 14 billion cubic meters produced annually[10]. Concrete has a very high carbon footprint, which gives the construction sector a problem amid pressure for greater sustainability in the industry.[11] The demand for concrete is expected to continue growing in Africa and Asia as urbanization increases, prompting governments and the private sector to invest more heavily in housing, transportation infrastructure, and public facilities.

- The key metals (Aluminium, Steel, Zinc, and Copper), most used in construction, account for 7-9% of global CO2 emissions. The mining of raw ore for metals has been attributed to massive deforestation, the removal of topsoil, resulting in erodible, barren lands, water pollution, and a loss of biodiversity[12]. Tailings (waste) in mining have been attributed to leaching harmful substances like arsenic, mercury, and cadmium that have adverse human health impacts when they contaminate water and food systems.

- For instance, steel production methods are primarily based on coal, which is a carbon-intensive source, while aluminium processing is electricity-intensive and often powered by fossil fuels[13]. The extraction and processing of materials release particulate matter and other harmful gases, such as sulphur dioxide, contributing to air pollution. Although there is a push for greening steel production and adopting a circular economy, production costs remain higher than those of conventional methods, and the demand for cheaper materials outstrips supply.

- Over 2 billion people live in water-stressed areas, and it is projected that by 2050, 40% or 5.7 billion more may be affected in developing countries. The water demand, which is crucial for mixing and curing concrete, is projected to increase by 20-30% by 2050 from 2019 levels. A significant portion of this demand is anticipated to occur in water-stressed regions, thus intensifying the water pressure[14]. By 2030, the global freshwater demand-supply gap is expected to be 40%, with the built environment accounting for approximately 15%. As construction water needs continue to compete directly with agricultural, domestic, and

[10] **"***Reinventing* **Construction through a Productivity Revolution"** by McKinsey Global Institute (February 2017):
[11] *Clough, Harriet (2022-10-14). "11 major players join calls for a cross-industry sustainable building taskforce". Planning, BIM & Construction Today. Retrieved 2023-01-12.*

[12] Aznar-Sánchez et al. (2019). *Environmental impacts of mining and raw material extraction: A review*. *Sustainability,* 11(17), 4753. https://doi.org/10.3390/su11174753
[13] IEA (2023). *Iron and Steel Tracking Report*. IEA.org
[14] UNESCO

ecological uses, there is a likelihood of increased groundwater depletion, lower river flows, stress on ecosystems, and communities[15].

- **Housing Operations and Maintenance:** The building sector, comprising residential and commercial buildings, is responsible for 28% of global energy-related CO2 emissions, with residential housing accounting for approximately 20% of the global total emissions. Fossil-fuel-based electricity generation, required for appliances, HVAC, and natural gas and oil-based heating and lighting, is the primary source of operational carbon emissions in housing. Inefficient appliances and HVAC systems are a key contributor to the increasing demand for operational energy, alongside ageing and poorly ventilated homes in many regions that demand increased energy for seasonal cooling and heating[16].

- One key factor contributing to the increasing demand for operational energy of buildings is the global increase in floor space. In 2020, global building floor areas were approximated at 250 billion square meters and are projected to double by 2050. This will be driven by the rapid urbanization in the global South, and rising living standards mean families are building larger homes per capita and demanding greater thermal comfort, enabled by HVAC and hot tap water. Increasingly hotter climates are also increasing the demand for air conditioning. With the global population expected to reach over 9.5 billion by 2050, the housing stock is likely to double in size[17]. Without drastic changes in energy generation, the promotion of green building codes, and efficiency upgrades of appliances and HVAC systems, operational emissions from housing will continue to rise and miss the Paris targets.

- Household water accounts for more than 70% of municipal water demand, with an average per capita consumption in high-income countries exceeding 150 litres per day[18]. Inefficient fixtures (toilets, taps, and showers), as well as ageing water and sewage infrastructure, are some of the unsustainable practices in water management within homes. The overextraction of freshwater from aquifers and rivers is anticipated as urbanization and water demand continue to grow. Furthermore, over 80% of the water used in homes becomes wastewater, and much of it is not treated or recycled, leading to environmental pollution.

- **Housing End-of-Life:** At the end of their life cycle, most buildings are demolished to make way for new structures or to utilize the land for other purposes. Most existing buildings are not designed for repurposing, and retrofitting would be expensive. Construction and demolition (C&D) waste is categorized into nine groups, including ferric metals, non-ferric metals, mixed ferric and non-ferric metals, wood, plastic, glass, polychlorinated biphenyl waste, mineral wastes containing asbestos, and waste from all C&D activities[19]. Much of this waste ends up in landfills, having detrimental environmental impacts, including land degradation and pollution.

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[15] World Economic Forum (2023) *Global freshwater demand will exceed supply 40% by 2030, experts warn*: https://www.weforum.org/agenda/2023/03/global-freshwater-demand-will-exceed-supply-40-by-2030-experts-warn/
[16] GlobalABC/IEA/UNEP (2023). 2022 Global Status Report for Buildings and Construction
[17] IEA (2021). Net Zero by 2050: A Roadmap for the Global Energy Sector
[18] UN-Water (2021), WHO, World Bank (2020)
[19] Kabirifar et al 2020.Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: https://doi.org/10.1016/j.jclepro.2020.121265.

Demolition is resource-intensive, thereby increasing the carbon footprint due to its handling, which includes the use of heavy machinery and the transportation of bulk materials. Demolitions associated with urban regeneration, although they eventually improve the quality of housing, disproportionately affect vulnerable communities, such as informal settlements and low-income areas, leading to the loss of livelihoods and a breakdown of social cohesion[20]. Further, the construction sector lacks systems for material recovery, reuse, and lifecycle tracking, limiting progress toward material circularity. Without systemic shifts in material sourcing and reuse, sustainable housing will remain costly and resource-intensive.[21]

- It is estimated that more than 40% of total solid waste in the EU in 2024 consisted of C&D waste, with the potential to recycle 83% of this waste, resulting in an additional annual savings of 22-52 million tonnes of CO2[22]. While much of the C&D waste can be repurposed and recycled, the reuse rates are low, especially in developing economies.

2.2. Land Use Changes Driven by the Housing Demand

Urbanization and population growth drive the demand for new housing; these causes combined are significant causes of land use change and are responsible for the conversion of farmlands, forests, and open spaces into the built environment, altering landscapes, affecting biodiversity, destroying agricultural land, and driving land and soil degradation overall.

Between 2000 and 2020, the suburban and urban areas increased from 3.4% to 4.1% of the total land area, equivalent to a 930,000 km^2 expansion. Another 490,000 km^2 are expected to be converted into built environment by 2050, resulting in more than 110,000 km^2 of natural habitat disappearing.[23] Not only are cities expanding beyond administrative boundaries into agglomerations, but mega-urban regions emerge from the merger of multiple urban agglomerations, generating huge, continuous urban areas.[24] A considerable amount of the urban sprawl is unplanned and comprises informal settlements.

This rapid expansion is responsible for swallowing up agricultural land that is converted to housing and infrastructure, lowering local productivity, altering ecological dynamics, and fragmenting habitats. Impervious surfaces created by infrastructure (roads, rooftops, and driveways) reduce groundwater recharge and increase runoff, which elevates the risks of flooding and reduces overall ecosystem services (climate regulation, water purification, and natural cooling by vegetation).

[20] UN-Habitat. (2010). Fact Sheet 21: Adequate Housing. https://unhabitat.org/sites/default/files/documents/2019-05/fact_sheet_21_adequate_housing_final_2010.pdf

[21] Habitat International (2012). *Sustainable Housing for Sustainable Cities*. https://unhabitat.org/sites/default/files/download-manager-files/Sustainable%20Housing%20for%20Sustainable%20Cities.pdf

[22] https://ec.europa.eu/newsroom/env/items/822475/en?utm_source=chatgpt.com

[23] Ren, Qiang, et al. "Impacts of global urban expansion on natural habitats undermine the 2050 vision for biodiversity." *Resources, Conservation and Recycling* 190 (2023): 106834.

[24] d'Amour, C. Bren, et al. "KC Seto Future urban land expansion and implications for global croplands., 2017, 114." *DOI: https://doi. org/10.1073/pnas* 1606036114: 8939-8944.

2.3. Regional Insights

Over the past three decades, global building energy demand has steadily increased, primarily driven by indoor heating, water heating, cooking, and increasingly, air cooling and the proliferation of appliances (connected/smart, lighting, refrigeration, etc.).

- Africa's building energy demand is rising quickly as access to energy improves. Cooking and water heating dominate, though there is rapid growth in cooling and lighting.
- Eastern Asia (notably China) shows the highest collective energy demand across all regions. Space and water heating are leading drivers, but appliance use is also expanding.
- Southern Asia & South-East Asia, and the Pacific exhibit rapidly increasing demand in all end-uses, especially cooling, lighting, and cooking.
- Europe shows a gradual decline in building energy demand due to deep renovation policies, insulation upgrades, and renewable integration. Indoor heating remains the largest end-use.
- In North America, historically high building energy consumption is dominated by indoor heating and cooling, followed by appliances.
- In Latin America and the Caribbean, energy demand grows modestly, mainly due to rising access and urbanization. Lighting, cooking, and cooling gain importance. Efficient, low-energy building designs and passive strategies offer high mitigation potential here.
- In the Middle East, there is a high reliance on cooling and water heating, with demand projected to grow due to extreme heat and wealth-driven appliance use. However, targeted envelope improvements and renewable-based cooling systems could flatten growth.
- Australia, Japan, and New Zealand regions maintain a stable energy demand profile with a transition from heating to cooling and appliances.

3 Trends

Negative trends

Below is a range of structural, financial, technical, and institutional challenges that hinder the widespread adoption and scaling of sustainable housing practices:

3.1.3. Barriers for Adoption of Sustainable Housing Solutions

Decarbonizing the building sector presents a complex challenge shaped by a wide array of intertwined barriers—technical, economic, social, and institutional. While energy-efficient technologies and construction practices are increasingly cost-effective and technically mature, their uptake remains constrained by a persistent "implementation gap."

At the forefront are **economic and financial barriers**, including high upfront investment costs for energy-efficient construction or retrofitting, limited access to affordable finance, and insufficient public subsidies—particularly in the Global South. Even when life-cycle savings are significant, many households, developers, and small-scale landlords lack the liquidity or credit access to pursue sustainable upgrades. In rental markets, the **landlord–tenant dilemma**—where landlords bear the costs while tenants benefit from energy savings—creates a disincentive for investment in sustainable features.

Information and awareness gaps remain widespread. Many consumers are unaware of the energy performance of buildings or the long-term benefits of sustainable materials and technologies. Inadequate labelling, absence of performance data, and a lack of trusted intermediaries contribute to inertia in consumer behaviour.

Behavioural and cultural factors also influence uptake. Risk aversion, attachment to traditional housing styles, or scepticism towards new technologies can limit demand, even where options are available. Behavioural anomalies, such as underestimating long-term benefits or discounting future energy costs, also play a role.

From a **supply-side perspective**, there is often a lack of skilled labour, high-performance materials, and appropriate construction methods, particularly in low-income or rural settings. This is compounded by **fragmented policy and institutional landscapes**, where outdated building codes, weak enforcement mechanisms, and policy discontinuity discourage private-sector engagement.

3.1.4. Affordability vs Sustainability

The tension between short-term affordability and long-term sustainability remains a significant barrier. Sustainable buildings often entail higher upfront costs, even though they offer lower life-cycle expenses and greater long-term community benefits. Developers and governments under pressure to deliver housing quickly and cheaply tend to prioritize short-term savings over long-term efficiency. These financial barriers are compounded by weak incentive structures, limited financing options, and low public awareness or commitment, which collectively fuel cultural and political resistance to sustainable development.[25]

3.1.5. Retrofit Difficulty vs Rebuild Bias

Retrofitting existing housing is often more expensive, technically complex, and disruptive than building new. This is especially true in lower-income areas with diverse, aging structures and limited access to finance or institutional support. As a result, policymakers and developers frequently favour new builds, even when retrofits could offer more sustainable outcomes. These new homes are often larger and more expensive, skewing housing market trends and raising property prices.[26]

3.1.6. Impact on Real Estate

Sustainable housing policies and climate mitigation or adaptation measures create a new landscape of **risks and challenges not only for the private sector**, particularly in real estate and construction, but also for **households**, especially low- and middle-income ones.

Stranded assets in the housing sector represent a growing and underacknowledged risk, both for private investors and for households. As climate policies become more stringent and public expectations shift

[25] Habitat International (2012). *Sustainable Housing for Sustainable Cities*. https://unhabitat.org/sites/default/files/download-manager-files/Sustainable%20Housing%20for%20Sustainable%20Cities.pdf
[26] Intergovernmental Panel on Climate Change (IPCC) (2022). Working Group III Contributions to the Sixth Assessment Report. *Chapter 9: Buildings*. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter09.pdf

toward sustainability, buildings that fail to meet environmental, efficiency, or resilience standards may lose economic value or become functionally obsolete.

For the **private sector**, this poses significant financial exposure. Outdated or vulnerable properties may face devaluation, regulatory penalties, or asset write-downs. Projects that ignore climate risks may also struggle to secure financing or insurance, limiting future marketability. The real estate sector is also slow to integrate sustainability due to misaligned incentives, investor hesitation, and market preferences for short-term returns and traditional development models. Developers and investors often avoid sustainable design due to upfront cost concerns and uncertain returns because policy incentives are limited, and sustainable features are not consistently reflected in property valuations. These dynamics discourage innovation and restrict large-scale adoption of sustainable housing models.[27]

For **households**, particularly those with limited resources, the risks are just as profound. Low-income families may find themselves trapped in inefficient or at-risk housing that cannot be upgraded and loses value over time. These homes may become uninsurable or unfinanceable, cutting off access to credit and further investment. As new green standards become the norm, there's a danger that older, non-compliant housing becomes a “second tier” market, deepening inequalities in housing quality, location, and opportunity. In the Global South, where most of the housing stock is yet to be built, this risk is especially acute: the choices made today will determine whether the homes of tomorrow are future-proof—or quickly devalued.

3.1.7. Increase in energy consumption

Global energy demand in residential buildings is evolving rapidly due to climate change, rising incomes, and digitalisation. Cooling needs are expanding with global warming and urban growth; without mitigation, the number of air conditioning units may rise from 4 billion today to 14 billion by 2050, significantly increasing emissions. Prioritizing passive design, energy-efficient systems, and renewable-based solutions is essential to curb these trends. Electricity demand in buildings has surged—up 161% since 1990—driven by appliance use and growing electrification of heating through heat pumps. While heat pumps offer decarbonisation potential when powered by renewables, they also raise halocarbon concerns and require policy incentives due to high upfront costs. Meanwhile, digital infrastructure, including data centres and connected devices, now consumes 5–12% of global electricity. Though increasingly powered by renewables, the sector’s rapid growth calls for efficiency improvements and sufficiency measures to limit rising demand.[28] While efficient technologies exist, their adoption is limited by affordability, access, and a lack of consumer awareness. Without intervention, emerging energy demand trends threaten to undermine climate targets and increase household energy burdens.[29]

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[27] Habitat International (2012). *Sustainable Housing for Sustainable Cities*. https://unhabitat.org/sites/default/files/download-manager-files/Sustainable%20Housing%20for%20Sustainable%20Cities.pdf

[28] IPCC (2022). Sixth Assessment Report, Working Group III, Chapter 9 – Buildings.

[29] Habitat International (2012). *Sustainable Housing for Sustainable Cities*. https://unhabitat.org/sites/default/files/download-manager-files/Sustainable%20Housing%20for%20Sustainable%20Cities.pdf

3.1.8. Underfunding Informal Settlements

Although informal settlements are often at the frontline of climate vulnerability, they receive an alarmingly small portion of global funding dedicated to urban adaptation and resilience.[30 &31]. According to Cities Alliance's analysis of 22 significant climate funds active between 2003 and 2023, only 3.5 % of global climate finance[32]—across just 2.1 % of projects—was allocated to support informal settlements or the urban poor (World Bank).

This imbalance is striking, considering that over one billion people live in slum or informal settlement conditions globally—many of whom are on the frontlines of climate-related threats such as floods, heatwaves, landslides, and waterborne diseases.[33]. Despite this vulnerability, investments targeting the built environment, infrastructure upgrades, or climate-resilience programming in informal urban areas account for just a fraction of the overall finance flows. [34]

Yet slum upgrading must be recognized not only as a social or developmental imperative, but as a vital climate strategy. Upgrading strengthens resilience to climate hazards by improving housing quality, sanitation systems, drainage, and other critical infrastructure, while also supporting livelihoods and reducing exposure to environmental risks. These integrated interventions offer significant co-benefits for urban sustainability, equity, and adaptation.

This funding gap is not simply a technical failure: it reflects systemic exclusion. Informal settlements are often excluded from grant eligibility due to a lack of title, unclear jurisdiction, or incomplete data. Donor institutions and investment frameworks typically bypass community-based plans if they fall outside national planning systems or formal urban development pipelines.

As a result, this underinvestment deepens vulnerability and undermines global goals tied to climate justice, human rights, and sustainable development—including the SDGs and the New Urban Agenda. Closing this gap will require purposeful mobilization of climate finance, recognition of informal settlements as eligible urban constituencies, and the design of participatory, inclusive funding mechanisms that support community-led adaptation, upgrading, and resilience-building.[35]

3.1.9. Knowledge Gaps

Despite growing literature on building decarbonization, significant knowledge gaps remain—especially in developing regions like Southeast Asia, Africa, and Latin America. Evidence is limited on costs, mitigation potential, and the role of indigenous knowledge. Data on embodied emissions is also lacking. Few case studies from the Global South exist, and behavioural, sufficiency, and circular economy measures are underrepresented in research and models. Co-benefits of mitigation actions are rarely quantified, and key modelling assumptions (e.g., retrofit rates) may be overly optimistic. Finally, there

[30] United Nations Human Settlements Programme (UN-Habitat). 2024. World Cities Report 2024: Cities and Climate Action.
[31] Cities Alliance. 2025. Slum Upgrading is Climate Action: Experiences and Insights from the Global South. Brussels: Cities Alliance.
[32] Cities Alliance (2024). Climate Finance for the Urban Poor: A Review of Global Climate Funds. Cities Alliance/UNOPS, Brussels.
[33] Shand, W. & Ndezi, T. (2025). Community-Led Climate Adaptation in Informal Settlements. World Bank, Washington, DC.
[34] United Nations Framework Convention on Climate Change. (2019). 2019 SCF Forum: Climate Finance and Sustainable Cities. Report of the Standing Committee on Finance, Bonn, Germany.
[35] Birch, E. L., L. Campo & M. Rodas (2024). The Green Cities Guarantee Fund: Unlocking Access to Urban Climate Finance. Philadelphia: Penn Institute for Urban Research for the SDSN Global Commission for Urban SDG Finance

is a lack of comprehensive cost assessments and consistent analysis of investment needs versus flows, hindering effective planning and policy.[36]

Many cities also lack the institutional and technical capacity to plan, monitor, and enforce sustainable housing initiatives. Fragmented governance, poor intersectoral coordination, and outdated data systems hinder integrated decision-making. Local governments often struggle to collect or use building performance data, track progress, or tailor solutions to local contexts. These knowledge and capacity gaps weaken both implementation and accountability, making it challenging to scale sustainable housing effectively.[37]

Positive trends

3.1.1 Decarbonization of the Building and Construction Sector

The residential housing sector is both a major contributor to greenhouse gas (GHG) emissions and a significant opportunity for climate mitigation. As urban populations grow and the global housing stock expands—particularly in Asia and Africa—the need to decarbonize how homes are built, powered, and maintained has become central to sustainable development.

Mitigation efforts in the housing sector primarily focus on lowering the operational energy demand (from electricity, heating, and cooling) and embodied carbon emission (from materials and construction processes), particularly by promoting the use of low-carbon, bio-based, and recycled materials [2][3]. Key aspects include:

- **Energy-efficient design**: Passive building strategies such as improved insulation, natural ventilation, solar orientation, and reduced window-to-wall ratios are increasingly integrated into housing projects to reduce energy demand. Examples include energy-positive homes in Northern Europe and solar-aligned settlements in parts of Latin America.
- **Electrification of thermal energy**: A shift from fossil-fuel-based heating and cooking to clean electricity—using technologies like electric stoves and heat pumps—is underway in many countries. This trend is particularly impactful when combined with renewable energy, such as rooftop solar in residential buildings.
- **Low-carbon materials**: In response to the growing recognition of embodied carbon, the housing sector is seeing increased use of sustainable, locally sourced, and low-carbon materials—such as bamboo, compressed earth blocks, or timber.
- **Retrofitting existing homes**: In developed economies, retrofitting older homes with efficient heating systems, insulation, and lighting remains the most effective mitigation pathway. Public renovation schemes in Europe, South Korea, and Canada exemplify this approach.

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[36] IPCC (2022). Sixth Assessment Report, Working Group III, Chapter 9 – Buildings.

[37] OCED (2020). *OECD Regional Development Working Papers. Housing policies for sustainable and inclusive Cities.* https://www.oecd.org/content/dam/oecd/en/publications/reports/2020/04/housing-policies-for-sustainable-and-inclusive-cities_60823cd0/d63e9434-en.pdf

- **Digitalization and monitoring**: Smart meters, sensors, and energy management systems are increasingly deployed in homes to track energy use and encourage behavioural change, with co-benefits for efficiency and cost savings.

The IPCC identifies a three-part strategy based on Sufficiency, Efficiency, and Renewables (SER): reducing demand for floor space and energy through compact and shared living models, improving building performance via deep renovation, and integrating renewable energy generation[38].

These technical goals align with community-led, low-cost construction practices in the global South[39]. These practices involve the use of natural materials like adobe and compressed earth blocks, and a reliance on sweat equity and traditional knowledge to ensure both affordability and low emissions. Such hybrid approaches offer scalable models for just decarbonization.

3.1.3. Promoting Social Sustainability

In informal and low-income settlements, social sustainability is typically realized through community participation in the construction and management of housing. This approach is key to supporting residents to incrementally build and retrofit their homes with climate-adaptive solutions like rainwater harvesting, solar heaters, and passive ventilation as resources allow. These practices allow for a form of gradual environmental upgrading that preserves social ties and autonomy.

Furthermore, compact, mixed-income neighbourhoods with access to services and opportunities foster stronger social cohesion. Policies that support inclusionary zoning and social mixing can integrate lower-income groups into green and well-located urban developments.[40]

3.1.4. Bundling Housing Affordability and Sustainability

A growing trend links climate action with housing affordability, recognizing that sustainability must also be economically viable for households. The use of fiscal tools (e.g., tax reform, impact fees, rental subsidies) is critical to support compact and low-emission housing in urban cores, where land values are high.

3.1.5. Housing Resilience

Housing must be built not only for today's conditions but also for tomorrow's risks. Climate resilience in housing means adapting to increasing heat, flooding, water scarcity, and other climate extremes. Adaptation is becoming a critical design driver as housing must withstand increasingly severe climate events. Key resilience trends include:

- **Nature-based solutions**: Using vegetation, permeable surfaces, and rain gardens in housing developments to buffer against floods and heat, with pilot projects in cities like Singapore and Medellín.

[38] IPCC (2022). Sixth Assessment Report, Working Group III, Chapter 9 – Buildings.
[39] Sullivan, E. & Ward, P. (2012). Sustainable Housing Applications in Self-Help and Informal Contexts. Habitat International.
[40] OECD (2020). Integrating Environmental and Housing Policy: A Policy Toolkit

- **Risk-informed design**: In flood-prone areas (e.g., Bangladesh, Vietnam), elevated foundations and floating homes are being developed as proactive adaptation measures.
- **Materials and durability**: The use of climate-resistant materials—such as treated wood, reinforced concrete, and composite roofing—helps extend building life and reduce repair costs after disasters.

Traditional and community-based housing solutions offer valuable lessons. Numerous examples exist of dwellings designed for local climate conditions using affordable materials and simple technologies, such as shading devices, water tanks, and insulation upgrades, that reduce dependency on infrastructure and enhance adaptive capacity.

3.1.6. Energy Efficiency retrofit

As most of today's housing stock will remain in use for decades, retrofitting existing buildings is essential to achieving climate goals. Energy efficiency retrofits—such as upgrading insulation, installing energy-efficient windows, and integrating innovative heating, ventilation, and air conditioning (HVAC) systems—significantly reduce household energy demand and operational emissions.

In the European Union, deep renovation strategies are accelerating, with targets to retrofit 3% of the building stock annually to align with 2050 net-zero commitments. These measures not only lower emissions but also improve indoor comfort and reduce energy bills, enhancing long-term affordability. The *Canada Greener Homes Grant* supports homeowners in adding insulation, upgrading windows and doors, and installing renewable energy systems. Over 700,000 households are expected to benefit by 2027. In the United States, The *Weatherization Assistance Program (WAP)* offers low-income households retrofits such as insulation, air sealing, and efficient heating systems.

Globally, the IPCC highlights the importance of combining energy retrofits with adaptation features, such as structural reinforcement, green or reflective roofs, and decentralized energy and water systems, to build climate resilience. However, the scalability and equity of retrofit efforts depend heavily on financing tools, government subsidies, and inclusive community engagement. As climate change intensifies and energy demands rise, the housing sector is evolving to meet both mitigation and adaptation needs. Emerging trends emphasize low-carbon, low-energy solutions that enhance comfort, affordability, and resilience. From passive cooling techniques to renewable energy integration and built-in system redundancies, innovative housing strategies are increasingly vital—especially in regions facing heat stress, unreliable utilities, or rapid urbanization. These trends reflect a shift toward housing that not only reduces emissions but also safeguards well-being under changing climate conditions:

- Passive Cooling and Design: Innovative design solutions—such as reflective roofs, cross-ventilation, shaded courtyards, and green roofs—are reducing indoor heat without energy use. In Ahmedabad, India, the Cool Roofs Program uses reflective paint to lower indoor temperatures by up to 2°C in low-income homes.
- Electrification and Renewable Integration; Housing is moving toward electric-based heating and cooling, supported by rooftop solar and battery storage. The Netherlands is eliminating

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natural gas in new housing developments, promoting electric heat pumps and solar PV to reach climate targets.

- Redundancy in Housing Systems: Designing homes with backup systems—like rainwater harvesting, solar lighting, and composting toilets—enhances resilience in crisis or service failures. In Cape Town, South Africa, many homes installed water storage tanks during the drought crisis, while off-grid sanitation is expanding in informal settlements.

These approaches are building more climate-resilient, low-emission housing—especially critical in vulnerable and fast-growing regions.

3.1.7. Policy, Finance & Local Engagement

Transforming the housing sector requires systemic change across governance, finance, and planning. None of the above trends can scale without the proper **governance, financial architecture, and local engagement**:

- **National and municipal leadership**: Policies such as building codes, zoning laws, and climate action plans are increasingly aligning to prioritize low-emission and climate-resilient housing. The primary role of national governments is to coordinate housing, environmental, transport, and fiscal policy through integrated strategies to unlock sustainable housing at scale.
- **Climate-sensitive urban planning**: Integrating housing into flood-resilient layouts, green corridors, and elevated infrastructure, particularly in coastal and delta regions like Bangladesh and the Netherlands.
- **Risk-informed building codes**: Updating building codes to account for future climate projections (e.g., storm resistance, floodproof foundations) is being adopted in countries like Japan and the United States. The IPCC underscores the role of regulation and accountability: mandating performance standards, measuring lifecycle emissions, and investing in institutional capacity for monitoring and enforcement. Achieving housing sustainability ultimately hinges on enabling local action within a coherent national framework.
- **Climate finance and incentives**: The use of subsidies, carbon credits, and concessional loans is helping mobilize private capital for sustainable housing. Effective instruments include green incentives (e.g., subsidies, fast-track permits, rebates), inclusionary zoning, and updated building codes tied to lifecycle performance. Importantly, these are more effective when coupled with targeted support for vulnerable populations and local governments.
- **Local governments and communities**: Cities and neighbourhoods are spearheading innovation through participatory planning, local materials sourcing, and decentralized energy systems. Decentralized and participatory approaches are essential for social legitimacy and impact. Empowering residents to co-design and co-implement sustainable solutions ensures alignment with cultural norms, builds local capacity, and fosters long-term stewardship.

Enabling frameworks that combine policy ambition with bottom-up engagement are proving to be the most impactful.

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