Circular Built Environment
Highlights from Latin America and the Caribbean
Policies, Case studies and UN2030 Agenda Indicators

Countries considered:
Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama and Peru

Authors: Guillermo Penagos[1], Jordi Morató[1,2], Nicola Tollin[2,3]

Organisations:
1: UNESCO Chair on Sustainability, Technical University of Catalonia
2: Recycling Cities International Network - RECNET
3: Urban Resilience Research Group. University of Southern Denmark

November 2021

One planet
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Suggested citation:

Penagos, G., Morató, J. & Tollin, N. 2021. Circular Built Environment Highlights from Latin America and the Caribbean. Policies, Case studies and UN2030 Agenda Indicators. November 2021, UNESCO Chair on Sustainability and United Nations One Planet Sustainable Buildings and Construction Programme.

Cover design: Ninni Westerholm

Cover photos: Pekka Huovila

Layout design: Ninni Westerholm

ISBN/ISSN: 978-952-361-428-4

One Planet Network

The One Planet network has been formed to implement the 10-Year Framework of Programmes on Sustainable Consumption and Production (SCP), which supports the global shift to SCP and the achievement of SDG12. The One Planet Network acts as an enabler bringing actors from all regions to pool their expertise, resources, innovation and commitment towards a shift to more sustainable modes of production and consumption. The network comprises of six programmes: Sustainable Buildings and Construction, Sustainable Public Procurement, Sustainable Tourism, Consumer Information for SCP, Sustainable Lifestyles and Education and Sustainable Food Systems Programme.

Sustainable Buildings and Construction Programme

The Sustainable Buildings and Construction Programme (SBC) aims at improving the knowledge of sustainable construction and to support and mainstream sustainable building solutions. Through the programme, all major sustainable construction activities can be brought together under the same umbrella. The work involves sharing good practices, launching implementation projects, creating cooperation networks and committing actors around the world to sustainable construction. The goal is to promote resource efficiency, mitigation and adaptation efforts, and the shift to SCP patterns in the buildings and construction sector. The SBC work in 2021-2022 focuses on circularity and responsibly sourced materials.

Circular Built Environment Highlights

SBC has published regional reports on the state of play for circular built environment in Africa, Asia, Europe, Gulf Cooperation Council countries, Latin America and the Caribbean, North America, and Oceania. In addition to regional outlooks, a global report has been produced to summarise and compare the state of play regarding circularity in different regions. A crucial role of the reports is not only to provide a benchmark but also recommendations on how to move forward towards a sustainable and circular built environment.

These highlights from Latin America and the Caribbean provide a deep dive on the circular built environment in Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama, Peru presenting policies, key stakeholders and good practice case studies covering different life cycle stages and impact categories. Most important sustainable development goals and indicators for circularity from the UN2030 Agenda for Sustainable Development were identified through a survey. The results are presented at regional scale.

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List of acronyms and abbreviations

BE	Built Environment
CAF	Development Bank for Latin America
CBE	Circular Built Environment
CELADE	Latin American and Caribbean Demographic Centre
CODS	Sustainable Development Centre for Latin America
C&D	Construction and demolition
FIIC	Inter-American Federation for the Construction Industry
ECLAC	Economic Commission for Latin America and the Caribbean
GHG	Greenhouse Gas Emissions
GDP	Gross Domestic Product
IADB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IPCC	Intergovernmental Panel for Climate Change
LAC	Latin America and the Caribbean
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Cooperation and Development
SBC	Sustainable Buildings and Construction
R&D&i	Research, Development and innovation
SDG	Sustainable Development Goals
UN	United Nations
UNEP	United Nations Environment Programme
WB	World Bank

Executive summary

Latin America and the Caribbean is the most urbanised developing region, with the construction sector making a relevant contribution to the regional economy. However, this is not a homogenous feature, and is mainly determined by Mexico and Brazil, followed by some South American countries, including Colombia, Argentina, Chile, Venezuela and Peru. These countries concentrate three-quarters of both total and urban population and a similar proportion for construction activity . By contrast, Central America and the Caribbean have lower proportions of urban population, with smaller and less consolidated cities. Despite these differences, two characteristics are common to the built environment in LAC; first, urban sprawl is the dominant growth pattern for cities; second is the characteristic socio-spatial segregation. Urban sprawl implies loss of both rural and natural areas, thus affecting food security, biodiversity and ecosystem services, while increasing vulnerability to natural disasters and climate change. Urban sprawl also increases material and energy flows, thus reducing resource efficiency while increasing the costs of developing and operating the built environment. Altogether, these factors hinder the economic advantages of agglomeration, thus reducing productivity. On the other hand, urban spatial segregation excludes poor communities from access to housing, basic services, public space and job opportunities, which enhances informal economies and informal settlements, thus exacerbating problems arising from urban sprawl. Hence, the first challenge to introduce circularity in the LAC built environment would be to guide land planning towards urban compactness and social inclusion.

The LAC region faces important challenges concerning resource efficiency in the built environment. Building systems in LAC are usually intensive concerning materials, energy and carbon, with low degree of industrialisation, prefabrication, modular design and flexibility. Concerning energy, the region stands out for hydroelectric production, however climate change implies uncertain future availability of water resources. Therefore, an important challenge for the circular built environment is to increase building energy efficiency, as well as promoting non centralised production of renewable energy. LAC region is abundant in water resources and access to drinking water is high. Yet, access to sanitation is lower, only 20% of municipal wastewater is treated before discharge, while water reuse is almost absent, thereby showing the absence of a circular approach to water resources management.

Most LAC countries have advanced in urban and housing policies, half of them including buildings and human settlements in their NDCs and some have issued regulations and voluntary green building schemes. Likewise, while municipal waste management focuses mainly on collection and final disposal, thus providing few opportunities for recovery and valorisation, some countries are encouraging C&D waste reuse and recycling. However, there is still a need to harmonise all these policies with each other, while aligning these with criteria concerning biodiversity protection, reduction of social inequalities, resource efficiency from a life cycle approach and economic productivity. Emerging circular economy strategies and roadmaps may significantly contribute to this harmonisation, but only five countries have issued these instruments and only three of them give priority to the built environment.

Mainstreaming circularity in the built environment involves multiple stakeholders, acting at different scales, including multilateral and bilateral cooperation agencies, development banks, private banks and other financial entities, national, sub-national and local governments, material suppliers, urban developers and building companies, business associations, construction professionals and labourers, universities and other training centres, utility companies as well as users and occupants. This report describes some persistent challenges, such as the absence of sustainability tools, methods, concepts and principles in architecture and engineering university programmes; the high labour informality characterising the building sector, which is related to social inequality and lack of access of labour force to basic education; the low capacity of SMEs to develop circularity strategies and business models; the absence of a circular approach to

water supply and sanitation services; the difficulty of transferring costs and benefits of circularity among investors, developers, owners, and occupants in the built environment; and the general perception of greater safety and durability of conventional construction systems as compared to industrialised and prefabricated systems.

This report highlights the crucial role that multilateral cooperation agencies, and regional and national development banks have been playing in promoting the circular economy, while stressing the role of banks and other financial entities in supporting green investments by issuing green bonds, encouraging sustainability reports, participating in global sustainability initiatives and including climate change in financial risk analysis. National regulations, regional associations and business initiatives encourage efficiency, digitisation and new business models concerning electricity supply across the region. Likewise, national and regional business associations have been promoting green building and digitisation of the building sector and a Regional Coalition for Circular Economy, involving multilateral agencies, development banks, governments, academic institutions and private actors, has included cities and construction among priority areas. Case studies provided by this report show material producers that are successfully increasing resource efficiency and carbon footprint reduction, along with research projects, digital tools, guidelines and national platforms, emerging business models, as well as practical experiences in building and neighbourhood projects. Disseminating these initiatives and experiences may provide valuable opportunities to mainstream the circular built environment.

In order to assess and report progress towards the CBE, both management and performance indicators are required. The SBC programme network is building a SDG based indicator matrix by means of a global survey targeting experts and network participants, who have given priority to SDGs 11, 12, 13 and 9. While respondents from the LAC have prioritised the same goals, they have also prioritised a greater number of SDG indicators and have conferred higher importance to certain aspects relevant to the region, such as inclusive urbanisation and biodiversity protection. This is consistent with the fact that SDG10 and SDG15 are among the most critical goals according to a recent regional report concerning progress towards SDGs in LAC, which also stresses circularity as a strategy to boost Post-COVID economic recovery in line with fulfilling the 2030 Agenda. While the circular economy is not explicit in the 2030 Agenda, SDGs actually may provide a comprehensive pathway to guide policies, actors and initiatives towards circularity at different geographical and institutional levels. However, this requires addressing SDGs not as a list of objectives, but as an interconnected system of targets and indicators. Understanding these interactions would lead to more coherent and cost-efficient policies, programmes, projects and actions aimed at introducing circularity in the built environment.

Existing strategies and roadmaps concerning circular economy recently issued by LAC countries will favour circularity in the construction sector. However, developing circular built environments in LAC demands a systemic approach that not only focuses on resource efficiency but also addresses biodiversity protection, climate resilience and social equality, while considering every scale of the built environment from materials and components, to buildings, public spaces, infrastructures, neighbourhoods, metropolitan areas and regions. At the governance level, such systemic approach requires policy and regulatory harmonisation under participatory approaches, multi-stakeholder engagement via networks, alliances and initiatives, aimed at promoting circular built environments, increasing R&D investment, while putting circularity based challenges at the centre of innovation agendas; transformative educational systems providing sustainability based tools, methods, principles and concepts; and developing, displaying, disseminating, replicating and up-scaling demonstrative projects while strengthen financing mechanisms.

1. Introduction

Cities play a central role in the transition towards the Circular Economy, not just by being responsible for 80% of global resources demand and producing 75% of GHG emissions, but also by concentrating most of the world´s assets, financial flows, businesses and knowledge centres, thus being powerful engines to power eco-innovation. Transition of cities towards circular economy requires current urban trends and patterns to transform for reducing urban sprawl, while enhancing eco-efficiency and regenerating natural systems. The built environment is a key system of this transformation by being the spatial and material expression of the urban fabric.

From a social perspective, the built environment consists of the collection of buildings and public spaces where people live, work, learn and interact, as well as the infrastructure required to satisfy basic human needs. From an economic perspective, the construction value chain involves multiple economic sectors such as mining, industry, transportation, energy, water, sanitation, real estate, and finance. Consequently, construction-related expenditures are estimated to contribute 13% to global GDP, while employing 7% of the global workforce (Barbosa et al, 2017). However, from an environmental point of view, the built environment faces significant challenges. The operational stage of buildings consumes 30% of the world's final energy, while the manufacture of construction materials consumes an additional 10%. Buildings are estimated to be responsible for 30-40% of all energy-related carbon emissions and 12% of water consumption. 40% to 50% of the global flow of materials is used by the construction sector and construction and demolition waste accounts for 40% of solid waste flows (UNEP & IEA, 2017).

These multiple relationships between social, economic and environmental aspects; gives the built environment a cross-cutting role in fulfilling the Sustainable Development Goals and the Paris Agreement. A transition to a circular built environment is therefore urgently required, particularly in the developing world where most of urban growth is currently taking place. In Latin America and the Caribbean, where 81% of the population already lives in cities, a circular approach to the built environment may contribute to solving complex challenges such as housing deficit, informal economies and settlements, incomplete infrastructure, ecosystem loss, environmental pollution, social inequality and exclusion and increased exposure to natural disasters.

The aim of this report is to provide a state of play regarding the circularity of the built environment in Latin America and the Caribbean. First, grey literature review is used to provide an understanding of social, economic and environmental aspects of urban dynamics in the LAC region. Second section discusses urban, housing, green building and waste management policies; analyses the urban content of the NDCs and examines the emerging national strategies on circular economy and discusses the potential role of stakeholders is discussed, from the multilateral level to the local level. With the support of the RECNET and One Planet Network, initiatives and case studies of circularity in the built environment are identified and described in the third section. Based on the global survey developed by the SBC Programme, the relevance of SDG based indicators to inform the transition to the built environment in the LAC region is discussed in section four. Conclusions discuss challenges and opportunities for the CBE identified by the report while offering recommendations to enhance circularity transitions from a life cycle, multi-scale and governance perspective.

2. Significance of this work

While circular economy has received multiple definitions, a straightforward approach expresses three basic principles: 1) to reduce waste and pollution, 2) circulate products and materials and 3) regenerate natural systems (Ellen Mac Arthur Foundation, 2021). On the other hand, the standard definition of the built environment is a “Collection of man-made or induced physical objects located in a particular area or region. When taken as a whole, the built environment typically includes buildings, external works (landscaped areas), infrastructure and other construction works within the area under consideration” (ISO, 2008). Yet a comprehensive perspective requires a multi-scale, multi-sector and life cycle approach which ranges from materials and components, to buildings, infrastructures, neighbourhoods, cities and regions; while engaging diverse economic sectors such as mining, forestry, industry, construction, energy, water, sanitation, real estate and finance in activities going from planning and design, to materials extraction and manufacturing, construction, operation, maintenance, renovation and deconstruction. Hence, circularity in the built environment would consist of applying the principles of the circular economy to the life cycle of the built environment, considering its multiple scales while engaging its multiple economic and social sectors.

The most recent report on the advance of LAC towards the SDGs highlights the potential of the circular economy to enhance the post-COVID-19 recovery while ensuring the realisation of 2030 Agenda (ECLAC, 2021). The same report points to SDG9, SDG10, SDG15 and SDG16 as the most challenging goals for the region, due to low investment on R+D and infrastructure; lack of progress in reducing social inequalities (SDG10); deforestation and biodiversity losses (SDG15); along with weak institutional capacity and corruption (SDG16).

This report emphasises pollution reduction, resource efficiency and nature regeneration as the key circular economy principles. Yet it addresses specific challenges concerning sustainable development involving the built environment in the LAC region. First, there is a strong relation between urban sprawl, biodiversity loss, climate vulnerability, air pollution, infrastructure deficit and urban diseconomy. On the other hand, there is a strong relation between urban planning and social disparities. While the quantitative housing deficit has decreased, four of every ten households in LAC live under some condition of qualitative deficit; a relevant proportion of urban development and urban economy is informal and 90% of social inequality in the region can be explained by the inherent spatial segregation characterising its cities.

This report builds on the premise that urban issues concerning nature preservation, resource efficiency, equitable access to housing and basic services, job provision, climate resilience, innovation and productivity are all interconnected. Hence, addressing the circular built environment from a multi-scalar, multi-sector and life cycle approach may provide valuable elements to overcome these challenges.

3. Economic, social and environmental relevance of the Built Environment in Latin America and the Caribbean

3.1 Urbanisation trends in Latin America and the Caribbean

3.1.1 Latin America and the Caribbean is the most urbanised developing region in the world

Current population in the LAC region is 659 million inhabitants (World Bank, 2021). Although population growth rates have been declining, the region is expected to have 100 million more people by 2050. Currently, **81% of its population lives in cities** (The World Bank, 2021), being the most urbanised developing region in the world. Although the highest rates of urban population growth in the LAC region occurred during the 1950s to 1970s, driven by rural-urban migration, whose importance has decreased in the last two decades, urbanisation will continue growing and **will reach 90% in 30 years** (CELADE, 2019).

Urbanisation rates have not been homogeneous across countries and cities (Figure 1). There are **38 large cities** with more than two million inhabitants, including six mega-cities, with more than ten million inhabitants. Most of these are located in South America –especially in Brazil and Mexico–, and **concentrate 40% of the urban population**. On the other hand, there are **645 intermediate cities** (with populations ranging between 100 thousand and 2 million inhabitants), that **are home to 50% of urban population, being also the ones currently showing the fastest growth rates. This disaggregation trend of urban growth distinguishes Latin America and the Caribbean from other developing regions** (IADB, 2016).

While the highest proportions of urbanisation are shown in South America and Mexico, most of the Central American countries show proportions of urban population below 70%, and the island nations of the Caribbean tend to show relatively low levels of urbanisation (Figure 1), being characterised by unconsolidated cities, consisting mostly of continuous successions of urban and rural areas (UN, 2017).

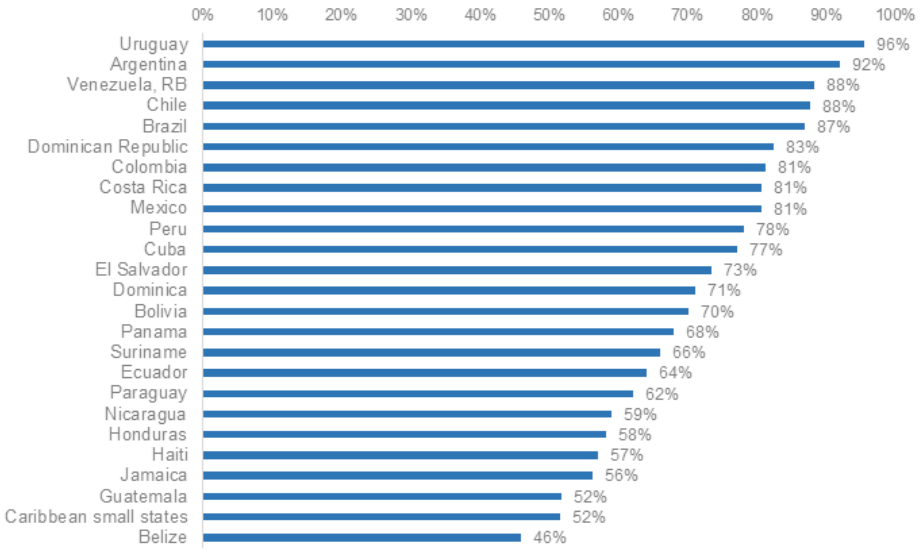


Figure 1: Urban population in Latin America and the Caribbean. Proportion of total population.

Source: United Nations (2018)

3.1.2 While rates of urban population growth are declining, Latin American cities are sprawling

Growth rates of urban population in LAC have been decreasing over the last 20 years. However, cities have experienced a fast expansion during that same period. The rate of land use is estimated at 1076 ha / year, which is equivalent to 20 m^2 per minute. Hence, urban areas have increased by 73% since 1990 (Inestroza, 2017). This sprawl has been driven by two main factors. The first one is informal urban development, which has historically played a major role in the region, and is currently occurring mainly in urban peripheries. Second factor is the sub-urbanisation produced by formal development of new residential areas, which is also occurring at urban peripheries, where both social housing projects as well as gated communities destined to middle and upper social classes are being built (IADB, 2016; Duque, 2019; Inestroza, 2017).

This sprawl stimulates intensive use of private vehicles, thus producing traffic jams while increasing both pollutant emissions and urban carbon footprint. On the other hand, this type of growth produces urban fragmentation and reduces urban densities (Table 1), which increases the cost of both land management and infrastructure development, while hindering equitable access to urban goods and services (Duque, 2019), thus deepening spatial segregation and social inequality (see section 3.3). Urban sprawl also poses environmental challenges, such as the loss of natural areas and ecosystem services, which increases vulnerability to climate change and natural disasters (Vera & Sordi, 2020).

Table 1: Gowth type of selected cities in Latin America

Source: UN-Habitat, 2017

City	Country	Land use (m^2/person)		Difference	Type of growth
		1990	2015		
Belo Horizonte	Brasil	180	158	-12%	Dense
Bogotá	Colombia	71	47	-34%	Dense
Buenos Aires	Argentina	126	140	11%	Sprawl
Cohabamba	Bolivia	194	255	31%	Sprawl
Culiacán	Mexico	204	248	22%	Sprawl
Holguín	Cuba	129	127	-2%	No change
México City	Mexico	106	119	12%	Sprawl
Quito	Ecuador	110	185	68%	Sprawl
Santiago	Chile	102	118	16%	Sprawl
Tijuana	Mexico	253	214	-15%	Dense

3.1.3 Urban sprawl increases vulnerability to natural disasters, reduces resilience to climate change and threatens ecosystem services

Latin America and the Caribbean are exposed to natural risks of geological and climatic nature. Colombia, Ecuador, Chile and Haiti have experienced major earthquakes during the last two decades, leaving a significant negative balance in terms of life losses and damages to the built environment, as described below (Bello et al, 2015; Risk Management Secretariat - Ecuador, 2016; OCHA, 2021):

- Colombia (1999), 1 185 fatalities, 79 500 homes destroyed or seriously affected
- Chile (2010). 200 thousand houses collapsed, 2 million people affected, 30 billion USD losses, 17% of the country's GDP
- Haiti (2010). 250 000 lives were lost, 5 million people lost their houses, with 3,5 million people affected.
- Ecuador (2016), 35 000 houses were destroyed or badly damaged, leaving more than 100 000 people in need of shelter. Water, sanitation, and healthcare facilities were also destroyed
- Haiti (2021). This country suffered a new earthquake in August 2021. The balance of fatalities and destruction of homes has not yet been processed at the time this report is prepared.

Concerning climate risks, the region ranges across different climatic zones, giving rise to different kinds of threats. **Mexico, Central America, and the Caribbean islands are particularly susceptible to hurricanes. The tropical countries of Central and South America are particularly susceptible to prolonged rains and storms. Cities located in flat areas are susceptible to flooding, while cities located in mountain valleys are susceptible to landslides and torrential floods. On the other hand, the whole region is susceptible to the inter-annual Thermal Oscillation known as ENSO, which exacerbates the effects of both dry and rainy periods. Since climate change is expected to increase the frequency and intensity of these events, susceptibility to natural disasters in the LAC region will also rise** (Bello et al, 2015).

While natural disasters threaten agricultural production systems, **most loss and damage occurs in the built environment, mainly affecting dwellings and schools** (Bello et al, 2015). This is a challenge for urban sustainability, but is also an opportunity to introduce strategic urban planning, building and operating criteria based on eco-efficiency, durability, flexibility and resilience in the built environment.

Concerning urban sprawl and ecosystems, it is estimated that **LAC have lost more than 2,400 km² of natural protected areas due to urban growth, between 1996 and 2010** (Duque et al, 2019a). Considering that the **region is home to 50% of the world's biological diversity, this trend may undoubtedly have an effect upon the biosphere on a global scale** (Dobbs et al, 2019). But the loss of natural areas not only affects the structure and composition of ecosystems, **it also affects their ability to provide services to cities themselves, thus affecting food security, access to basic services, public health and climate change resilience**. However, ecosystem services do not come up exclusively from natural areas. Semi-natural areas such as urban parks and forests, gardens, streetscapes, wetlands, rivers, streams, riparian, coastal and estuarine areas inside cities are also potential providers. Hence, **protecting biodiversity in urban areas may go hand by hand with providing equitable access to high quality public spaces, based on circularity principles** (see section 3.2)

Challenges for sustainable urban development in Latin America and the Caribbean include controlling both formal and informal driven sprawl, while preserving biodiversity and ecosystem services. Such kind of growth will increase resources and capital efficiency, while reducing vulnerability to natural disasters and climate change. Introducing circularity principles and criteria to land planning and urban design will be required to move the region forward in this direction.

3.2 Social aspects of the built environment

3.2.1 Spatial segregation in the built environment is a major challenge for LAC region

The LAC region has been consistently reducing poverty over the last two decades, however results in terms of reducing inequality have been scarce. Reducing social inequality was already the biggest social challenge by 2019 (Busso & Messina, 2020), but it became most urgent as **the region has been the most affected worldwide by the COVID-19 pandemics, mainly due to its deep social inequality** (OECD, 2020; CEPAL, 2021)

A clear evidence of social inequality in LAC is the **urban spatial segregation**, where slums, informal settlements and social housing projects are clearly separated from neighbourhoods for middle and upper social classes (UN, 2017). In fact, almost 90% of the total inequality in the LAC region can be explained by inequality within cities, rather than between cities, regions and countries (Busso & Messina, 2020).

Concerning **urban population living in slums**, the regional proportion has decreased in recent years, but still **remains at 21% and also varies significantly from one country to another.** In Chile, Uruguay and Costa Rica the proportion is less than 10%, but in Bolivia and Nicaragua proportions are above 40%, while in Haiti and Jamaica it exceeds 50% (World Bank, 2018) (Figure 2). **However, this inequality in the built environment is not restricted to slums.** Since self-building has been a major way for housing development in the region, **four of every ten dwellings are in qualitative deficit condition**. Such dwellings are usually located in areas that were informal during the 1960s and 1970s, but were assimilated into the formal urban fabric as cities sprawled. Considering this indicator, countries with low proportions of the urban population living in slums, such as Chile, Costa Rica and Uruguay, have qualitative housing deficits above 20%, while countries with high proportion of people living in slums, such as Bolivia, Nicaragua and Peru reach more than 70% of housing deficit (Figure 2) (UN-Habitat, 2015).

According to the Lincoln Institute for Land Policy (2014), most important factors that have historically contributed to slums and housing deficit in LAC are the following:

- High land prices limit access to lower income groups
- Zoning rules and regulations that low-income households are unable to follow, and procedures for obtaining building permits are very costly
- Public interventions are reactive, partial and insufficient; not all public housing policies are adequate in terms of quantity, diversity and access for the poorest segments of the population (some are developed in remote areas, with transport costs that low-income groups cannot afford)
- There has been a lack of respect for property rights and a lack of management of overlapping property regimes.

Spatial segregation is not only related to informal urban development. In fact, social housing projects are usually located at urban peripheries and are often given incomplete access to infrastructure and urban services. Hence, these projects do not necessarily reduce poverty and actually may contribute to reinforcing inequalities (Montero & García, 2017). For instance, residents of low-income housing in Brazil, Colombia, and Mexico report spending twice as much money and three times more time on daily traveling, than people living in central areas (IADB, 2017). In some countries, beneficiaries have even dropped out of social housing projects. There are about 5 million abandoned houses in Mexico, representing 14% of the country's total housing stock. Main causes of leaving are the lack of basic services and the distance to the workplace (UN, 2017).

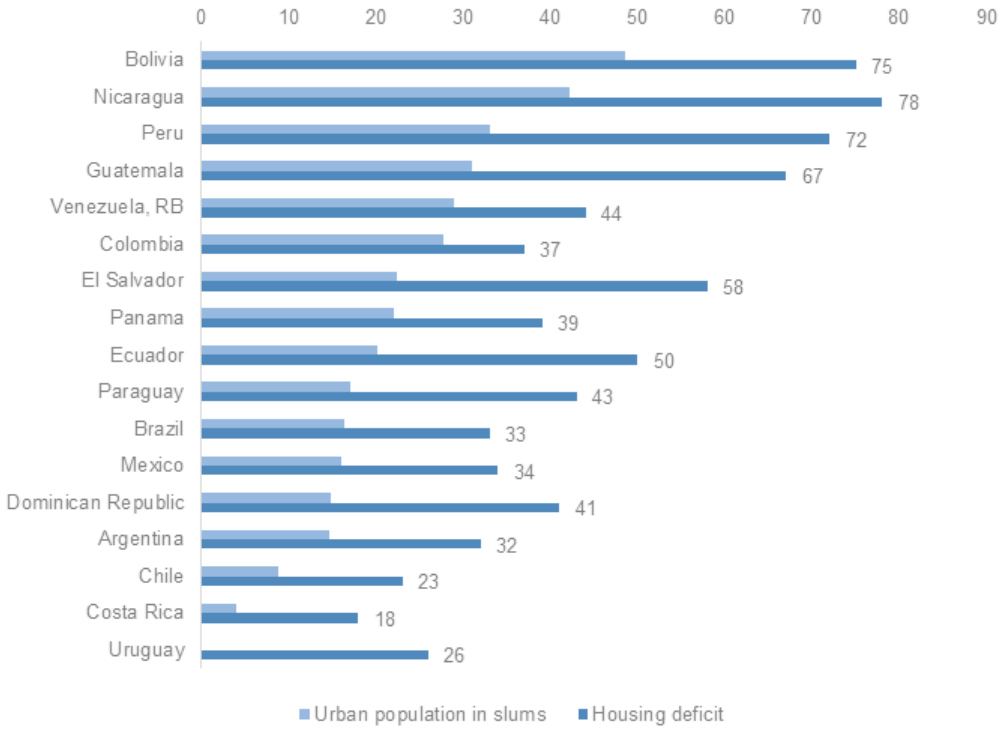


Figure 2: Comparison between urban population living in slums and housing deficit in Latin America and the Caribbean.

Sources: WB (2018) and UN-Habitat (2015)

3.2.2 Spatial segregation produces unequal access to Infrastructure and public space

Housing deficit accounts for the precariousness of dwellings in terms of its structure, construction materials and built area, but also includes access to basic services such as water, sanitation, and electricity, thus **housing deficit is also related to infrastructure deficit**. LAC region has an important **investment deficit concerning infrastructure** (see Section 3.3), which adds to the growing demand generated by formal and informal urban expansion, **becoming a factor contributing to deepening social inequality** (Sánchez et al, 2017).

Concerning public space, the World Health Organisation recommends a minimum of 9 m^2 of public space per inhabitant within a 15-minute walkable distance. **With the exception of some cases in Brazil, public space in Latin American cities tends to be scarce** (Table 2). A major

reason for this is the persistence of informal development, where housing tends to occupy most of the space, leaving just enough for roads and streets. However, social housing projects also contribute to this deficit, because these often do not provide public space, because it is considered an over-cost. At the same time, private projects aimed at the middle or upper classes develop open spaces, but these are not usually for public use. Therefore, **there is not only quantitative deficit of public space at city level, its uneven distribution also contributes to spatial segregation** (ADB & IADB, 2014)

Table 2: Public space availability in selected cities from Latin America

Source: IADB (2012)

City	Country	Public space (m^2/person)
Rosario	Argentina	10,4
Bucaramanga	Colombia	4,2
Curitiba	Brazil	51,5
Barranquilla	Colombia	1
Cali	Colombia	3
Medellín	Colombia	4,04
Santiago	Chile	3,7
Guadalajara	Mexico	2,53
Bogota	Colombia	4,1
Buenos Aires	Argentina	2,69
Poto Alegre	Brazil	13,62
São Paulo	Brazil	11,58
Belo Horizonte	Brazil	9,4
Campinas	Brazil	6,4
Guayaquil	Ecuador	3,2
Recife	Brazil	2

Slum upgrading and housing reduction is a relevant urban challenge for the LAC region in terms of reducing inequality and disaster risk. **The inclusion of circularity criteria will be useful for developing social housing projects and improving existing dwellings with resource efficiency and lower construction and maintenance costs.**

Circularity principles and criteria are required at the scale of buildings and infrastructures, but are also needed at the public space scale, as nearby natural areas, urban forests, parks, squares, gardens, playgrounds and even streets and pedestrian alleys, may play important roles in the promotion of social cohesion, facilitating active non-motorised mobility (walking, cycling), helping protect biodiversity and ecological connectivity, regulating local temperature, reducing heat islands and maintaining the hydrological cycle, among other relevant functions for mitigation and adaptation to climate change, while promoting urban resilience and sustainability on a broader perspective (IADB, 2021).

3.3 Contribution of the built environment to the economy of the LAC region

The economic importance of the built environment in the LAC region has two dimensions, one concerning construction activity, the other related to informal urban development, whose general conditions and causes have been previously discussed.

3.3.1 Formal construction activity plays a major role in the economy of the LAC region, thus providing an important opportunity to introduce circularity principles and criteria

Formal construction activity in the LAC region contributed 8.1% to the world construction sector GDP by 2019, ranking far behind Asia (42.4%), Europe (23.0%) and North America (20.6%). The specific contribution strongly differs across countries, with **Brazil and Mexico**, being the most important players, by **providing 54% of the construction GDP. When adding the activity of Colombia, Argentina, Venezuela, Chile and Peru, 86% of the regional GDP of construction is reached.** The Central American sub-region only contributes 6% of the construction activity. Among the Caribbean states, information was only found for the Dominican Republic, whose contribution to regional construction GDP reached 2.2% in 2019 (Figure 3).

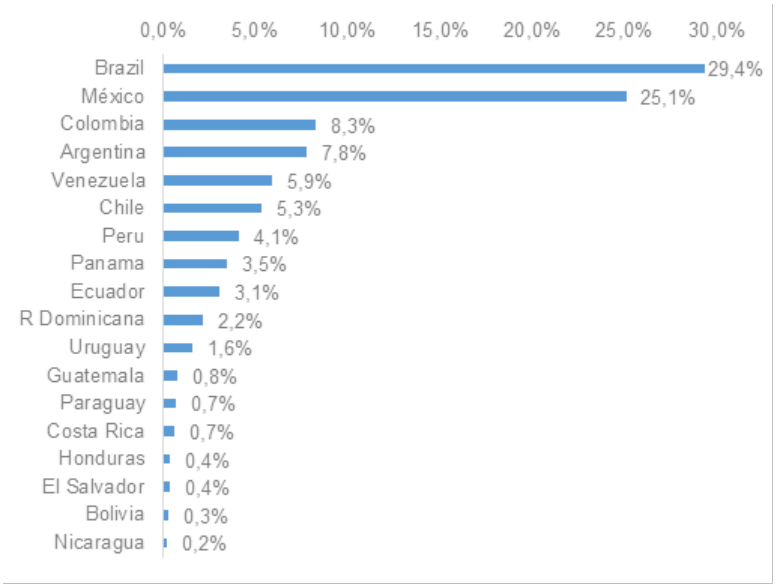


Figure 3: Economic contribution to the Regional GDP of the construction sector by Country

Source: FIIC (2020)

In 2019, construction activity accounted for 6.2% of the Region´s GDP. However, this number only includes direct construction activity and does not account for investments and expenses related to operation, maintenance, administration, renting and sale of built assets. A recent estimate at world scale concludes that construction activity represents 44% of the annual contribution of the built environment to the global economy (Barbosa et al, 2017). Keeping this proportion, **developing and operating the built environment might contribute 14% of the economy for Latin America and the Caribbean. Similarly, it is estimated that in 2018 construction provided 20 million direct jobs in the region**. There are no further estimations

concerning jobs in real estate and other related activities. In other words, the contribution of the built environment to the formal economy of Latin America and the Caribbean is quite significant. Hence it provides an important opportunity to introduce circularity principles and criteria.

In 2020, construction production in Latin America contracted by 17.3% as a result of the economic recession caused by the global pandemic of Covid 19. The most affected countries have been Panama, Bolivia, Argentina and Colombia, while Ecuador, Uruguay and Brazil have been less affected as construction works remained active during the quarantine periods. In 2021, construction production is expected to recover up to 0.7% with Peru and Chile growing with better performance while in Colombia and Brazil a slight growth is expected (Global Data, 2020).

3.3.2 LAC region must increase infrastructure investment in order to improve competitiveness, which may also be an opportunity for circularity

Since this report focuses on urban areas, large infrastructure works of national importance (dams, highways, railways, power transmission systems, etc) are not within the scope. However, information concerning infrastructure investment in the LAC region also includes urban infrastructure (water supply, sanitation, public space, public buildings, etc). Therefore it provides indication for public investment in the urban built environment.

Infrastructure investment in the LAC region has been historically low, averaging 2.2% of annual GDP during the last decade. According to estimates from the Inter-American Development Bank the investment rate should rise to 6%, in order for the region to fulfil its actual infrastructure needs (Sanchez et al, 2017). This places the region far behind in the global competitiveness ranking in the infrastructure area, where only Chile and Mexico are among the top 50 places. Most Latin American countries lag behind the 70th place and some are among the laggards under the 100th place (Table 3).

The characteristic low investment in infrastructure of the cities from the LAC region, combined with the urban sprawl, has affected equitable access to basic services and formal employment, while contributing to urban fragmentation, thus creating barriers to interaction between firms. Altogether, this situation **hinders benefits from agglomerated economies and reduces productivity** (Duque et al, 2019b).

Introducing circularity principles and criteria would provide cost-effectiveness to future investments, thus facilitating expansion of current infrastructure coverage in order to reduce social inequality and increase economic productivity. Such principles may also be oriented to developing and expanding new Green Infrastructure and Nature Based Solutions, which may complement, or in some cases, even replace functions of conventional grey infrastructure, while enhancing land planning and urban design measures aimed at protecting biodiversity and ecosystem services, thus providing greater adaptability and resilience to climate change (Watkins et al, 2019; OECD, 2021) (see Section 3.1).

Table 3: Latin American countries in the Global Ranking Competitiveness index by infrastructure

Source: FIIC (2020)

Country	Place in the Global Competitiveness Ranking by Infrastructure
Chile	41
México	49
Ecuador	59
Uruguay	62
Panamá	66
Argentina	68
Dominican Republic	77
Costa Rica	78
Brasil	81
Colombia	83
Perú	85
El Salvador	90
Guatemala	96
Honduras	98
Paraguay	101
Bolivia	102
Nicaragua	104
Venezuela	118

3.3.3 Labour informality and urban informality go hand by hand in LAC region

Economies in LAC countries are characterised by a high level of informality. In the built environment this is evident in two ways. First, there is a high rate of labour informality in the construction sector. On the other hand, a significant proportion of construction activity and urban growth in the region are carried out informally.

Since, informality occurs by definition, outside legal recognition, it is difficult to measure with precision. **Labour informality in the LAC region is estimated to be over 50%. In the construction sector the proportion of workers that are self-employed or do not have a contract may range between 60% and 75%** (Fernandes, 2011). One important challenge to the circular built environment consists of building capacities within this framework.

Concerning informal urban development, the proportion of the urban population living in slums is decreasing (see section 3.2). However, according to the Lincoln Institute for Land Policy (2014), informal urban development in LAC region includes other typologies, whose magnitude may be even harder to estimate:

- Occupation of public, communal and private land, followed by self-building
- Unlicensed subdivision of private, communal and public land to sell individual lots,

followed by self-building
- Irregular public housing projects (housing complexes), some of which have gradually become informal
- Urbanisation and development of areas classified as rural
- The unauthorised subdivision of pre-existing legal lots for the construction of additional buildings
- The widespread occupation of river banks, water reservoirs, mountain slopes and other ecologically protected areas
- The occupation of public spaces, such as streets and pavements.

Considering these typologies, it is clear that the proportion of the urban population living in slums is not a suitable approach to informal urban development. As previously discussed, the qualitative housing deficit continues to be very high in most countries. This index can be considered as a proxy for informal construction activity in the cities of Latin America and the Caribbean. **A rough estimate considers that up to 75% of the area built annually in the region falls into some type of informality** (The World Bank, 2017).

Urban and housing policies have been moving away from conventional approaches based on demolitions, relocations and forced evictions, towards the improvement of dwellings, public space and infrastructure (Alverez-Rivadulla et al, 2019). This may be an opportunity for the inclusion of circularity criteria to increase the eco-efficiency, durability, flexibility and resilience of the informal city in the LAC region.

3.4 Material, energy and water flows in the built environment

3.4.1 Resource productivity of the LAC region has remained stagnant over the last two decades. Construction materials account for 21% of the region´s material flow

Latin America and the Caribbean accounts for 10% of the global material flow, which places it above North America (9%) and Africa (7%), but leaves it behind Europe (14%) and far below Asia and the Pacific (60%) (WU Vienna, 2019). While material flow in the region has been increasing during the last two decades, going from 11 to 15 tonnes/person/year, this growth has occurred at a comparable rate to that of the economic growth. Therefore, **resource productivity in LAC has remained stagnant and is well below the global average** (Figure 4).

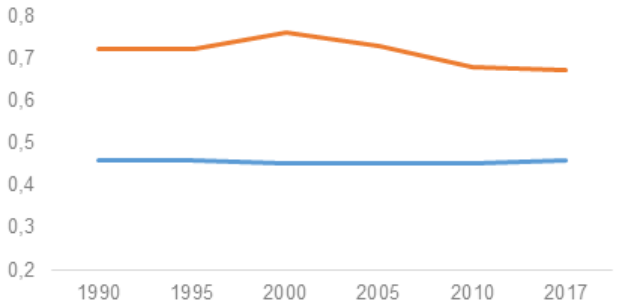


Figure 4: Resource productivity (USD/ton of material). LAC region (blue) compared to the World Average 1990 – 2017 (orange)

Source: WU Vienna (2019)

Concerning material flow composition, the relative importance of biomass has been increasing during the last two decades, while the proportion of fossil fuels has been decreasing. The proportion of metallic minerals has remained relatively constant. **The importance of non-metallic minerals, considered as a proxy for construction materials, has also remained constant in the last 20 years. By 2017, this material category accounted for 21% of the total material flow of LAC region** (Figure 5).

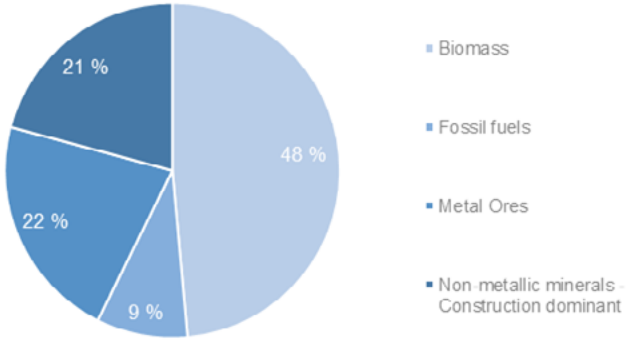


Figure 5: Share of annual material flow of the economy in LAC region by material category

Source: WU Vienna (2019)

By 2017, the flow of non-metallic minerals through the Latin American economy reached 1,834 million tonnes/year. The dominance pattern at country scale (Figure 6) is similar to that of economic activity in the construction sector (Figure 3). **Brazil and Mexico are the dominant players, being responsible for 41% and 19% of non-metallic minerals flow. By adding the following seven countries –all of these from South America– 91% of the total non-metallic minerals flow of the region is reached**. Central American countries account for 3.1%, while the Caribbean countries account for 2.7% (Figure 6).

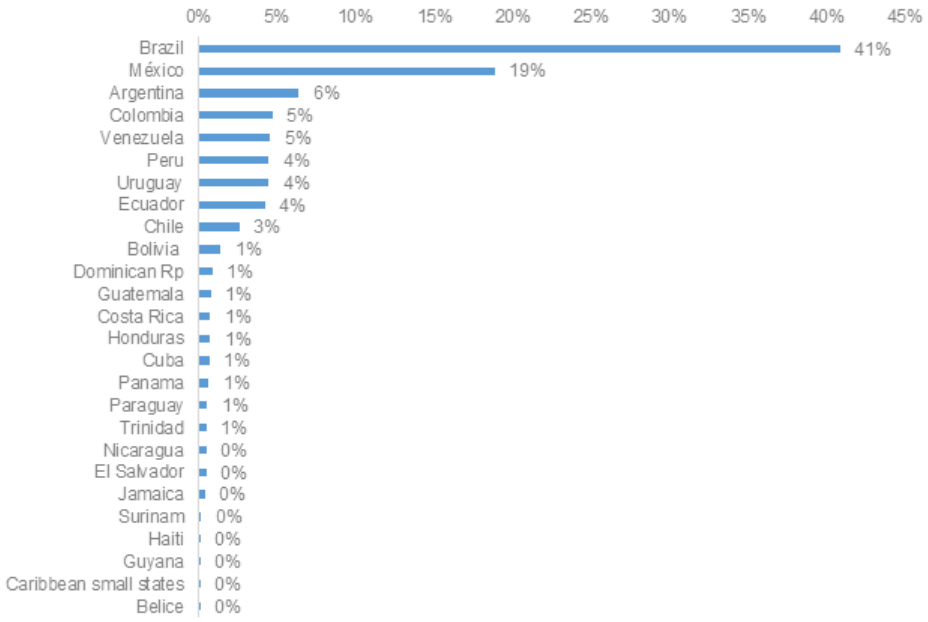


Figure 6: Non-metallic minerals (construction dominant) in the LAC region. Contribution by Country

Source: WU Vienna (2019)

3.4.2 Masonry systems and concrete based structures dominate both building stock and current building activity in the LAC region

A recent study on building systems and materials used in countries of the Andean sub-region (Argentina, Chile, Bolivia, Peru, Ecuador, Colombia and Venezuela), shows that **55% of the building stock is built using some type of masonry** (either reinforced, not reinforced or confined), **while 17% is built in concrete** (either blocks or walls). On the other hand, **13% of building stock is built using earth based systems** (either adobe or compressed earth), which is mainly present in Peru and Bolivia and **8% is built in wood**, which is mainly present in Chile. Other traditional construction systems, such as stone and other more modern ones, such as steel, occupy a smaller proportion of the building stock in this sub-region (Table 4). In Mexico, 76% of the building inventory is also built in some type of masonry (Martinez, 2013). No recent data concerning building inventory of Brazil was found. However, recent studies confirm that masonry systems are also the most widely used in this country (Camargo, 2018).

Table 4: Constructive systems in the residential building stock of the Andean Sub-region: Argentina, Chile, Bolivia, Peru, Ecuador, Colombia y Venezuela

Source: Yepes-Estrada et al (2017)

System	System %	Sub-system	Sub-system %
Masonry	55%	Unreinforced	31%
		Confined	22%
		Reinforced	2%
Concrete	17%	Blocks	14%
		Wall	3%
Earth based	13%	Adobe	7%
		Earth	6%
Wood			8%
Steel			1%
Stone			2%
Other			4%

It is worth noting that not only buildings based on concrete blocks or walls are using concrete as a structural base. In fact, **both reinforced and confined masonry buildings are also based on concrete structures. Moreover, concrete accounts for nearly 80% of material intensity in masonry systems and 60% of buildings in Latin America use concrete structures** (Global ABC, 2018). **Hence, concrete has become the most relevant material, followed by baked clay used for making bricks and tiles, other materials play a minor role. However, considering embodied energy and embodied carbon, other materials, such as ceramics and metals gain relevance** (Figure 7). Categorising material composition of both existing and buildings in the region is important in order to identify existing opportunities for circularity and designing pertinent strategies to enhance circular economy in the built environment.

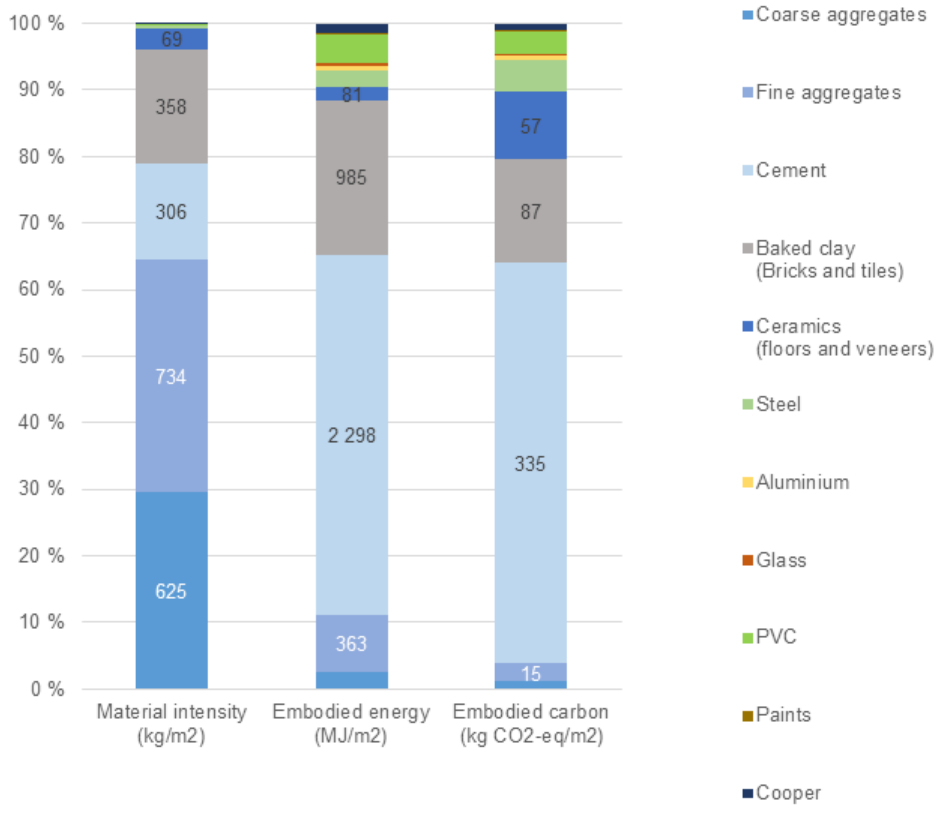


Figure 7: Relative contributions of materials in reinforced and confined masonry systems to material intensity, embodied energy and embodied carbon

Source: Modified Pardo et al, 2017

3.4.3 Timber plays an important role concerning material flows in the built environment and may be considered as an opportunity to reduce resource intensity in the construction sector

While dominant building systems in the LAC region are concrete based, **timber** has an important role in the built environment since it **is used to make forms required to mould structures and other elements made of concrete**. Another relevant temporary use consists of **wooden platforms or pallets for storing materials during the construction stage**. As construction works are finished, these wooden forms and pallets are removed having a temporary use that is often unaccounted for the material flow of buildings. In some cases, timber used for both forms and pallets may be reused in more than one project, but it is commonly given a single use and then discarded (de Araujo, 2019).

Volumes of temporary use of timber in buildings are unknown at Regional level, but there is some relevant data at national level. **In Colombia**, for example, **the construction sector accounts for 56% of domestic timber demand**. Volumes of illegal timber extraction from natural forests to be used in construction are also unknown, but this practice is probably occurring in some areas. However, **high rates of deforestation in the region are mainly related to the expansion of soybean plantations and cattle farming, rather than construction materials** (Punhagui et al, 2014)

Besides temporary use, **timber is an important end material for buildings in Chile, where wooden structures account for more than 20% of the urban stock and nearly 60% of the rural stock.** Timber **also plays a relevant role in rural areas of Colombia, Ecuador and Peru, where wooden structures account for more than 10% of the building stock** (Yepes-Estrada, 2017). By the 1970s, 20% of the building stock in Brazil was also based on wooden structures, but currently this percentage is residual compared to masonry systems (de Araujo, et al, 2019). Wooden structures are also common in Central America and the Caribbean, but no quantitative data concerning building systems in these sub-regions was found. Likewise, no data concerning timber as an end material for buildings in Mexico was available.

Despite its temporary use in most countries, it is convenient to produce data concerning timber flows in building activity in order to identify opportunities for circularity for this material. Likewise, **considering the high capacity of timber production in the LAC region** (Blackman et al, 2020), **its use in buildings as end-material could be explored, as an alternative that may contribute to reduce the characteristic material, energy and carbon intensity from masonry systems, while promoting a sustainable economic recovery** (The world bank, 2020).

3.4.4 Three areas concerning waste in the material flow of the built environment

The role of waste in the built environment may be approached from three different areas:

1. The production and management of construction and demolition waste – C&D waste
2. The potential for industrial symbiosis concerning the use of waste produced by other economic sectors, as secondary sources for construction materials
3. Municipal waste management, which requires spaces and infrastructures that are part of the built environment at different scales, from buildings to neighbourhoods and cities

This section focuses on the first area, by presenting general data concerning the production of C&D waste at country scale. The second area is briefly considered due to the lack of quantitative information on a national and regional scale regarding symbiosis between the construction sector and other economic sectors. However, both lines are further addressed in the case study section, where both research projects and implementation experiences are presented. Furthermore, the first area is again addressed in the Section concerning Policies, due to the existence of regulations for C&D waste management in several countries. The third area is addressed here by presenting general data at regional scale, concerning municipal waste management and the potential role of a circular approach in the design of the built environment as a strategy to address this issue.

Construction and Demolition waste is a growing challenge

Since only some countries in the LAC region have delivered national estimations and calculations, no data concerning C&D waste production at regional scale has been produced. Table 5 shows national estimates for Brazil, Mexico, Colombia and Chile. It is worth noting that these values do not seem consistent with data concerning the relative contribution of these countries to construction activities at Regional scale in terms of economic (Figure 3) and material flows (Figure 6). The most likely reason for these discrepancies is an absence of standardised concepts and methodologies for defining and calculating C&D waste production. For instance, Colombia is including estimations of illegal disposal, while Mexico and Brazil only include quantities at official disposal sites.

Table 5: Estimated annual production of Construction and Demolition Waste in some Latin American Countries

Data sources: Abrelpe, 2020; Ministerio de Ambiente y Desarrollo Sostenible-Colombia, 2019; Semarnat, 2020; Corfo, 2020

Country	National Data and estimations
Brazil	44 million ton/year 213 kg per capita Collected by Municipalities
México	6.5 million ton/year
Colombia	25 million ton/year 520 kg per capita Reuse = 2%
Chile	7.4 million ton/year (only for residential buildings) 376 kg Roadmap = reducing 70% of CDW

Despite the lack of consistent and comparable data, it is clear that waste CD production in the LAC region is a growing challenge. Several countries have issued regulations on this regard, which is further discussed in the Policies section. It is worth noting that **most emerging regulations are setting mandatory levels for C&D waste recycling**, which is consistent with a circular approach. Some cities that currently have C&D waste recycling systems include Sao Paulo, Belo Horizonte, Rio de Janeiro, Buenos Aires, Santiago, Bogotá, Medellín, and Panama City (Ministry of Foreing Affairs, 2021). Several experiences presented in the case studies section are related to C&D waste recycling.

Symbiotic interactions for secondary materials are already taking place

The symbiotic potential of the construction sector with other economic sectors has not been addressed on a national or regional scale yet. However, **there are some research projects and implementation experiences, which include the following categories**:

1. Use of fly ash and silica fume from coal combustion processes and other industrial processes for the partial replacement of Portland cement
2. Use of agricultural waste and non-recyclable plastics as an alternative energy source in cement production
3. Use of chemically activated mining excavation residues for the production of geopolymer-based concretes and mortars

These categories are further presented by specific examples in the case studies section.

Harnessing and expanding this symbiotic potential requires investment on research, development and innovation. It is also necessary to break the conventional sectoral approaches, both in public policy and private initiatives. These topics are further discussed in the recommendations section.

A circular approach to municipal waste management goes hand by hand with a circular built environment

Average production of municipal solid waste per inhabitant in the LAC region is 1.09 kg / day, which is slightly below the global average and well below the average of OECD countries (Savino et al, 2018). While **most countries are using controlled landfills as disposal sites, an estimated 40 million people still lack access to waste collection**. Hence, **27% of municipal waste continues to be disposed of in unregulated open dumps**. This type of disposition is particularly high in Guatemala and Nicaragua (> 70%), but it is also important in Peru, Venezuela, the Dominican Republic and Panama (> 40%).

It is estimated that **only 10% of waste is currently being recycled, which is highly dependent on separation and commercialisation activities performed by informal collectors**, whose number is estimated at 3 million people in the whole region. In Argentina, Colombia, Panama and Uruguay, it is estimated that there are more than 20 collectors for every 10 000 inhabitants.

Concerning composition, **organic fraction accounts for 50% of municipal waste**. However, **alternatives other than final disposal in landfills are not feasible due to the lack of on-site separation**. Hence, anaerobic decay of organic waste in landfills is responsible for a relevant proportion of carbon emissions in the LAC region (Hettiarachchi et al, 2018). Separation and recovery activities from municipal waste currently focus only on “recyclable” materials, mainly glass, plastics, metals and paper.

The approach to municipal waste management in Latin America and the Caribbean **continues to be focused on household collection and final disposal**. Whether this disposal occurs in dumps or controlled landfills, **it is a linear approach that does not acknowledge environmental externalities from conventional disposal or economic opportunities derived from resource recovery.** In order to move towards circularity in municipal waste management, **the region must shift its focus towards on-site separation, recovery and recycling. These activities require spaces and infrastructures at different scales, from buildings to neighbourhoods and cities. Which includes temporary storage and separation sites, transfer stations, and recycling facilities**, among others. Hence, municipal waste management goes hand by hand with the design, construction and operation of the built environment.

3.4.5 A circular approach to water management in the built environment is still missing

With an **average availability of 24 000 m^3 per capita**, LAC region **is abundant in water resources. However, this availability is not homogenous across sub-regions and countries.** A study on the water footprint found relevant water shortage in Mexico, in parts of Central America, along the coasts, west and north, of South America, in the northeast of Brazil and several regions in Argentina. Three out of 77 watersheds assessed face severe water shortages throughout the year and 26 watersheds experience severe water shortages for at least one month a year (Mekonnen et al 2014).

By 2017 **agriculture production accounted for 72% of the total freshwater withdrawal in LAC, whereas the industrial and domestic sectors accounted for 11% and 17% respectively** (The World Bank, 2021). If construction materials are considered, both industrial production and domestic water supply are related to the water use in the built environment. However, from a lifecycle perspective, there are other relevant implications that are described in Table 6.

Table 6: Circularity considerations for water in the built environment

Source: The authors

Built environment Lifecycle stage	Circularity considerations and opportunities for water
Extraction and manufacture of materials	Water Incorporated to materials, materials cleaning and facility maintenance
Construction	On-site concrete manufacturing (roughly 20% of concrete mass is water), materials cutting. i.e. ceramics, blocks, bricks; cleaning of equipment and vehicles; runoff from construction sites; domestic use by workers
Operation and maintenance (building scale)	Water efficient devices; rainwater use; On-site wastewater treatment ; On-site water reuse
Operation and maintenance (urban scale)	Water efficiency (treatment and distribution at water facility); water cycle management: urban runoff management, aquifer recharge; wastewater treatment and reuse; nutrient recover; energy production from sludge
End of life	Cleaning of equipment and vehicles; runoff from construction site; domestic use by workers

For most of the water flows listed in Table 6, no quantitative data are available at the regional or national level. Information regarding water in the built environment mainly focuses on domestic water supply and sanitation services. In this sense, countries in **LAC have historically prioritised investments on water supply, thus achieving 97% coverage.** However, this average obscures the disparity between rural (88%) and urban (99%) coverage and does not reflect the sustainability and quality of the service level. In fact, the proportion of the population with access to safely managed drinking water services is 74% (Martin-Hurtado & Nolasco, 2020).

On the other hand, approximately 87% of the population has access to some form of basic sanitation, with a significant difference between rural (70%) and urban (91%) areas. However, only 66% of the population is actually connected to a sewer system (18% percent in rural areas and 77% in urban areas) and **only 20% of municipal wastewater is treated before discharging to water ecosystems**. This is very low value considering the high levels of urbanisation in LAC and the condition of middle to high income countries prevailing in the region (Hernandez et al, 2016).

Despite the lack of quantitative information concerning water flows from a life cycle approach, a **comparison between the high levels of water supply and the low levels of municipal wastewater treatment in the LAC region provides an indication for a linear approach to water management in the built environment.** The policy section of this report will show that most policies, codes and certification schemes on sustainable buildings being used in the region promote the installation of low flux devices, but do not focus on water reuse, alternative supply sources or water qualities segregated by purpose. Likewise, there is a lack of policies aiming beyond conventional water supply and basic sanitation schemes to promote comprehensive management of the whole water cycle on an urban scale (Penagos, 2021). The case study section presents an interesting experience of closed water cycles in building construction and operation stages. However, the circular management of water in the built environment remains largely unexplored in the LAC region.

3.4.6 There are important opportunities to reduce energy demand and carbon emissions from a circular built environment

Buildings account for 24% of final energy use and 21% of non-AFOLU carbon emissions in the LAC region. Indirect emissions from electricity account for 13% and direct emissions from the use of fossil fuels (mainly for cooking and water-heating purposes) account for 8%. Policies, codes and certification schemes concerning sustainable buildings in LAC have focused on reducing electricity consumption, which is expected to increase 46% by 2040 (UNEP & IEA, 2020).

Currently **most electric energy produced in Central and South America comes from hydropower (55%) and this share is expected to reach 60% by 2040** (UNEP & IEA, 2020). **However, the combined effect of Climate Change and the Pacific Ocean Thermal Oscillation (ENSO) will have repercussions on the spatio-temporal patterns of rainfall, which implies that hydropower may not guarantee a continuous energy supply** despite the installed infrastructure. Therefore, it is important to increase the share of solar and wind power generation, but **it is also essential to increase energy efficiency in buildings, where circularity strategies such as eco-design can play an important role. This not only applies to new buildings, but also to retrofits, where sustainability considerations are not yet a priority** (Penagos, 2021).

From a lifecycle perspective, there is a lack of quantitative data concerning the contribution of construction materials to carbon emissions at Regional level. However, on a global scale this contribution is estimated at 11%. **A recent analysis for Colombia shows that annual emissions from construction materials in this country are comparable to those from electricity use in buildings.** Although some general concerning materials are considered, **the issue of embodied carbon has received little attention by most sustainable building policies, codes and certification schemes** (Penagos, 2021).

The implementation of combined circular economy strategies in new buildings has a potential for relevant reductions. This combination includes industrialised construction and precast, modular design, substitution of Portland cement (by both other natural sources and secondary materials from materials from other industries), use of high-performance concrete, and increased recycling of steel. In Colombia, this combination of strategies would have a cost-effectiveness of USD 14 per ton of CO2-eq reduced, compared to up to 150 USD per ton CO2-eq reduced for measures derived from efficient electrical equipment and devices (Penagos, 2021) . Other circularity strategies that may be relevant to reduce energy use and carbon emissions in the construction sector may include **the use of timber and other biomaterials**, but this potential remains largely unexplored by the industry, with some exceptions, as is the case in Chile (de Araujo, 2014; The World Bank, 2020).

4. Policies and stakeholders

4.1 Policies

An integrative approach to circularity of the built environment includes a wide range of policy areas:

- Urban planning and housing
- Solid waste management, including C&D waste
- Sustainable buildings
- Climate change
- Circular economy

Considering the scope of this report, not all of these areas are developed here to the same extent. Housing and urban planning policies are discussed at regional scale. Municipal waste management is also approached at Regional scale, but in the area of C&D waste management specific standards at country level are described. Regarding, sustainable buildings, both voluntary (standards, guides and certification schemes) and mandatory instruments (regulations and codes) at country level are presented. Climate change policy is approached from the content related to human settlements and buildings in updated NDCs. Concerning circularity, emphasis is made on national strategies and roadmaps on circular economy that include the construction sector among priority areas.

4.1.1 Urban and housing policies

Urban policies in LAC tend to focus on defining planning methods rather than setting performance goals for territorial development (UN-Habitat, 2017). The relation between spatial decisions, urban metabolism, social inclusion and economic growth is not explicitly analysed but considered an implicit principle. Consequently, **local compliance to the national urban policies do not necessarily contribute to increasing eco-efficiency, reducing inequality or increasing productivity** (Penagos, 2021).

Concerning housing, policies have focused on reducing quantitative deficit by promoting social housing projects based on subsidies. In Mexico and Brazil, sustainable building instruments are being integrated into social housing programmes. However, the location of these projects in peripheral areas is contributing to urban sprawl, with ecological, metabolic, economic and social consequences that have already been discussed in sections 1.1 and 1.2. **An integrative and inclusive approach to circularity is required in this regard for housing policies not only reducing quantitative deficit, but also promoting more compact, resilient, efficient and equitable urban development in LAC**.

Concerning informal urban development, conventional approach has consisted of forced evictions and relocations (Alvarez-Rivadulla et al, 2019). However, emerging approaches aimed at improving both housing and neighbourhood conditions in informal settlements have been implemented in several LAC cities, like Medellin, Bogota, Rio or Montevideo. However, these interventions have failed to become structural long-term strategies for urban and housing policy, and have rather remained as emblematic examples. While these interventions are coherent with a circular approach to the built environment by focusing on refurbishing existing houses, infrastructures and public spaces, it is important to explicitly incorporate decisions aimed at optimising material and energy flows in the life cycle of these projects.

4.1.2 Municipal and C&D waste management

As discussed in section 3.4, **policies and institutions related to municipal solid waste management in LAC are mainly oriented towards collection and final disposal services, mainly based on subsidy schemes.** In most countries regulated landfills are in place, but open dumps still exist and illegal disposal in unauthorised sites remains as a common practice. **Despite most policy documents promoting recovery, recycling of municipal waste remains below 5% and largely depends on informal workers** (Hettiarachchi et al, 2018).

Policies based on subsidised collection and disposal services produce disincentives to on-site separation, valorisation and recycling, thus leading to the absence or deficiency of adequate spaces and facilities for waste management at the different scales of the built environment. Hence, a major policy gap consists on setting a clear relation between waste management policies and urban planning and design policies.

Concerning C&D waste, most countries include this stream into the regulatory frameworks for municipal waste management. However, **Mexico, Brazil, Colombia, Chile and Peru have issued specific norms on this regard, advising reuse and recycling as alternatives to final disposal** (Table 7).

The Colombian code on C&D waste stands out because it sets mandatory minimum limits for incorporating C&D waste in construction works with built areas over 2000 m^2. This minimum level is based on the total flow of construction materials, which must be calculated and reported to the local environmental authorities. The minimum percentage of recycled C&D waste to be incorporated was 2% by 2018, with an annual increase of 2%. The goal is to reach 30% by 2032.

In addition to the mandatory codes listed in Table 7, existing standards and voluntary certification schemes in sustainable building in the region include guidelines for the management of C&D waste. Likewise, the existing circular economy strategies and roadmaps, which include the construction sector, establish actions concerning the management of C&D waste. Both types of instruments advise the technical feasibility analysis for reuse and recycling. In Argentina, the Ministry of Environment and Sustainable Development issued a national circular economy plan focusing on municipal solid waste management and including C&D waste in its scope. Since, this instrument is rather a waste management plan than a circular economy strategy, it is included in this section (Table 7).

Table 7: Regulation on C&D waste management in LAC

Source: The authors

Country	Regulation	Specific to C&D waste management	Guidelines for C&D waste recycling
Brazil	CONAMA 307/02 (CONAMA, 2002)	Yes	Advised upon technical and economic viability
Mexico	NOM-161-SEMARNAT-2011 (SEMARNAT, 2011	Yes	Advised upon technical and economic viability
Colombia	Resolución 472:2017 (Minambiente, 2017)	Yes	Mandatory Target: 30% of the material flow in construction projects over 2000 m^2 by 2032
Chile	Norma Chilena 3562 (Ministerio de vivienda y urbanismo, 2019)	Yes	Advised upon technical and economic viability
Peru	DECRETO SUPREMO Nº 003-2013-VIVIENDA (Presidencia de la Republica del Peru, 2013)	Yes	Advised upon technical and economic viability
Argentina	Plan Nacional de Economía Circular de Residuo (MINISTERIO DE AMBIENTE Y DESARROLLO SUSTENTABLE, 2020)	No	Not considered
Ecuador	PROGRAMA NACIONAL PARA LA GESTIÓN INTEGRAL DE DESECHOS SÓLIDOS (PNGIDS). (Ministerio del Ambiente, 2010)	No	Not considered
Uruguay	Ley Nº 19.829 (Parlamento de la República Oriental del Uruguay, 2019)	No	Advised upon technical and economic viability
Dominican Republic	NA-RS-001-03 (SECRETARÍA DE ESTADO DE MEDIO AMBIENTE Y RECURSOS NATURALES, 2004)	No	Not considered

4.1.3 Sustainable building policies

Several countries in LAC have issued guidelines, voluntary standards, certification schemes, and technical regulations to promote sustainability in buildings. In South America, Brazil, Argentina, Chile, Mexico, Colombia, Peru and Ecuador have at least one of these instruments. In Central America, Panama and Costa Rica both guides and technical regulations are in place. No evidence of such instruments was found for Caribbean countries. A description of sustainable building instruments identified in the LAC region is provided next.

Mexico

New buildings

Both the Energy Conservation Code for Buildings (Comisión Nacional para el Uso Eficiente de la Energía, 2016) and the Housing Building Code (Gobierno de México, 2017) set minimum energy efficiency requirements in commercial and residential buildings, including aspects of architectural design and efficient technologies. At the federal level, the code is voluntary, but when adopted by the sub-national or local government it becomes mandatory.

The Eco-CASA (Gobierno de México, 2020) initiative, which was initially oriented towards energy efficiency based on bioclimatic design, has been updated to consider operational GHG emissions and water use. The goal is to achieve a 20% -40% reduction in energy-related GHG emissions relative to the baseline. By May 2019, the programme had certified about 64 thousand homes in energy efficiency.

Existing buildings

Mexico signed a NAMA (Comisión Nacional de Vivienda, 2016) in 2015 to increase the energy efficiency of housing, targeting low- and middle-income households. Likewise, the National Commission for the Efficient Use of Energy is carrying out energy renovation programmes for public administration buildings (SENER, 2020)

The Mexican standard, NOM-008-ENER-2001 (Gobierno de México, 2001), requires that non-residential buildings (new buildings and new additions to existing buildings) have a label indicating the estimated solar heat gain. NOM-020-ENER-2011 (Gobierno de México, 2011) requires that residential buildings have a label to reveal the estimated solar heat gain, compared to the reference buildings.

Systems and Devices

Mexico established in 2012 an energy efficiency seal for household electrical equipment based on several previously existing standards (Comisión Nacional para el Uso Eficiente de la Energía, 2014).

Materials

Materials that include cement, aluminium, and polyvinyl chloride (PVC) have voluntary environmental performance standards named EPD (Gobierno de México, 2013). EPD is one of the most recent certifications for materials and Mexico is in the process of defining the product category rules to be used in EPDs. A product declaration reports on environmental impacts such as acidification of water or soil or depletion of the ozone layer, life cycle, water consumption and consumption of non-renewable resources and energy.

Brazil

New buildings

The Residential Building Performance Standard ABNT 15.575: 2013 (Comitê Brasileiro da Construção Civil, 2013) is mandatory for new buildings, and includes criteria for the thermal performance of the envelope and other aspects of bioclimatic design. Likewise, the Brazilian Eco-labelling Programme is mandatory for new Federal buildings, although it remains voluntary for other sectors.

Existing buildings

The Energy Operational Performance Programme established a Benchmarking platform that allows comparing energy performance between buildings of similar use, located within specific climatic zones.

Systems and Devices

Brazil established in 2019 minimum levels of energy efficiency for HVAC systems and established a ban on the import and sale from 2020 of devices and equipment that do not meet these minimum requirements (PROCEL, 2014). The implementation of this standard has been possible because the Federal Electricity Commission requests the certificate of compliance of the lighting system before the provision of electrical service.

Argentina

New buildings

The Argentine Institute of Standardisation and Certification (IRAM) established the IRAM 11900: 2017 (Instituto Argentino de Normalización y Certificación, 2017) standard that establishes an energy efficiency standard for new buildings based on categories ranging from A to G based on the use of efficient technologies.

Materials

The Argentine government has focused on developing a local market for the construction of wooden houses using sustainable forest management practices and on mobilising the forestry, wood processing and prefabrication industries to meet Argentina's housing needs. In 2016, the Government of Argentina signed an ambitious strategy with forest industries, banks, R&D and academic institutions to finance and accelerate the construction of 100 000 timber houses through a value chain that incorporates sustainable forest management (Gobierno de Argentina, 2017). A national financing scheme has also been established, the Argentine Bicentennial Credit Programme for Single Family Housing (PROCREAR) to promote the financing and construction of wooden houses. The National Housing Fund is also aligning with PROCREAR to continue supporting the construction of homes and schools with wood products.

Colombia

New buildings

Colombia established resolution 549: 2015, which establishes the minimum criteria for energy and water efficiency in new buildings. The levels are based on the climatic location and the type of building, being mandatory for homes, schools, hotels, offices and commercial buildings, depending on the built area (MInvivienda, 2015). Social housing was excluded from mandatory compliance.

The Conpes 3919: 2018 document establishes general guidelines for a sustainable building policy where a life cycle approach is proposed, which includes existing buildings (DNP, 2018). Currently, these general guidelines have not been regulated, thus this policy has not advanced into implementation.

Existing buildings

The National Planning Department has been leading an energy audit programme for public administration buildings. Based on the results, some buildings have started renovation programmes.

The Ministry of Housing is developing a NAMA (Nationally Appropriate Mitigation Action) project for the inclusion of mitigation and adaptation criteria to climate change in programmes for the improvement of neighbourhoods and informal homes, including aspects related to materials, as well as energy and water operational efficiency (Minambiente, 2017). This project has a technical document, but it has not been published, financial resources have not been sought to support it, and there is no implementation plan.

Systems and Devices

Resolution 41012: 2015 established a technical regulation for the energy labelling of systems and end-use devices for electrical energy and fuel gas for the industrial and building sectors in Colombia. The code establishes five categories of energy performance ranging from A to E, but does not establish any restrictions on the importation and commercialisation of low-efficiency systems (Minenergia, 2015). The project calculated projections of the energy saving potential, but so far no studies have been carried out to measure their real impact.

Chile

New buildings

The Sustainable Building Certification (Sustainable Building Certification – CES (Ministerio de Obras Públicas, la Cámara Chilena de la Construcción, el Colegio de Arquitectos & Instituto de la Construcción, 2014) is a voluntary certification system that evaluates and certifies both new and existing public buildings in Chile. This includes educational buildings, health care centres, services, and social buildings. An equivalent certification system for housing projects has recently been created (Ministerio de Vivienda y Urbanismo & CTeC, 2020). The system evaluates five sustainability criteria: 1) quality of the indoor environment; 2) energy; 3) water; 4) waste; and 5) management.

Systems and Devices

A minimum efficiency criteria was established by the NCh 3000: 2006 standard,for energy - Refrigerators, freezers and refrigerator-freezers for domestic use (Instituto Nacional de Normalización, 2006). Decree 64: 2014 establishes an energy label for products, machines, instruments, equipment, artefacts, appliances and electrical, gas and liquid fuel materials or that use any type of energy resource (Ministerio de Energía, 2014).

Peru

New buildings

Peru approved a voluntary sustainable building code for commercial and residential buildings in 2014 (Ministerio de Vivienda, construcción y saneamiento, 2014), which promotes the efficient use of operational water and energy through bioclimatic architectural design and the use of efficient devices. It also recommends on-site water treatment and reuse.

Existing buildings

The Ministry of Mines and Energy published an energy use efficiency guide for new and existing buildings of the public administration, whose goal is to reduce 15% of total energy consumption by 2040 (Ministerio de Energía y Minas, 2014). The guide establishes a baseline, establishes recommendations and offers an estimate of expected benefits.

Ecuador

New and existing buildings

The INEN 2506: 2009 standard establishes a voluntary energy efficiency standard in 2009, aimed at both new buildings and existing buildings that develop renovation programmes that involve more than 25% of the built-up area (INEN, 2009).

Costa Rica

New buildings

The technical regulation INTE 06 -12 -01:2014/Enm 1: 201 2017 establishes a voluntary standard for sustainable buildings that includes aspects related to the operational efficiency of energy and water, defines bioclimatic architectural design guidelines, as well as criteria for the selection of materials, for vegetation and landscaping, and for location and transportation. This standard also considers the economic implications of decisions regarding sustainability (INTEC, 2017).

Panama

New buildings

In 2016 Panama issued a voluntary Guide to save energy in new buildings through Resolution 3142 (Secretaría Nacional de Energía, 2016). In 2019, the country issued the sustainable building regulation JTIA 035 that focuses on the operational energy efficiency of new buildings, mandatory except for industrial buildings, electrical substations and other types of utility facilities. The regulation establishes bioclimatic design guidelines, as well as selection criteria for efficient equipment and devices (Ministerio de Obras Públicas, 2019).

4.1.4 The built environment in Nationally Determined Contributions - NDCs

Fifteen countries in LAC include at least one aspect related to the built environment in their NDCs (Table 8). Several countries consider mitigation aspects, but only few set specific measures with distinctive goals. **While adaptation concerns tend to focus on reducing vulnerability to natural disasters, mitigation concerns tend to focus on operational energy efficiency in buildings**, with the exception of El Salvador and Costa Rica, which also introduce general concerns related to construction materials. Concerning the scales of the built environment, while some adaptation measures consider the scale of urban planning, most mitigation measures are concentrated at the building level, specifically targeting new buildings. Only the Dominican Republic NDC lists mitigation measures for existing buildings (Table 8)

Table 8: Built environment considerations included in NDCs in LAC countries

Source: The authors. Based on the NDC Registry. https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx

Country	NDC measure/mention concerning human settlements/housing/buildings	2nd NDC submitted	Mitigation	Adaptation
Mexico	Implementing comprehensive adaptation strategies that strengthen resilience in human settlements Design of programmes and actions in various levels of government to optimise energy consumption in homes and businesses, but also to promote mechanisms and regulations that promote the inclusion of best practices in new construction and renovations, such as strengthening generation distributed	x	x	x
Costa Rica	Use of wood, bamboo and other local materials (based on traditional knowledge), including those from sustainably managed forest plantations, up to a minimum of 10% in 2025 over the 2018 baseline. In the year 2030, 100% of new buildings will be designed and built adopting low emission and resilience systems and technologies under bioclimatic parameters	x	x	x
Belize	Building Resilience of Human Settlements: Discouraging human settlements in areas prone to natural hazards (flooding, land slippages, high winds and storm surges), and develop housing and settlement patterns/ practices that enhance climate change adaptation and are resilient to climate change			x
Panama	Resilient human settlements This strategic area refers to public policy and management actions aimed at sustainable and resilient development in urban and territorial areas, improving the quality of life of the inhabitants. It includes matters related to urban and territorial planning and housing, and its relationship with patterns of production, distribution and consumption of goods and services such as education, health, employment, infrastructure, transportation, among others. Energy Transition Agenda and legal framework related to sustainable buildings that includes: i) the sustainable building regulations for the Republic of Panama; ii) the Sustainable Construction Guide for saving energy in buildings and measures for the rational and efficient use of energy for the construction of new buildings	x	x	x

Country	NDC measure/mention concerning human settlements/housing/buildings	2nd NDC submitted	Mitigation	Adaptation
El Salvador	*Updating of the Urbanism and Construction Law, the Law of Development and Territorial Ordering of the Metropolitan Area of San Salvador and of norms and construction regulations *Promotion of bioclimatic and vernacular architecture appropriate for the different types of infrastructure *Densification of housing *Insurance and risk transfer with appropriate options for the different types of infrastructure, as foreseen within the National Climate Change Plan. *Create incentives and community systems to reduce the high cost of eco-efficiency, especially in low-income socioeconomic classes for the improvement of thermal comfort in homes and offices (bioclimatic architecture, energy efficiency, microclimate, heat islands)		x	x
Colombia	Adaptation to climate change in sectoral instruments, through the development of guidelines, tools and criteria that guide the management of adaptation in the sector to be applied to Land Use Plans, focusing on areas exposed to high risk of natural disasters. Sustainable construction: Guidelines for the design and construction of sustainable buildings, achieving reductions in energy consumption, which allows reducing GHG related to the development of housing and other buildings, through 1) Reduction of the consumption of natural gas and electricity in new homes not including Social and Priority Interest Housing and 2) Reduction of natural gas and energy consumption in new buildings other than housing	x	x	x
Ecuador	Human Settlements Sector Development and implementation of the public policy of habitat, land use planning, land planning and land management, with adaptation criteria in the face of climate risks Reduction of climate risk of the population through the validation of safe land, promotion and provision of decent, accessible and affordable housing in areas with low exposure to climate hazards.			x
Argentina	Efficiency in residential electricity consumption, efficiency in residential gas consumption, and improvement of the building envelope	x	x	

Country	NDC measure/mention concerning human settlements/housing/buildings	2nd NDC submitted	Mitigation	Adaptation
Chile	• 57% of houses (70% of apartments) electric heating by 2050 • 1 800 GWh in distributed residential electricity generation • 20 000 houses/year renovated • 35 GWh Geothermal • District heating programme	x	x	
Guyana	Guyana will continue to conduct energy audits and replace inefficient lighting at public, residential and commercial buildings		x	
Uruguay	Regulation of energy-efficiency labelling in new homes and buildings by 2025 Implementation of the Pilot Programme for the Improvement of Energy Efficiency in housing Implementation of energy-efficiency labelling programme in used and non-residential buildings by 2025 Use of solar collectors for domestic hot water in large users, industrial and residential users Implementation of a residential area pilot plan of smart grids, replacing 100 000 electricity meters by smart meters Replacement of current equipment with efficient equipment: 4 million incandescent light bulbs replaced in the residential sector, and 30% of LED lights in public lighting Wider use of solar collectors for hot water in large users, industrial and residential users: 100 MWth of installed capacity for 2025		x	
Dominican Republic	Resilient Cities Sector (infrastructures, human settlements) Improve urban planning and land use to ensure that new and existing developments, infrastructure, buildings and land management promote long-term climate resilience, Improve current building standards for climate risk integration Promote strategic environmental assessment integrating climate risk. Strengthen the capacity of professionals and institutions related to planning to prevent and mitigate exposure to the risk of climate change. Facilitate access to an insurance system for damages related to climatic events for the different structures and components of human settlements	x		x
Cuba	To disallow the construction of new buildings edifications in threatened coastal settlements with a prognosis of disappearance due to severe flooding and the most vulnerable ones, as well as reducing demographic density in the low-lying coastal areas	x		x

Country	NDC measure/mention concerning human settlements/housing/buildings	2nd NDC submitted	Mitigation	Adaptation
Antigua and Barbuda	*Conditional target: By 2030, all buildings are improved and prepared for extreme climate events, including drought, flooding and hurricanes *Unconditional target: By 2020, update the Building Code to meet projected impacts of climate change	x		x
Bahamas	Establishing environmental guidelines for heights of infrastructure relative to mean sea level, incorporate climate change considerations in public building, and improving the building code to provide for stronger wind loads	**x**		**x**

4.1.5 The built environment in National strategies and roadmaps on Circular Economy

In the last three years, Colombia, Chile, Peru, Uruguay and Ecuador have issued strategies and roadmaps explicitly concerned with circular economy. With the exception of Peru and Uruguay, these instruments include the construction sector in their strategic lines or action plans. Table 9 provides an overview on the existing instruments concerning circularity in LAC. A detailed description on the built environment concerns included in the instruments issued by Chile, Colombia and Ecuador is provided below.

Table 9: National Strategies and Road maps on circular economy in LAC

Source: The authors

Country	Instrument	Approach to the built environment
Colombia	Estrategia Nacional de Economía Circular (Minambiente & Minindustria, 2019)	Focus on C&D waste Considers certifications on sustainable building as circularity tools
Chile	Hoja de Ruta para un chile circular a 2040 (Ministerio del Medio Ambiente, 2021)	Comprehensive view on circularity
Peru	Hoja de Ruta hacia una economía Circular en el Sector Industria (Ministerio de la Producción, 2020)	Construction sector not considered
Ecuador	Libro Blanco de Economía Circular de Ecuador (Ministerio de Producción, comercio exterior, inversiones y pesca, 2021)	Focus on C&D waste
Uruguay	Plan de Acción en Economía Circular, (Transforma Uruguay, 2019)	Construction sector not considered

The built environment in the Roadmap for Circular Chile

The “Circular Chile” roadmap seeks to create circular models for different economic sectors by promoting R&D and scaling strategies for circular models, while strengthening the regulatory framework for circular economy and promoting circular public procurement. The roadmap also proposes creating information systems; building capacity at every educational level; and incorporating circularity criteria to regional and urban planning. This instrument sets specific goals for job creation, waste reduction and resource productivity based on circular economy.

The built environment has a cross-cutting role in the roadmap, thus preventing a sectoral approach and emphasising the opportunities for industrial symbiosis. Furthermore, two specific documents concerning the circularity in the built environment have been issued: a state-of-play for circularity in construction and a circularity-based roadmap for C&D waste management. A national strategy for the inclusion of the carbon footprint in the construction life cycle has also been issued in 2021.

Circularity principles for circularity in construction include:

- Building by layers, considering that the durability of the life cycle descends from system, site, structure, envelope, services, spaces, equipment and furniture.
- Design without waste, considering eco-design and strategies to optimise the use of materials, avoiding waste.
- Design for adaptability, allowing adaptability to changing needs over time and flexibility so that they can change their use (for example, change from being an industrial building to a loft or office).
- Design for disassembly, with a modular design that allows disassembling parts and components, and enabling transportation or adaptations.
- Selection of materials according to their attributes of sustainability, durability, recycled content, etc.

Opportunities for companies in the construction sector introducing circularity principles include:

- Increase in industry productivity
- Increased productivity on site / company
- Improvement of the environmental performance of the sector
- Better planned and more efficient projects
- Safer and cleaner works
- Increase availability of aggregates and reduce their illegal extraction
- Reduce the gap between waste generation and availability of final disposal sites
- Greater link with the academy (R&D projects)

Specific action lines for circularity in construction are:

- Territorial planning and infrastructure for the management of the RCD and the Circular Economy
- Public coordination for the regulatory framework and promotion of the Circular Economy in Construction
- Ecosystems and value chains for Circular Economy markets in Construction
- Information and indicators for the development of markets, public policies and innovation
- Restoration of environmental liabilities and risks

An explicit goal is set on integrating circular economy criteria with policies, regulations and certification schemes concerning sustainable building and the carbon footprint strategy, aimed to promote NetZero buildings in Chile.

The built environment in the Colombian National Strategy on Circular economy

The Colombian circular economy strategy seeks to increase the productivity, competitiveness and sustainability of national economy through research, development and innovation aimed at the circular economy in the following areas:

- **Circular business models:** defined as the set of ideas, strategies and principles with which organisations generate value by meeting market needs.
- **Sustainable supply in value chains:** considering the interconnections between suppliers and anchor customers that are part of the same system articulated to market segments.
- **Sustainable cities:** integrating production cycles and contributing to the smart use of products, materials, water and energy at the city-region scale. Urban centres concentrate infrastructure such as transportation systems, aqueduct and sewerage systems, housing, and shopping centres. Urban infrastructure transports, transforms and delivers materials, products, water and energy for consumption, and determines waste and sewage disposal, among others.
- **Eco-efficient industrial parks:** industrial parks are geographic spaces where various companies are located, as they are connected to the logistics infrastructure to share infrastructure or to access a favourable tax regime. Due to the conglomeration of companies of different sectors and sizes, industrial parks present opportunities to develop industrial symbiosis activities to close material cycles or to share services or infrastructure.
- **Extended producer responsibility:** it is the principle by which producers maintain a degree of responsibility for all the environmental impacts of their products throughout their life cycle, from the extraction of raw materials, through production and until the final disposal of the product as waste in the post-consumer stage.

The action plan has a sectoral focus, where the flow of construction materials includes clays, cement, wood, plastics and glass, being approached independently of the flows of industrial materials, biomass, energy and water. Steel, which takes a prominent part in the most used building systems in Colombia (see section 3.4), as well as other metallic materials, are part of the industrial materials line.

Concerning the flow of construction materials, KPIs emphasise utilisation of C&D waste and sustainable building certification schemes. The energy flow line prioritises the building sector and the water flow line considers municipal wastewater. Likewise, premises of the strategy include industrial symbiosis and the goals set aggregate targets and indicators for the national economy, related to energy intensity, water productivity, resource productivity and carbon emissions. However, the **sectoral focus of the action plan of this strategy may be an obstacle to creating and implementing cross-cutting plans and programmes for the circularity of the built environment** with a comprehensive approach.

The built environment in the white-paper for Circular Economy in Ecuador

The Ecuadorian Standardisation Service (INEN), concerned with guaranteeing sustainable consumption and production modalities for Ecuador, is currently working on a technical normative document on **"Principles of Circular Economy"**. At the same time the National Government is working on a **"Circular Economy Seal"**, and a technical standard for incorporating **"Circular Economy Principles in organisations"**. These initiatives are in the formulation process and have not yet been published. However, the Ministry of Production and Foreign Trade developed a **White Paper on Circular Economy**, setting general goals and a roadmap for the circular economy in Ecuador.

The proposed goals consist of:

1. Adopting an inclusive circular development model with a territorial vision for the transition of the productive system.
2. Minimising the socio-environmental impact of products and services, promoting economic well-being through circular business models.
3. Achieving a partial decoupling between development and the use of natural resources.
4. Supporting the innovation ecosystem to adopt the circular economy and facilitate the implementation of circular strategies.
5. Strengthening the financial system to identify investment opportunities on circular business models

Strategic lines proposed by the White paper are:

- Including the circular economy in the development model of the State
- Creating and strengthening human and social capital for the circular economy ecosystem
- Creating a circular culture
- Articulating collaboration between government entities and other relevant actors
- Generating accessible and transparent data on circular economy
- Removing barriers to implement circular economy
- Promoting various financing mechanisms for circular strategies

While the action plan has a sectoral structure, prioritising agriculture, industry, mining, construction and retail; the general approach is based on a life cycle view of material and energy flows, considering critical inputs and outputs in each phase. Concerning the construction sector, critical inputs are water, energy and materials, including those from other sectors, such as wood, metals and glass. Critical outputs are material and energy losses, C&D waste production, wastewater and GHG emissions.

Specific strategies concerning construction are:

- Modular design
- Design for deconstruction
- Buildings as material banks
- Reuse and refurbishment of whole buildings
- Materials with low environmental impact and long life cycles
- Energy and water efficiency
- Waste reduction

Specific actions proposed for the construction sector are:

- Increasing energy efficiency throughout the life cycle of both new and existing buildings
- Reducing urban sprawl by introducing circularity principles to land planning and urban design
- Promoting new business models in construction, based on increasing refurbishment; modular and industrial building systems, off-site construction and deconstruction,
- Promoting manufacture, marketing and use of low impact materials
- Ensuring proper management of C&D waste, including valorisation, reuse and recycling

Despite the sectoral approach, the life cycle vision based on critical inputs and outputs that not only encompasses material flows, but also water and energy flows, **may favour the implementation of comprehensive circularity programmes and plans in the built environment.**

4.2 Stakeholders for the built environment in LAC

Development, operation, administration, maintenance and deconstruction of the built environment involves **multiple stakeholders operating at different scales, ranging from the Regional level to the local level and belonging to diverse sectors social and economic sectors.** An overview of these actors in LAC and the role they may play in the transition towards sustainability, resilience and circularity of the built environment is provided here.

4.2.1 Multilateral and bilateral Organisations

This chapter does not describe the role of global multilateral organisations, it only emphasises the work of organisations operating on a regional scale and already promoting sustainability and circularity through policy advice, technical support or financing.

United Nations Environment Programme – UNEP

The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment. UNEP is included here because it is currently chairing the **Coalition for Circular Economy in Latin America and the Caribbean**, which is a regional platform aimed to increase knowledge and understanding about the circular economy, facilitate education, training and technical assistance for the development of public policies for circular economy and sustainable consumption and production. The structure and work of this Coalition will be further described in the subsection corresponding to initiatives.

Economic Commission from the UN to Latin America and the Caribbean – ECLAC

ECLAC (CEPAL in Spanish) is one of the five regional commissions of the United Nations and its headquarters are in Santiago, Chile. It was founded to contribute to the economic development of Latin America, coordinate actions aimed at its promotion and strengthen the economic relations of the countries with each other and with the other nations of the world. Subsequently, its work was extended to the Caribbean countries and the objective of promoting social development was incorporated.

The working areas of ECLAC that can be related to circularity in the built environment are:

- 2030 Agenda
- Human settlements
- Planning for development
- Natural resources
- Population and development
- Economic development
- Productive and business development
- Human and social development

This entity can significantly contribute to promoting the circular economy through the production of technical documents, the holding of regional integration events and providing advice on policy making to member countries. Recently, **ECLAC has been working to identify challenges and opportunities to achieve a more sustainable and low-carbon style of development based on the Circular Economy.**

Organisation for Economic Cooperation and Development – OECD

The Organisation for Economic Co-operation and Development (OECD) is an international organisation that works to build better policies for improving life quality. Together with governments, policy makers and citizens, the organisation works on establishing evidence-based international standards and finding solutions to a range of social, economic and environmental challenges. From improving economic performance and creating jobs to fostering strong education and fighting international tax evasion. The OECD member countries in LAC are Mexico, Costa Rica, Colombia and Chile, other countries are in the process of joining, including Brazil and Peru.

The OECD working topics that can be related to circularity in the built environment are:

- Biodiversity, water and natural resource management
- Chemical safety and biosafety
- Climate change
- Consumption, innovation and the environment
- Environment in emerging and transition economies
- Environmental country reviews
- Environmental indicators, modelling and outlooks
- Environmental policy tools and evaluation
- Greening transport

The OECD may take a leading part in promoting the circular economy in LAC by providing a forum and knowledge hub for data and analysis, exchange of experiences, best-practice sharing, and advice on public policies. **The Organisation currently acknowledges the leading part of cities in the transition from a linear to a circular economy and has recently published a synthesis report based on the findings from 51 cities and regions around the globe. OECD is currently approaching resource management issues by encouraging the transition towards a circular economy.**

Organisations for bilateral cooperation

In addition to multilateral organisations, bilateral cooperation organisations are also operating in Latin America by providing financial and technical support on pre-feasibility and feasibility studies, as well as project implementation activities aimed at meeting sustainable development and climate agendas in the region. These are mainly Cooperation Agencies of European

Countries such as Germany, the Netherlands, France and Spain, it also includes the Cooperation Agency of the United States and the Global Institute for Green Growth, based in South Korea.

These organisations may make an important contribution by introducing circularity criteria in the life cycle of the built environment to the extent that the circular economy is an explicit part of the strategic lines of technical and financial support to be implemented in LAC.

City lead organisations

In addition to multilateral organisations led by nations, there are also global organisations led by cities that can also contribute to mainstream circularity in the built environment. These organisations include C40 and Local Governments for Sustainability - ICLEI.

C40 Cities connects 97 cities to take bold climate action, leading the way towards a healthier and more sustainable future. Representing more than 700 million citizens and one quarter of the global economy, mayors of the C40 cities are committed to delivering on the most ambitious goals of the Paris Agreement at the local level, as well as to improve local air quality. Twelve cities in Latin America and the Caribbean are current members of C40.

Under a new agreement, the Ellen MacArthur Foundation and the C40 Cities Climate Leadership Group have joined forces to accelerate progress towards a circular and low carbon economy, recognising the prominent contribution cities can make concerning this transition. The collaboration will promote valuable joint programming and knowledge sharing on the circular economy and the role it may play in reducing greenhouse gas emissions in cities. In 2018, C40 launched a publication on Municipality-led circular economy case studies in partnership with the Climate-KIC Circular Cities Project (C40 and Climate-KIC, 2018). This report mainly focuses on European cities, but the case study of the Water fund to support the City's water shortage in Aguascalientes, Mexico is included.

ICLEI – Local Governments for Sustainability is a global network of more than 2500 local and regional governments committed to sustainable urban development. Active in more than 125 countries, where the organisation influences sustainability policy and drives local action for low emission, nature-based, equitable, resilient and circular development. More than 90 cities in Latin America and the Caribbean are currently part of the ICLEI Network.

ICLEI has recently created the Circulars programme, which gathers knowledge on circular economy interventions at local government levels around the world, provides materials for awareness raising and global advocacy, offers implementation support on circular development actions and policies and facilitates peer-to-peer exchange.

4.2.2 Governments

National governments

With the exception of Mexico, Brazil, Argentina, and Venezuela, which have federal government systems, all other LAC countries have unitary government systems, where power is concentrated in a central government that sets the rules at the national level, while local governments are responsible for implementation. Despite these differences, a common factor is that **national policies are generally issued by ministries and agencies that, although depending on national presidencies, function independently from each other, leading**

to a predominantly sectoral approach (ONU Ambiente, 2018). Therefore, **policies related to sustainable development, climate change or circular economy are mainly issued by the Environment Ministries with little or no participation from other sectors. Therefore, mostg policies related to economic productivity, social development, Energ water and sanitation, land and housing planning, do not usually include holistic and structural perspectives on sustainability.**

Concerning the built environment, in most Central and South American countries, ministries related to land planning and housing are independent offices, thus facilitating formulation of specific and autonomous policies. However this may hinder the incorporation of territorial sustainability and sectoral productivity into urban and housing policies. In fact, **urban and housing policies in LAC have mainly focused on setting methods and procedures for land planning and reducing quantitative housing deficits, rather than promoting sustainable development, climate action, resource efficiency, circularity, biodiversity protection or social equality.**

Participation of Ministries for land planning and housing is essential in the transition towards sustainable, inclusive, resilient and circular cities, but this alone is insufficient. **Cross cutting policies, involving ministries of economy and finance; productivity and industry sectors involving energy, water and sanitation are required. It is also important to incorporate Ministries of Education,** since this transition also implies new knowledge and skills of professionals and labourers. This will be further discussed in the chapter concerning education institutions.

Subnational and local governments

Technical standards related to construction materials and elements, structural systems, characteristics of water and energy facilities are generally formulated at the national level. Therefore, the ability of sub-national and local governments to introduce circularity criteria for construction materials and technical installations is limited. These aspects require consultation with national governments.

On the other hand, although there are national urban policies in most LAC countries, **regions and municipalities tend to have a certain degree of autonomy on determining land use, urban expansion areas, urban densities, public space design and building architecture** (Penagos, 2021). Hence, sub-national and local governments in LAC may contribute considerably to mainstream circularity in the built environment, concerning the following areas:

- **Promoting compact cities** by limiting urban expansion areas (mainly on zones exposed to natural risks and protected areas) while encouraging urban renovation and re-densification projects.
- **Implementing transportation-oriented planning strategies**, thus increasing connectivity of public space to facilitate active mobility (walking and cycling).
- **Designing public spaces with considerations for restoring and protecting biodiversity** (ecological corridors), **reduction of heat islands and circular water management** (sustainable urban drainage systems - SUDS)
- **Setting mixed-used land plans**, thus facilitating physical proximity between companies from different sectors In order to promote industrial symbiosis
- **Defining urban design guidelines that include spaces and facilities for the integral management of municipal solid waste**, including C&D waste.
- **Establishing bioclimatic design criteria** for both buildings and open spaces, thus promoting energy efficiency and indoor comfort

- **Implementing projects to improve houses, infrastructure and public spaces in informal settlements**, based on resource efficiency, pollution reduction, climate change resilience and biodiversity protection

4.2.3 Development banks

Latin America established the first regional and sub-regional banks. **Currently there are more Development Banks in LAC than in any other region** (Daza, 2016). These institutions feature prominently in promoting projects focusing on sustainable development and may also play a central role in providing technical and financial resources to promote circularity initiatives. This section describes the main members of this stakeholder group on a regional scale.

Inter-American Development Bank – IADB

The IADB is a Regional development bank for Latin America and the Caribbean, **providing both financial and technical support for social inclusion and equality; productivity and innovation; and regional economic integration by addressing cross-cutting issues of gender equality and diversity; climate change and environmental sustainability**; and institutional capacity and the rule of law. The bank provides loans, grants, and technical assistance; while conducting extensive research.

The IADB working topics that can be related to circularity in the built environment are:

- Energy
- Environment and natural disasters
- Financial markets
- Industry
- Private firms and SME development
- Science and technology
- Social investment
- Urban development and housing
- Water and sanitation

The IADB promotes regional integration through various mechanisms, such as the Latin American Network of Financial Institutions, which seeks to promote the development and strengthening of the financial sector and financial inclusion in the region. Likewise, it is **a strategic partner of the Coalition for the Circular Economy of Latin America and the Caribbean**, previously mentioned.

On the other hand, the IADB bank has been leading important initiatives to promote the development of sustainable projects by **providing direct financing via green bonds and indirectly by creating a regional platform for green financing**. Similarly, the IADB has served as a **partner of the Green Climate Fund supporting climate change related projects, such as the financial innovation pilots carried out in Colombia that supported various economic sectors, including construction** (Asobancaria, 2016); and the sustainable social housing initiative in Argentina, which includes a sustainable building guide with a life cycle approach and 128 prototypes of sustainable social housing. This last initiative will be further described in the corresponding section.

Considering its natural duty on financial support to national and local initiatives, but also its role concerning regional integration, policy counselling and technical assistance, **the IADB may take a leading part in promoting a circular built environment in LAC.**

Development Bank for Latin America – CAF

It is a regional development bank that seeks to promote sustainable development through loans, non-reimbursable resources and support in the technical and financial structuring of projects in the public and private sectors of Latin America.

As the IADB has done, **CAF has also created financing schemes for projects in infrastructure, energy, social development, environmental sustainability and climate change via green bonds.** Likewise, CAF has shown interest in promoting the circular economy through website publications and holding events, such as the **Latin American Circular Economy Forum, held in 2020**, which brought together local and international representatives, to discuss the ways to energise key actors in society and promote the transition from the current linear economy to a circular model.

International Finance Corporation - IFC

The IFC is a World Bank branch focused on the private sector in developing countries, providing both financial and technical support aimed to broaden access to foreign and domestic capital markets, while unlocking private sector investment. Like IADB and CAF, IFC has also issued green bonds to facilitate the financing of sustainable projects in Latin America and the Caribbean, as well as other regions.

Concerning sustainability of the built environment, the IFC has been promoting sustainable building practices in Latin America through the EDGE Buildings standard, which focuses on energy and water efficiency in the operational phase, but also includes material efficiency, by including embodied energy as a performance variable. **Furthermore, IFC has conducted research on the potential market for sustainable building in emerging countries and provides technical assistance in the design of standards and incentives to promote sustainable building, with results in Peru and Colombia.**

National Development Banks

National development banks are financial units, usually from the public sector, whose purpose is financing projects that are not focussed on profit, but rather produce high social benefits. Hence, these banks commonly take a leading part in the implementation of public policy, especially concerning poverty reduction. **According to the IADB, there are currently 56 financial institutions in LAC that can be classified under this category** (Daza, 2016).

There are significant gaps between investment needs and financial flows towards sustainable projects in the region. However, financial support from national development banks to climate change related initiatives has been increasing. In fact, these institutions are already greatly contributing to financing initiatives, programmes and **projects related to the circular economy via green bonds, while also channelling resources from multilateral development banks** (Climate Bonds Initiative, 2019). There is evidence of this potential in Brazil, Chile, Mexico and Colombia, where these banks have been participating in the finance of **projects regarding energy efficiency, renewable energy, urban infrastructure, biodiversity, climate resilience and sustainable buildings**, among other areas. In the case of Colombia, the national development bank Bancoldex launched in August 2021 a special line of microcredits to promote the implementation of projects and the development of business models based on Circular Economy in Small and Medium Enterprises or SMEs.

Another important contribution from development banks consists of encouraging participation of private banks in financing circularity based initiatives. Again, in the case

of Colombia, three national development banks partnered with private banks to formulate a financial innovation pilot that would help identify barriers and financing opportunities for green projects. This initiative received funding from the Green Climate Fund and served to establish a green investment protocol for private banks in the agro-food, manufacture and construction sectors.

4.2.4 Private Banks and other financial institutions

Private Banks

In several LAC countries private banks have begun to finance projects related to energy efficiency, pollution reduction, mitigation and adaptation to climate change, and sustainable buildings, among other areas, mainly via green bonds. In fact, green bonds issued by the private sector seem to be more popular in LAC than in the rest of the world, representing 20% of the financial capital and 27% of the number concerning green bonds. It should be noted that private issuance of green bonds in LAC is not only through banks. In fact some companies from the infrastructure and energy sectors are among the most important issuers in the region, using this mechanism to finance their own projects, providing that resource efficiency, pollution control or climate change issues are being considered. This regional trend may be favourable to the inclusion of circularity criteria in the built environment through green building projects. However, most important allocations in LAC are currently going to energy efficiency and renewable energy (44%), forestry, agriculture and biodiversity protection (20%) and transportation (20%) projects. Sustainable buildings have received only 4% of these resources (Climate Bonds Initiative, 2019).

Other financial institutions

Other relevant financial institutions for the transition to sustainable means of production are stock exchanges and insurance systems. Stock markets work as capitalisation mechanisms for private companies while the insurance sector intervenes, defines risks and guarantees concerning investments, thus affecting capital costs.

Concerning the stock market, sustainability considerations are already taking place in LAC. **The most important stock markets, such as Brazil, Mexico, Argentina, Colombia, Chile and Peru are part of the Sustainable Stock Exchanges initiative**, while also stating principles or codes good corporate governance; producing sustainability reports; creating platforms for green bonds exchange and even having their own sustainability indices (GRI & AG Sustentable, 2020). **Considering that companies in the construction value chain take part in stock markets, the existence of codes, standards, reports and sustainability indices may send signals to investors thus promoting responsible investment in the construction sector**. Eventually, these trends may even contribute to enhancing market value of companies including sustainability and circularity criteria in their businesses, products and processes.

Regarding the insurance sector, no consolidated information at the regional level was found concerning the inclusion of sustainability criteria in setting financial risks and guarantees. However, **progress is evident in Brazil, Colombia, Peru and Costa Rica, where governments are already issuing regulations concerning sustainability and climate risk considerations in financial underwriting. Furthermore, business associations in the insurance sector are producing sustainability protocols and codes while also publishing sustainability reports and monitoring sustainability related actions from the associated**

companies. This tendency may be useful to reduce financial risks, thus facilitating financial structuring of initiatives, projects and business models based on circularity principles.

4.2.5 The construction sector

Property and project developers

Construction activity in LAC is carried out by companies of all sizes, from small companies of local reach to large companies of transnational activities. Small companies tend to specialise in either building, infrastructure or real estate activities, while medium and large companies tend to participate in all activities, which makes it difficult to distinguish the building sector from the real estate sector. **At the national level, these companies are gathered in business associations called "Construction Chambers".** Industrial companies manufacturing materials and even private banks financing building projects also take part in these associations. In turn, **Construction Chambers are further joined into an Inter-American Federation of the Construction Industry - FIIC, which groups together the Construction Chambers of Mexico, all countries in Central America (excluding Belize); all countries in South America (excluding Guyanas and Suriname); and Dominican Republic in the Caribbean.**

The role of the National Construction Chambers is to represent the construction industry in order to:

- Encourage development by pursuing technical improvement and strengthening links among the construction industries.
- Call and / or hold congresses, conventions and all types of meetings, as well as maintaining constant and participatory relationships with international organisations, on matters of interest to the construction sector.
- Addressing common interests of the construction sector based on sectoral studies
- Collecting, disseminating and exchanging experiences related to the construction industry among associates

The FIIC aims to fulfil these same functions on a regional scale, but also seeks to strengthen the relationship with multilateral organisations such as the IADB and the World Bank (WB), with the purpose of channelling financing for infrastructure and housing projects.

As representatives of the formal sector, both the national construction chambers and the FIIC may greatly contribute to enabling the transition towards a sustainable built environment in LAC. **All these institutions already have working groups on green building, as a sign of industry looking in such a direction**. However, an important challenge that persists with this stakeholder group is that sustainability is still perceived as a regulatory requirement and a market tendency, its relationship to resource efficiency and economic effectiveness has not yet been clearly outlined. **Circular economy principles may help to make this relationship evident and attract the attention of the private sector to bring together sustainability and productivity agendas.**

Manufactures and suppliers

Material suppliers for construction are not a homogeneous group. **Different types of materials are manufactured and distributed by different types of companies, from large multinationals, as in the case of cement and aluminium, to small manufacturers that can be found even in the informality spectrum, in the case of bricks and concrete blocks** (Table 10).

Some large materials manufacturing companies in LAC have subscribed sustainability strategies and publish reports under GRI standards. As will be seen in the section corresponding to case studies, some of these companies have been developing circularity related initiatives, including waste to energy projects, extended producer responsibility, industrial symbiosis and incorporating secondary materials as substitutes for raw materials. **Given their transnational operation, these companies can significantly help drive the construction sector towards circularity. However, as the size of companies decreases, economic and institutional capacity to develop innovation projects enabling new processes, products or business models based on circularity also tends to decrease. Therefore, the challenge in relation to the value chain of the construction sector in LAC would be finding the way into small and medium business to help them identify and develop opportunities fitted to their scale**. A relevant prospect for such businesses which are already in place in several countries, as Mexico, Brazil, Colombia, Chile and Uruguay, is the use of construction and demolition waste as material source. Examples in this regard will be seen in the case study section (see section 5.2).

Table 10: General features concerning the production of building materials in Latin America

Source: Modified from Llacer-Pantion (2017)

Material	Type of market	Production features
Cement, Steel, Aluminium, Glass, plastic pipes, electric components (wires, devices, control systems)	Dominant position by few multinational companies	• Large size production plants • Full standardised production • Long term investments • Strong technical and economic barriers for new entrants • Low sensitivity to market demand fluctuations. Prices mainly determined by production capacity • Low product differentiation based on quality or perception
Ceramics, paints, timber boards, concrete aggregates	Dominant position at national level by few large companies	• Large to medium size production plants • Full to medium standardised production • Medium sensitivity to market demand fluctuations • Some technical and economic barriers for new entrants • Certain degree of product differentiation upon quality or perception
Bricks, sawn timber, concrete blocks	Competitive market, with numerous small to medium local companies with no dominant positions	• Medium to small size production plants with some degree of informal production • Low product standardisation • High sensitivity to market demand fluctuations • No technical and economic barriers for new entrants • Product differentiation upon quality or perception

Professionals

Decisions concerning planning, development, and operation of the built environment are largely made by professionals in the fields of engineering and architecture. The intervention of professionals trained in other areas, such as natural sciences or social sciences, is usually restricted to the scales of land planning.

Sustainability approaches in architecture and engineering university programmes in LAC are either insufficient or absent. Therefore, these professionals start their professional career without the ability to understand and implement sustainability concepts into construction activities. **Therefore, when a client or investor pushes for green building issues, responsibilities on this regard are not taken by the core design teams, but are transferred to external consultants, who get involved after draft designs are already in place**, being thus limited to introducing adjustments that may grant green building certifications but do not necessarily lead to optimal solutions in terms of resource efficiency.

As will be seen in the initiatives section, **the introduction of collaborative design methodologies and tools based on Building Information Management (BIM) may be an opportunity to bring life cycle approaches to construction professionals in LAC**. An important challenge in this regard consists of helping the sector to identify digitisation and other areas of technological development as tools to increase both productivity and sustainability in the construction industry.

Labourers

Some academic institutions founded by governments in LAC countries are in charge of providing technical training in various areas, including construction activities. **While a proportion of workers in the construction sector are formally trained, as mentioned in section 3.3, labour informality, even inside the formal sector, exceeds 50% and may even reach 75%. This condition mainly affects workers who, in many cases, do not even have primary education.** These workers are usually trained on-site by other workers who started their work under similar conditions.

Adequate training of workers is a real challenge to increase productivity in the construction sector, and furthermore, is also necessary to combat social inequality in LAC cities, since educated and trained workers are more aware of labour rights and may qualify their work, thus obtaining better wages. The Colombian Chamber of Construction has been developing an initiative in this regard, called “Obras Escuela” (School at Works), where primary education followed by formal training is provided to construction workers at works. This initiative received the UNESCO Literacy Prize in 2019, and may be easily replicable to other countries in LAC.

Appropriate training of construction workers is essential for mainstreaming circularity into both formal and informal construction activities, because **workers often live in informal settlements and develop self-construction activities, either for themselves or their neighbours**. Therefore, informal construction systems and materials used for self-construction are currently influenced by the formal sector, to the point that the building stock in LAC cities is built with unreinforced masonry or confined masonry techniques (see section 3.4). **While this means ancestral and vernacular knowledge and techniques have been displaced, it may also provide an opportunity to introduce materials with less environmental impact in informal activities, through formal construction.**

4.2.6 Green Building Councils

The World Green Building Council and the National Green Building Councils are independent, non-profit organisations convening businesses and governments to collectively drive environmental, economic and social impact within the built environment on a national, regional and global scale. **In Latin America and the Caribbean, the Green Building Councils have played a pivotal role in promoting sustainable building principles for both the private and public sectors.** These councils may be classified in three categories, as follows:

- Established - a fully developed and operational organisation that is running impactful green building programmes of work - delivering change on a national level
- Emerging - an organisation open to membership and which has a strong foundation, such as an elected board and staff to manage day-to-day operations. It is expected to progress to Established status within 24 months.
- Prospective - an organisation at the early stages of development but which has put in place a comprehensive strategy on how it will operate and advance green building in its country. It is expected to progress to Emerging status within 24 months.

While there are established green building councils operating in Mexico, Brazil, Argentina, Colombia, Chile, Peru, Guatemala, Panama and Costa Rica, emerging councils are running in Paraguay and El Salvador and prospective councils are starting in Venezuela, Ecuador, Uruguay and Bolivia.

Green building councils can make a relevant contribution to mainstreaming circularity in the construction sector by creating partnerships, developing studies and research, disseminating criteria, principles and best practices. **In fact, the Green Building Councils have already contributed to develop new standards and guidelines adapted to national contexts. This is the case of the CASA certification system, developed by the Colombian Green Building Council, now being adapted to be replicated in other LAC countries, or the guide for the circular and sustainable management of construction projects, jointly developed by the Colombian Green Building Council and the Colombian Chamber of Construction.** This guideline will be shown in the initiatives section of this report.

4.2.7 Universities and other academic institutions

Mainstreaming circularity in the construction sector requires updating curricula of architecture, engineering and other disciplines in order for them to provide principles, concepts, methods and tools oriented to resource efficiency, pollution reduction, climate resilience and circular economy. This approach should also be introduced in academic institutions providing technical training to workers.

A recent study concludes that dissemination and implementation of the international frameworks for Education for Sustainable Development has been slow and sporadic in LAC education systems. Although there are some signs of implementation in university curricula of countries such as Brazil and Colombia, these practices have not been substantial or have not permeated the sustainable development strategies of higher education. This study also shows that the introduction of sustainability in professional programmes is more conspicuous in social and natural sciences than in architecture and engineering (Hernandez et al, 2018).

While the most evident role of Universities and other academic institutions in promoting circularity is including sustainability concepts, methods and tools in academic

programmes, these institutions carry out other relevant activities, including knowledge production based on research and **knowledge transfer** based on outreach activities. In this sense, **one of the main challenges for LAC is tackling the low investment in R+D, both in the public and private sectors. Another relevant area where Universities may enable circularity is in the construction, administration, operation and maintenance of their own facilities.** In this sense, university campuses could become life centres for experimenting circularity based ideas.

A study carried out in 2013 measured the performance of universities from 10 LAC countries in 11 thematic areas related to sustainability: sustainability policies, awareness and participation, social and environmental responsibility, teaching and learning, research and knowledge transfer, urban planning and biodiversity, energy, water, transport, waste and responsible sourcing. The study found that 64% of the evaluated institutions offer professional undergraduate programmes in environment or sustainability, while 56% percent offer specialisation, master's or doctorate. In addition, 47% of the universities have permanent programmes aimed at finding environmental solutions in the communities and 52% maintain continuous collaboration with the government's environmental policies (Andrés et al, 2013).

These results provide an insight to the multiple roles that educational institutions can play in the region, which can also be favoured by alliances and collaboration networks. There is currently an Alliance of Ibero-American Networks of Universities for Sustainability and the Environment (ARIUSA), which promotes the commitment of universities to sustainability. Currently this alliance has 26 university networks, in which 442 universities from 19 countries in the region participate, as well as Spain. Such initiatives may be a vehicle to promote a circular economy in LAC Universities.

4.2.8 Utility companies

As seen in section 3.4, urban coverage of energy and water services in LAC is relatively high for a developing region, but sanitation services have limited coverage. It was also seen in section 3.2 that social inequality in LAC may be 90% explained by urban spatial segregation, which tends to place poor communities in slums and other types of informal settlements with limited access to public services. Similarly, some social housing projects in LAC have been under-developed and may also limit the access of residents to these services. **Therefore, efficient provision of energy, water and sanitation services is a key aspect for reducing poverty and inequality in LAC.**

Utility companies in LAC have diverse characteristics that include private companies, government-owned companies, and mixed capital companies. Concerning energy services there are large companies with national or even transnational activity. On the other hand, municipal water and waste management services are mainly provided by local companies or can even be provided directly by municipal governments. There are some exceptions, such as large multinational companies providing water and sanitation services in different cities, likewise, there are companies providing both energy and water services at the same time.

Energy companies have been making important efforts by expanding renewable energies, implementing carbon reduction and climate resilience strategies, advancing on digital modernisation, experimenting with smart grids and development of new business models, such as thermal districts. Regional integration mechanisms, where the Regional Electricity Integration Commission and the Latin American Energy Organisation stand out, are helping disseminate best practices and initiatives.

Concerning water and sanitation, efforts have been more scattered as compared to the energy sector. **A recent study by the World Bank on circular economy in sanitation, shows some case studies in Mexico, Peru, Bolivia and Brazil** that include municipal wastewater reuse in industry and agriculture, water efficiency strategies and biogas production in wastewater facilities (Rodriguez et al, 2020).

Concerning municipal solid waste management, as discussed in section 3.4 and 4.1, these services are based on subsidised schemes that focus on collection and final disposal. **The fact that the recycling of this waste is below10% and that it depends mainly on informal workers, shows that companies and public institutions in this sector are still far from introducing circularity criteria in their activity.**

4.2.9 Owners and occupants

The category of owners and occupants is quite heterogeneous and **varies, depending on at least three factors** (Penagos, 2021):

- **The first factor is the type of building.** Houses, schools, offices, hotels, shops, hospitals, industrial facilities and public spaces have completely different uses and occupation times, which gives rise to different needs for accessibility, comfort, privacy and socialisation, as well as different behaviours in terms of energy and water use, and waste production.
- **The second factor is the cultural context and derivative cognitive biases.** This directly affects the decision making in terms of investment, purchase and rental in relation to construction systems and materials that are considered safer, more durable and aesthetically acceptable. These criteria end up being more important to owners and occupants than those related to resource efficiency or environmental impact
- **The third factor is related with the conditions of ownership, occupation and administration,** because the facilities used by a company, a public institution, a family or an individual can be owned or leased. Depending on the scale of the facility, third-party actors may also be required to take care of administration, maintenance, and security. The needs, interests, behaviours and decision-making power of all these actors vary significantly from one another. These variations determine the way costs and benefits from construction, operation and maintenance are either retained or transferred among incumbent actors

The consideration of these three factors are key to understanding the participation that owners and occupants may have in the transition to a circular built environment in LAC. Two areas of analysis may illustrate this idea:

Area 1. Construction systems and materials in housing buildings.

The purchase of a home by a poor or middle-class family in LAC is usually the most important investment of lifetime. A cognitive bias of masonry systems as being safest and most durable seems to be installed in different countries. This not only means that currently most of the built stock in the region uses this construction method, even in informal settlements (see section 3.4), but also makes it difficult to introduce other faster and more resource efficient methods to the housing market. The use of industrialised and prefabricated methods, as well as the use of alternative materials, is currently taking place in other types of buildings, such as retails, offices and industrial facilities.

Area 2. Dynamics of sustainable construction certifications

From the entry of international certification schemes more than a decade ago to the recent development of national certification schemes on green building, most certified projects are institutional projects, where the investor is also owner and occupant, thus receiving all the benefits that may be obtained at the operational phase, such as lower utility costs. On the other hand, the use of certifications in housing projects has depended either on State subsidies (Sustainable Housing Programme in Mexico and Minha Casa - Minha vida in Brazil, or soft loans provided by private banks (as is occurring in Colombia), thus generating incentives that allow additional investments to be compensated.

In summary, **while owners and users can benefit from the introduction of circularity criteria in the life cycle of the built environment, their degree of acceptance will depend on the type of building, cognitive biases derived from cultural context and ownership conditions. The formulation and effective implementation of public policies must incorporate strategies to tackle these basic issues.**

5. Initiatives and case studies

5.1 Initiatives

5.1.1 Circular Economy Coalition for Latin America and the Caribbean

The idea of the Circular Economy Coalition for Latin America and the Caribbean responds to the great interest and initiatives on circular economy promoted by governments, the private sector, research institutes and other social actors, as well as by the multiple initiatives of regional and international organisations providing technical support on innovation and circular economy approaches.

The Circular Economy Coalition's main objectives are:

1. Creating a vision and a common regional agenda in a circular economy.
2. Promoting promotion and awareness at the local, national, regional and global levels.
3. Facilitating South-South cooperation and North-South cooperation.
4. Developing tools and indicators.
5. Facilitating and offering training opportunities.
6. Implementing pilot projects and promoting the strengthening of alliances and collaborations.
7. Supporting the mobilisation of resources to adopt the circular economy in the region.
8. Facilitating cooperation and sharing knowledge with other actors.

The Circular Economy Coalition of Latin America and the Caribbean aims to provide a regional platform to enhance inter-ministerial, multi-sector and multi-stakeholder cooperation, increase knowledge and understanding of the circular economy, provide capacity development and assistance technique for the development of public policies for the circular economy and sustainable consumption and production.

The Coalition is an open platform. Any interested institution, organisation, NGO and government can join as a member of the Coalition according to their interest or their activities and scope in the circular economy.

The Coalition, coordinated by the United Nations Environment Programme (UNEP), is led by a steering committee composed of four high-level government representatives on a rotating basis, starting with Colombia, Costa Rica, the Dominican Republic and Peru for the period 2021 - 2022. In addition, it is made up of eight international organisations called Strategic Partners.

The Circular Economy Coalition responds to national and regional priorities. Its current focus falls into six areas, one of which corresponds to Cities and Construction,

5.1.2 BIM Forum Latin America

Several authors coincide in highlighting the role that digitalisation and collaborative design have in promoting the circular economy in the built environment. The most prominent methodological framework in this area is Building Information Management – BIM.

In 2018 The Inter-American Association for the Construction Industry – FIIC (see section 2.2) created a Work Group on BIM within the framework of the Network of Innovation Centres in Construction. This work group known as **BIM Forum Latam**, is a joint work environment that allows permanent coordination of strategies and generates useful information to promote the use and advance of BIM in Latin America and the Caribbean.

In collaboration with the IADB (see section 2.2) the BIM Forum LATAM at FIIC carried out a survey concerning the state of play of BIM in the region. The target group for this survey was composed of 879 companies, including developers, design studios and construction companies. Countries surveyed were Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Uruguay and Venezuela. Results show that 47% of companies have less than three years of experience with using BIM methodologies. While the most frequent use is concerned with the design phase, companies are also increasingly using BIM for planning and construction phases including calculations of quantities and costs. This survey is expected to serve as a tool for increasing the use of BIM by construction companies in the region, while the support provided by the IDAB is expected to have an impact on policy making aimed at promoting BIM via technical standards and public procurement (IADB & FIIC, 2020).

Although the survey does not analyse the contribution of BIM methodologies to increasing eco-efficiency, results indicate that 57% of the surveyed companies experienced benefits in terms of coordination and work completion times. It is important for institutions involved in both the survey and the BIM Forum Latam initiative to identify BIM methodologies as useful tools for introducing circularity criteria into construction activities, while Circular Economy is also acknowledged as the most suitable approach to address sustainability and productivity agendas in the construction sector (IADB & FIIC, 2020).

5.2 CASE STUDIES

Introduction

Circular Built Environment case studies showcase good practices of various project types in different life cycle phases across various countries. Environmental, social and economic impacts in selected projects are explained, and related Sustainable Development Goals identified. Compact illustrated overviews of the case studies summarise their main challenges and success factors. In providing these examples, it is expected that they can be successfully replicated, adapted to different environments and scaled up. The SBC programme thanks the authors, experts and other stakeholders contributing to the collection and dissemination of the case study data.

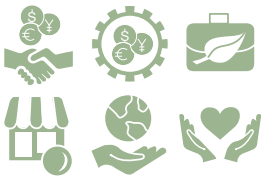
Webpage

https://www.oneplanetnetwork.org/sites/default/files/2021-11/SBC_cases_web_LAC_211102.pdf

Life Cycle Phase(s)

Project type

Impacts



Related SDGs

Sustainable and circular interventions in vulnerable communities: a proposal for social technology

Brazil, ongoing project

Project type

Research

Impacts

Environmental impacts,
social impacts,
green jobs and skills

Related SDGs

SDG1, SDG8, SDG10,
SDG11, SDG12

Life Cycle Phase(s)

Keywords

Policies promoting circularity, adaptability,
flexibility and refurbishment of buildings and neighbourhoods

Contact information

Elaine Varela
Universidade Federal da Bahia
elaine.varela@ufba.br

Overview

Housing units have a long life cycle, in which the construction process exploits a large number of resources. Improvements that extend the life of the building, and that do not necessarily imply the demolition and construction of new units, have significant potential for reducing the environmental impact. The challenge of the Project is to promote tools and technologies that underpin the ways to incorporate resilience and circularity into social housing, by prioritising these interventions, since the main objective is to provide affordable, decent and safe housing for the most vulnerable and poorest people, in order to make the most of the existing building material and consider the wishes and needs of these citizens.

Impacts

The project is still under development. Our vision is to have a prototype developed, tested and improved in the end of the project. In a one-year picture we expect to have a solid set of performance indicators and apply for funding (i.e. venture capital, etc), in order to grow and expand to more areas.

Replicability and scalability

The platform is being developed based on the design science research methodology. Considering the regional aspects, a similar artefact can be developed in other regions. On the other hand, the platform will be developed considering the particularities of one or more vulnerable areas located in Salvador (Bahia – Brazil), but it will developed considering the possibility to adapt for use in other communities.

Main challenges

The main challenges include: the complexity of the process and its various stakeholders; the lack of technological infrastructure in the sector; (3) the lack of knowledge and expertise in the applied technologies in the sector.

Main success factors

So far, the project identified and selected, through a systematic review of the literature, technologies applicable to the treatment of data to characterise the resilience of HUVS. In the future, the project will analyse data to characterise the resilience of housing units in a vulnerable situation (HUVS), considering identified assessment criteria, and will develop and evaluate a proposal for a data processing platform that seeks to guide the prioritisation of HUVS interventions to promote circularity and sustainability in the region; involving decision makers and citizens.

The main successes include: (1) the use of a structured methodology based on applied problem solving (Design Science Research methodology); (2) The project has important scientific relevance and impact for society, as its results involve the creation of an artifact that aims to directly contribute to the sustainability of buildings located in vulnerable communities; (3) Technological gains can provide a fluid, structured and efficient process, with a view to guaranteeing the quality, cooperation, responsibility and transparency necessary for interventions and constructive improvements in housing units in a vulnerable situation.

Green Chain Project: Blockchain technology for a Sustainable Management of Supply Chains in the Construction Industry, Brazil, ongoing project

Project type

Tools, guidelines and platforms

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG11, SDG12

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Management of material and waste flow

Contact information

Elaine Varela
Universidade Federal da Bahia
elaine.varela@ufba.br

Overview/Summary

In contrast to a world that lives the era of integration, transfer and interpretation of data and values almost simultaneously, the construction industry is the second least computerised industrial sector in the globe. Thus, concepts, such as Industry 4.0, Society 5.0, and Blockchain Technology, are yet to be fully adopted by the construction sector, bring relevant windows of opportunities for developers that understand the pains, desires and the complex context of this industry. The Green Chain Project aims to sole this real file problem: the lack of efficient, auditable and distributed systems to foster Circular Economy in the Construction & Demolition Industry (C&D industry).

The major pains points to be addressed by the Green Chain Project are: (1) inefficient mechanisms for registration, trade and traceability of all construction systems used in a building; (2) the search for a decentralised system to promote the best results with the lowest possible cost, creating a favourable environment to flourish Circular Economy business opportunities.

Impacts

The project is still under development. Our vision is to have a MVP (Minimum Viable Product) developed, tested, improved and launched and to reach the one-year timeframe with at least 30 clients in the State of Bahia in Brazil (5 free trails and 25 first adopters). In a one-year picture we expect to have a solid performance indicators and apply for funding (i.e. venture capital, etc), in order to grow and expand to new markets.

Replicability and scalability

The platform is being developed based on the design science research methodology. Considering the regional aspects, a similar artifact can be developed in other regions. On the other hand, the platform is being developed considering the supply and waste management processes of the construction industry in Brazil, but it can be adapted for use in other regions, as these processes have similarities around the world.

Main challenges

The main challenges include: (1) the complexity of the construction sector and its various stakeholders; (2) the lack of technological infrastructure, knowledge and expertise in the sector; and the uncertainties about governance, security and privacy, and (3) interoperability in processes.

Main success factors

So far, the project has carried out a systematic review of the literature, a process mapping through interviews and field observations and a proposal of framework. Algorithms for smart contracts are being developed to implement the model. The performance of the framework will be evaluated through simulation and quantitative and qualitative indicators.

The main successes include: (1) the use of a structured methodology based on applied problem solving; (2) the work focused on delivering a remarkable and intuitive user experience (UX) that seeks to influence users to join our community, using design elements that evoke familiarity and the feeling that the platform is responding to their pains and desires; (3) the high potential of impact once the platform is launched. In Bahia, the construction sector handles $ 2.2 billions per year in materials. In Brazil the construction retail sector handled $ 110 billions per year.

Construye 2025, Chile, ongoing project

Project type

Tools, guidelines and platforms

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG11, SDG12, SDG13

Life Cycle Phase(s)

Keywords

Policies promoting circularity, Construction and demolition waste management, Design for disassembly, reuse and easy to recycle.
Adaptability, flexibility and refurbishment of buildings and neighbourhoods, Use of reused or recycled content in new products and buildings, Financing circular processes

Contact information

Alejandra Tapia
Sustainability Director, Construye 2025
atapia.c2025@gmail.com

http://construye2025.cl

Figure 8: Front page of the Roadmap for Circular Economy in the Construction Sector.

Credit: Construye 2025, Chile

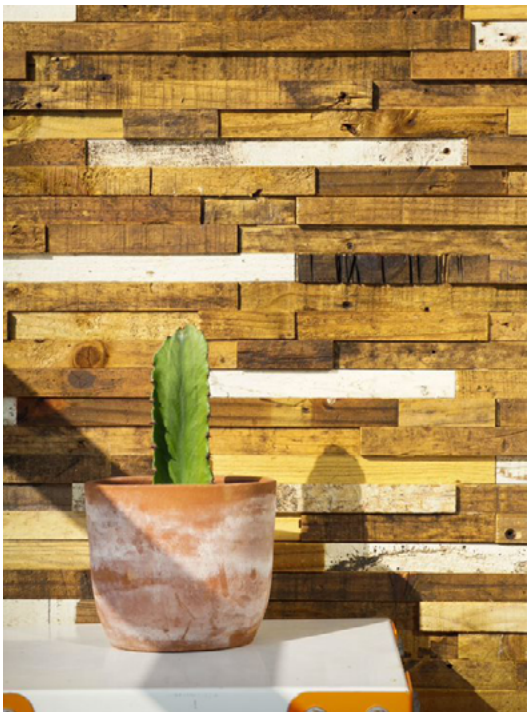


Figure 9: Recovered timber

Credit: Reviste https://www.reviste.cl/ and Construye 2025

Overview

Construye 2025 issued a roadmap for circular economy in the construction sector (Figure 8). This initiative is led by the public sector, in the context of an Inter-Ministerial agreement, with the participation and representation of the private sector and academia, with a national presence (Figure 15). The roadmap is based on the common vision / dream: “a country that manages its resources efficiently, positively impacting the social, environmental and economic spheres” (Figure 16). To achieve this, five strategic axes are defined that promote the circular economy under construction: the sustainable planning and ordering of the territory; public coordination and articulation; sustainable and circular ecosystems and value chains; the need to develop and strengthen data platforms that provide information for the design of public policies and the creation of new markets around the circular economy, and environmental remediation for the impacts resulting from the extraction of aggregates and improper disposal of C&D waste.

The project involves the Ministry of Housing and Urbanism, Ministry of the Environment, Ministry of Public Works, Corfo (Productive Development Corporation of the Ministry of Economy)

Replicability and scalability

The roadmap is an initiative with interministerial scope under a National Sustainable Construction Plan that incorporates Circular Economy and Carbon Footprint, among other topics. Based on the agreement, the Regional Commissions for Sustainable Construction are formed, these commissions operate in different regions across the Country

Main challenges

The construction sector, mainly the challenge is for the union to visualise the benefits of sustainable waste management and business opportunities around the circular economy.
Main successes

Main success factors

Articulation between different sectors of the public sector to align efforts based on collaborative work. Advances in regulatory framework, requirements in public tenders, initiatives and promotion of innovation and entrepreneurship (Figure 15).

Figures 10-14: Reviste is an emerging company recovering timber from construction works to manufacture new building materials. This initiative is supported by Construye 2025.

Credit: Reviste https://www.reviste.cl/ and Construye 2025

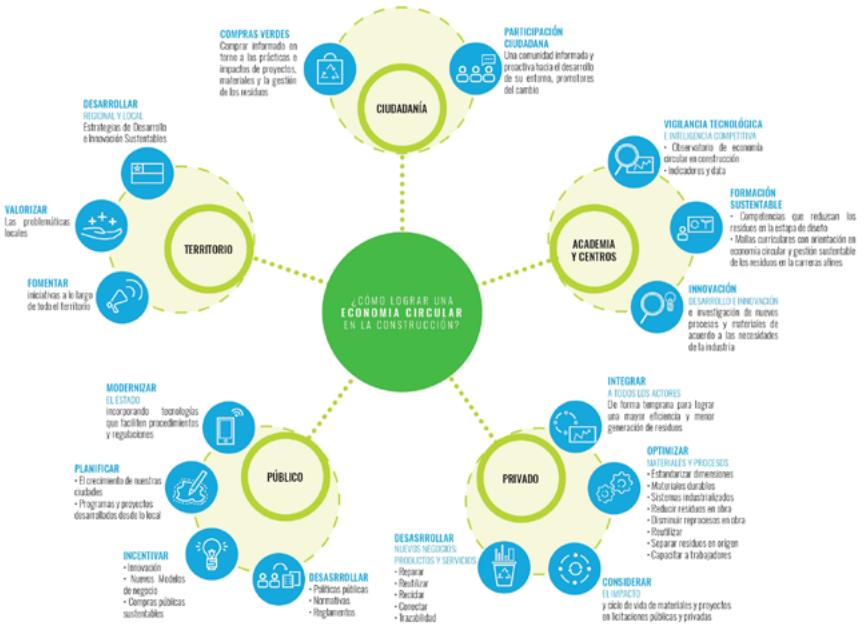


Figure 15: Stakeholder approach for Circular Economy in the Construction Sector.

Credit: Construye 2025, Chile

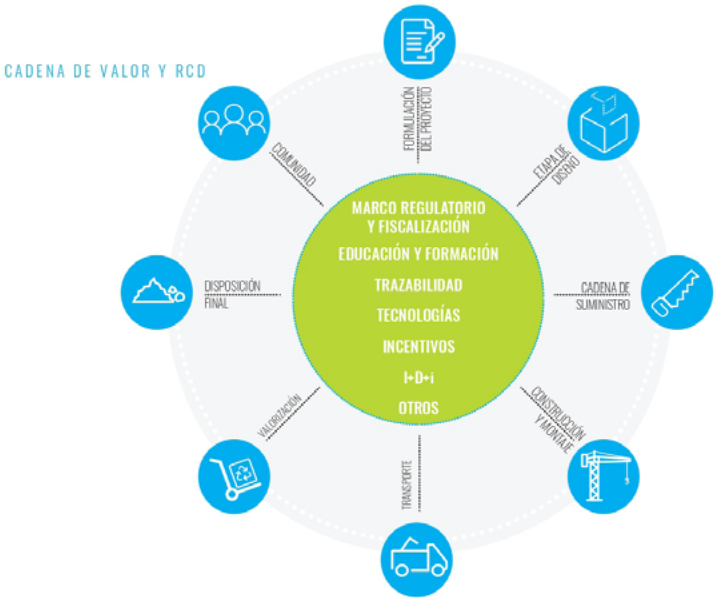


Figure 16: Value chain for Circular Economy in the Construction Sector under a Life cycle approach.

Credit: Construye 2025, Chile

Moravia Urban Renovation Project, Colombia 2014

Project type

Neighbourhood & policy

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG1, SDG3, SDG5, SDG6, SDG8, SDG10, SDG11

Life Cycle Phase(s)

Keywords

Policies promoting circularity, Adaptability, flexibility and refurbishment of buildings and neighbourhoods, Circular water

Contact information

Jordi Morato, UNESCO Chair on sustainability
jordi.morato@upc.edu

https://www.unescosost.org/post/restauraci%C3%B3n-socio-ambiental-en-moravia-medell%C3%ADn-colombia

Figure 17: Community gardening in Moravia

Credit: UNESCO Chair on Sustainability. Technical University Catalonia

Overview

By 1970s – 1980s “Morro (hill) Moravia” was Medellin´s municipal dump and the livelihood source for poor people working on waste recovering. After closure, it eventually became an informal settlement. By 2000s. The hill was housing more than 2000 families, living under precarious and permanent risk conditions (environmental pollution, fires, landslides). Starting in 2007, a project was developed by the Medellín mayor’s office, with the cooperation of the Government of Catalonia and the participation of the UNESCO Chair of Sustainability, with the aim of improving life conditions for the local community while reducing environmental risks.

Impacts

Social impacts: 2224 families relocated in more decent and safer settlement,
Environmental impacts: 4.4 hectares of land under environmental recovering by phyto-remediation, using buffer-strips and constructed wetlands
Green jobs and skills: 200 jobs created on community gardening and flowering production

Replicability and scalability

The project could be replicated in other urban environments in countries of the global south, considering local particularities

Main challenges

Initial resistance of the settlers to leave their environment and livelihood
Continuity of the project throughout the different periods of government

Main success factors

Improvement of the quality of life of poor communities, environmental and landscape recovery of a degraded urban area

Figure 18: Community gardening in Moravia

Credit: UNESCO Chair on Sustainability. Technical University Catalonia

Figure 19 & 20: Constructed wetlands installed in Moravia

Credits: UNESCO Chair on Sustainability. Technical University Catalonia

Figure 21 & 22: Moravia before (2004) and after (2014) intervention

Credits: UNESCO Chair on Sustainability. Technical University Catalonia

BioHotel, Colombia 2015

Project type

Building

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG6, SDG7, SDG11, SDG13

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Use of reused or recycled content in new products and buildings, Circular water, Circular energy

Contact information

Guillermo Penagos
MARES Consultoría sostenible S.A.S.
guillermo.penagos@upc.edu

https://repository.eia.edu.co/bitstream/handle/11190/1933/RamirezSantiago_2014_EvaluacionPracticasUtilizadas.

Figure 23: Building façade showing window elements designed for allowing natural light while avoiding sunshine income, thus providing energy efficiency and indoor comfort

Credit: MARES Consultoría Sostenible S.A.S.

Overview

Terra Bio Hotel is a small hotel with 41 rooms built in the city of Medellín, incorporating sustainability criteria in design and construction. The project was built on urban land on a lot where a house previously existed, which was deconstructed and dismantled, allowing the reuse of materials and elements. The soil removed in the excavation was used for the production of aggregates that were used in the concrete blocks that form the envelope. The water used in the construction phase was treated and recycled within the process. The architectural design used bioclimatic strategies for ventilation and natural lighting. In its operation phase, the building captures rainwater and reuses previously treated gray water for tiolets and general cleaning. The solid waste management room includes a composting system for the use of organic waste.

Impacts

- 70% of materials from deconstruction of pre-existing building recovered (Figures 24-25)
- 60% of soil from excavation used for construction materials (Figure 26)
- Energy efficiency and comfort provided by passive design (Figures 27-28)
- 50% of water needs at operational stage reduced from water efficient devices, rainwater use and grey water reuse (Figure 29).

Replicability and scalability

The principles of the project are replicable, but it is important to evaluate the economic and financial impacts of the decisions made.

Main challenges

Project management took a long time to make decisions, which delayed development time and led to cost overruns. Some sustainability-oriented decisions were not easily understood or accepted by local authorities.

Main success factors

Neighbours involved in the environmental management of the project, several articles published in events and scientific magazines, dissemination of the project in local events, quantifiable reduction of environmental impacts.

Figure 24 & 25: Indoor and Outdoor inventory of existing building for material recovering previous to deconstruction of the pre-existing building

Credits: MARES Consultoría Sostenible S.A.S.

Figure 26: C&D waste from excavation and concrete blocks fabricated from it

Credit: MARES Consultoría Sostenible S.A.S.

Figure 27: Building façade showing window elements designed for allowing natural light while avoiding sunshine income, thus providing energy efficiency and indoor comfort

Credit: MARES Consultoría Sostenible S.A.S.

Figure 28: Grey water and rainwater treatment plants installed in the Biohotel

Credit: MARES Consultoría Sostenible S.A.S.

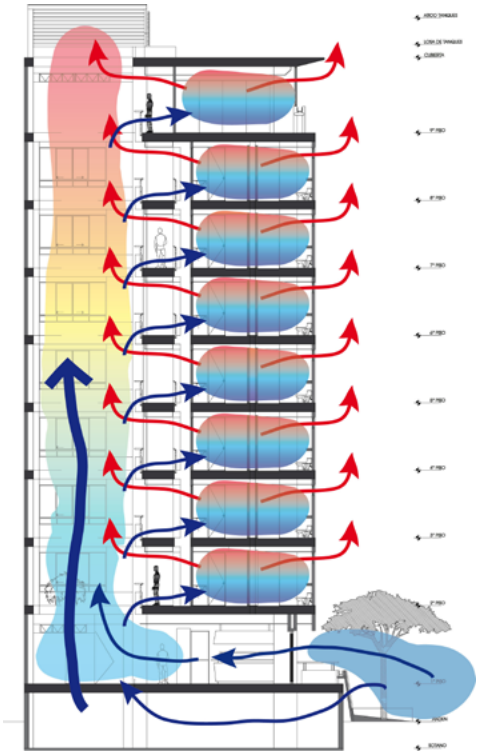


Figure 29 (right): Schematic representation of natural ventilation system

Credit: MARES Consultoría Sostenible S.A.S.

Sinesco C&D waste integral management, Colombia 2010-

Project type

Waste valorisation

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG11, SDG12

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Use of reused or recycled content in new products and buildings

Contact information

Anibal Sepulveda
Directive Board President, SINESCO Group
sinesco@sinesco.co

https://www.sinesco.co/

Figure 30: Stony waste separated for recovering

Credit: SINESCO S.A.S

Figure 31: Timber pallets separated for material recovery

Credit: SINESCO S.A.S

Overview

Sinesco is a company offering services of collecting, managing and recycling construction and demolition waste (Figures 30-32), producing recycled aggregates that are supplied for on-site concrete fabrication in construction works. We work to satisfy and exceed the needs of our clients, with competent and committed personnel, promoting sustainability and the culture of the circular economy in the construction sector and profitability for our shareholders. We are one of the first companies in Colombia working on the integral management of C&D waste and we have helped construction companies respond to the emerging regulatory framework in Colombia that made the reuse of C&D waste mandatory as of 2018

Impacts

85 thousand tonnes of recycled aggregates annually produced (Figure 30)
New building materials produced from C&D waste (Figure 32)

Replicability and scalability

The initiative already operates on an industrial scale and it is potentially replicable in all cities of Colombia and Latin America

Main challenges

Obtaining environmental permits for the operation was a challenge at the beginning, the lower service prices offered by operators that do not advise their clients, or value or take advantage of waste, hinders the expansion of the business

Main successes

The main success consists of having put the business model and the waste reuse plant into operation before the regulatory framework at the national level pointed in this direction.

Figure 32: Expanded polyurethane pallets separated for material recovery

Credit: SINESCO S.A.S

Figure 33: Cobblestones out of C&D waste

Credit: SINESCO S.A.S

Development of alkaline activated concrete from silic-aluminum waste, as an alternative for reducing greenhouse gas emissions in the construction sector, Colombia, 2019

Project type

Research

Impacts

Environmental impacts,
social impacts &
green jobs and skills

Related SDGs

SDG12, SDG13

Life Cycle Phase(s)

Keywords

Use of reused or recycled content in new products and buildings

Contact information

Nicolás Pardo Alvarez
M.Sc. Fellow, Universidad de Antioquia
nicolas.pardo.alvarez@gmail.com

http://bibliotecadigital.udea.edu.co/handle/10495/14232

Figure 34: Best condition mortar (CFm30) to develop concrete

Credit: Nicolas Pardo

Overview

Mine tailings cause several environmental impacts, due to high and progressive mineral exploitation, as well as waste management considerations. This study focuses on the use of waste from the mining industry in Antioquia, Colombia (Figure 35-36), to manufacture construction materials. The study found that use mining waste as the main cementitious material with partial substitutions of cement, can increases compressive strength by 10% and reduces greenhouse gas emissions by 29%, compared to reference concretes (Figure 37).

Impacts

- Identify adequate compressive strength conditions for the possible implementation of concrete with mining waste.
- Validate the reduction in greenhouse gas emissions in concrete with mining waste.
- Identify the economic increases per cubic meter of concrete with mining waste.
- Determine the reduction in the carbon footprint of a building when implementing concrete with mining waste.

Figure 35: Sampling in El Bagre, Antioquia, Colombia. Flotation tails corresponding to vein gold mining waste
Credit: Nicolas Pardo

Figure 36: Laboratory work drying for subsequent milling
Credit: Nicolas Pardo

Replicability and scalability

The project is replicable with a complete study of characterisation of raw materials. Scalability depends on the type of mining waste. Once the type of waste has been identified, a complete physical and chemical characterisation must be carried out. Subsequently, after validating the residue, it is taken to particle sizes similar to cement, and then the dosages of the concretes are calculated.

Main challenges

- To validate the other properties of resistance and durability of conventional concretes.
- To validate the economic and environmental cost associated with transporting mining waste to cement companies for use.
- To socialise the results with a large number of mining companies for their possible implementation

Main success factors

The study identified a condition in which the compressive strength of concrete with mining residues was higher than that of reference concrete, reducing the emissions associated with manufacturing. After analysing the feasibility of implementation, the results of the analysis showed that concretes with alkaline-activated mining residues are suitable for substituting conventional concretes, with a reduction in the building of 8.02% in greenhouse gas emissions.

Guidance for sustainable and circular management of construction Works, Colombia, 2021

Project type

Tools, guidelines and platforms

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG11, SDG12

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Use of reused or recycled content in new products and buildings, Circular water, Circular energy, Construction best practices

Contact information

Tatiana Carreño
Colombia Green Building Council
tcarreno@cccs.org.co

https://www.cccs.org.co/wp/download/guia-de-gestion-sostenible-y-circular-en-obras/

Figure 37: Front page Guidance for sustainable and circular management of construction works

Credit: Colombian Green Building Council

Overview

The Guide for Sustainable Management and Circularity in Construction Works (Figure 37), has the intention of contributing to the sustainable movement in the construction sector of Colombia. In this publication, you will find a series of strategies focused on the construction phase of projects, as well as considerations on the pre and post-construction stages that provide specific support to the builder. The guide highlights the builder as an actor in the value chain highly committed to sustainability, and with his actions it greatly reduces and mitigates waste and emissions, improves environmental impacts and contributes to the decarbonisation of the sector.

For its preparation, interviews were carried out with experts and professionals responsible for caring for the environment and direct work on site, supported by secondary resources obtained from other studies and existing guides on the matter. At the end of each chapter and sub-chapter you can find a checklist that summarises the actions that the builder must take, in order to follow up on a sustainable work.

The document was structured and prepared by the Colombian Council for Sustainable Construction (CCCS) and the Colombian Chamber of Construction (CAMACOL), two leading organisations with extensive experience in the construction and sustainability sector.

Impacts

The guide has annexes for the application of all the best practices described: Master checklist, Matrix of environmental aspects and impacts, Erosion, sedimentation and discharge control, Inspection format, RCD management, RCD control format, Traffic management, Air pollution control, Indoor air quality, Neighborhood communication format, Noise control, Flora and fauna management, Signage and Education on site

Replicability and scalability

The guide can be used by the construction team of the project and interested parties, including the different contractors, subcontractors, construction managers and people in charge of the planning, execution and control of the work.

The guide can be used by the construction team of the project and interested parties, including the different contractors, subcontractors, construction managers and people in charge of the planning, execution and control of the work.

Main challenges

The collection of information from professionals, construction companies and other actors with the best practices implemented, since there are several who have been working on sustainability. The articulation with national and international regulatory requirements and the structuring of the document so that it is practical and easily applicable. Everything was achieved.

Main success factors

The guide is structured in 4 large chapters following the sequence of the project, starting from the considerations for collaborative methodologies that are transversal to every project, followed by the considerations from the planning and design with emphasis on the decisions that will influence the sustainability of the project construction, giving way to pre-construction where the work is planned and ending with a chapter associated with construction where the activities for the execution of the work are broken down according to a standard construction process. The main success is to unify all the best practices in a single document. Cover not only the aspects of work but also the previous and subsequent phases as well as collaborative methodologies, and deliver a tool that is easy to apply for builders in any type of building work.

CEMEX Circularity strategy

Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Trinidad and Tobago, Ongoing project

Project type

Material manufacture

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG6, SDG7, SDG11, SDG12, SDG13, SDG15

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Use of reused or recycled content in new products and buildings, Circular water, Low carbon construction meterials, industrial symbiosis, biodiversity recovering

Contact information

Camilo Alejandro Sanchez
Sustainability Director for South America, CEMEX
CamiloAlejandro.Sanchez@cemex.com

https://database.globalreporting.org/organizations/849/
https://www.cemexcolombia.com/sostenibilidad/gestion-ambiental/economia-circular
https://www.cemexcolombia.com/sostenibilidad/modelo-de-sostenibilidad

Figure 38: Tree production for biodiversity recovering

Credit: CEMEX

Overview

CEMEX is a global building materials focusing on concrete and cement products. The company's sustainability model incorporates circular economy activities that include: 1) the substitution of raw materials for resources with less environmental impact, including secondary materials from other economic sectors, 2) energy efficiency and substitution of fossil fuels in production of energy from non-recyclable waste, 3) efficiency, recirculation, reuse and industrial symbiosis in water management, 4) Recovery of quarry sites to enable ecological connectivity and recovering biodiversity.

Impacts

- Low to zero-carbon concretes based on: 1) Clinker plants using biomass (wastewater sludge, rice scale) and non-recyclable waste (non-recyclable plastics) as energy source, 2) Cement substitution by alternative raw materials (clay) and industrial waste (fly ash, mil scale), 3) Recycled aggregates from C&D waste and 3) Compensation of transport emissions via reforestation plans (Figures 38-42)
- Circular Water: Currently 95% of concrete operations and 75% of cement production plants recirculate and recycle wastewater from production process. A concrete plant in Colombia is treating water from the food sector and reusing it for concrete production in a joint initiative with a food company "Meals de Colombia S.A
- Recovery of former quarry sites: Reshaping of soils and reforestation of quarry sites after finishing extraction activities. Biodiversity is being monitored and is being recovered" (Figures 38-41).

Replicability and scalability

The projects developed so far have been taken on an industrial scale and are part of the company's production processes. Due to the global scope of the company, all projects are potentially replicable, according to local peculiarities.

Main challenges

- Political cycles hinder the continuity of projects that involve the public sector
- Legal instability in Latin American countries
- Persistence of disincentives to circular activities
- Lack of instruments to internalise environmental externalities
- Lack of sustainability and circularity criteria in public procurement and public-private alliances
- Lack of skills and knowledge concerning sustainability and circularity in professionals related to the construction sector (architecture and engineering).

Main success factors

Projects built with materials produced with circular processes, urban developers and projects that are interested in reducing the environmental impact of their activities, alliances with companies from other sectors, alliances with the public sector, compliance with national environmental regulatory frameworks and contribution to compliance of global environmental goals.

Figure 39 & 40 (up, left & right): Rice scale used for energy production

Credit: CEMEX

Figure 41 (left): Recovery of former quarry sites

Credit: CEMEX

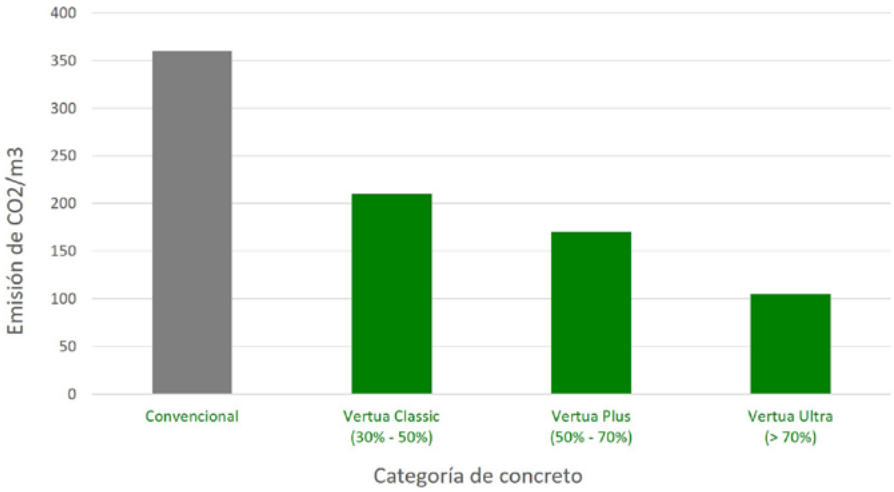


Figure 42: Low carbon concretes emission factors

Credit: CEMEX

Circular economy of organic waste for cities and rural areas

Colombia, Cuba, Ecuador and Paraguay, 2010-

Project type

Waste valorisation

Impacts

Environmental impacts,
social impacts &
green jobs and skills

Related SDGs

SDG11, SDG12

Life Cycle Phase(s)

Keywords

Policies promoting circularity, Financing circular processes, Composting, Urban Agriculture

Contact information

anibalsepulvedav@gmail.com

https://www.earthgreen.com.co
https://www.youtube.com/channel/UC_VjayJxN5N7AuygJKLGHFw

Figure 43: Urban gardening using compost produced by earthgreen systems

Credit: Earthgreen S.A.S.

Overview

2 000 million tonnes / year of waste are generated in the world. 50% are organic. In Latin America, 200 million tonnes / year are generated; 100 million tonnes / year are biodegradable organic waste. In South Africa, 175 million tonnes / year are generated; 45-50% are organic waste and wood, biodegradable, which can go to composting (80 million tonnes / year). 27% are recyclable waste. 9% are plastics, 10%, paper and cardboard. 70% of the waste goes to open dumps and only 1% goes to composting. With composting and recycling programmes, 50-65% of the waste generated can be used. With 80 million tonnes / year of organic waste, 30 million tonnes / year of compost or organic fertilisers are produced by composting, in 60 days, with which they recover or improve 6 million hectares / year (5 tonnes / ha / year), for Urban gardening (Figure 43), Regenerative Agriculture, organic and healthy food production

Impacts

Earthgreen has standardised to date 16 composting models: 8 SAC models: Small-scale Autonomous Composting Systems (1 to 500 families of 4 people / family: 1 kg to 500 kg / day of organic waste) (Figure 44) and 8 models of Stacks Mixed Earthgren (PME), for medium-scale composting plants: 550 to 25 000 families (600 kg, up to 50 tonnes / day of organic waste). To date, there are success stories, in all SAC systems and in composting plants, up to 15 tonnes / day. In the Earthgreen Circular Economy model there are: development, prototype validation, patented, production modeling, production, marketing, installation, commissioning of composting systems. In the chain of replication and growth of the model and value proposition in other countries, or regions of the world, the complete proposal can be exported and implemented, with training and training throughout the value chain of small and medium-scale composting.

Replicability and scalability

Earthgreen’s value proposition is replicable to any country in the world. You have all the designs, plans, specifications, production. There are processes of commercialisation, training, training, community education. They are known and have intervened in the planning and local, regional organisation, with plans, development of local regulations and policies, they can be adapted in measurable and controllable times. The achievements of 10 years can be replicated in 3 years in other countries, with projections of exponential growth and high economic, social and environmental impact.

Earthgreen is scalable in all social sectors, agro-industry, commerce, institutions, education, health, security, recreation. How: 1) Dimension of the problem, characteristics, need for the solution. 2) Production of the models in S. Africa with the. Rotational molding industry. 3) Business agreements to produce in Africa. 4) Manufacture of molds in S.Africa, Europe or China, or in Colombia. 5) Training in the manufacture, assembly of composters. 6) Training of personnel in S. Africa in composting according to the Earthgreen model. 7) Planning and implementation of pilot projects, with training of local personnel. 8) Adaptation of local planning models for Waste Management, with training of technical personnel and government managers and leaders. 9) Development and adaptation of pedagogical models to learn by doing with communities. 10) Information systems. 11) Agreements with universities for applied research in composting.

Main challenges

1) Marketing of the solution. 2) Production of composting models. 3) Growth and working capital

Main successes

1) Design of composters. 2) Acceptance of models when known. 3) Usability: customer satisfaction and educational projection of the Earthgreen model are continuously reported

Main success factors

Composting is the most efficient and demonstrative alternative for the Circular Economy of organic matter. It is the alternative, more economical and universally viable, to recycle and take advantage of biodegradable organic waste; composting allows, that the C, O, N, P; K, S, Ca, and beneficial micro organisms, return to soils, elements that are in 95% of living beings and are essential for the production of healthy food in the world. Earthgreen composting models are patented and are based on thermodynamic principles, bio oxidative, production variables per person of organic waste, they are tested and validated in laboratories and applications for 10 years.

Figure 44: Small composting systems that can be used indoors for houses and apartments

Credit: Earthgreen S.A.S.

Green Sacks Argos, Colombia and Honduras, ongoing project

Project type

Waste valorisation

Impacts

Environmental impacts, social impacts & green jobs and skills

Related SDGs

SDG12

Life Cycle Phase(s)

Keywords

Construction and demolition waste management, Design for disassembly,
Reuse and easy to recycle, Waste reduction, disposal

Contact information

Maria Isabel Cardenas
Sustainability Director, Cementos Argos
mcardenasb@argos.com.co

https://colombia.argos.co/sacos-verdes/
https://www.youtube.com/watch?v=Ib91LyVsQnc
https://www.youtube.com/watch?v=9-8pdtk0ARU
https://youtu.be/HqPP-BGeXjk

Figure 45: Green sacks programme

Credit: Cementos Argos

Figure 46: Used up sacks packed for valorisation

Credit: Cementos Argos

Overview

Based on our Sustainability and Environmental strategy, in 2013 we started with the Green Sacks Programme (Figure 45), an initiative to use cement sacks to reduce waste at the construction site and give them a correct disposal. The purpose of contributing to the design and construction of more sustainable and environmentally friendly projects has driven us over the years to raise awareness of the importance of collecting and using waste paper sacks after

using cement. It is no secret that empty sacks are considered garbage at construction sites and can end up anywhere, generating waste and particulate matter emissions. Paper can be recycled up to 11 times and can be converted into different types of paper and cardboard; in addition, paper recycling saves 30% of the electrical energy and 70% of the water that would normally be used to produce it from wood.

The Green Sacks programme arise from the need to provide an solution to our customers regarding the question “What is the correct disposal of the sacks?”. Therefore, in 2013 we conducted a pilot with two construction companies and approximately 20 construction sites in the city of Medellin, we conducted an investigation on the proper use of these bags and we made inroads in the generation of culture in works for the collection of the bags, in our drivers for the collection of these and our logistical and administrative staff to handle the bags inside our distribution centre, we were able to demonstrate the interest of everyone in contributing to the environment, the results were satisfactory, we achieved a return of 60% of the material we dispatched, and with this experience we began the launch of the programme as such in 2014, and there we began to receive much more material and seek logistical solutions to take advantage of everything that came to us from our customers.

Impacts

With the Green Sacks programme, the amount of trees and water required for the manufacture of new products is reduced, as these sacks are the raw material for new products in the fiber-cement and paper pulp industry (Figure 46). From 2013 to 2020, 10,025 trees have not been cut down and 80,198 m^3 of water have not been consumed, which is equivalent to supplying 471,751 people in one day.

Replicability and scalability

The project is scalable. However there are several challenges concerning logistics and the linkage of some costumers. The project is also replicable through the work with the provider of the sacks and the training of the clients.

Main challenges

The Green Sacks programme was born as a proposal to meet the needs of our customers in IDEAXION, a programme that we have within Argos to promote initiatives that create value, based on the need of customers to give a correct use to these sacks, we started looking for companies that could take advantage of this material, which had a limitation in the recycling of paper, However, during the green sacks pilot we managed to find companies interested in testing this material, until they were able to adjust their products with the characteristics of our sacks, such as the ink of the packaging, the texture, the packaging, the cement content, among others.

Main success factors

With this initiative we stop cutting down trees and consuming water for the production of new materials, we avoid waste and handling of material used in the projects, we improve cleanliness and reduce the dispersion of particulate matter, we avoid polluting because the cement sacks are not being disposed of properly, generating an impact on the environment because once the cement is used, the empty sack becomes a non-usable waste. At Argos we are convinced that all actions that help care for the environment contribute to a better future for everyone.

6 The circular built environment and the Regional progress on SDGs

6.1 Global and regional survey on SDG based indicators for the circular built environment

While the circular economy is not an explicit concept in the 2030 Agenda, there is a growing global consensus on the potential contribution that the circular economy could make to meet the SDGs. By studying indicators associated with the SDG targets, a list of 59 indicators related to circularity principles was compiled. Since May 2020, a global survey has been implemented to determine the relevance of these indicators to inform the circular built environment in the view of partners and experts from the Sustainable Buildings and Construction (SBC) programme network.

By September 2021, the global survey received 176 responses from international experts identifying SDG11, SDG12, SDG13 and SDG9 as crucial for the circular built environment, followed by SDG6, SDG7, SDG8 and SDG3. Respondents in the LAC Region set practically the same priority order conferred by the global responses. Only relevant differences occurs in SDG15, where regional responses confer low importance, while global responses confer medium importance (Figure 47).

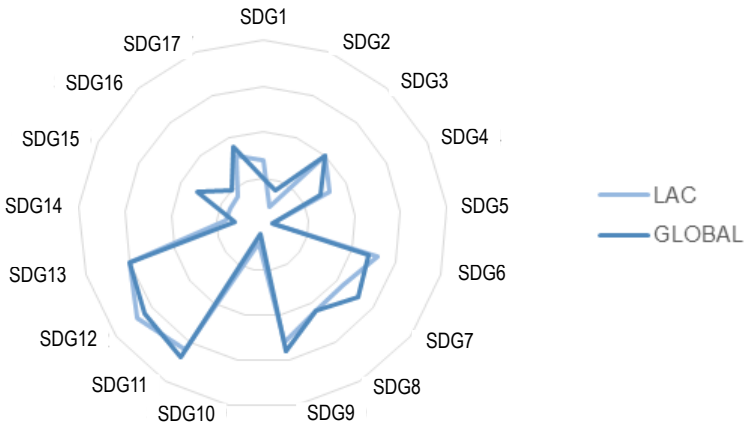


Figure 47: SDG priorities concerning the circular built environment according to global survey. Comparison of global and regional responses

Source: One Planet SBC Circular Built Environment (CBE) Survey on SDG based indicators

Concerning specific SDG indicators, 14 indicators were prioritised by global respondents , where highest relevance is given to material footprint (12.2, 8.4); waste management (11.6) and recycling (12.5); use of local materials (11.C) and use of clean technologies (9.4). High importance is also conferred to water efficiency (6.4) and wastewater treatment (6.3); integration of climate change policies (13.2); access to clean energy (7.1) and use of renewable energies (7.2); access to affordable housing (11.1); implementation of sustainable public procurement (12.7) and scientific and technological development (12.A) (Table 11).

Table 11: SDG indicators prioritised from the global survey. Priority indicators are those considered as crucial by 50% or more survey respondents

Source: One Planet SBC Circular Built Environment (CBE) Survey on SDG based indicators

#	Indicator	Respondents finding the indicator crucial (%)
1	12.2 efficient use of natural resources: material footprint	80%
2	12.5 waste reduction, recycling and reuse: national recycling rate	80%
3	8.4 resource efficiency in construction: material footprint	79%
4	11.C sustainable and resilient buildings utilising local materials: financial support	75%
5	9.4 clean and environmentally sound technologies: CO2 emission per unit of value added	67%
6	11.6 air quality and waste management: proportion of urban solid waste regularly collected	61%
7	6.3 water quality: proportion of wastewater safely treated	60%
8	13.2 climate change measures: countries with an integrated policy/strategy/plan	59%
9	6.4 water use: change in water-use efficiency	58%
10	7.2 renewable energy: share in the total final energy consumption	58%
11	11.1 affordable housing: proportion of urban population living in inadequate housing	57%
12	12.7 public procurement practices: countries implementing policies	54%
13	7.1 access to affordable and modern energy: reliance on clean fuels and technology	54%
14	12.A scientific and technological capacity: support to developing countries	54%

Respondents from the LAC region also confer highest importance to indicators concerning material footprint (12.2, 8.4), waste management (11.6) and recycling (12.5), use of local materials (11. C) and use of clean technologies (9.4). Regional responses also coincide with global responses on the relevance of indicators concerning water efficiency (6.4) and wastewater treatment (6.3); integration of climate change policies (13.2), access to clean energy (7.1) and use of renewable energies (7.2); implementation of sustainable public procurement (12.7) and scientific and technological development (12.A). However, there are some peculiarities, which are described below (Table 12):

- The most notable difference is that 28 indicators are prioritised by LAC respondents, comparing to 14 indicators prioritised by global responses.
- Regional respondents also give higher importance to the access to affordable housing (11.1) than global respondents. Likewise, mainstreaming education (12.8) and strategies (11.B.1) concerning natural risks, which are not considered by global responses, appear among the first ten selected indicators in the LAC region.

- Other indicators prioritised by respondents from the LAC region and not by the global survey include disaster risk management (13.3, 11.B.2); investment on research and innovation (9.5, 9.B, 7.A); reduction of informal employment (8.3), inclusive urbanisation and access to basic services (11.A, 1.4); biodiversity protection (15.1, 15.A) and the proportion of women in managerial positions (5.5).

With the exception of women participation in managerial positions, all particularly highlighted priorities by LAC respondents were already discussed as priority aspects of the built environment in section 3 of this report. All those findings show coherence between the vision of the experts and the background information used for the preparation of this report.

Table 12: SDG indicators prioritised from the regional LAC survey. Priority is given to indicators considered as crucial for 50% or more responses. Core indicators in the global survey are marked green and secondary indicators blue. Indicators prioritised at LAC but not at global responses are shown with black

Source: One Planet SBC Circular Built Environment (CBE) Survey on SDG based indicators

#	Target: Indicator	Respondents finding the indicator crucial (%)
1	**12.5** waste reduction, recycling and reuse: national recycling rate	82%
2	**8.4** resource efficiency in construction: material footprint	77%
3	**11.C** sustainable and resilient buildings utilising local materials: financial support	77%
4	**12.2** efficient use of natural resources: material footprint	77%
5	**9.4** clean and environmentally sound technologies: CO2 e mission per unit of value added	77%
6	**11.1** affordable housing: proportion of urban population living in inadequate housing	68%
7	**12.8** sustainable development awareness: extent to education mainstreamed	68%
8	**12.A** scientific and technological capacity: support to developing countries	68%
9	**6.3** water quality: proportion of wastewater safely treated	68%
10	**11.B.1** resource efficiency policies: local governments implementing risk reduction strategies	64%
11	**12.7** public procurement practices: countries implementing policies	64%
12	**7.1** access to affordable and modern energy: reliance on clean fuels and technology	64%
13	**11.6** air quality and waste management: proportion of urban solid waste regularly collected	59%

#	Target: Indicator	Respondents finding the indicator crucial (%)
14	**7.2** renewable energy: share in the total final energy consumption	59%
15	**6.4** water use: change in water-use efficiency	59%
16	**13.2** climate change measures: countries with an integrated policy/strategy/plan	59%
17	**13.3** awareness-raising: countries with impact reduction and early warning curricula	59%
18	**11.B.2** resource efficiency policies: countries with national and local risk reduction strategies	55%
19	**9.5** technological capabilities: research and development expenditure as a proportion of GDP	55%
20	**9.B** domestic technology development: proportion of medium and high-tech industry value added	55%
21	**8.3** policies supporting productive activities: proportion of informal employment …	50%
22	**11.3** inclusive urbanisation: proportion of cities with a direct participation structure	50%
23	**11.A** regional development: population living in cities that i mplement development plans	50%
24	**7.A** clean energy research and technology: mobilised amount of USD	50%
25	**1.4** rights to economic resources: access to basic services	50%
26	**5.5** women's participation: proportion of women in managerial positions	50%
27	**15.1** ecosystems: important sites for terrestrial and freshwater biodiversity	50%
28	**15.A** biodiversity: ODA and public expenditure on conservation and sustainable use	50%

6.2 The role of circular economy in realising the Agenda 2030 in the LAC region

By 2019, progress in meeting the SDGs in the LAC region revealed good results in the case of SDG13 (climate action), SDG11 (sustainable cities and communities), and SDG6 (clean water and sanitation), SDG7 (renewable and clean energy) and SDG1 (end of poverty). However, the Region was performing poorly on targets concerning SDG9 (industry, innovation and infrastructure; SDG10 (reduction of inequalities) and SDG15 (life of terrestrial ecosystems) (CODS, 2020).

The 2021 progress report published by ECLAC shows that the COVID-19 pandemic will bring setbacks in 61 of the indicators included in the SDG Index for Latin America and the Caribbean. The most obvious setbacks correspond to SDGs 10, 8, 1, 3, 4, 2 and 5. On the other hand, a positive impact is visualised in 20 indicators for SDGs 14, 12 and 13. However, such positive effects are not an outcome from policies and programmes, but rather due to the contraction of the economy. Therefore, these effects may not be considered as an actual progress towards fulfilling the SDGs (CELAC, 2021).

The ECLAC Report proposes a lists of strategies for a transformative recovery that may lead the LAC Region to realise the Agenda 2030 in the post-COVID era. Developing a circular economy is a priority among this list. This proposal emphasises the need to strengthening local productive chains while shifting public policies, investment and financing systems to encompass the entire life cycle of products. Furthermore, standards on resource efficiency, reparability and recyclability as well as restrictions on highly toxic substances should be enforced. It is also important to promote eco-labelling mechanisms, while updating consumer laws, promoting shared use and enhancing green public purchases. To make new businesses viable, it is important to foster innovation and training, aligning fiscal policy with sustainable consumption and production goals, and forge regional and sub-regional alliances to increase the scale and potential of new activities and new businesses (CELAC, 2021).

6.3 The potential contribution of the circular built environment to fulfilling the SDGs in the LAC region

While the ECLAC proposals on enhancing circular economy are consistent with most priorities identified by both global and regional respondents to the survey prepared by the SBC programme, it is notable that ECLAC emphasis is placed on the production and use of consumer goods, while the contribution of cites and the built environment is not considered. Therefore, it is important to continue the advances on the analysis of **the relations between the circular economy, the urban agenda and the SDGs to provide a broader vision about the potential of the circular built environment to contribute to the global aspirations of sustainable development.**

As showed in section 3 of this report, while growth rates of urban population in LAC are decreasing, urban areas continue sprawling at the expense of both rural and natural areas, which increases vulnerability to natural risks and climate change; threatens food security; hinders infrastructure development; increases costs of supplying basic services and makes cities less productive. When considering also that social inequality in the Region is clearly related to urban spatial segregation, **it is clear that transition towards circular built environments in LAC must be encompassed with a transition towards urban resilience, ecosystem regeneration and social inclusion**, thus SDGs 15 and 10 must be prominently considered here.

However, these relationships are not always obvious. In fact, at the overall SDG level, regional respondents to the SBC global survey did not give importance to SDG15 and SDG10. However, when going down to the indicator level, they prioritised important sites for terrestrial and freshwater biodiversity (15.1) and public expenditure on conservation and sustainable use (15.A). Likewise, they also prioritised aspects clearly related to social inequality in the urban domain, such as affordable housing (11.1), access to basic services (1.4) and inclusive urbanisation (11.3). This suggests that, even from an expert point of view, some sustainability priorities may go unnoticed at the SDG goal level. It also shows the intrinsic interaction between SDGs, which only becomes evident at the target and indicator level. Therefore, it is important to approach the 2030 Agenda, not just as a list of goals, but as a system of interconnected targets and indicators (Le Blanc, 2015). Hence, it is not only important to continue advancing on identifying suitable indicators for the circular built environment, but also torecognise synergies between targets and indicators in order to overcome silo approaches resulting from addressing each goal in isolation. Understanding these interactions would lead to more coherent policies, programmes, projects and actions that will use more efficiently local, national and international resources, to comprehensively advance towards social inclusion, resilience and circularity in the built environment. (Penagos 2021).

7. Conclusions and recommendations

7.1 Conclusions

Two characteristics are common to the built environment in LAC. First, sprawl is a dominant urban growth pattern, second is socio-spatial segregation. Urban sprawl implies loss of both rural and natural areas, thus affecting food security, biodiversity and ecosystem services, while increasing vulnerability to natural disasters and climate change. Urban sprawl also increases material and energy flows, thus reducing resource efficiency while increasing the costs of developing and operating the built environment. Altogether, these factors hinder the economic advantages of agglomeration, thus reducing productivity. On the other hand, urban spatial segregation excludes poor communities from access to housing, basic services, public space and job opportunities, which enhances informal economies and informal settlements, thus exacerbating all the other problems arising from urban sprawl. Hence, the first challenge for introducing circularity in the built environment in LAC consists of orienting land planning towards urban compactness and social inclusion.

This report shows that most LAC countries have been advancing on urban and housing policies, half of them included buildings and human settlements in their NDCs and some have issued regulations and voluntary green building schemes. Likewise, while municipal waste management focuses mainly on collection and final disposal, thus providing few opportunities for recovery and valorisation, some countries are encouraging C&D waste reuse and recycling. However, there is still a need to harmonise all these policies with each other, while aligning these with criteria concerning biodiversity protection, reduction of social inequalities, resource efficiency from a life cycle approach and economic productivity. Emerging circular economy strategies and roadmaps may significantly contribute to this harmonisation, but only five countries have issued these instruments and only three of them give priority to the built environment.

Mainstreaming circularity in the built environment involves multiple stakeholders, acting at different scales, including multilateral and bilateral cooperation agencies; development banks; private banks and other financial entities; national, sub-national and local governments; material suppliers; urban developers and building companies; business associations; construction

professionals and labourers; universities and other training centres; utility companies; as well as users and occupants. The report highlights some persistent challenges, such as the absence of sustainability tools, methods, concepts and principles in architecture and engineering programmes; the high labour informality characterising the building sector, which is related to social inequality and lack of access to basic education; the lack of capacity of SMEs to develop circularity strategies and business models; the absence of a circular approach to water supply and sanitation services; the difficulty of transferring costs and benefits of circularity among investors, developers, owners, and occupants in the built environment; and the general perception of greater safety and durability of conventional construction systems as compared to industrialised and prefabricated systems.

On the other hand, this report highlights the crucial role that multilateral cooperation agencies and regional and national development banks have been playing to promote the circular economy, while highlighting the role of banks and other financial entities in supporting green investments by issuing green bonds, encouraging sustainability reports, participating in global sustainability initiatives and including climate change in financial risk analysis. National regulations, regional associations and business initiatives are promoting efficiency, digitisation and new business models concerning electricity supply across the Region. Likewise, national and regional business associations have been promoting green building and digitisation of the building sector and a Regional Coalition for Circular Economy involving multilateral agencies, development banks, governments, academic institutions and private actors, has conferred priority to cities and construction. Case studies provided by this report show material producers that are successfully increasing resource efficiency and carbon footprint reduction, along with research projects, digital tools, guidelines and national platforms, emerging business models, as well as practical experiences in building and neighbourhood projects. Disseminating these initiatives and experiences may provide valuable opportunities to mainstream the circular built environment.

While the circular economy is not explicit in 2030 Agenda, SDGs may provide a comprehensive pathway to guide policies, actors and initiatives towards circularity at different geographical and institutional levels, but this requires addressing SDGs not as a list of objectives, but as an interconnected system of goals and indicators, since recognising synergies between targets and indicators in order to overcome silo approaches resulting from addressing each goal in isolation. Understanding these interactions would lead to more coherent policies, programmes, projects and actions that will use local, national and international resources, more efficiently to comprehensively advance towards social inclusion, resilience and circularity in the built environment.

7.2 Recommendations

Developing circular built environments in LAC demands a systemic approach to Urban Transformative Capacity (Wolfram, 2016), that not only focus on resource efficiency but also addresses biodiversity protection, climate resilience and social equality, while considering every scale of the built environment from materials and components, to buildings, public spaces, infrastructures, neighbourhoods, metropolitan areas and regions under a life cycle approach.

7.2.1 Life cycle considerations

The life cycle of the built environment includes 5 phases: manufacture of building products, design, construction, operation and use, renovation and deconstruction activities or end of life (Figure 48).

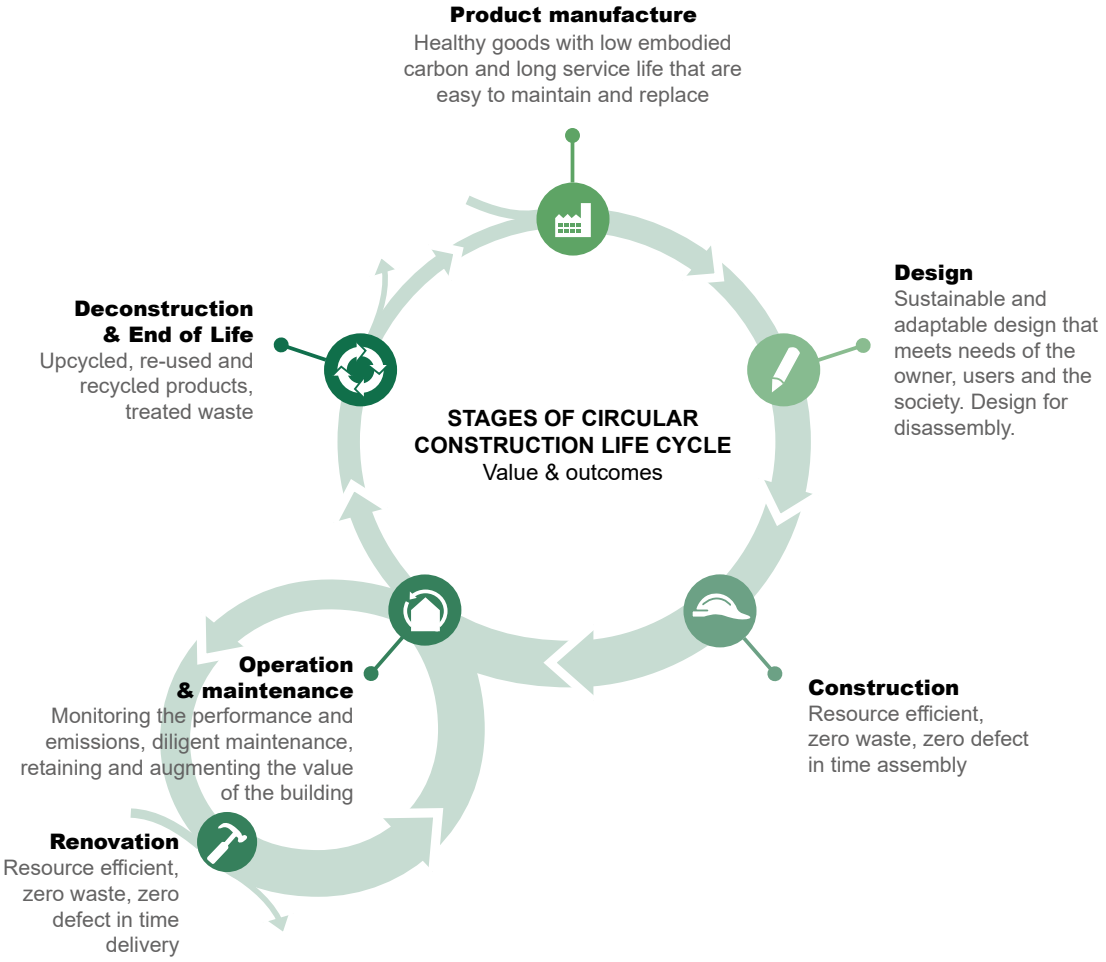


Figure 48: Stages of circular construction life cycle - value & outcomes

Credit: Ninni Westerholm. Developed from UNEP (2021)

Table 13 provides a detailed insight into the various lifecycle considerations from the perspective of capital and operational costs, green business opportunities, new jobs and skills required, with focus on the LAC region, according to the highlights of this report. Since informality will continue to be prevalent in the coming years in the LAC region, considerations related to the informal sector are also included.

Table 13: Lifecycle considerations in the built environment for LAC region

Source: Modified from Iyer-Raniga & Huovila, 2021

Impact area/ Life cycle phase		Design	Manufacture	Construction	Operation & use	Renovation	Reconstruction
Capital costs	**Formal**	The importance of design in green building is being recognised. Mandatory codes and voluntary guidelines and certification schemes are being implemented in some countries. Digital methods based on BIM being promoted at the regional level	Dominant building systems based on masonry, with high material, energy and carbon intensity, thus preventing capital costs reduction based on industrialisation, prefabrication, modular design and flexibility.	Current construction processes do not support reuse or repurpose. Education, awareness-raising and capacity building across all sectors of the building and construction industry are urgently required.	Currently, lifecycle thinking is not properly understood. Value is not well understood and is confused with cost. To reduce capital cost, quality is usually compromised	Currently, there is only a very small market for second-hand renovation products. This can be tapped further to improve understanding and increase the use/reuse of products for renovations	The end of life value of materials is not well understood. Only certain types of materials are currently reused. However, emerging regulations are encouraging reuse and recycling of C & D waste.
	Informal	Informal construction does not include design processes	Informal construction using similar building systems as formal construction may provide opportunities to introduce low impact materials into informal activities	Self-construction as a dominant practice. Capital costs largely unknown	Impacts of building orientation, materials and components on operational costs are not considered	Informal construction often consists on a permanent renovation process, either limited or encouraged by family budget	Informal construction often making illegal disposal of C & D waste
Operational costs	**Formal**	Good passive design supports reduced utility use. The use of renewable energy, water harvesting, design for durability and reuse all offer opportunities for optimising resources and creating circular built environments.	Bioclimatic properties of building materials are not relevant building criteria. The operation of buildings needs to incorporate optimising resources.	Construction processes are not always undertaken professionally. Cheap hand labour and an informal economy support the construction process. Skills need to be improved.	Operational considerations for the built environment offer opportunities for lower energy and other utility expenses. They support a better return on capital investments and represent better options in the current milieu.	Renovations are not always considered as part of design and operations. Usually, only new products are considered in the marketplace. Opportunities exist for extending to renovations and these need to be tapped.	End of life considerations should be part of the full design process. At present, very little construction and deconstruction waste is recovered, and there are almost no opportunities for reuse and recycling.
	Informal	Impacts of building orientation, materials and components on operational costs are not considered		Impacts of self-construction practices on operational costs largely unknown	Impacts of self-construction practices on operational costs largely unknown	Impacts of renovation activities on operational costs largely unknown	Deconstruction and renovation activities are difficult to distinguish from each other
Environmental impacts	**Formal**	Design considerations have yet to be fully understood and explored with respect to environmental impact. Skills need to be developed further. For example, zero-carbon design or design for deconstruction are either unknown or poorly understood in the LAC region. Digital and collaborative design methods based on BIM, being promoted at regional level may provide opportunities for better understanding and managing environmental impacts.	A concerted effort is required to consider environmental impacts. Practices leading to no waste, reduced or no emissions, carbon-negative policies and programmes are all important considerations. Renewable energy sources and bio-based materials can play an important role. Important manufacturers are already developing circularity initiatives and projects, with effective impacts on reducing environmental impacts of materials.	The environmental impacts of construction are not fully understood. Generally, debris is not separated in situ. Landfills are generally scarce so not all waste ends up in landfill; it ends up in the local landscape as visual pollution and pollution to air, water and land	Alleviation of environmental impact through operation and use is yet to be mainstreamed across the region. Some technologies such as water harvesting and solar lights are currently known and used but there is a lot more that can be done.	The environmental impact of renovations is yet to be fully understood and options for renovations have yet to be explored.	The environmental impacts of end of life have not yet been studied in the region. There is no practical use for construction and deconstruction waste as no best practice or guidelines have been developed. 90% of the waste is not used and ends up in landfill or as an eyesore in the local environment. However, emerging regulations are encouraging reuse and recycling of C & D waste.
		Environmental impacts of buildings are not a priority in informal construction		Natural hazards, including climate change are a major concern for informal construction, which is often taking place in high slopes and flooding areas	While Impacts of informal buildings on energy use may be comparable to those of formal buildings, impacts concerning water use may be higher due to the lack of sanitation infrastructures	Impacts of renovation activities on operational costs largely unknown	Deconstruction and renovation activities are difficult to distinguish from each other

Impact area/ Life cycle phase		Design	Manufacture	Construction	Operation & use	Renovation	Reconstruction
New business	**Formal**	Design considerations have yet to be fully understood and explored with respect to environmental impact. Skills need to be developed further. However, certification schemes are contributing to increase knowledge and skills via consultancy companies.	A concerted effort is required to consider environmental impacts. Practices leading to no waste, reduced or no emissions, carbon-negative policies and programmes are all important considerations. Renewable energy sources, industrialisation, prefabrication, modular design and flexible design, as well as bio-based materials can play an important role.	The environmental impacts of construction are not fully understood. Generally, debris is not separated in situ. Landfills are generally scarce so not all waste ends up in landfill; it ends up in the local landscape as visual pollution and pollution to air, water and land.	Alleviation of environmental impact through operation and use is yet to be mainstreamed across the region. Some technologies such as water harvesting and solar lights are currently known and used but there is a lot more that can be done	Most economic activity focuses on new buildings. Business opportunities based on renovations are not being leveraged.	Emerging regulations encouraging reuse and recycling of C & D waste are creating new business opportunities in several countries. Deconstruction is not fully understood and it is still confused with demolition. Hence, market opportunities for secondary materials and components are not being yet leveraged.
	Informal	Masonry construction systems are widely used in informal construction, but the absence of structural reinforcement makes them unsafe, due to the high weight of materials. Construction systems providing low-cost, low-weight, easy handling, high durability and high safety are urgently required to be mainstreamed into construction activities in informal settlements			New business opportunities may arise from renovations in informal settlements aiming to increase resilience and improve health and safety while promoting resource efficiency and environmental sustainability		
Jobs and skills	**Formal**	Training and formal education in design for a circular economy is required as this is not yet understood.	A new production workforce that will facilitate lower costs for the built environment has yet to be explored in the region.	Training requirements for construction materials optimisation, zero waste and reuse of materials need to be understood. The potential green jobs that a circular built environment might offer will require training.	Lifecycle designs focusing on operations of buildings requires a skilled hand labour force for maintenance and repair. Local job opportunities in this area can be explored.	Opportunities in the renovation sector are not currently being explored. Examining what is feasible in other regions will identify potential options for the sector, and capacity-building plans for reskilling need to be put in place.	There are currently some opportunities in metal recycling. These base recyclers learn selective deconstruction and reuse of parts from buildings. This needs to be expanded across the sector.
	Informal	Training of labourers working in the formal sector on issues related to resource efficiency, environmental impacts, health and safety, and natural risk assessment may have positive impacts on informal construction since these labourers are often involved in self-construction activities in informal settlements					

7.2.2 Multi-scale considerations

Materials and components

A circularity approach in construction materials and components would consider the following elements (GBCe, 2020):

- **Efficiency:** Reduction of material intensity, reducing over-specification through the use of high-performance materials (mainly steels and concrete).
- **Durability:** Materials and components must be designed and manufactured with the longest possible lifespan, so that their life cycle can exceed the period of use of buildings and infrastructures.
- **Recirculation:** recycling of materials at the end of their useful life. This implies the design intended for selective disassembly rather than demolition.
- **Replacement:** replacement of high carbon footprint and environmental impact materials with materials with lower impact. Environmental Product Declarations are the first step towards moving products that take into account a circular economy.

Buildings

In addition to material considerations, a **building circularity approach** should include the following elements:

- **Durability:** planning of the elemental and building useful life, fostering a medium to long-term approach in the design of the useful life of building elements, as well as in the associated maintenance and replacement cycles;
- **Adaptability:** prolonging the useful life of the building as a whole, either by facilitating the continuation of the intended use or by possible future changes of use, with special attention to replacement and rehabilitation. In this sense, there is a significant potential to be developed in the LAC region.
- **Reducing waste and facilitating high-quality waste management:** facilitating future circular use of construction elements, components, and parts, with a focus on producing less waste and on the potential for high-quality reuse or recycling of main building elements following deconstruction. This includes efforts throughout the value chain to promote: 1) the reuse or recycling of resources (i.e. materials) so that most of the value of the material is retained and recovered at the end of the useful life of a building; 2) the design of the components and the use of different construction methods to influence recovery for reuse or recycling to avoid down cycles.
- **Digitisation: Digitisation is one of the best opportunities to promote CE in buildings**. In this sense, the approach known as “Building Information Management” or BIM, for its acronym in English, stands out. This approach can be a tool for circularity, since it enables a record of building materials in terms of type, quantity / quantity, origin, carbon footprint, recycled content, as well as the possibilities of dismantling, reuse and recycling at the end. of its useful life. In this way, the BIM approach could not only facilitate design based on circular principles, but also improve recycling, reduce waste and close cycles (Steuwer et al, 2020).

Infrastructures

Similar principles applying at building scale may be used at the infrastructure level. Here, circularity criteria must also be introduced at an early design process, to ensure circularity is embedded throughout the lifecycle of an infrastructure asset. Coordination and collaboration are essential to achieve this. In addition to the elements already considered at the level of materials and buildings, some particular aspects at the infrastructure level include (CONAMA, 2018):

- New models for the construction and operation of assets and maintenance strategies tend to focus on minimising negative externalities, increasing longevity and integrating systems and network components to maximise circular flows of resources and materials.
- Optimisation of current design, construction, financing, operation and maintenance approaches, including extended concession periods
- Enhance interaction between industries and stakeholders that are not normally in contact, for example designers and demolition companies.

Neighbourhoods

The principles of the circular economy can be taken to the level of districts or neighbourhoods with possibilities that go beyond individual buildings. Thinking circularity at this level has the potential to (Steuwer et al, 2020):

- Generate potentially significant cost savings through economies of scale and smart logistics.
- Be more attractive to investors due to the aggregation of projects and distributed risk portfolios.
- Produce synergies between different aspects of urban sustainability, such as energy efficiency, renewable energy, water efficiency, material efficiency, green infrastructure, active mobility, health and well-being, among others

Cities and regions

Urban planning acquires special relevance for the transition towards the circular economy. At this scale, the main considerations are (GBCe, 2019):

- **Compactness:** a compact urban development that avoids dispersal favours efficient resource management by contributing to more sustainable transport options, including helping to reduce car trips, shortening daily travel distances and ensuring that new settlements are oriented to public transport. Reducing urban sprawl also contribute to preserve rural and natural areas, thus favouring both food security and ecosystem services, while contributing to increase climate resilience
- **Complexity:** combined land uses facilitate sustainable mobility, lower energy consumption and less air pollution.
- **Closure of cycles:** Urban planning is important in the closure of resource cycles: materials (spaces and facilities required to separate, process and valorise municipal waste), organic matter (urban gardens and composting systems), water (sustainable urban drainage systems, groundwater recharge, rainwater use, wastewater reuse and recirculation)
- **Social inclusion:** Just as existing urban planning in LAC has favoured spatial segregation, social exclusion and informality, a new form of planning focusing on urban compactness and combined land uses can be used to promote social inclusion.

Projects based on urban renovation and urban densification may provide housing and urban services in city centres instead of urban peripheries. At the same time, initiatives related to closing resource cycles may provide these communities with green jobs.

7.2.3 Governance considerations

This multi-dimensional, multi-scale approach must be supported by policies, partnerships, initiatives, projects, and actions described below.

1. **Policy and regulatory harmonisation under participatory approaches.** Policy and regulations must be coherent and complementary. Areas concerning the circular built environment that must be mutually harmonised include urban and housing policies, building codes and regulations, policies concerning human development, economic productivity, environmental sustainability and disaster risk management, down to technical regulations. Furthermore, incumbent stakeholders from the private sector, academy and civil society may contribute to policy making and implementation.
2. Cooperation agencies, governments, financial institutions, business associations, companies, universities and civil society; at regional, national and local level, actively engaging in **networks, alliances and initiatives**, aimed at promoting circular built environments
3. **Increasing R & D & I investment**, while putting circularity based challenges put at the centre of innovation agendas
4. **Transformative educational systems** providing future politicians, managers, practitioners and citizens with sustainability based tools, methods, principles and concepts that may guide decision-making at every spatial and institutional level, in every economic and societal sector
5. **Developing, displaying, disseminating, replicating and up-scaling** demonstrative projects aimed at transforming technologies, business models, practices and cultures concerning every level of the built environment
6. **Strengthen financing mechanisms.** Which includes 1) creating new financing mechanisms at national level, 2) strengthening indirect mechanisms (such as stock markets and financial risk assessments) and 3) refocusing existing direct mechanisms to support initiatives, projects and business models based on a circular economy. This includes non-financial mechanisms, such as the green climate fund, and debt mechanisms such as green bonds.

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