RETHINKING BUILDING PRACTICES:
INTERVENTIONS IN BUILDING DESIGN, CONSTRUCTIONS, COST EFFECTIVENESS AND RESOURCE EFFICIENCY
ACKNOWLEDGMENTS

Core Team
Housing Unit Leader: Christophe Lalande
Editor: Jesús Salcedo Villanueva
Contributing Team: Mahfouz Djirna, Aisha Mugo, Giulia Lavagna, Alessandro Ercolani, Francesca Lionetti, Andrey Prigov

Contributors
Chapter 1: UN-Habitat
Chapter 2: Luca Valentini, Department of Geosciences, University of Padua; Zeenat Niazi, Soumen Maity, Pankaj Khanna, Development Alternatives Group; Christina Cheong, Global Green Growth Institute; Natasha Nass, GlobalABC.
Chapter 3: Giulia Celentano, Guillaume Habert, and Francesco Pittau, Federal Institute of Technology, ETH Zurich; Silas Markert, École Polytechnique Fédérale de Lausanne; Mathieu Hardy, Nubian Vault Association; Madeline Schneider and Jessica Weir, adelphi; Anica Mayer and Roland Göttig, Technical University Munich; and Natasha Nass, GlobalABC.
Conclusions: Madeline Schneider, Jessica Weir and Carolina Borges, adelphi; Anica Mayer and Roland Göttig, Technical University Munich, Natasha Nass, GlobalABC, and UN-Habitat
Additional contributions: Rajat Gupta, Oxford Brookes University; Usha Iyer-Raniga, RMIT; Pekka Huovila, One Planet Network

Illustrations: Malin Praktiknjo
Design: Jesús Salcedo Villanueva

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The Sustainable Development Goal - House or SDG-House is a joint effort by UN-Habitat and its partners to encompass the important and novel breakthroughs in areas related to the sustainability of the Housing Sector. The approach recognises that the housing sector is complex, and touches on many socio-economic, environmental, and cultural aspects of development.

This first summary of the future publication: The SDG House, RETHINKING BUILDING PRACTICES: INTERVENTIONS IN BUILDING DESIGN, CONSTRUCTIONS, COST EFFECTIVENESS AND RESOURCE EFFICIENCY, recalls the important role that housing plays in mitigating climate change, achieving affordable, adequate, and sustainable development, as well as proving that sustainability considerations can indeed catalyse positive socio-economic impact in myriad sectors.

This first summary, presented during the 10th edition of the World Urban Forum in Abu Dhabi, 2020, has a focus on the design, construction, material innovation, cultural adequacy, and participation as they all have a role in achieving a sustainable housing sector. The different sections presented showcase how diverse considerations and processes from the housing sector can link strongly to the Sustainable Development Goals, and thus showcase the impact of the housing sector on the 2030 Agenda.

The full SDG House Book will be published after the 10th edition of the World Urban Forum.

Upcoming SDG House publications will also include a focus on health, inequality, gender, and employment, among others.

Expressions of interest to become an active member of the SDG House Series, and to contribute to future publications can be sent to: Christophe.Lalande@un.org and Jesus.Salcedo@un.org
EXECUTIVE SUMMARY

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INTRODUCTION

RETHINKING BUILDING PRACTICES: INTERVENTIONS IN BUILDING DESIGN, CONSTRUCTIONS, COST EFFECTIVENESS AND RESOURCE EFFICIENCY

Half of the building stock that will exist in 2050 is yet to be built, most of it in rapidly growing cities in developing countries where building codes are yet to have strong sustainability considerations. The housing sector alone consumes significant amounts of energy, with overall building stock - mainly composed of residences - responsible for more than 40 percent of global energy use and representing the single largest contributor to greenhouse gas emissions. It also uses about 40 percent of resources and generates an equal amount of waste. Therefore, the construction sector is arguably one of the most resource-intensive industries; it is rapidly growing and so is the use of fossil fuels, resulting in heavy environmental impacts.

Current national housing policies place great emphasis on affordability of housing and not much attention is placed on social inclusiveness and environmental sustainability, which in the long run lead to savings that ensure better quality housing with lower operational costs. New housing constructions are an opportunity for innovative solutions to mitigate environmental pressures and change in building practices to generate economic growth, promoting circular economy and new building techniques, while providing adequate, attractive, healthy, and affordable housing for all.

The housing sector also represents a vector for socio-economic development. However, housing construction carries a large ecological footprint through raw material extraction and high water consumption, and vast amounts of greenhouse gas emissions some of these activities generate. Therefore, it is vital that sustainability concerns are made central to national and local governments; as housing design and effective city planning can play a leading role in making cities more sustainable for future generations.

As climate change is recognized as the most urgent challenge of our time, action has to take place now for us to avoid being trapped in inefficient and unsustainable building processes in the future.

If cities continue to grow in a ‘business as usual’ manner, they will also grow to become places of exclusivity and segregation. However, UN-Habitat reaffirms the central role the housing sector represents to environmental, social and cultural sustainability in achieving SDG 11, and making cities and human settlements inclusive, safe, resilient and sustainable.
Discourse on city sustainability usually focuses on physical attributes such as energy consumption, waste, and greenhouse emissions. However, cities must also consider the long-term environmental, social, cultural, and economic balance of all their components.

Given the substantial anticipated growth of new construction in emerging economies and the current lack of efficient and sustainable building practices, greenhouse gas emissions from buildings will more than double in the next 30 years if cities do not make every effort to become sustainable.

A Sustainable City requires moving beyond environmentally sustainable technologies and green walls to a more comprehensive approach that considers material selection and construction methods; culturally and socially inclusive urban development processes; and affordable, well-connected infrastructure and service networks.

Keeping this framework in mind, nature-based solutions and low-tech innovation can help member states reach Paris Agreement targets even as increases in population and built surfaces contribute to higher emissions in the building sector. To ensure mitigation and adaptation guide state action, all housing, building design, and construction projects must be integrated into local contexts and climates.

*Sustainable building materials refer to construction materials that do not have a negative impact on the environment, society, or economy.*
How can a sustainable buildings sector be achieved?
Sustainable building materials refer to construction materials that do not have a negative impact on the environment, society, or economy. For example, they can have lower carbon requirements throughout their lifecycle relative to conventional materials, such as traditional Portland cement and steel. Due to their production, sourcing, use, and disposal, these low carbon materials produce no long-lasting threat to the environment.

By transitioning to these sustainable building processes, the building sector can contribute to overall sustainability, thereby, increasing the efficiency of energy resources and reducing negative impacts on human health and the environment. These processes must address all phases of the building lifecycle (design, construction, operation, maintenance, demolition, removal, and reuse).

Construction practices
The construction process creates massive environmental problems such as air pollution, toxic waste, and degradation of land and ecosystems. More so, inadequate and inefficient construction materials and techniques also put construction workers and end-users at risk. For instance, consider the negative consequences asbestos and lead-based paints have on people. Cities and government entities in charge of drafting building codes should promote sound and safe construction processes that do not harm the environment and people alike. This includes promoting materials that do not foster long-term soil and vegetation loss, air and noise pollution, and the disposal of harmful chemicals.

Affordable building techniques and materials
Sustainable construction technology and practices involving environmentally friendly materials hold enormous potential to improve city sustainability. Where do the materials which shape the cities come from? What are they made of? For new buildings, improving construction techniques and promoting innovative building materials can make a difference in lowering global CO₂-emissions. The largest reductions will come from improvements in the cement sector, which accounts for about 50% of everything built worldwide. Due to these large production quantities, cement production is responsible for about 8% of global CO₂-emissions. Increasing the use of Supplementary Cementitious Materials (SCMs) and Portland cement clinker in mortars and concrete can reduce global CO₂ emissions by more than 2%. For the construction stage, adapting traditional building techniques that are in harmony with local conditions, will contribute toward making housing affordable, reliable and functional for modern life, and spur localized employment generation.

Low emissions and energy efficiency in housing
While housing is responsible for as much as a quarter of the global operational energy demand, energy use in the housing sector is a basic service recognised by international human rights. Many communities are still transitioning from using traditional and toxic fuels at the household level, therefore, it is imperative that improving energy efficiency and renewable energy be the answer to a complex knot of environmental and social problems. Energy efficiency is the key to leapfrog from unsustainable and dangerous fuels to clean and affordable ones.
SDG 1.4 Equal rights to ownership, basic services, technology and economic resources.

SDG 11.6 Reduce the environmental impacts of cities.

SDG 11.C Support least-developed countries in sustainable and resilient building.

SDG 12.6 Encourage companies to adopt sustainable practices and sustainability reporting.

SDG 13.2 Integrate climate change measures into policy and planning.
Recycling in the construction industry

To ensure more sustainable housing, planners need to focus on creating buildings that are recyclable and disposable at a minimal environmental cost. Recycling confers a number of advantages, including limiting the consumption of natural resources and deposition of landfill, saving energy in material production, and reducing pollution. Recycling can be done at all levels - from construction to demolition. To achieve this, all components of buildings need to be envisioned from the start and included in the initial design.

Material substitution

Substituting materials that have high material and energy footprints with renewable and secondary low energy intensity should be the priority. In construction, replacing conventional cement and steel with materials such as low-cement concrete or other bio-based materials can drastically reduce life cycle emissions.
As the housing gap widens, and the demand for affordable and adequate housing increases throughout the world, there is an increasing need to explore alternative, sustainable, and affordable building materials to meet this demand.

What does the future of materials and constructions look like?

The future of building materials, the construction sector, and settlement development is progressively being based on closing the loop, which refers to having zero waste in both production and consumption processes. The idea of closing the loop between our limited resources and our growing needs for human life is taking a new turn with the upcoming mainstreaming of the circular economy. Circular economy approaches call for closing the loop in production and consumption cycles, based on three principles:

1. DESIGN OUT WASTE AND POLLUTION
2. KEEP PRODUCTS AND MATERIALS IN USE
3. REGENERATE NATURAL SYSTEMS

As global urbanisation grows at a fast pace, society faces the challenge of building sustainable cities that provide satisfactory access to housing, sanitation systems, clean water, renewable energy, and public transport infrastructures. One extraordinary technical and societal development is represented by the supply of environmentally efficient building materials,
that contribute towards a circular economy and sustainable cities. Some of the most recent concepts and innovations in materials are mentioned below:

**Circular economy**
A circular economy provides new economic opportunities for local wealth and prosperity - a necessary outcome for the achievement of the SDGs identified in Agenda 2030.

**Bio-based building materials**
Bio-based materials are biodegradable construction products made from fast-growing organic crop-based material, typically straw, hemp, bamboo etc. Their advantages include:

- They are renewable; naturally capture CO₂ in their growing phase;
- Materials are affordable and locally available;
- They have low-embodied energy;
- Positive hygrothermal properties; this means that the movement of heat and moisture through the material works to the advantage and comfort of inner room temperatures;
- Positive effect on preserving land and improving soil fertility;
- Their use can promote local expertise and new skills.

**Low-carbon building materials**
Low-carbon materials are building products that have low carbon emissions, a reduced carbon footprint, and high potential for recycling and reusing.

**Waste-based building materials**
Waste-based building materials can reduce the pressure exerted on disposal facilities such as landfills and incinerators, as well as on the unsustainable extraction of raw materials. Today, building materials can be based on:

- Construction and demolition waste.
- Agricultural and industrial waste which is rich in silicon-aluminium.
- These include waste and by-products, which are produced by the iron and steel industries, and fly ash, which refers to the waste coming from coal combustion.
- Waste from the stone industry, such as marble slurry or gabions.

The use of such materials represents the potential that the circular economy can play in rendering processes more sustainable. The greater challenge is also related to cultural aspects as it will require more awareness raising about the benefits of using such materials.
LINKS TO SUSTAINABLE DEVELOPMENT GOALS

SDG 8.4 Improve resource efficiency in consumption and production

SDG 9.4 Upgrade all industries and infrastructures for sustainability

SDG 11.6 Reduce the environmental impacts of cities

SDG 12.2 Sustainable management and use of natural resources

SDG 12.4 Sustainable management of chemicals and waste

SDG 13.2 Integrate climate change measures into policy and planning

SDG 14.2 Protect and restore ecosystems

SDG 15.A Increase financial resources to conserve and sustainably use ecosystem and biodiversity
BUILDING A SUSTAINABLE URBAN FUTURE

Today, over 55 percent of the world’s population lives in urban areas and this number is projected to increase to 68 percent by 2050. As cities continue to grow and address the shortages of housing which are both affordable and sustainable; it is clear that the buildings and construction sector has no other choice than to go sustainable. Here is why.

Why go sustainable?
Infrastructure plays a key role in all three dimensions of sustainable development: the economy, the environment and society. Within the sector, buildings and construction, one of which housing will play the major role, will be the litmus test for urban sustainability. As the world seeks to achieve the SDGs as set out in Agenda 2030, the importance of sustainable infrastructure, construction and building materials is becoming more widely recognised. The following are some of the factors that prove why it makes absolute sense to go sustainable when it comes to the housing sector and the way it is built.

Material Cost
Sustainable materials, such as bio-based materials for instance straw, wood and bamboo have recently been gaining popularity as low-carbon and environmentally friendly. Recent innovations in cement, such as LC3, have the potential to become mainstream where governments may promote them as the better solution, thus encouraging costs to go down via regulations and incentives. More so, when using locally sourced material, the costs tend to be significantly lower than imported materials such as conventional cement, steel and corrugated sheets.

Ease of building
The ease of construction is highly dependent on the materials due to the different construction systems and techniques that might require specialised training or machinery, skills and amount of labour, amongst others. Construction with bio-based materials often requires less machinery and foundation requirements are reduced due to their light weight and construction can be completed in a short time. It also allows for pre-assembled constructions, prefabrication, such as massive wood walls solutions, which are faster to build and generate less waste. Constructing with prefabs and ready-made molds and systems also allows for wider non-highly specialised workers to assemble constructions following a set of pre-determined steps. Something similar occurs with innovations on 3D printing where computer assisted processes can build pre-determined designs. There is still a lot of work to be done in terms of awareness raising and capacity building so that new innovations stemming out from the labs and universities can be mainstreamed and used widely by the majority of people who still build informally and with standardised, industrialised, and often carbon heavy materials.
**Durability**
Low-carbon materials have proven to construct extremely durable structures. There are documented cases of structures built of straw, wood, bamboo, earth and stone that continue to function well over a hundred years! LC3 has also proven to have better performance and durability than conventional cement. Likewise, innovations in earth compounds and earth casting are also allowing traditional building techniques to be revamped and strengthened. This has the potential to reach isolated communities where minor equipment might be needed to produce stronger earth constructions that can still follow vernacular traditions and techniques but be resilient to growing climate related events.

**A regenerative approach:**
In the last decades, there have been vast advancements in diverse strategies to align building technologies with current sustainability standards. Beyond material and technological innovation, a shift towards a regenerative approach, proposing to provide not only a reduced environmental footprint but also the maximum amount of positive benefits for the environment. As mentioned above, bio-based and waste-based materials have the power to do this, as they reduce potential negative impacts on the environment.

As technologies and innovations become available to a larger share of people, we foresee that environmentally efficient materials will provide a potential alternative for sustainable and affordable housing. However, perceptions of such alternative materials as ‘niche materials,’ the insufficient design capacity of its users, and the poor availability of product data constitute considerable barriers for scaling up the use of these materials. Significant engagement with industry professionals across the supply chain and the creation and sharing of technical knowledge are important levers for improving the living conditions of millions of people.

Countries like France have already started to produce experimental building codes. They can help increase the uptake of innovations before they are incorporated into official building codes. Often, countries only certify the use of conventional building materials, rendering the uptake of new ones quite difficult.

**LINKS TO SUSTAINABLE DEVELOPMENT GOALS**

- SDG 9.1 Develop quality, reliable, sustainable and resilient infrastructure
- SDG 9.4 Upgrade all industries and infrastructure for sustainability
- SDG 11.C Support least developed countries in sustainable and resilient building
- SDG 13.3 Build knowledge and capacity to meet climate change
In order to mainstream sustainable housing and contribute to the achievement of the SDGs, it is necessary to design holistic approaches that address all four sustainability components of housing: cultural, social, environmental, and economic. A housing sector that follows the Sustainable Development Goals should operate and interact with their surroundings. This is a pathway towards sustainability, however UN-Habitat recognises that in order to be 100% sustainable considerations on employment, health, gender, participation, among others are also needed.

Following the focus of this first issue of the SDG House Series on building practices and design, UN-Habitat recommends to keep the following points to achieve sustainability in the housing sector:

**Affordability:**
By adopting environmentally efficient materials and building techniques, adequate and affordable housing can become accessible to low-income populations. Not only do sustainable materials have the opportunity to lower construction and operations costs, they also have the potential to develop new non-polluting industries, create jobs, and foster a healthy and sustainable environment.

**Circularity:**
Actively engaging in a circular economy is about decoupling growth from resource consumption and maximising positive environmental, economic and, social effects. The more this concept is mainstreamed, the less that society has to engage in pressing needs concerning the management of municipal and industrial waste. Likewise, buildings and housing construction need to include both mitigation and adaptation actions.
Inclusivity:
Sustainable housing should be affordable to everyone, with a strong focus on low-income populations, who have often been excluded. Increased access to safe, affordable, and adequate housing should be provided to marginalised groups such as women, youth, people with disabilities, indigenous people, and the elderly to ensure no one is left behind. Investments on this front, coupled with inclusive socio-economic policies, will allow governments to tackle underlying challenges related to household expenditure in a long-term way.

Resilience:
As impacts of climate change intensify, sustainable housing must be able to withstand the natural elements and future changes. To support resilience, most importantly, vulnerabilities in the targeted regions must be identified. Housing authorities should conduct risk assessments to take natural hazards, often linked with climate change, into account and prevent consequences beforehand. New housing construction needs to have design and materials that are durable and resistant to such events.

Community:
A successful ingredient is the involvement of communities in the planning and implementation processes, from the start. Existing community structures should be taken into consideration and self-organisation of resources ensures that decisions and investments are made in the right place. The involvement and full participation of the final users from the beginning of the scheme can lead to innovative solutions, reinforcement of capacities, mainstreaming the use of innovations, and further innovation. Without this element, innovations in the construction sector will not pick up in all sectors of society.

Culture:
The preservation of culture is inherent to sustainable development and can be achieved through traditional building design, materials, and methods. Vernacular architecture can provide valuable contributions to sustainable construction practices by applying design elements and construction materials that are appropriate for local conditions and available resources, and by establishing a regional identity that is unique, shared and celebrated.

LINKS TO SUSTAINABLE DEVELOPMENT GOALS

- SDG 8.4 Improve resource efficiency in consumption and production.
- SDG 9.2 Promote inclusive and sustainable industrialisation.
- SDG 11.2 Ensure access for all to adequate, safe and affordable housing.
- SDG 11.4 Protect the world’s cultural and natural heritage.
- SDG 12.8 Promote universal understanding of sustainable lifestyles.
- SDG 12.5 Substantially reduce waste generation through prevention, reduction, recycling and reuse.
- SDG 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.