



Global Alliance
for Buildings and
Construction

GlobalABC Regional Roadmap for Buildings and Construction in **Latin America**

2020-2050

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



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Construction

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construction sector*

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Executive summary

With the Paris Agreement countries have agreed to a common goal of maintaining the global temperature increase to well below 2 degrees, and preferably no more than 1.5 degrees, by the end of the century. According to the latest UNEP Emissions Gap report, to be on track for the 1.5 degree goal, the world needs to reduce global emissions by over 50% by 2030 and work towards carbon neutrality by 2050. As the buildings and construction sector accounted for 36% of final energy use and 39% of energy and process-related carbon dioxide (CO₂) emissions globally in 2018, it will have to play a major part in achieving this vision.

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In 2018, the buildings sector in Latin America¹ accounted for 24% of final energy use and 21% of process-related carbon dioxide (CO₂) emissions, excluding emissions from manufacturing building materials and products such as steel, cement and glass (IEA, 2019a). Since 2018, energy demand has grown by 14% and emissions by 18%. Across Latin America, the carbon content of the electricity grid is comparatively low due to the high proportion of hydropower.

Since 2010, growth in energy demand and emissions has been driven by a 10% increase in regional population and 26% increase in wealth (gross domestic product), which has driven floor area growth, along with a greater demand for energy services (IEA, 2019a). By 2040, Latin America's population is expected to grow by a further 20% and could increase its economic wealth by 83%.

Decarbonising buildings across the entire life cycle would require a transformation of the buildings and construction sector. Reaching net-zero operational and embodied carbon emission buildings is possible, but requires clear and ambitious policy signals to drive a range of measures including passive building design, material efficiency, low-carbon materials, efficient building envelope measures, and highly efficient lighting and appliances.

According to the *World Energy Outlook*, energy efficiency and decarbonisation of electricity in buildings in Latin America under a Sustainable Development Scenario² could reduce annual emissions from buildings in 2040 by almost 140 megatonnes of carbon dioxide (MtCO₂) compared to a Stated Policies Scenario³. Such measures could in fact reduce emissions from buildings by 51% from 2018 levels, while accommodating a 6% increase in energy demand (IEA, 2019b).

Achieving these outcomes at pace and scale will require greater collaboration among policy makers at all jurisdictional levels, as well as with urban planners, architects, developers, investors, construction companies and utility companies. In addition to providing healthier, more resilient and more productive environments, the decarbonisation of the buildings sector presents a business opportunity in Latin America and the Caribbean with an estimated value of approximately USD 4 trillion by 2030 (IFC, 2019). Decarbonising buildings is also in full alignment with the aims of SDG 12, to ensure sustainable consumption and production patterns.

Latin America is home to 624 million people and presents high rates of urbanisation, with over 80% of its population living in cities (UN DESA, 2019). Cities and countries in the region face challenges like urban sprawl and fragmentation, lack of public infrastructure, expansive areas of informal settlements and high percentage of population living in inadequate housing, located in vulnerable areas (The World Bank, 2014b). This is aggravated by the high levels of informality in the construction sector, with self-construction being a common practice.

¹ Excludes Mexico in the following figures. Within International Energy Agency (IEA) modelling, Mexico is grouped with the North American region. Where possible, Mexico has been shown separately.

² As well as meeting the energy-related UNFCCC Sustainable Development Goals in full, the Sustainable Development Scenario (SDS) is fully aligned with the Paris Agreement, holding the global average temperature rise to below 1.8°C with a 66% probability without reliance on global net-negative CO₂ emissions.

³ The Stated Policies Scenario (STEPS) reflects the impact of existing policy frameworks and today's announced policy intentions.

Despite the high demand for new residential buildings, in many countries, progress on building energy codes is slow (IEA, 2019a; GlobalABC/IEA/UNEP, 2019). Only 6 out of 33 countries in Latin America and the Caribbean had mandatory or voluntary building codes in place in 2018 (Figure 1), although most had certification programmes in place.

Figure 1 • Building codes in Latin America, 2017-18



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Note: These maps are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Source: GlobalABC/IEA/UNEP (2019), *2019 Global Status Report for Buildings and Construction: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector*.

The purpose of this roadmap is to set up a framework for the buildings and construction sector to support a common language and vision for the complete decarbonisation of buildings across their life cycle, and to support the development of national or subnational strategies and policies, including, for example, nationally determined contributions (NDCs).

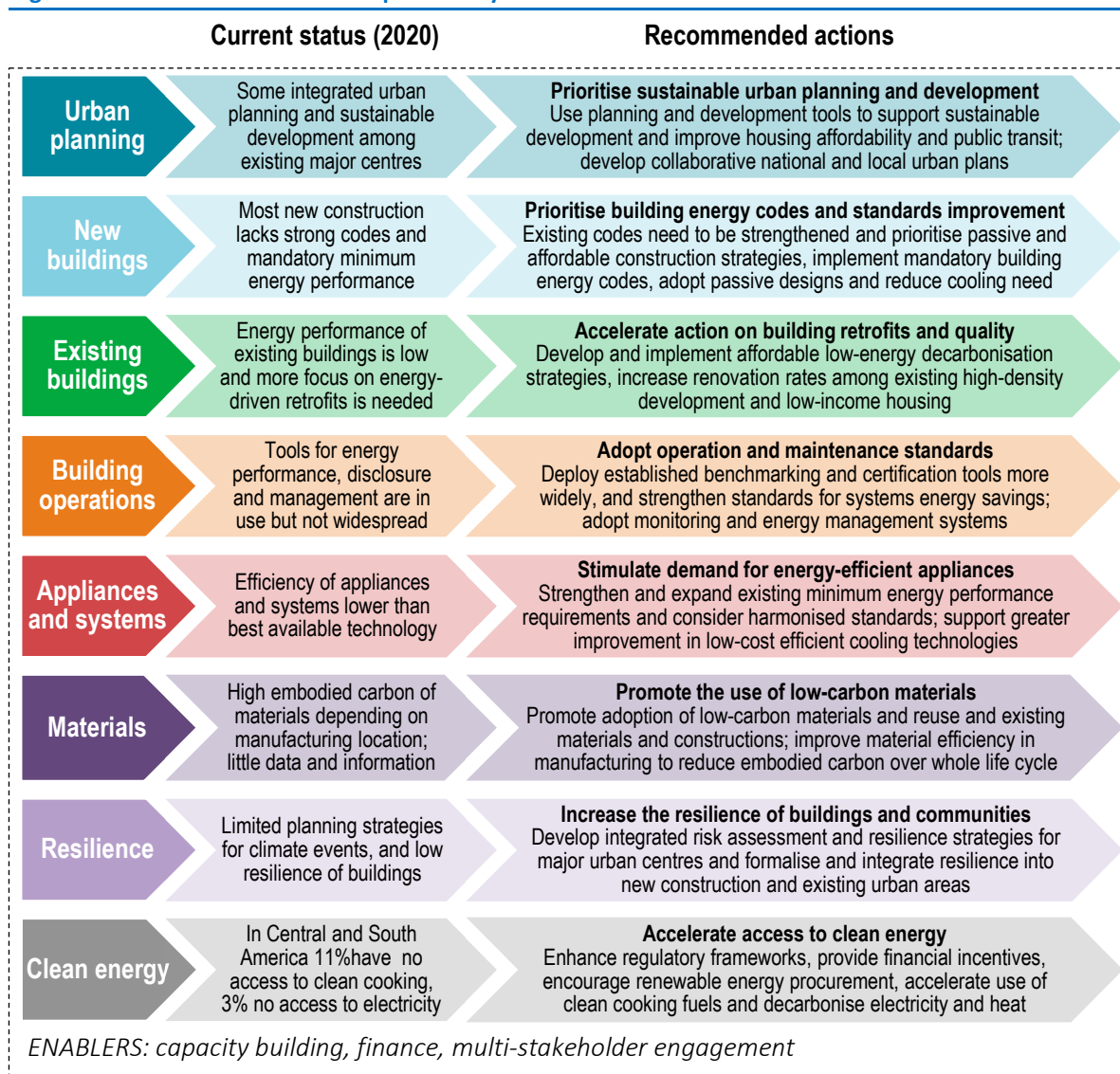
Developed in consultation with over 250 stakeholders and buildings experts across the region, this roadmap outlines the range of actions that different actors can take in the short, medium and long term to achieve a built environment that is zero-emission, efficient and resilient.

It covers eight “activities”: urban planning, new buildings, existing buildings, building operations, appliances and systems, materials, resilience, and clean energy, and for each of these proposes key actions, targets for policies and technologies, and enabling measures with the aspiration of reaching net-zero carbon emission buildings by 2050.

Getting to zero-emission, efficient and resilient buildings by 2050

The timelines below describe the actions identified by stakeholders as being key to delivering zero-emission, efficient and resilient buildings in Latin America by 2050. The sections “Activities 1-8” and “Roadmap support: Enablers” develop the strategies that support the delivery of these objectives.

Figure 2 • Latin America Roadmap summary timelines



Key actions and strategy

To support decarbonising new and existing buildings, effective policies and regulations need to cover the entire building life cycle, including the design, development, operation and decommissioning stages, and also act beyond site boundaries through neighbourhood planning and clean energy. To accelerate action, greater collaboration involving a range of stakeholders is needed, including policy makers, urban planners, architects, construction companies, materials suppliers, utility companies, developers and investors.

Based on extensive stakeholder consultation and analysis, the following actions would deliver progress towards zero-emission, efficient and resilient buildings. The following key actions can be undertaken now to support the roadmaps and their implementation towards zero-emission, efficient and resilient buildings. The timelines and key actions described in the roadmap provide a further breakdown of the key policy actions and technology approaches required.

National roadmaps and strategies set priorities for the sector

National ministries and city agencies should develop ambitious, comprehensive strategies and roadmaps to outline the pathway to a zero-emission, efficient and resilient buildings and construction sector. These strategies should be developed through consultation and engagement, address the multiple disciplines of urban planning, new and existing buildings, and resilience and clean energy. New development will need to address integration with existing housing stock and infrastructure, and improved transit-oriented design and better services to low-income households. A key to this is to address the data and ambition gaps identified in this roadmap.

Government agencies and ministries should partner with key stakeholders to develop targeted metrics and data collection mechanisms for existing and new buildings that include quantified building energy performance benchmarks and sector targets, the embodied carbon of building materials, building energy performance and building ratings systems, and building resilience.

Governments and industry coalitions should work to close key information gaps by establishing data collection systems and methodologies, which can provide essential evidence to inform decarbonisation and efficiency planning, as well as highlight the concrete, quantifiable benefits of efficiency and sustainability interventions.

Ministries should also develop national and local renovation and financing strategies to accelerate implementation and achievement of decarbonisation and efficiency goals, such as increasing the annual energy efficiency renovation rate to 2% by 2040.

Local agencies should undertake risk mapping and resilience assessments and develop integrated strategies to improve the resilience of the building stock. Agencies should develop strategies to address resilience risks in existing low-income dense developments to inform zoning and building performance standards, engaging with the relevant disciplines. It is equally critical to map and develop strategies for adapting existing buildings to mitigate against extreme climate events and changes in climate conditions.

Standards and codes gradually drive up performance

Regulators can reduce future energy demand in new buildings through ambitious and progressive mandatory energy codes that focus on highly efficient and net-zero carbon emissions for new construction within the next decade. Focal areas should include replicable and locally adapted strategies for mitigating heating and cooling demand that address the wide variation in Latin American climates, such as passive design, natural ventilation, insulation, shading and low-emissivity windows.

Regulators should expand and strengthen minimum energy performance standards (MEPS) to set ambitious product energy performance requirements covering all major appliances and systems. MEPS could be especially effective if developed in collaboration across the region to enable cross-border applicability.

Expand existing energy ratings and labelling programmes within the region and align performance metrics to support improvements in building and appliance energy efficiency and complement mandatory energy codes and MEPS.

Regulatory frameworks to facilitate integrated action

National and local agencies should develop ambitious regulatory and incentive frameworks to increase investment in energy efficiency improvements and reduce carbon emissions from the production of major building materials produced across the region.

National and local agencies should develop clear regulatory and incentive frameworks to promote the use of on-site and building-integrated renewable energy including solar photovoltaic, solar thermal and advanced biofuels where appropriate. New frameworks that define operational rules, remuneration schemes, incentives allocation, integration mechanisms and goals at national and local levels will support the broader deployment of Latin America's opportunity to capture its considerable solar resources.

Narratives and engagement to drive demand

Governments and large organisations can take leadership in zero-carbon procurement and standards to promote investment in low-carbon building construction and renovation and encourage the adoption of efficient technologies at scale.

Governments, industry coalitions and civil society should promote the multiple benefits that zero-emission, energy-efficient and resilient buildings have for different stakeholders. By identifying and reporting how multiple benefits can improve aspects such as jobs, economic growth, health, poverty alleviation, environmental quality and security of buildings, a broader buy-in from stakeholders can be achieved.

Capacity building

Governments and industry coalitions should promote opportunities for capacity building on topics including embedding circular economy concepts into buildings through life-cycle approaches, data collection for efficiency improvement, reuse of construction materials and phasing out refrigerants with high global warming potential.

Government and industry coalitions should promote the adoption of existing efficient building construction and operation techniques and low-cost technologies that can improve building performance and lower embodied carbon.

Building on the Latin America Roadmap: Address gaps and raise ambition

Address key information gaps by collecting data and evidence to support actions to decarbonise and improve the efficiency of buildings. Across Latin America, information is lacking on integrated and spatial urban planning policies and activities; informal development activities; the use of space and water heating technologies; uptake of smart devices; the use, energy and carbon content of materials; risk mapping; and decentralised renewables deployment. Putting in place systems to capture this information will allow for greater certainty around the impacts that policies and markets are having.

Raise the level of ambition on actions that can support improved building performance and construction methods that match the scale of development change. There is a reported lack of ambition in advancing the use of spatial planning approaches, passive design principles and low-energy building system technologies, building code adoption and compliance, building labelling and benchmarking, use of audit and building management tools, and integrated building renewables. Increased efforts towards making new and existing buildings across Latin America zero-emission, efficient and resilient should look to harness the wave of investment and construction across the region in coming years.










How to use the regional roadmap document

This section describes how to read the document and how to interpret the targets and timelines.

This document is intended to identify common goals, targets and timelines for key actions across eight “activities”. Each activity represents a segment of the buildings and construction sector: urban planning, new buildings, existing buildings, appliances and systems, building operations, materials, resilience, and clean energy, as each of these represents a key ingredient of how buildings influence our environment and vice versa.

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Table 1 • Roadmap definitions

| | |
|---|---|
|  | Activity 1: Urban planning. This activity covers land use, zoning and other planning associated with how buildings, transport and energy systems interact. |
|  | Activity 2: New buildings. This activity covers all aspects of new buildings, including the design process, design strategies, codes and labels. |
|  | Activity 3: Existing buildings. This activity covers all aspects of the improvements of existing buildings. |
|  | Activity 4: Building operations. This activity covers all aspects of the operations and management of buildings. |
|  | Activity 5: Appliances and systems. This activity covers lighting, appliance and equipment systems that are used in both new and existing buildings. |
|  | Activity 6: Materials. This activity covers envelope, structural and product materials used in buildings. |
|  | Activity 7: Resilience. This activity covers all aspects of building resilience that enables increased capacity to adapt to and mitigate the effects of changing climates and other natural disasters. |
|  | Activity 8: Clean energy. This activity covers the clean energy transition away from carbon-intensive fuels to renewable energy resources. |
|  | Roadmap support: Enablers. These constitute the key success factors for capacity building, financial tools and multiple benefits and how they can support the achievement of the targets and timelines for the activities. |

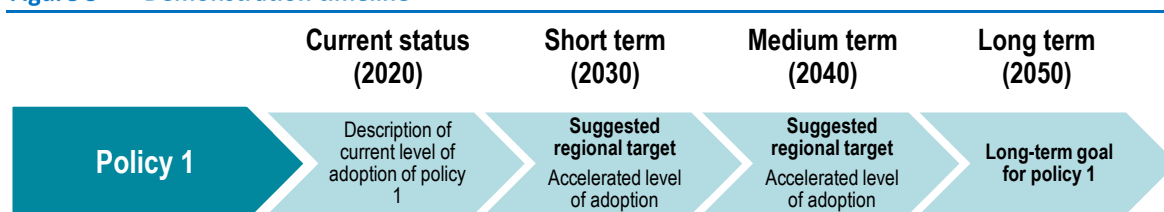
Each of the activities is structured in a similar manner, illustrated by relevant examples, and can be read either in isolation or in conjunction with the other parts of the document.

Each of the activities covers:

- **Key actions:** A summary of key actions and timelines identified for the activity.
- **Stakeholders:** A map of the different stakeholders relevant to the activity and their relative importance.
- **Recommended policy action:** A list of recommended policies with a description of the current status of that policy in the region, and proposed targets for the short, medium and long term. These are shown as a set of timelines, with a description of each below. See note below about how to read the timelines.
- **Recommended technology action:** A list of recommended actions related to particular technologies, with a description of the current status of that technology in the region, and proposed targets for the short, medium and long term. These are shown as a set of timelines, with a description of each below. See note below about how to read the timelines.
- **Finance action:** A list of recommended financial tools particularly relevant to the activity, followed by a series of local examples of current practice.
- **Capacity building:** A list of recommended capacity-building actions particularly relevant to the activity, followed by a series of local examples of current practice.
- **Multiple benefits:** A catalogue of the types of multiple benefits most relevant to the activity.

Figure 3, and the paragraph that follows, provides guidance on how to interpret the timelines:

Figure 3 • Demonstration timeline



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Note: The **proposed regional target** is in bold. Below that is the proposed accelerated target.

The target written in bold represents a regional target. The accelerated target, given below the regional target, represents a “stretch target” to be aimed for by countries able to go further, quicker. The 2050 target represents the ultimate desired long-term outcome. Some indicators do not contain accelerated targets due to a lack of data or input. The targets serve to represent a goal or milestone towards the longer-term objective.

These targets and key actions were proposed based on a wide stakeholder consultation with local building actors, as well as the expertise of the authors and evidence from the global and regional building community.

Stakeholder consultation took the form of questionnaires, in-person workshops, webinars and phone conversations, and included engagement with over 250 people.

Below each of the timelines, a description of each policy or technology item outlines the following:

- **Policy type 1:** Description of how the policy works and what the key success factors are for successful implementation. *Description of how the stakeholders consulted believe it will evolve over time, based on their experience of the market.*

Where there is a significant gap between the target and what stakeholders believed to be achievable, the item has been marked with a **red bullet**, as a way of highlighting it as a priority area for action. Where there was a lack of data or a lack of consensus, the item has been marked with an **orange bullet**, denoting the need for additional consultation and/or data.

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These timelines and targets serve to raise ambition and to frame subregional or national roadmap development.

The regional roadmap is a LIVING document for Latin America that can be adapted over time to support subregional and local roadmap needs and adapt to trends in the buildings and construction sectors.

The input included: 282 regional stakeholders who provided in-person input via three events across the region, almost 200 who provided input via five webinars, and 80 who responded to the regional roadmap survey.

Introduction

The year 2015 was pivotal in addressing the critical need to tackle climate change, with the adoption of the Sendai Framework for Disaster Risk Reduction, the 2030 Agenda for Sustainable Development and the Paris Agreement reached at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). Decarbonising the buildings and construction sector has a significant role to play in achieving these objectives and the related Sustainable Development Goals (SDGs).

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The buildings and construction sector is responsible for 36% of final energy demand globally, representing 39% of energy- and process-related emissions. Climate scenarios show that emissions in this sector will have to be significantly reduced in order to achieve the Paris Agreement goals. Yet the [2019 Global Status Report](#) of the Global Alliance for Buildings and Construction (GlobalABC) highlights that today's progress on emissions reductions are not on track, as energy efficiency improvements are outpaced by growth in floor area and demand. To counteract these trends, the global average building energy intensity per unit of floor area would need to be at least 30% lower than 2018 levels by 2030.

As identified in the *2019 Global Status Report for Buildings and Construction*, and building on the *Guide for Incorporating Buildings Actions in NDCs*, actions including sustainable material choices and building design; urban planning measures, adaptation and resilience plans; clean energy transitions; and building operations and renovation all provide opportunities to realise the goals of the Paris Agreement, i.e. to maintain the global temperature increase well below 2 degrees, and preferably below 1.5 degrees, by the end of the century.

The buildings and construction sector is a highly "local" and "fragmented" industry, with no single group of large businesses having significant control of the stock and value chain. Innovation is slow, largely due to this fragmentation, and there is a lack of a common and international vision from the disparate actors in the buildings sector. Thus, this roadmap aims to facilitate a common language and vision, foster transparency, promote inclusion and co-operation among these stakeholders to implement effective long-term policies, and integrate emerging and innovative technologies into everyday practices.

This roadmap is the result of a stakeholder-driven process in which buildings experts around the world were consulted and provided input to collectively build the timelines for each of the activities. These serve as a framework for the buildings and construction sector to align with the climate related objectives set out in the Paris Agreement. The GlobalABC Regional Roadmaps for Africa, Asia and Latin America cascade this methodology for the regions, incorporating relevant key insights and examples of best practice.

As a regional document, there is great diversity in terms of climate, buildings culture, baseline starting points and data availability. Countries are represented in the roadmap according to the extent of the available information.

This roadmap intends to guide policy makers when designing their national buildings and climate strategies, for example when undertaking a review of their 2020-25 nationally determined contributions (NDCs). It aims to identify goals and milestones, and to help organisations in determining their long-term and medium-term investment strategies. It does not replace a more detailed national or local buildings and construction roadmap that would take into account individual country circumstances.

Decarbonising the buildings sector

The buildings sector will play a major role in supporting the decarbonisation of the global economy, through improvements in energy efficiency to reduce energy demand; reducing use of materials and in so doing, reducing the embodied carbon; and finally, by supporting adoption of distributed low-carbon and renewable energy generation.

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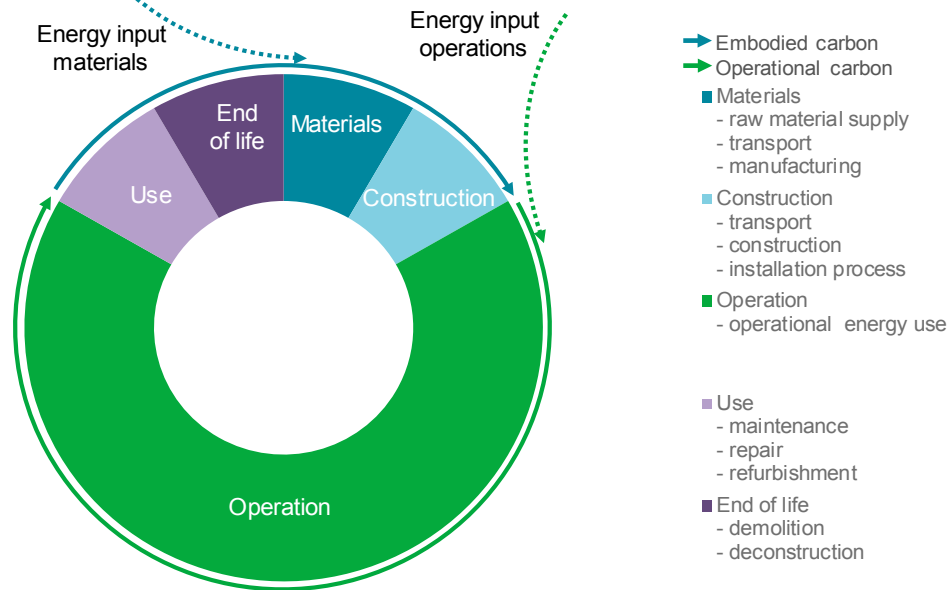
Over its lifetime, a building's carbon footprint consists of the embodied carbon from the manufacture and processing of building materials and construction, as well as the operational carbon from the energy use of its operations. **Whole-life carbon** is described as **operational carbon + embodied carbon**, as calculated over the whole life cycle of the building (Figure 4).

The terms “net-zero energy” and “net-zero carbon” emission buildings do not have widely recognised standard definitions, and they can be applied to different scopes and site boundaries; however, this roadmap utilises the following definitions, based on those described in *Zero Energy Building Definitions and Policy Activity – An International Review* (OECD/IPEEC, 2018):

- **Net-zero operational energy** buildings are buildings whose energy consumption over the course of the year is offset by renewable energy generation. Depending on the definition boundary, the renewable energy generated can be on-site or off-site.
- **Net-zero operational carbon buildings** are buildings whose carbon emissions resulting from electricity consumption and any other fuels consumed on-site are offset through renewable energy generation or other forms of carbon offsetting. Again, the offset may occur on-site or off-site.
- **Whole-life net-zero carbon emission** buildings are therefore buildings whose carbon emissions from the materials used in their construction, or embodied carbon, are offset, as well as its operational carbon emissions.
- **Note:** These definitions of net-zero imply a strong effort to increase efficiency first. In the event that renewable energy is not available or feasible, the term “**near-zero**” or “**net-zero ready**” can also be used to reflect the fact that the building itself has done what it can to get as close to zero energy demand.

These definitions can be applied to the building level as well as to the neighbourhood, district or city level, i.e. achieving net-zero carbon neighbourhoods, districts or cities.

Figure 4 • Whole-life carbon: Definitions, adapted from European standard EN 15978



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The electricity sector will have a crucial role in reaching a net-zero carbon buildings sector, with particular challenges in each region given the fuels used to generate electricity. Indeed, the decarbonisation of the electricity sector will represent over 30% of the emissions reductions needed to reach the International Energy Agency (IEA) Sustainable Development Scenario (SDS) pathway (IEA, 2019a).

Finally, to reach the ultimate goal of whole-life net-zero carbon in buildings, the embodied carbon of building materials should be reduced and offset through low-carbon materials, more efficient manufacturing techniques and the optimisation of materials usage. Indeed, material efficiency strategies can reduce the whole life-cycle emissions of residential buildings by up to 35-40% in Group of Seven (G7) countries⁴ (IRP, 2020). Increased data collection, labelling, the development of new construction techniques and disclosure of building performance will be essential tools for enabling this transformation at scale, in all regions.

All eight activities described in this roadmap have an essential part to play in decarbonising buildings across their life cycle.

⁴ Estimate for G7 countries.

Latin America overview

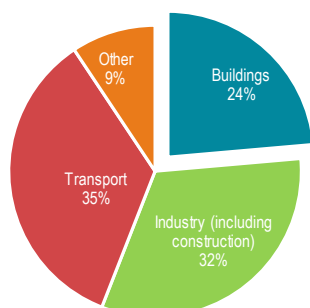
Energy and emissions

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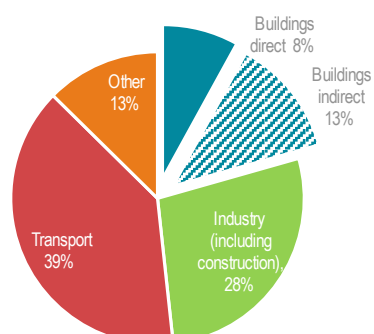
As shown in Figure 5, in 2018, buildings accounted for 24% of total final energy consumption in Central and South America, and 21% of total process-related carbon dioxide (CO₂) emissions. Electricity use accounted for almost half (43%) of total final consumption in buildings (IEA, 2019a). Figure 6 shows the share of buildings energy in Mexico, which accounted for 18% total final energy (SENER, 2000). When accounting for the production of construction materials, which accounts for approximately 11% emissions globally (GlobalABC/IEA/UNEP, 2019), buildings and their construction stand out as critical to address climate change.

Figure 5 • Share of buildings final energy and emissions in Central and South America, 2018

Buildings' share of total **final energy consumption** in Central and South America, 2018



Buildings' share of total **CO₂ emissions** in Central and South America, 2018

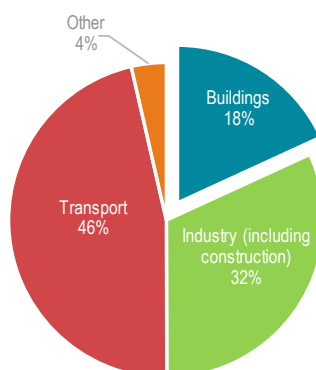


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Notes: “buildings” energy use and emissions refers to the operational energy consumption, and does not include the construction phase or the energy and emissions associated with the manufacture of materials. Direct emissions include those from coal, oil, natural gas and biomass. Indirect emissions relate to the generation of electricity consumed in buildings and to district heat consumption.

Source: Adapted from IEA (2019a), *World Energy Outlook 2019*.

Figure 6 • Share of buildings final energy in Mexico, 2018



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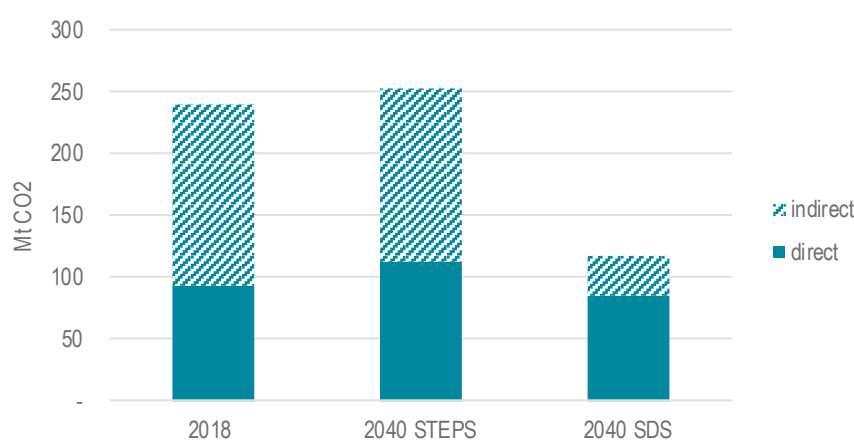
Note: as above, “buildings” energy use refers to the operational energy consumption, and does not include the construction phase or the energy and emissions associated with the manufacture of materials.

Source: Adapted from SENER (2020), *National Energy Balance (Balance Nacional de Energía: Consumo final de Energía por sector)* (database).

Opportunities exist for significant reductions in energy and emissions in the buildings and construction sector, as well as supporting universal access to electricity and clean cooking. These opportunities are illustrated in the IEA SDS.⁵ In the SDS, global CO₂ emissions fall from 33 billion tonnes in 2018 to less than 10 billion tonnes by 2050 and are on track to net-zero emissions by 2070.

As shown in Figure 7, in the SDS, emissions from buildings in Central and South America in 2040 could be 136 million tonnes of CO₂ (MtCO₂) per year lower than they are on track to be in the Stated Policies Scenario (STEPS),⁶ while supporting growth in gross domestic product (GDP) per capita of over 60% and an increase in floor area of about two-thirds. In fact, annual emissions from buildings could even be 123 MtCO₂ lower than they are today. Emissions of 123 MtCO₂ per year is equivalent to the emissions from over 30 coal-fired power plants.⁷

Figure 7 • Emissions from buildings in Central and South America in 2018 and in 2040 under the IEA STEPS and SDS



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Notes: “Buildings” energy use and emissions refers to the operational energy consumption, and does not include the construction phase or the energy and emissions associated with the manufacture of materials. Direct emissions include those from coal, oil, natural gas and biomass. Indirect emissions are the emissions from the power generation for electricity.

Source: Adapted from IEA (2019a), *World Energy Outlook 2019*.

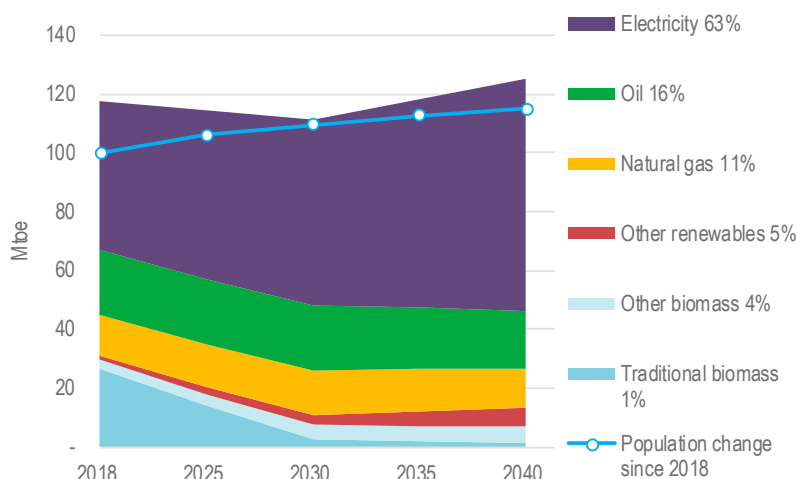
Improved efficiency in the consumption of coal, natural gas and oil could deliver 28 MtCO₂ reductions in direct emissions. Decarbonisation of the grid and more efficient use of electricity could deliver a further 107 MtCO₂ of emissions reductions.

⁵ The SDS holds the temperature rise to below 1.8°C with a 66% probability without reliance on global net-negative CO₂ emissions; this is equivalent to limiting the temperature rise to 1.65 °C with a 50% probability.

⁶ The STEPS aims to reflect the outcome of all current policies as well as policies that have been announced in targets and plans.

⁷ www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Figure 8 • Final energy consumption in buildings in Central and South America in the SDS



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Note: Mtoe = million tonnes of oil equivalent.

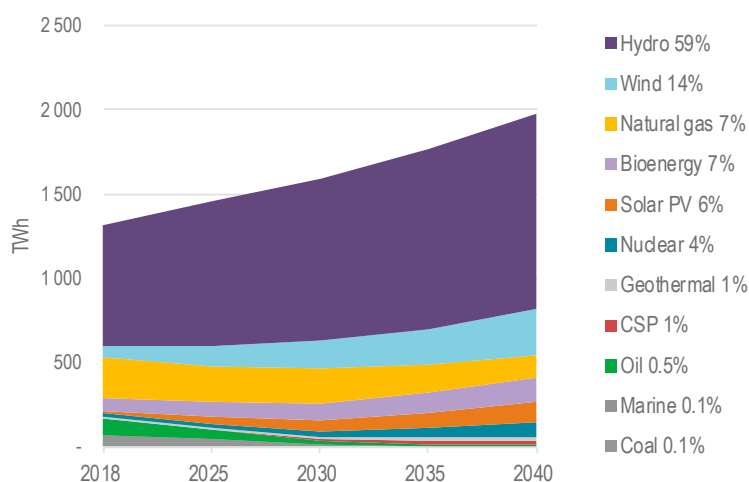
Sources: Adapted from IEA (2019a), *World Energy Outlook 2019*; IEA (2017), *Energy Technology Perspectives 2017*.

Accounting for 40% of energy consumption in 2018, electricity is the largest energy source in buildings in Central and South America. In the SDS, this share increases to 63% (79 Mtoe) by 2040 (Figure 8).

Traditional biomass for cooking and heating currently accounts for 23% of final energy consumption in buildings. In the SDS, this share is significantly reduced as access to clean cooking is assumed to expand. Energy efficiency could limit buildings energy consumption growth between 2018 and 2040 to 7 Mtoe, despite growing population, a 50% increase in floor area and higher appliance ownership rates. However, this would imply a 2% year-on-year improvement in energy efficiency until 2030, and a 35% decrease in buildings unitary energy intensity (Mtoe per square metre [m²]) compared with 2000 (IEA, 2019b).

Figure 9 shows how the electricity generation mix in Central and South America would evolve under an SDS scenario.

Figure 9 • The evolution of the electricity generation mix in Central and South America in the SDS



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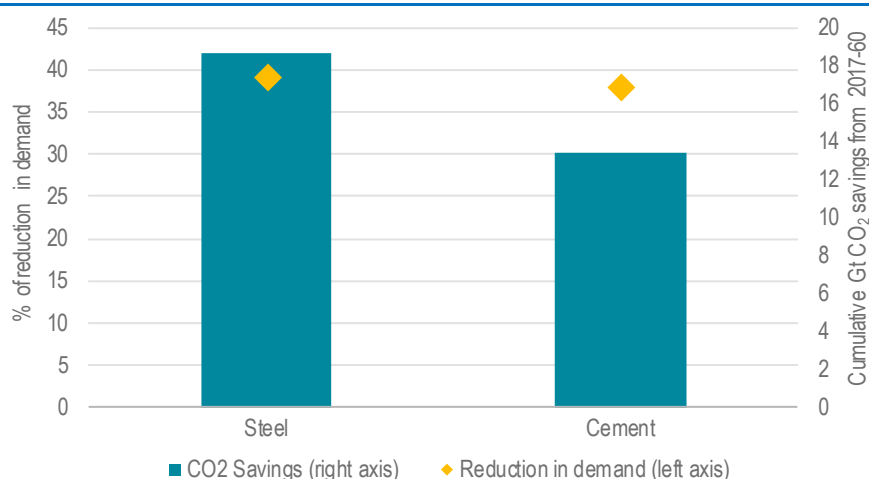
Notes: TWh = terawatt-hours; PV = photovoltaic; CSP = concentrated solar power.

Source: Adapted from IEA (2019a), *World Energy Outlook 2019*.

Electricity from the grid in Central and South America in 2018 is largely generated through hydropower (55%) and natural gas (19%). By 2040, hydropower generation is expected to continue growing, to 1 150 TWh, making up almost 60% of total generation. Wind and solar PV are expected to grow significantly, while the share of natural gas decreases to approximately 7%. By 2040, electricity generation is almost 90% renewable.

The buildings and construction sector, with its demand for building materials and building appliances, is one of the most resource-intensive global value chains and is both a challenge and an opportunity for the region to address carbon emissions.

Figure 10 • Possible reductions in material demand and CO₂ emissions reductions in buildings under the Material Efficiency Scenario compared with the RTS by 2060 (global)



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Note: GtCO₂ = gigatonnes of CO₂.

Source: Adapted from IEA (2019c), *Material Efficiency in Clean Energy Transitions*.

In Latin America, there is a lack of data on the potential for emissions reductions from material efficiency at a regional or national level. However, at a global level, with greater material efficiency in design and construction, the demand for steel and cement in buildings in 2060 could be almost 40% lower than in a Reference Technology Scenario (RTS) (IEA, 2019c) (Figure 10). These reductions could be achieved through optimising building frames and structures, extending the lifetime of buildings, and using best available steel and cement. These are two of the main components of buildings and major sources of CO₂ emissions.

Regional context: Latin America

This section aims to provide some key information on the region to describe the context in which the buildings and construction sector policies are embedded.

Page | 28 *Macroeconomic and demographic*

With 624 million people, the Latin America and Caribbean (LAC) region is home to 8.4% of the world's population and is responsible for 6.2% of global GDP (IMF, 2019). The LAC region has seen sustained population growth, but at a rate lower than the global average. While regional GDP contracted in 2018 and 2019, it is forecast to grow at an average of around 4.8% from 2020 to 2024 (IMF, 2019).

Latin America is highly urbanised, with over 80% of the population living in cities (UN DESA, 2019). Economic growth has resulted in the expansion of the middle class to represent one-third of the population, and its share in the population continues to increase. The growing middle class has resulted in increased demand for better-quality public services, buildings with larger dwellings and more services (including heating, cooling and consumer appliances), and higher levels of comfort (OECD, 2019).

Many countries within the LAC region have natural and mineral resources, and large energy-intensive extractive and manufacturing industries represent a significant part of their economies (OECD, 2019). Latin America is one of the regions where demand for materials is expected to continue rising as investments in infrastructure, including in buildings, grow. For this reason, material efficiency will be crucial for a sustainable development strategy (IEA, 2019a).

The share of low-carbon energy supply in the region is significantly higher than the global average. In 2018, hydro represented 55% of the electricity generation mix in the LAC region, and bioenergy represented 6%, compared with 16% for hydro and 2% for bioenergy at the global average (IEA, 2019a).

Priorities

Most countries in Latin America have a head start in decarbonising their energy sectors. Favourable geographic and climatic conditions mean that there is significant potential for the production of renewable energy. Hydropower already accounts for half of installed electrical capacity in Central and South America, and renewables (including hydro) account for 63% of total installed electrical capacity (IEA, 2019a). Greenhouse gas (GHG) emissions average 3.0 tonnes of CO₂ (tCO₂) per capita, compared with 16.4 tCO₂/capita in North America (excluding Mexico) and 6.4 tCO₂/capita in Europe (The World Bank, 2014a). Bioenergy, in turn, accounts for 21% of total primary energy demand in the region.

The development of distributed renewable generation capacity, including solar PV, presents a particular challenge. In Latin America, the growth of solar PV has been much slower than in other regions and countries, such as the People's Republic of China (hereafter, "China"), North America, Europe and Asia Pacific (IEA, 2019d).

Latin America's urbanisation has been accompanied by urban sprawl and fragmentation, with expansive areas of informal settlements in cities⁸ (The World Bank, 2014b). This has posed challenges for urban planners and policy makers, for instance in the implementation of building standards, and makes urban planning a priority for the region.

⁸ Informal settlements as percentage of urban population varies between low (11% to 13%, such as in Mexico and Colombia), medium (34% to 44%, such as in Peru and Bolivia), to high (74% in Haiti) (The World Bank, 2014b).

Making cities resilient, as well as the infrastructure and regions connecting them, is a significant priority because the LAC region is particularly vulnerable to climate change. The economic cost of the physical impacts of a 2°C increase over pre-industrial levels in the region were conservatively estimated at between USD 85 billion and USD 110 billion a year by 2050 (in USD 2012) (Vergara et al., 2013).⁹ Moreover, a recent study showed that over 50% of the region's population lives in countries with "high or extreme climate vulnerability risks", which underlines the importance to create buildings, cities and infrastructure that are climate-resilient (The Resource Foundation, 2019) (see Activities 1 and 7). Thirty percent of the population in Latin America and the Caribbean is considered to live in poverty, rendering them even more vulnerable to climate risks.

An important part of the regional context impacting the buildings and construction sector is the dynamics of the labour market. In the Latin American region, informal labour represents a significant proportion of the labour force, especially in the buildings, services and construction sector. Around 60% of the construction workers are either self-employed or salaried workers in small establishments (Gasparini and Tornarolli, 2009). According to other estimates, this share is as high as 75% for the construction of residential buildings (The World Bank, 2017). In the context of a highly informal and decentralised construction sector, awareness and expertise in low-carbon building is often lacking and difficult to develop. Ensuring the capacity building for these professions would be one of the main priorities in order to achieve the net-zero target (see capacity-building activities).

Investment environment

Investing in zero-emission, efficient and resilient buildings is a cost-effective way to reduce carbon emissions, improve air quality and contribute to productivity (IEA, 2019e). A significant scale-up in investment will be needed to unlock these potential benefits.

In the LAC region, the buildings sector offers significant potential for climate-smart investments. For example, the International Finance Corporation (IFC) has identified that over a third of all climate-smart investment potential in LAC lies in the buildings sector (IFC, 2016). To put this into perspective, the investment potential identified for the buildings sector is almost four times higher than investment potential in renewables. This demonstrates that a low-carbon, energy-efficient buildings sector not only is good for the climate but also makes financial sense in the LAC region. Indeed, the IFC estimates the investment opportunity for green buildings (residential and commercial) to be over USD 4 trillion in the LAC region (IFC, 2019).

Despite these numerous benefits, the investment potential remains largely untapped. Many economies are prioritising investments in energy supply infrastructure (rather than buildings infrastructure) and have fossil fuel subsidies in place, which can distort the market for low-carbon investment decisions.

Access to finance is particularly challenging for low-income segments of the population and small and medium-sized enterprises (SMEs), given the high interest rate environment. In many Latin American countries, lending interest rates are between 8% and 20%, which is significantly higher than in Asia (The World Bank, 2019). This creates a challenging environment for investments in general, and especially for medium- to long-term investments, such as the ones in the buildings and construction sector, which tend to have longer payback periods than in industry.

An enabling policy framework for investment and finance is thus critical to mobilise and effectively channel finance to investments to the low-carbon buildings and construction sector. This includes removing fossil fuel subsidies, building capacity among policy makers and financial institutions,

⁹ These estimates are conservative and have limitations as they do not factor in all possible economic costs. For example, data were not available for all nations within the region and estimates did not include loss of biodiversity or natural resource stocks.

mechanisms to de-risk investments, and establishing effective retail channels. Each section in this roadmap provides an overview of tools that can be used to stimulate finance.

Policy

According to the GlobalABC's [Guide for Incorporating Buildings Actions in NDCs](#) (UNEP, 2018), most NDCs do not incorporate net-zero energy performance in buildings or building decarbonisation strategies. Certain areas, such as building design and cooling, are included in only a small minority of countries' NDCs. Policy coverage of low-carbon materials, reducing embodied carbon and links to urban-scale policies are often missing (UNEP, 2018). The majority of Latin American countries do not mention buildings explicitly in any form in their NDCs (GlobalABC/IEA/UNEP, 2019). Indeed, according to the 2019 *Emissions Gap Report*, many national and subnational governments are yet to adopt legally binding ambitious targets in the buildings sector, among others (UNEP, 2019).

The policy environment and priorities vary across the region. A number of countries have high-level strategies in place, including the Energy Transition Law in Mexico and Brazil's law establishing the National Policy on Conservation and Rational Use of Energy. However, across the region, the coverage of mandatory building energy codes is still weak, with Argentina, Brazil, Chile and Mexico having mandatory building energy codes for part of the sector, while the rest of the region has voluntary or no codes in place (GlobalABC/IEA/UNEP, 2019).

Most countries in the LAC region have minimum energy performance standards (MEPS) and energy labels in place. However, progress in transforming the market towards more efficient appliances is slow. Standards are set at the national level, and the lack of regional harmonisation of MEPS and labelling programmes limits the ability for markets to scale, posing a challenge for manufacturers, importers and retailers (Braungardt and Göthner, 2017). Regional harmonisation of MEPS and labels, including strengthening of standardisation bodies, assessment institutions and regulatory agencies, can make these programmes more effective.

There is also a need to consider complementary policies to ensure that the full value chain of buildings materials, design and construction have adequate policy support to move the sector towards decarbonisation. This includes a range of policies, from material efficiency to electricity tariff design. This report is structured to recognise the breadth of strategies – including policies and programmes – needed to advance the net-zero carbon goal for each priority activity.

The maps in Figures 11, 12 and 13 show the status of different jurisdictions for three different buildings policies, as of 2019 (GlobalABC/IEA/UNEP, 2019):

Building codes

Building energy codes, or standards, are requirements set by a jurisdiction (national or subnational) that focus on reducing the amount of energy used for a specific end use or building component. In 2018, only six out of 33 countries in Latin America and the Caribbean had mandatory or voluntary building energy codes, among which only French Guiana had a mandatory code (Figure 11).

Figure 11 • Building energy codes by jurisdiction, 2018



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

Source: GlobalABC/IEA/UNEP (2019), *2019 Global Status Report for Buildings and Construction: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector*.

Building certification

Building energy certification involves programmes and policies that evaluate the performance of a building and its energy service systems. Certification may focus on rating a building's operational or expected (notional) energy use and can be voluntary or mandatory for all or part of a particular buildings sector. As of 2018, approximately half of the countries in Latin American and the Caribbean had adopted building energy performance certification programmes; however, only French Guiana has a widespread certification (Figure 12).

Figure 12 • Building energy certification programmes by jurisdiction, 2018



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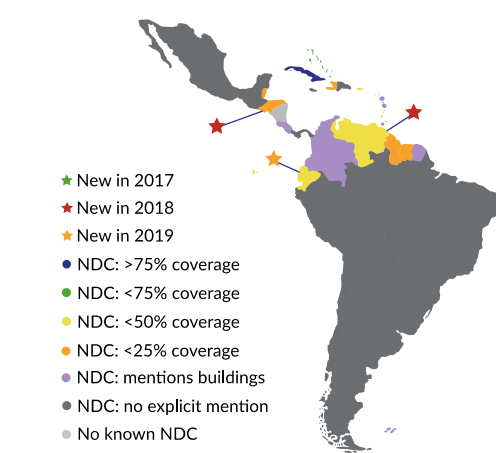
Note : this map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Source: GlobalABC/IEA/UNEP (2019), *2019 Global Status Report for Buildings and Construction: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector*.

Nationally determined contributions

All countries within Latin America and the Caribbean have reported an NDC, which is the process by which countries announce their national-level commitments to reduce carbon emissions. To date, most NDCs in the region mention buildings, although most still do not include explicit actions to address buildings sector energy use and emissions (Figure 13). This roadmap aims to support governments in their NDC development by providing an illustration of the pathway towards a zero-emission, efficient and resilient building stock.

Figure 13 • Buildings sector emissions coverage in NDCs by jurisdiction, 2017-18

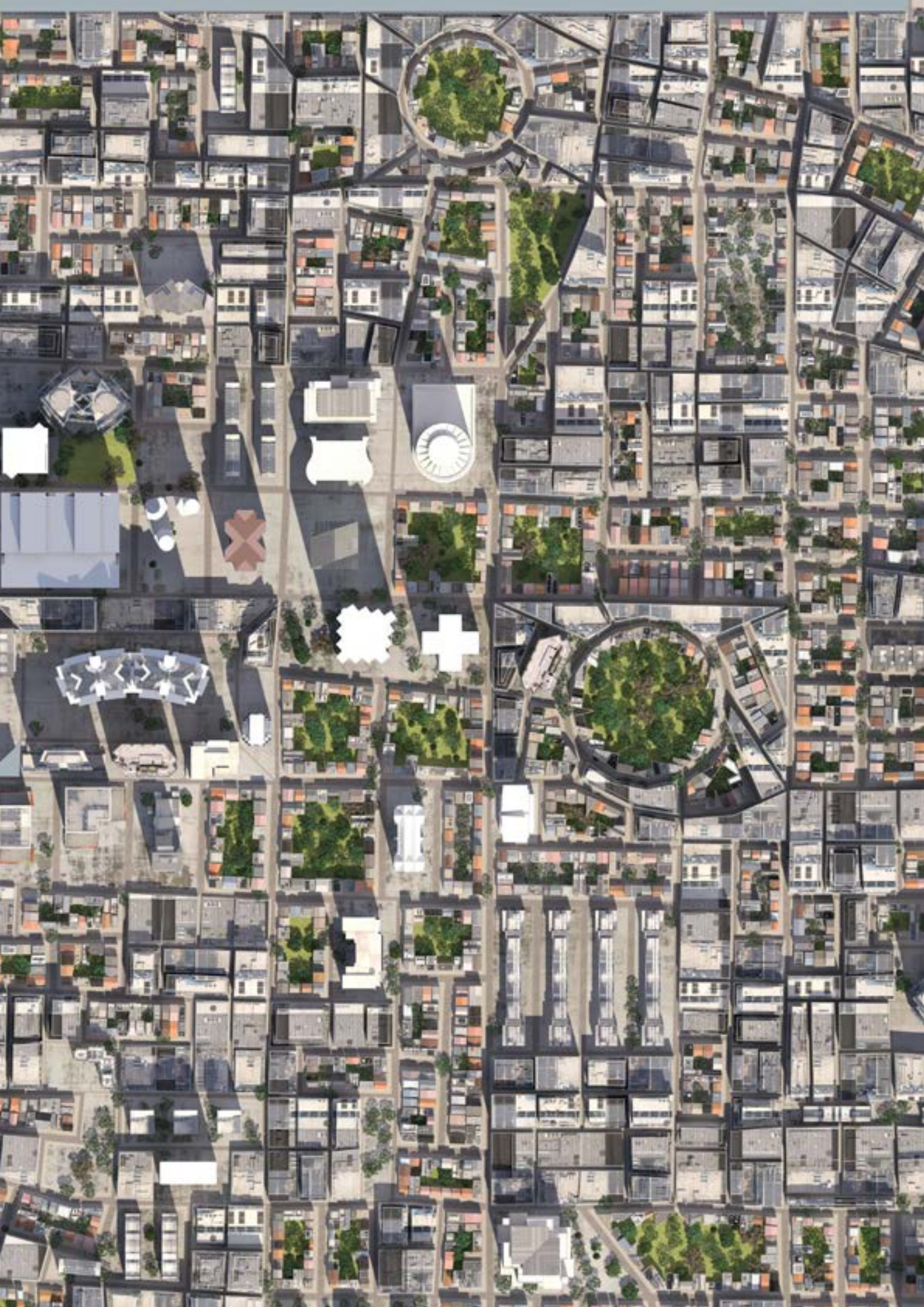


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Note: this map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Source: GlobalABC/IEA/UNEP (2019), *2019 Global Status Report for Buildings and Construction: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector*.

With rising demand for appliance ownership, especially for cooling appliances due to increasing incomes and living standards, more widespread adoption of MEPS will be crucial. The LAC region and its respective subregional economic communities could benefit from exploring harmonisation and co-operation in setting up new MEPS programmes as well as expanding and strengthening existing ones.



Targets and timelines

Activity 1: Urban planning

Urban planning is “the planning, design and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it” (Fainstein, n.d.). Sustainable urban planning frames the supply and demand for urban energy with a view to: 1) protecting the environment (including mitigating climate change, reducing air pollution and limiting resource depletion); 2) achieving economic and human development goals; and 3) improving the resilience of local communities and urban energy infrastructure to disasters (IEA, 2016).

In the wake of the COP21 and the Climate Summit for Local Leaders in November 2015, and the Habitat III United Nations Conference on Housing and Sustainable Urban Development, which took place in Quito in October 2016, cities are becoming increasingly central to the transition towards sustainable energy systems. Greater alignment among governance structures, both between national and local policies (vertical integration) and between local sectoral institutions (horizontal integration), plays an essential role in meeting environmental, economic and social objectives simultaneously (IEA, 2016). Read more about institutional coordination and multiple stakeholder engagement in the chapter “Roadmap support: Enablers”.

The [New Urban Agenda](#), adopted at the Habitat III conference in October 2016, lays out a 20-year collective vision to achieve sustainable cities, in line with SDG 11, and elevates the role of cities in addressing climate change and in disaster risk management. It promotes compact cities, polycentric urban growth, transit-oriented development, sprawl containment and vibrant public spaces.

At the urban scale, the siting of buildings has both direct and indirect impacts on energy use. Urban form is an important determinant of urban energy demand, encompassing the overall physical characteristics of the built environment, such as shape, size, density and configuration, the street network, and public spaces. Likewise, at the building scale, compactness, height, orientation and mutual shading have a great influence on energy demand in buildings and on local renewable energy potential. As buildings are typically governed by rules set in urban planning regulations, their impact on energy consumption and potential for local energy production should be taken into consideration when defining urban planning and land-use policies and deciding on development projects (e.g. new urban districts, rezoning, and district energy planning).

In the coming decades, with increasing linkages between urban planning and its impact on energy use and emissions from buildings and transport, urban planning policies can play a significant role in embedding energy efficiency in spatial planning to support the transition towards zero-emission, efficient and resilient urban form, buildings and construction.

Box 1 • Urban planning in Latin America: Trends and challenges

The LAC region is currently the second-most-urbanised region in the world. The share of its urban population rose from 71% in 1990 to 81% in 2011 and is expected to reach 86% by 2050 (UN-Habitat, 2015). Twenty-six percent of the urban population in LAC lives in poverty or extreme poverty and nearly one in four people lives in a slum.¹⁰ By 2020, 160 million people are expected to live in informal settlements in the region. Currently, it is estimated that 75% of housing built annually in the region is informal, which means that these dwellings lack property titles and access to basic infrastructure and services (The World Bank, 2017).

Socio-economic inequalities are manifest in the urbanisation patterns of Latin American cities, often in the form of socio-spatial segregation. The poor often have to resort to constructing their housing situated on the fringes of cities and “in the interstices of formal development” (Irazábal, 2009). As a result, informal settlements are generally built in residual unoccupied or outlawed urban spaces, i.e. those at greatest risk of natural hazards (flooding, landslides, etc.). Furthermore, these unplanned settlements often coincide with crime zones, further exacerbating the socio-economic vulnerability of the urban poor.

As a result, in Latin America, urban planning places strong emphasis on the intersection of social and spatial equity. This has important implications in the framing of sustainable energy interventions. Latin American local jurisdictions have significant control over energy use and emissions from transportation, building construction and buildings operations through the urban planning process, while taking into account equity and affordability considerations.

From this perspective, transportation and housing have strong linkages. The development of public transit systems plays a pivotal role in sustainable urban densification by “housing more people on less land” (Irazábal, 2009), connecting more people to employment centres and social amenities, allaying local congestion, expanding public spaces and promoting urban connectivity. Although mass transit infrastructure requires substantial upfront financial and material investment, there is clear evidence that it saves energy and enables more “egalitarian and effective access to the urban economy and amenities for citizens” (IRP, 2018).

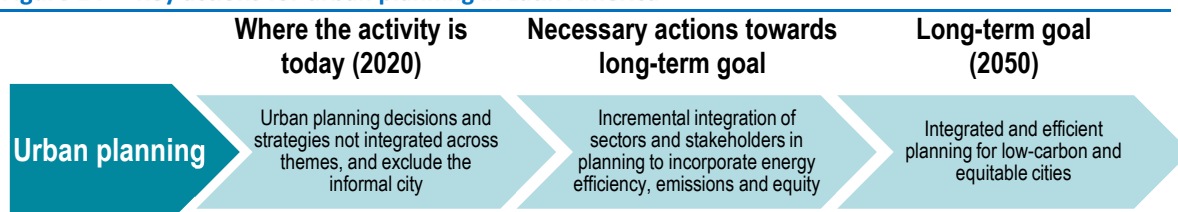
Urban planning can also play an important role in the prevention of climate risks through resilience planning at the city, district and building level, including by targeting the most vulnerable communities. While some dimensions of sustainable urban planning have already been incorporated, the intersections between climate risks such as sea-level rise in coastal cities, heat island effects or storm-water management and social vulnerability factors are still far from being systematically integrated into local urban development strategies (Carrizosa et al., 2019).

In the coming decades, with increasing linkages between urban planning and its impact on energy use and emissions from buildings and transport, urban planning policies can play a significant role in embedding energy efficiency in spatial planning to support the transition towards zero-emission, efficient and resilient urban form, buildings and construction.

¹⁰ UN-HABITAT has defined slums as “a group of individuals living under the same roof that lack one or more of the following conditions: access to safe water; access to sanitation; secure tenure; durability of housing; and sufficient living area” (Warah, 2003).

Key actions for urban planning

Figure 14 • Key actions for urban planning in Latin America



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Key actions for urban planning include:

- **Integrated urban planning policies.** Cities are complex and dynamic systems. As such, urban planning policies can achieve maximum impact when they are systemic and integrated rather than isolated and sectoral. Urban planning policies should incrementally increase in scope to include not only the formal city but also the informal city.¹¹ Enacting urban planning policies on a national and local level that takes into account the multi-faceted nature is central to ensuring the decarbonisation of buildings and construction, with a priority for those cities experiencing the highest and fastest population growth.
- **Local and national urban plans underpinned by location efficiency.** National and local policies play a key role in promoting compact and efficient urban forms. These plans should increasingly include rules for location efficiency, transport-oriented design (TOD), mitigation of the urban heat island (UHI) effect, zero-carbon building codes and resilience.
- **Institutional co-ordination.** Ensure collaboration and co-ordination among national, provincial and city levels, and across disciplines including transport, spatial planning, social housing and energy supply, based on good communication and awareness of the multiple benefits of decarbonising buildings and construction. Involve citizens and favour their active participation in the planning process so as to improve understanding of urban issues and foster knowledge-sharing and citizens' appropriation of the city.
- **Data collection.** The collection of robust urban energy statistics is central to identifying and prioritising major contributors to energy use and emissions. By investing in data collection, processing and analysis as well as streamlining across relevant stakeholders, national and local governments will be able to monitor progress towards national and local energy and climate goals. This will also enable benchmarking across sectors and levels.

Stakeholders for urban planning

By nature, robust municipal plans need to draw in all key stakeholders, so they come to understand different urban pressures and priorities and foster agreement on the acceptable trade-offs (Hardoy et al., 2017). In Latin America, the key stakeholders for sustainable urban planning include citizens, as well as those that can influence urban planning and those that can deliver the results of zero-emission, efficient and resilient buildings through urban planning. Additional stakeholders include those that can support the process through research, funding, training and making technologies available.

These stakeholders are mapped in Table 2, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

¹¹ Informal cities are defined as areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally. Those areas often lack utilities and services, e.g. clean water supply and sanitation (Within Formal Cities, 2014).

Table 2 • Stakeholder mapping for urban planning in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|-----------------|
| | | | | | | | | | |

* of appliances and materials

** including academia, non-governmental organisations (NGOs), research institutions, social networks and community associations.

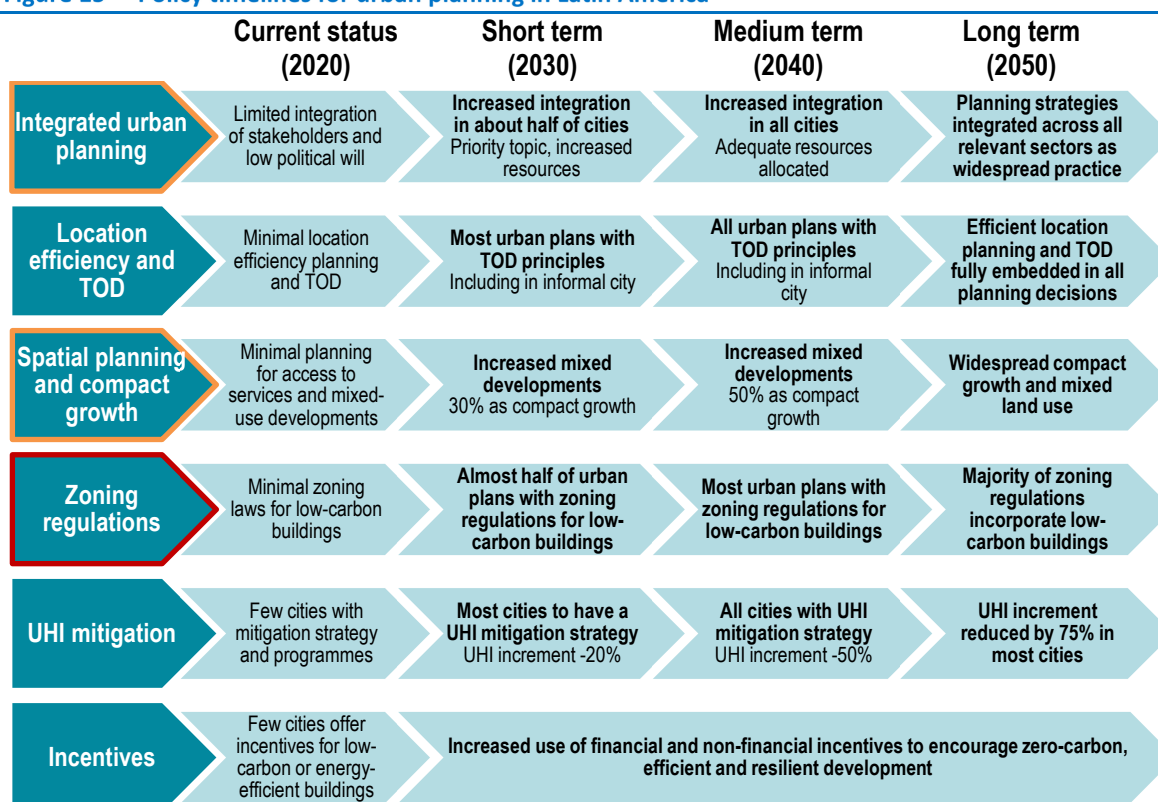
How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Policy for urban planning

Urban planning policy can support goals for zero-emission, efficient and resilient buildings by enabling a local environment where designers, developers and owners have the support to invest in the broader sustainable development goals.

The sub-targets and timelines in Figure 15 offer more details:

Figure 15 • Policy timelines for urban planning in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for new buildings are outlined below. For each item, in *italic* is a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it

is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

Urban planning policy target details:

- **[data gap] Integrated urban planning:** Integrated urban planning creates a formal framework to encompass multidisciplinary issues, such as climate change, disaster risk reduction and emergency response, as well as land use and transport, location of services and infrastructure, and social housing. A critical aspect of delivering this planning framework is the articulation of a clear city vision. Institutional co-ordination can start with the ministries in charge of land use, transportation, buildings, and energy and environment, and progressively integrate more sectors as priority areas are defined (e.g. health, education, water and sanitation, waste, public parks) The development of a shared and integrated city vision requires alignment between different levels of government and across the motivations of different stakeholders involved in designing and implementing projects at the city level. Integrated planning is therefore underpinned by active and ongoing processes of communication and co-ordination at all stages of planning. Such integration can help to mainstream energy efficiency strategies across all departments of local governments.
- **Location efficiency TOD:** There is growing consensus on the importance of strategically integrating urban infrastructure and land-use planning to achieve low-carbon emissions, efficiency and resilience goals. Urban form is a key determinant of travel needs and behaviour. Housing location decisions have a huge impact on overall energy use and emissions. Households can reduce their transportation-related energy use by opting for compact, mixed-use communities that are “location efficient”, i.e. accessible through multiple modes of active and public transportation (EPA, 2011). The majority of location efficiency strategies are controlled by local government authorities. Zoning regulations that support location efficiency promote mixed-use zones, adjust zoning standards to allow compact urban development, raise the threshold of building density in urban cores and around transit nodes that can support denser development, encourage walkable communities, and designate strategic growth areas to direct urban expansion and property development (IRP, 2018). Zoning mechanisms to promote location efficiency include the use of overlays that add transit-related and density requirements to existing codes (ACEEE, 2019). *Stakeholder feedback: There was strong consensus that transit accessibility could be fully incorporated into urban plans by 2030.*
- **[data gap] Spatial planning and compact urban growth:** Planners, developers and designers can work together to increase the mixed-use nature of dense urban districts that have easy access to transit, retail, employment, entertainment and residences to limit energy use and emissions from unnecessary transport and to increase quality of life. Compact urban configurations can improve living conditions of urban residents through: spatial restructuring of the urban form to achieve “strategic intensification”; human-scale design that creates socially mixed neighbourhoods, with a diverse mix of housing types and social functions, and strengthen access to employment opportunities near residential areas; and sustainable mobility options such as light rail and bus rapid transit systems, bike lanes, and overall walkability (IRP, 2018).
- **[ambition gap] Zoning regulations:** Local jurisdictions have an important role to play in integrating energy-related requirements into zoning regulations and streamlined “form-based” codes that increasingly link urban planning to sustainable buildings and communities not only in terms of controls on density and land use, but also in terms of the

physical form of the built environment. The objective is to create a specific type of urban fabric that promotes low-resource, compact, walkable and community-driven cities. For example, form-based codes can promote shared parking, integrated storm-water runoff solutions or shared solar PV rooftop installations. These approaches allow more efficient systems. This initially could include special zoning districts that require increased sustainability and expand over time to include all zoning districts. *Stakeholder feedback: Consensus from local stakeholders was that “few” to “about half” of cities would succeed in implementing zoning regulations for low-energy and low-carbon buildings, mainly due to lack of political will and capacity, and conflicting influence of the private sector.*

- **UHI mitigation:** Un-vegetated, impermeable and dark surfaces in cities tend to generate UHI effects, i.e. higher ambient temperatures. Buildings, parking lots and paved surfaces absorb more heat than moist vegetated surfaces, which release water vapour and provide shade to cool the surrounding air. Consequently, the annual mean air temperature of a city with at least 1 million people can be up to 3°C warmer than surrounding rural areas (EPA, 2019). These temperature increases will add to the warming that cities are experiencing from climate change. To minimise this effect and mitigate extreme heat events, cities are establishing goals for UHI reduction and implementing a variety of programmes and policies. Local authorities may aim at reductions in impermeable surface areas, increases in the tree canopy, deployment of cool or green roofs and facades, or the expansion of wetlands. Quantitative goals should be included in formal city plans and specify a future target date or annual commitment (ACEEE, 2019). *Stakeholder feedback: Strategies for mitigating the UHI effect in cities is largely absent from urban planning strategies currently, and there was strong consensus that this would only be implemented by 2040.*
- **Incentives:** Financial and non-financial incentives such as tax rebates, expedited permitting, density bonuses or increased project scope can be used by cities to encourage development that is in line with the aim of reaching zero-carbon, efficient and resilient buildings and cities. *Stakeholder feedback: There was consensus that the use of incentives is currently very limited across the region, but they were important tools and would increase to be widespread by 2050.*

Box 2 • Regional examples of policy action for urban planning

Mexico

Since 2012, Mexico has been designing urban policies towards a more sustainable urban spatial pattern, limiting the spatial expansion of cities as a key. The government introduced location-specific housing credits and subsidies in order to increase concentration and re-densification of the housing stock in the inner cities. The urban contention perimeters were determined for each city to limit the expansion of urban areas (CONAVI, 2019). In just two years, by December 2014, the number of housing developments located within the defined urban contention perimeters increased from 35% to 67% (Infonavit, 2015).

In 2019, the Mexican city of Merida created the Fiscal Stimulus Programme for the Construction or Acquisition of Vertical Housing, which consists of contributing to the urban consolidation and compaction of the city. This programme is aimed at the owners who build or acquire vertical housing in the Primary Urban Consolidation Zone, defined in the [Municipal Urban Development Programme](#), Mérida 2040. The benefit for the developer or buyer is the total subsidy of the payment of the property tax corresponding to the fiscal years 2018 and 2019.

Colombia

In 2016, the Colombian Council for Sustainable Construction and Building Efficiency Accelerator (BEA) carried out a study with the objective of developing a protocol for the implementation of Resolution 549 of 2015 ([Guide for Saving Water and Energy in Buildings of the Ministry of Housing, City and Territory](#)). The protocol enabled the implementation of it throughout the city's master plan for urban reconstruction. In 2018, the Bogotá Council made a draft for the implementation of the code, making it mandatory for all uses, except social and priority housing, in the cities of Barranquilla, Bogotá, Cali and Medellín. With the effective implementation of the resolution, new buildings in the city will save up to 20% in energy and 30% in water. Likewise, 2.84 million new homes by 2050 in

Bogotá will be able to meet their demand for water and energy efficiently, and their users will benefit from a 25% reduction in public service costs.

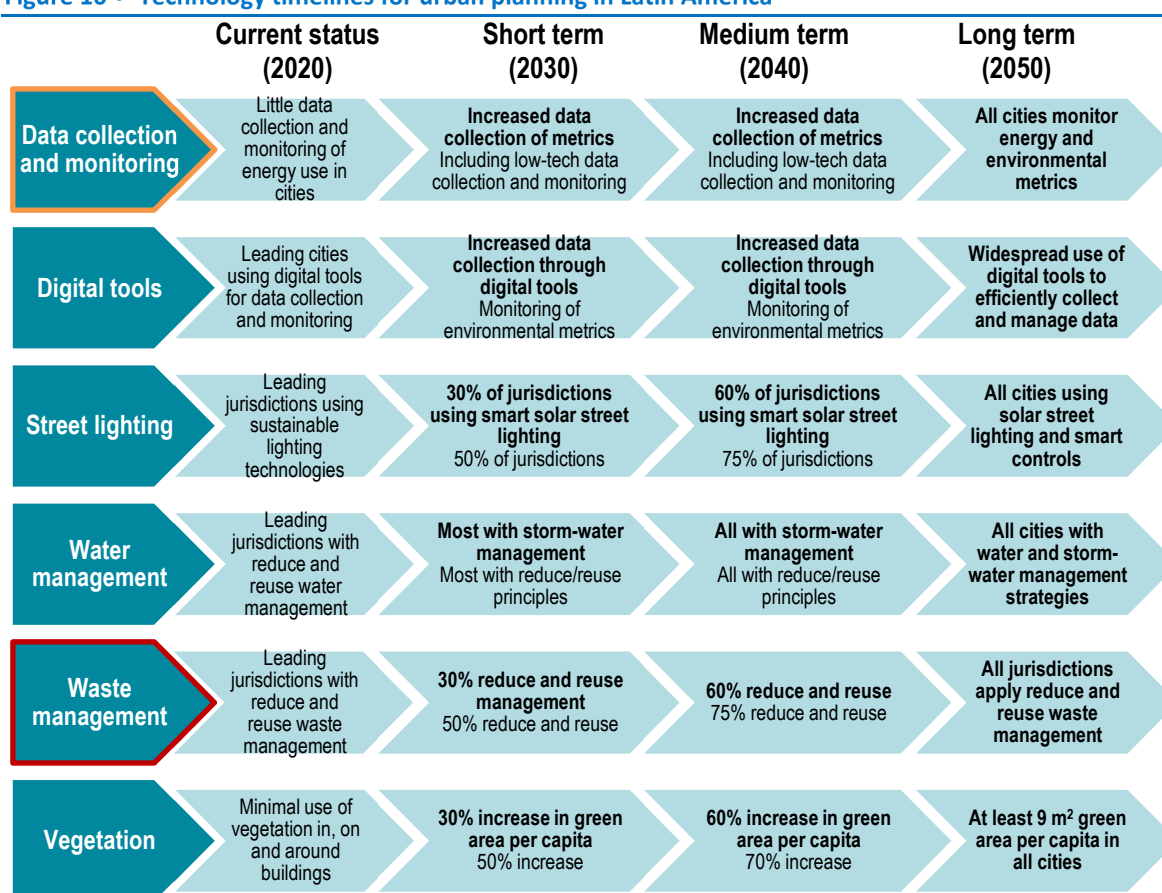
Brazil

The Metropolis Statute, Federal Law No. 13 089, from 2015 and modified in 2018, determines that all Brazilian metropolitan regions and urban agglomerations should develop an Integrated Urban Development Plan. The plan encompasses metropolitan issues that go beyond municipal limits, requiring an inter-federative approach. Examples are use of water resources, availability of electricity and telecommunications resources, and infrastructure for supporting economic activity.

Technology for urban planning

Technology can enable increased action towards zero-emission, efficient and resilient buildings when coupled with urban planning. Specific targets and timelines for sustainable urban planning technologies are outlined in Figure 16:

Figure 16 • Technology timelines for urban planning in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for new buildings are outlined below. For each item, in *italic* is a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it

is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

Urban planning technology target details include:

- **[data gap] Data collection and monitoring:** Improved access to data helps cities measure, monitor and manage energy use and environmental impacts. Regular tracking of energy-related metrics allows cities to set benchmarks for energy usage and target specific areas where savings can be quickly achieved (ACEEE, 2019). Local government authorities should collect complete energy data covering public buildings and infrastructure, private buildings, and transportation. For example, the City Footprint Project ([Proyecto Huella de Ciudades](#)) supports local governments in Latin America in implementing climate mitigation and adaptation strategies. An annual evaluation of the cities' carbon and water footprints demonstrates local achievements and informs their monitoring processes.
- **Digital tools:** Support the increased use of tools that use data and information, such as geographic information system (GIS) mapping, satellite images, cost data, benefits analysis and life-cycle analysis (LCA) to make science-based decisions in the urban planning process. While there is no commonly agreed definition, the emerging definition of smart cities is that they are monitored through information and communication technology and digital technologies, with the goal of using "enhanced real-time data, automated utility systems and digital communication tools to increase the provision of urban services (e.g. transport, energy, water) and governance in a way that is cost-effective and accountable" (OECD, 2016). Smart-city applications include among others: smart street lights, building management systems (BMS), smart electric grids, and intelligent traffic and transit solutions. Smart solutions may also offer valuable applications to enhance the resilience of the built environment, in particular to climate impacts, as discussed in the "Resilience" section. *Stakeholder feedback: There was consensus that "few" or "no" jurisdictions currently use digital tools for planning, but that they would become widespread by 2050.*
- **Street lighting:** Support the switch to smart and efficient lighting, including promoting solar street lighting technologies on the exterior of buildings and streets where relevant, and effective on a whole-lifecycle basis. Smart lighting can include sensors and controls and can be integrated with other environmental and site condition information, such as traffic. Appropriate measures should be taken to minimise impact on population health and biodiversity by using appropriate light diffusion devices and lighting schedules. Street lighting typically represents 5% or more of cities' annual operational budgets, especially in resource-constrained cities, and can therefore generate significant savings, while better quality and extension of street lighting can also contribute to crime reduction at night. *Stakeholder feedback: There was consensus that low-energy and smart lighting was employed by some jurisdictions currently and that these would become widespread before 2050.*
- **Water management:** Support the increased use of water management technologies that reduce water run-off and increase landscape permeability and rainwater retention. This can support resilience against floods and improved health of soil and underground aquifers. The measurement of rainwater flows through downpipes, into tanks, and drains through smart sensors can enable urban planning authorities to identify places where green infrastructure is needed to improve drainage and mitigate UHI effects. *Stakeholder feedback: There is variability on the extent to which storm-water management is currently incorporated into urban plans. There was consensus that it could be fully incorporated by 2030 to 2040.*

- **[ambition gap] Waste management:** Support the increased use of waste and wastewater storage and treatment technologies that can reduce energy use for waste from buildings. Waste management policies appear to be limited, and there is little consensus as to when they might be incorporated. *Stakeholder feedback: There was consensus that “few” or “no” jurisdictions used reduce-and-reuse waste strategies, and that these would grow to “about half” by 2050.*
- **Vegetation:** Landscaping and vegetation can support improved resilience and reduced need for heating and cooling through measures such as green roofs, green walls, trees and parks. In particular, urban parks are critical in improving urban quality of life, cooling cities, and acting as a sink for GHG emissions and some atmospheric pollutants. However, with few exceptions (e.g. Curitiba or Santiago de Chile), most cities in Latin America do not meet the World Health Organization’s recommendation of 9 m² of green space per urban dweller. Consequently, many cities are actively engaged in recovering fringe areas such as wetlands or refurbishing parks that have fallen into disrepair, and developing green spaces through linear parks (Aguascalientes) and urban reforestation initiatives (Buenos Aires). Vegetation measures should prioritise the use of indigenous plant species. *Stakeholder feedback: Currently, urban ecology has to some extent been included in urban planning strategies in the region, and there was strong consensus it would be fully integrated across the regions by 2040.*

Box 3 • Examples of regional action on urban planning technology

Brazil

The municipal council of Recife, Brazil, approved [Law 18 112/2015](#), which requires the installation of a green roof for buildings with more than four floors. These buildings must have their roofs covered with native vegetation, and require the construction of reservoirs for the accumulation of rainwater for non-potable purposes reuse. The law also applies to any commercial building with more than 400 m² floor area.

Argentina

Argentina’s second-largest city, Cordoba, adopted a bylaw in July 2016 mandating all buildings – new or existing – with a rooftop space of 400 m² or more to be converted into a green roof. The new policy aims to mitigate rising air pollution levels in the city’s central areas. While most green roofs bylaws cover only new buildings, Cordoba included retrofitting green roofs to existing buildings, through a [dedicated incentive programme](#).

Colombia

In 2010, the municipality of Bogotá promulgated the roof greening guidelines (Bylaw 418). In order to facilitate the implementation of the bylaw, in 2011, the Secretary of Environment of the city developed the [Official Green Roof Technical Guidelines](#) by adopting a participatory process which harnessed local knowledge and technologies adapted to local conditions.

Mexico

The Environmental Standard for the Federal District NADF-013-RNAT, from 2007, establishes technical specifications for the installation of systems for green roofs in Mexico City. The installation is incentivised by offering a 10% reduction in property tax for those who install green roofs in their buildings. Both new and existing residential buildings are currently eligible to receive the reduction. The strategy is part of Mexico City’s effort to improve overall air quality and reduce GHG emissions by 50% below 2000 levels by 2050.

Mexico City is currently home to one of Latin America’s largest green roofs (*azotea verde*) on the roof of the National Workers' Housing Fund Institute, which leads to a reduction of the UHI increment of 10-15%.

Finance for urban planning

Finance can enable increased action towards zero-emission, efficient and resilient buildings when coupled with urban planning.

Financial tools particularly relevant to urban planning include:

- **Urban development funds:** Dedicated funding for urban development projects, which can be directed towards sustainable urban development projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can be directed towards sustainable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, such as sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Preferential tax:** Direct funding from the government to reduce or eliminate the tax for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by the government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.
- **Participative budgeting:** Citizens engage in multiple rounds of debates and deliberations, and ultimately vote on how a certain percentage of the municipal budget gets spent. It contributes to a more equitable distribution of city services.

Capacity building for urban planning

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable urban planning.

The types of capacity-building activities relevant to urban planning are mapped in Table 3, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 3 • Capacity building for urban planning in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most relevant capacity-building activities are explained below:

- **Training within government:** Provide training on the integration of sustainable urban planning strategies across all relevant departments and levels of government, including those responsible for spatial planning, zoning regulations, and procuring and managing services such as waste and water management. Build capacity in collecting and using data to inform policies and urban plans. Finally, training on how to work in collaboration across stakeholder groups including governmental and non-governmental actors.
- **Training professionals:** Build capacity and awareness among service providers, including urban planners and designers, as well as technology providers about the broader framework of sustainable development goals and the implications for urban planning solutions. This will be important to ensure co-ordination and shared goals among relevant government organisations and NGOs for better implementation and enforcement of urban planning policies.





Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of sustainable urban planning

Many benefits can be achieved through sustainable urban planning, and many of these are aligned with several SDGs, especially with Goal 11 (sustainable cities and communities).

Some of these benefits are described in Table 4, although many of them require further analysis to quantify them:

Table 4 • Multiple benefits of urban planning

| Environment | |
|---|---|
|  | <ul style="list-style-type: none"> • Emissions reductions – sustainable urban planning delivers emissions reductions through the reductions in emissions from transport thanks to TOD and encouraging walking and cycling, and absorption of CO₂ through open green spaces. |
| | <ul style="list-style-type: none"> • Air quality – sustainable urban planning reduces air pollution through the reduction of transport-related emissions through TOD, open green spaces, and encouraging walking and cycling. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – sustainable urban planning through mixed-use developments and TOD reduces commutes and supports mass transit, walking and cycling. |
| | <ul style="list-style-type: none"> • Energy security – sustainable urban planning delivers buildings, cities and transport systems that put less strain on energy systems by reducing energy demand and favouring local renewable energy sources. |
| | <ul style="list-style-type: none"> • Energy prices – sustainable urban planning supports integrated buildings, transit and energy systems that optimise potential synergies and energy flows so as to reduce energy demand and peak loads, lowering network infrastructure and system costs. |
| Economy | |
|  | <ul style="list-style-type: none"> • Productivity – sustainable urban planning increases the efficiency of the urban infrastructure and can enable increased productivity through reduced commuting times, also improving health and well-being. |
| | <ul style="list-style-type: none"> • Asset value – sustainable urban planning can increase the asset value of homes, businesses and transit systems by creating more liveable cities. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – sustainable urban planning reduces building operation and transport costs, and can deliver improved access to employment and other services for vulnerable populations. |
| | <ul style="list-style-type: none"> • Health and well-being – sustainable urban planning can support increased physical and mental health through improved access to employment and transit, greater use of active modes for commuting (walking, biking), reduced air and noise pollution, reduced time spent in transport, green spaces, and other amenities. |
| | <ul style="list-style-type: none"> • Safety and security – sustainable urban planning by mixed-use and transit-oriented planning can support improved social integration and urban lighting, enhancing safety and security. |



Activity 2: New buildings

This section addresses measures to reduce the operational energy (and consequently, operational carbon) in new buildings. Integrated policies for new buildings can avoid locking in emissions from inefficient buildings for multiple decades. Fully decarbonising buildings over their whole life cycle will also require measures to reduce the embodied carbon of materials, addressed in “Activity 6: Materials”, and measures to increase the share of renewable energy, both in distributed generation and in the electricity sector, as described in “Activity 8: Clean Energy”.

Box 4 • New buildings in Latin America: Trends and challenges

In LAC, floor area is expected to grow by 65% by 2050, dominated by another almost 11 billion m² in residential buildings by 2050 (IEA, 2017). Furthermore, Latin American cities will continue to experience high growth, with an additional 150 million people expected to be living in urban areas by 2050. This means high construction rates of 3-5% per annum will continue and probably increase, elevating the need to ensure that new buildings are built to a high-performance standard.

Increasing population growth will increase the demand for housing, including social housing, exacerbating a challenge that is already faced by many countries in the region. A particular challenge will be delivering quality housing that is affordable to both the government budget and to the final building occupant.

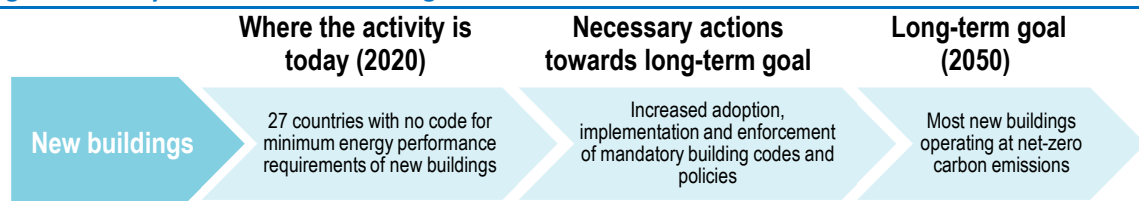
Building codes with energy efficiency and thermal performance requirements, referred to herein as “building energy codes”, are gaining traction in Latin America as countries realise the importance of energy savings and emissions reductions in the building sector. Of the 34 countries in the region, only Jamaica has a mandatory building code that applies to the entire sector and includes minimum standards for energy efficiency for new and existing buildings. A few other countries have codes that are mandatory or voluntary for part of the sector, including Argentina, Brazil, Chile and Mexico, while Colombia and Peru are in the process of developing their first building energy code. The remaining 27 countries have yet to introduce building energy codes.

Much of the region has a demand for active cooling due to high temperature and humidity, while many areas historically have been able to rely on passive design measures to remain cool. These needs highlight the importance of thermal performance and design standards to ensure comfort through passive cooling.

The role of the informal construction sector is high, accounting for up to 75% of new housing (The World Bank, 2017). This segment of the sector must be included to ensure equity and inclusion. Capacity building and the increased affordability and availability of quality materials and tools will be key to achieve this.

Key actions for sustainable new buildings

Figure 17 • Key actions for new buildings in Latin America



A series of key actions will be needed to achieve sustainable, zero-emission, efficient and resilient new buildings:

- **Develop a roadmap strategy.** Develop a locally appropriate strategy for decarbonising buildings using an efficiency-first approach, and including a strategy for decarbonising construction materials and energy aiming to reach new buildings that are ready to operate at net-zero carbon by 2030.
- **Develop and implement mandatory energy codes.** Transition from voluntary to mandatory codes that set the minimal efficiency in new buildings. Codes should set or refer to guidelines for locally adapted bioclimatic design principles, and increasingly incorporate climate resilience and low-embodied-carbon materials.
- **Strengthen building energy codes.** Ensure that there is a building code improvement cycle that strengthens the performance requirements every three to five years with aspirations of achieving net-zero carbon buildings by 2030.
- **Avoid the need for space conditioning.** Due to its climate, the region has traditionally avoided the need for active heating or cooling systems. Passive design should be prioritised in order to maintain thermal comfort and reduce space-conditioning costs.
- **Governments lead by example.** Develop policies that ensure all new government buildings are net-zero carbon and efficient.
- **Increase the use of building design tools.** More integrated design processes and simulation or modelling tools such as building information modelling (BIM) can help ensure higher performance in a cost-effective manner.
- **Reduce embodied carbon** through materials measures (see Activity 6: Materials) and **reduce operational carbon** through better operation and maintenance (O&M) (Activity 4: Operations) and the provision of clean energy (see Activity 8: Clean Energy).
- **Increase awareness and information.** Awareness of the benefits of more sustainable buildings will enable consumers to make better choices, and can enable more advantageous financing.

Stakeholders for sustainable new buildings

In Latin America, the key stakeholders for sustainable new buildings include those that can influence new buildings and those that can deliver the results of zero-emission, efficient and resilient buildings. Additional stakeholders include those that can support the process through research, funding, training and making technologies available.

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These stakeholders are mapped in Table 5, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 5 • Stakeholder mapping for new buildings in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers * | Labourers and installers | Building owners and occupants | Civil society ** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|--|--------------------------|-------------------------------|------------------|
| | | | | | | | | | |

* of appliances and materials

** including academia, NGOs, research institutions, social networks and community associations.

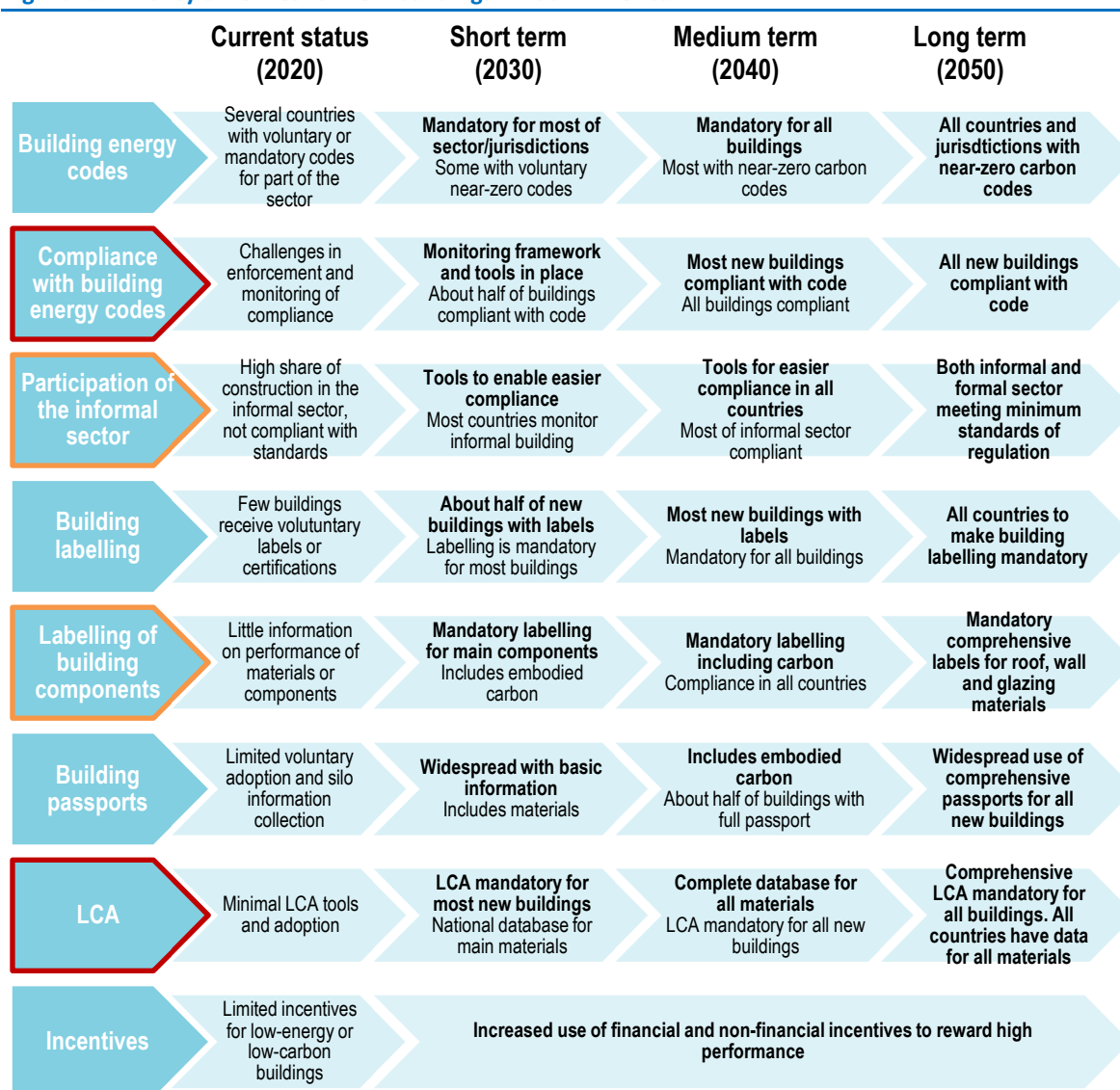
How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Policy for sustainable new buildings

The policies listed in Figure 18 represent key tools that policy makers have at their disposal to increase the performance of new buildings, to reach zero-emission, efficient and resilient buildings as soon as possible. These policies are applicable at both national and subnational levels, and will need to be supported by enabling policies and programmes as detailed in the subsections below.

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Figure 18 • Policy timelines for new buildings in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for new buildings are outlined below. For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **Building energy codes:** Building energy codes or standards provide minimum requirements for building components or for building performance. These aim towards net-zero emission buildings at lowest cost by ensuring highest efficiency levels first. Building codes should include or refer to locally adapted bioclimatic design principles in order that passive design is optimised. Specific standards and guidelines for social housing will enable this sector to also comply. *Stakeholder feedback: There is strong consensus that requirements for net-zero buildings should be on a voluntary basis from 2030, and mandatory for all new buildings by 2050.*
- **[ambition gap] Building energy code compliance:** Compliance with, and enforcement of, building codes is a crucial step, commonly carried out at the municipal level rather than the national level. A monitoring framework for compliance checking will facilitate compliance and enable compliance even of sectors such as the informal sector and the social housing sector. *Stakeholder feedback: There was consensus that reaching 100% compliance will be challenging, with only “about half” to “most” new buildings reaching compliance by 2050.*
- **[data gap] Participation of the informal sector:** Capacity building, construction guidelines, accessible tools and wide stakeholder engagement will be key to increase the compliance with codes within the informal sector and decreasing its participation over time. *Stakeholder feedback: The high participation of the informal construction sector was raised by several respondents as a key barrier. Tools mentioned by stakeholders to address the informal construction sector include financial incentives, proven low-cost technologies and passive strategies, and robust and high-performance construction systems.*
- **Building labelling:** Building energy labelling can be used to assess “as designed” building performance on a scale of less to more efficient. Labelling enables increased information sharing and awareness for consumers and investors. Labelling can also be linked to incentives and financial tools. *Stakeholder feedback: There is strong consensus that labelling will become widespread being adopted by “most” to “all buildings”.*
- **[data gap] Labelling of building components:** The availability of robust performance information of individual building components and materials is key for designers to optimise building design. Key performance parameters include the thermal transmittance of materials, the solar heat gain coefficient (SHGC) or solar factor of glazing, and the reflectance of surface finishes. Additional information may include embodied energy and embodied carbon.
- **Building passports:**¹² Building passports can be used to track information about the building, materials, systems, energy use, renovations and other real estate information to improve decision-making processes. At the time of handover of a new building, a new building passport could include floor area schedules, bill of quantities, embodied energy of materials, description of systems, maintenance schedules and estimated energy consumption. During its operational phase it may be completed with further information (see Activity 4: Building operations). *Not much consensus in region as to potential for adoption, but it is considered that building passports should include: bill of materials, embodied energy, description of systems and maintenance schedules by 2030, and identification of energy efficiency and clean energy measures by 2040.*
- **[ambition gap] LCA:** Decisions regarding the building use, design and choice of materials should consider the entire lifetime of the building and its components. National databases containing information on the embodied energy and carbon of construction

¹² A building passport is a document or logbook that is used to store and track information about the building: basic characteristics, materials, systems, energy use, renovations and other building information.

materials will be necessary to undertake comprehensive life-cycle impact analysis of design choices. *Stakeholder feedback: Few tools to enable robust LCA are available today. It is estimated that only up to “about half” new buildings will be undertaking LCA by 2050.*

- **Incentives:** Fiscal incentives should be awarded to the very best performing buildings to enable the uptake of most novel technology and tools. Criteria for obtaining fiscal incentives must be updated over time. Non-fiscal incentives, such as expedited permits or increased floor area allowances, are also powerful in encouraging lower-energy new buildings. *Stakeholder feedback: Consensus was that incentives would be important for new buildings, and would become more and more widespread rather than decrease over time. There was consensus that growth in non-financial incentives would be modest. The most relevant forms cited are expedited permitting, reduced permit fees, special crediting schemes and increased scope.*

Box 5 • What is a building code?

Building energy codes, also known as “energy standards” for buildings, “thermal building regulations”, “energy conservation building codes” or “energy efficiency building codes”, are the key policy instrument used by governments to reduce the energy consumption of buildings. Such codes consist of a set of mandatory minimum energy performance requirements designed to regulate energy use in buildings. They can cover both new buildings and existing buildings undergoing renovation or alteration. Architects and engineers use the functional energy requirements stated in building energy codes to design buildings that meet the required standards (IEA, 2013).

Building energy codes can be adopted as part of the larger body of building codes covering other aspects of a building construction’s requirements, such as safety and structural integrity, that are all necessary to be satisfied as a condition for approval to construct and occupy buildings.

Box 6 • Regional examples of policy action for new buildings

Mexico

Based on the International Energy Conservation Codes developed in the United States, the Energy Conservation Code for Buildings in Mexico (Código de Conservación de Energía para las Edificaciones de México), was released in 2016. The document is an evolution of the sustainability chapter of the Housing Construction Code (Código de Edificación de Vivienda) from 2009, and contains minimum energy efficiency requirements for energy conservation for new commercial and residential buildings and renovations, including air-conditioning and water heating systems, appliances, solar gains, and the building envelope. Because it is codified at federal level, the code is voluntary. However, once adopted by a local government, it becomes mandatory. The code will be updated every three years, addressing developments in technology and the evolution of energy efficiency standards.

The Eco-CASA Initiative, which initially focused on bioclimatic energy efficiency standards and rating for new residential buildings, recently expanded to consider operational GHG emissions, water use and comfort. The goal was to achieve a 20-40% reduction in energy-related CO₂ emissions compared with baseline houses by providing three primary energy performance standards, Eco-CASA I, II and III, corresponding to different levels of energy efficiency, adapted to different building types and climate zones. As of May 2019, the Eco-CASA programme had certified 63 986 homes, 85% of which have been financed.

Peru

Peru approved the Sustainable Building Code in 2014, which is a voluntary code for new commercial and residential buildings. The code seeks to promote energy efficiency and water efficiency through requirements that integrate the architectural design with local bioclimatic conditions, energy efficiency labels for lighting and cooling appliances, solar panels for water heating, and sanitary facilities that reuse treated wastewater.

Brazil

In Brazil, the Performance of Residential Homes standard (Norma de Desempenho de Edificações Habitacionais, [ABNT 15.575:2013](#)) is mandatory for new residential buildings and includes criteria for thermal performance of the building fabric and minimum provision of daylight. The building performance labelling programme (Programa Brasileiro de Etiquetagem) [PBE Edifica](#) is mandatory for new federal buildings, which must meet level A. It is still voluntary for all other sectors. However, studies are under way towards making it mandatory for all buildings (Procel, 2019).

Argentina

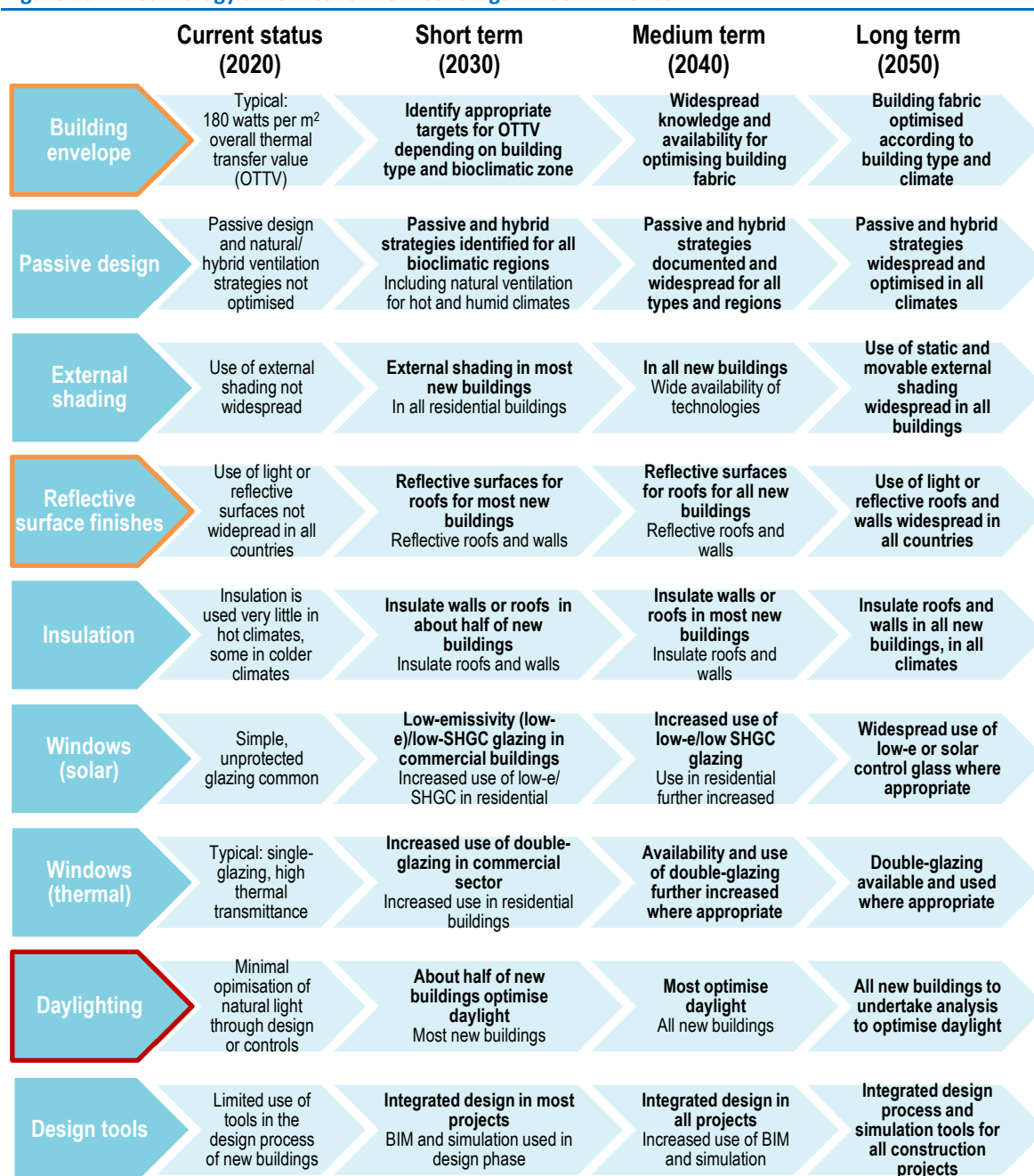
The Argentine Institute for Standardisation and Certification (Instituto Argentino de Normalización y Certificación [IRAM]) created [IRAM 11900: 2017](#), which establishes a method for calculation and the basis for energy efficiency labelling in homes using a comparative system of seven energy efficiency classes for all types of buildings, identified by letters (from A to G). It also promotes the use of on-site renewable energy.

Technology for sustainable new buildings

Figure 19 lists the key technologies or strategies needed to reach the long-term objective of decarbonising the buildings sector.

Specific targets and timelines for sustainable new building technologies are outlined below:

Figure 19 • Technology timelines for new buildings in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Sustainable new buildings technology target details include:

- **[data gap] Building envelope:** The OTTV is a measure of the building envelope performance including conduction and radiation heat transfer. This includes the performance of the building structure, insulation and windows. Lower OTTV can be achieved through optimised material choices and passive design strategies including building form, orientation, thermal mass, shading, the use of reflective surfaces to limit solar gain and the use of vegetation for example in cool roofs. *Stakeholder feedback: There was large divergence and uncertainty in common typical values; however, there was consensus on the rate of improvement of the typical value.*
- **Passive design:** Strategies for the most cost-effective combination of thermal performance of the building fabric, control of solar gains and ventilation, and daylight are highly dependent on the building type, how it will be used, and the macro- and micro-climate in which it is situated. Therefore, passive design strategies should be developed for specific bioclimatic regions and specific building types. These locally adapted design guidelines can ensure that passive strategies can be optimised before relying on active systems. *Stakeholder feedback: Passive forms of cooling are found in vernacular architecture but there was consensus that there is a need to increase the adoption of passive strategies in new buildings.*
- **External shading:** External shading in the form of horizontal, vertical, fixed or movable elements can be the most cost-effective method of blocking out solar radiation. Good shading can have the same effect on reducing the heat gain through windows as solar-performance glazing. *Stakeholder feedback: External shading is not widespread today; however, there was strong consensus over its increased adoption, particularly in the residential sector.*
- **[data gap] Reflective surface finishes:** Light-coloured surfaces or surfaces with reflective pigments reflect incoming solar radiation, therefore reducing the temperature of the surface. Reflective surface finishes are most effective on the surfaces most exposed to direct sunlight (generally the roof).
- **Insulation:** Insulation is one of the components of OTTV that should have specific targets for hot locations and cold locations. A material's insulation performance is determined by its thermal conductivity. "U-value" is also commonly used to express how much heat will transfer through a given thickness of a particular material, where the lower the U-value, the better the material is as an insulator. It is important to note that insulation can be effective in hot climates as well as in cold climates, and is most effective in the component of greatest surface area (i.e. the roof for low and flat buildings, walls for tall buildings). Note: the benefits of increased insulation should be assessed over a whole-life-cycle carbon assessment, given the high embodied carbon of traditional insulating materials. The extent of insulation required should be determined by cost-benefit analysis taking into consideration the local climate. *Stakeholder feedback: Today insulation is most commonly used in the roof, but there is strong consensus that its use needs to be increased in all climates.*
- **Windows (solar):** The dominant source of heat transfer through glazing is through solar radiation. This can be reduced with low-e and low-SHGC glazing. Building design and advanced technologies can enable low solar heat gain during hot weather, while allowing visible light transmittance for natural daylighting; however, the most cost-effective way of avoiding excess solar gain is reducing the size of windows and providing shading, which should always be prioritised. *Stakeholder feedback: Low-e or solar-performance glazing is today typically used in the commercial sector; however, there was consensus that its use would increase in other sectors.*
- **Windows (thermal):** Heat transfer by conduction through glazing can be reduced through a transition to double- or triple-pane glazing, which has lower thermal transmittance, or U-

value. When produced at scale, these types of windows can be cost-effective. These windows also provide noise protection, improve thermal comfort, and can enable passive architecture and natural ventilation. Note: the benefits of double- or triple-pane glazing should be assessed through a cost-benefit analysis over the whole life cycle (for example using building simulation tools), also assessing the impact on embodied carbon, given the high materials and energy costs of glass manufacturing. *Stakeholder feedback: Consensus is that double-glazing is typically employed only in the commercial sector, but that its use in other sectors should increase over time. The use of triple-glazing is expected to rise, but largely considered to remain limited.*

- **[ambition gap] Daylighting:** Access to views and to daylight is essential for building occupant well-being, health and productivity. Building design should ensure that all spaces have access to natural light and views, and have glare-free, adequate daylight levels for large portions of the day through improved control. However, there is a need to optimise the ingress of natural light with the control of excessive solar radiation. *Stakeholder feedback: There was consensus that the optimisation of daylight is an area of improvement between now and 2050; however, some believed it would become widespread in only about half of new buildings.*
- **Design tools:** The integrated design process of involving all disciplines of a building project from the early stages of the project enables the adoption of many more passive design measures than when disciplines are brought on at later stages. Other tools with significant potential to optimise passive measures and design choices include thermal and energy dynamic simulation, daylight simulation and BIM. More accessible tools such as IFC's [EDGE](#) free online software also offer ways of assessing and improving design decisions. *Stakeholder feedback: There was strong consensus that these tools will become mainstream by as early as 2040.*

Box 7 • Examples of regional action on new buildings technology

Chile

Chile is taking measures to promote the use of BIM. In 2017 a memorandum of understanding was signed between the United Kingdom (UK) and Chile to promote the implementation of UK BIM protocols in public projects, training and planning processes in Chile.

Argentina

The IRAM 11603 standard divides the country into bioclimatic regions. This division is accompanied by climatic data for winter and summer that are used in the verification of the thermal quality of the buildings. Each environmental zone has design recommendations following specific microclimatic conditions. For instance, in Tañá del Valle (zone III), characterised by large thermal amplitudes, it is advisable to build grouped dwellings to improve thermal inertia and avoid west orientation. In turn, for Misiones (zone I), characterised by a mild winter and warm temperatures during most of the year, the use of light colours on exterior walls and ceilings, cross-ventilation, semi-covered spaces (galleries, balconies) to be protected from insects, and small windows not facing east or west are recommended.

Brazil

The Eurobusiness, a commercial building located in Curitiba, Brazil, became the first building to receive the Leadership in Energy and Environmental Design (LEED) Zero Water certification, granted by the United States Green Building Council. Eurobusiness incorporated many strategies to achieve net-zero water. The 14-story building treats 100% of its wastewater (both grey and black) on-site, through a constructed wetland on its roof. In a conventional design, these systems would be housed underground, taking up the space of about two parking spots.

Finance for sustainable new buildings

Finance tools relevant to increasing the performance of new buildings may include:

- **Urban development funds:** Dedicated funding for urban development projects, which can prioritise sustainable urban development projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can prioritise sustainable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Green mortgages:** Prospective homeowners can solicit additional finance as part of their mortgage to install efficient features and technologies in their future homes.
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

Capacity building for sustainable new buildings

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable new buildings.

The types of capacity-building activities relevant to new buildings are mapped in Table 6, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 6 • Capacity building for new buildings in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training within government:** Provide training programmes for central and local government on:
 - How to collaborate across multi-stakeholders, including how to communicate the multiple benefits of zero-carbon, energy-efficient and resilient buildings. This will require data collection and analysis on the outcomes of policies and programmes.
 - How to implement and monitor policies, through the development of tools, checklists, databases.
- **Training professionals:** Provide training programmes for service and product providers of buildings and construction (architects, engineers, contractors, etc.) and building owners regarding how to design more sustainable buildings, and how to comply with new building policies, programmes or incentives for sustainable buildings and construction. Develop educational programmes on primary, secondary, vocational, university and adult education levels, to enable increased knowledge of sustainable new buildings. Provide certification or accreditation for professionals in the sustainable construction sector.
- **Training financiers and developers:** Develop tools and provide training for developers and financiers to be able to assess the relative benefits of zero-carbon, efficient and resilient buildings, to enable increased access to funding and increased demand for high-performance buildings.





Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of sustainable new buildings

Many benefits can be achieved through sustainable new buildings, and many of these are aligned to the SDGs, in particular Goal 7 (affordable and clean energy), Goal 11 (sustainable cities and communities), Goal 12 (responsible consumption and production) and Goal 13 (climate action).

Some of these benefits are described in Table 7, although many of them require further analysis to quantify them:

Table 7 • Multiple benefits of new buildings

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Emissions reductions – sustainable new buildings deliver GHG reductions because they consume less, and cleaner, energy. |
| | <ul style="list-style-type: none"> • Air quality – sustainable new buildings and zero-emission buildings reduce air pollution. |
| | <ul style="list-style-type: none"> • Resource efficiency – sustainable buildings reduce the use of materials for construction and increase the useful life of buildings and their components. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – sustainable new buildings are more energy-efficient. |
| | <ul style="list-style-type: none"> • Energy security – sustainable new buildings use less energy and put less strain on energy systems. |
| | <ul style="list-style-type: none"> • Energy prices – sustainable new buildings reduce energy consumption and peak loads, lowering network infrastructure and system costs. |
| Economy | |
|  | <ul style="list-style-type: none"> • Economic performance – sustainable new buildings create employment for sustainability services and reduce building operation costs, freeing up resources to invest in other parts of the economy. |
| | <ul style="list-style-type: none"> • Productivity – sustainable new buildings can increase the productivity of students and employees through improved thermal comfort, lighting and acoustic comfort. |
| | <ul style="list-style-type: none"> • Asset value – sustainable new buildings have strong asset values and flow-on effects for nearby properties and investment attraction. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – sustainable new buildings reduce building operation costs. |
| | <ul style="list-style-type: none"> • Health and well-being – sustainable new buildings deliver increased thermal comfort, light, noise and indoor air quality, improving physical and mental health and well-being. |



Activity 3: Existing buildings

The performance of existing buildings can be assessed in terms of their operational use compared with benchmarks, which is covered in “Activity 4: Building operations”, and in terms of the efficiency of the appliances and systems they are equipped with, covered in “Activity 5: Appliances and systems”.

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In order to reduce operational carbon emissions in existing buildings, renovations to the building envelope and systems are crucial, and these should increasingly reach the standards of new buildings. Operational carbon can also be reduced by ensuring improved repair and refurbishment to extend the life of the building, by increasing intensity of use of buildings, and through increased occupancy and utilisation rates, and especially by combining all three (IRP, 2020).

Box 8 • Existing buildings in Latin America: Trends and challenges

The Latin American building stock is characterised by a number of very large established urban centres across the region, which have continued to grow and adapt to an influx of rural and regional migration. Over the past two decades, the growth in floor space and wealth has continued to increase energy demand, but with only modest improvements in energy intensity. However, despite this increase in population, most of the buildings in 2050 already exist and these are located as high-density developments in large urban centres, along with a large amount of low-income housing that is both formal and informal.

While there are efforts being taken towards the construction of energy-efficient buildings in Latin America, the region has no or very few mandatory policies in place related to building operations. There is also a general slowdown in the economies of many countries in the region that has put downward pressure on overall investment across the buildings sector.

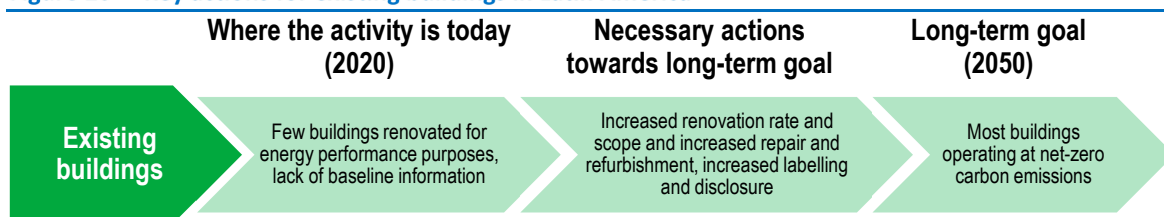
While the construction growth rate is higher compared with the rate of renovation of existing buildings in Latin America, there is still great scope in energy-efficient improvement of existing building stock. There is generally a lack of priority to carry out building renovations, reflected in the fact that there is a significant lack of data about the level of renovations currently undertaken in the region.

Codes and standards for energy efficiency refurbishment, which would trigger the requirement to use more energy-efficient products and designs, are virtually unused across the region. In Latin America, only Chile has a building code that covers the retrofit of existing buildings. In addition, the certification of existing buildings, such as LEED for O&M, is mainly acquired by private-sector buildings.

The economic slowdown seems to also mean that low levels of renovations are partly due to the lack of financial support and the high perceived costs of both borrowing and income. Additionally, there is likely a lack of awareness of the social and economic benefits brought by energy retrofits that are difficult to capture due to high upfront costs and that have not been addressed through service-style contracts for new equipment or renovation.

Key actions for sustainable existing buildings

Figure 20 • Key actions for existing buildings in Latin America



Key steps to improving the performance of existing buildings include both increasing the number of buildings that are improved and increasing the magnitude of improvement that is achieved.

- **Decarbonisation strategy for existing building stock.** Improving the availability of data on the performance of existing buildings will enable the creation of baselines and strategies for their decarbonisation. Across the region, adopting strategies to refurbish and retrofit existing buildings will make a big impact on existing energy use and emissions.
- **Increase renovation rates.** Annual renovation rates in the region should reach 1.5% by 2025 and 2% by 2040.
- **Increase the depth of renovation.** Enable deep energy renovations that reduce energy consumption of existing buildings by 30-50% or more.
- **Enable renovation investments.** Increase access to and use of finance to enable private investment in renovations.
- **Governments lead by example.** Develop policies that ensure existing government buildings are renovated to be low-emission and efficient.

Stakeholders for sustainable existing buildings

In Latin America, the key stakeholders for building retrofits include those that can influence existing buildings and those that can deliver the results of zero-emission, efficient and resilient buildings through retrofits. Additional stakeholders include those that can support the process through research, funding, training and making technologies available.

These stakeholders are mapped in Table 8, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 8 • Stakeholder mapping for existing buildings in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society ** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|------------------|
| | | | | | | | | | |

* of appliances and materials

** including academia, NGOs, research institutions, social networks and community associations.

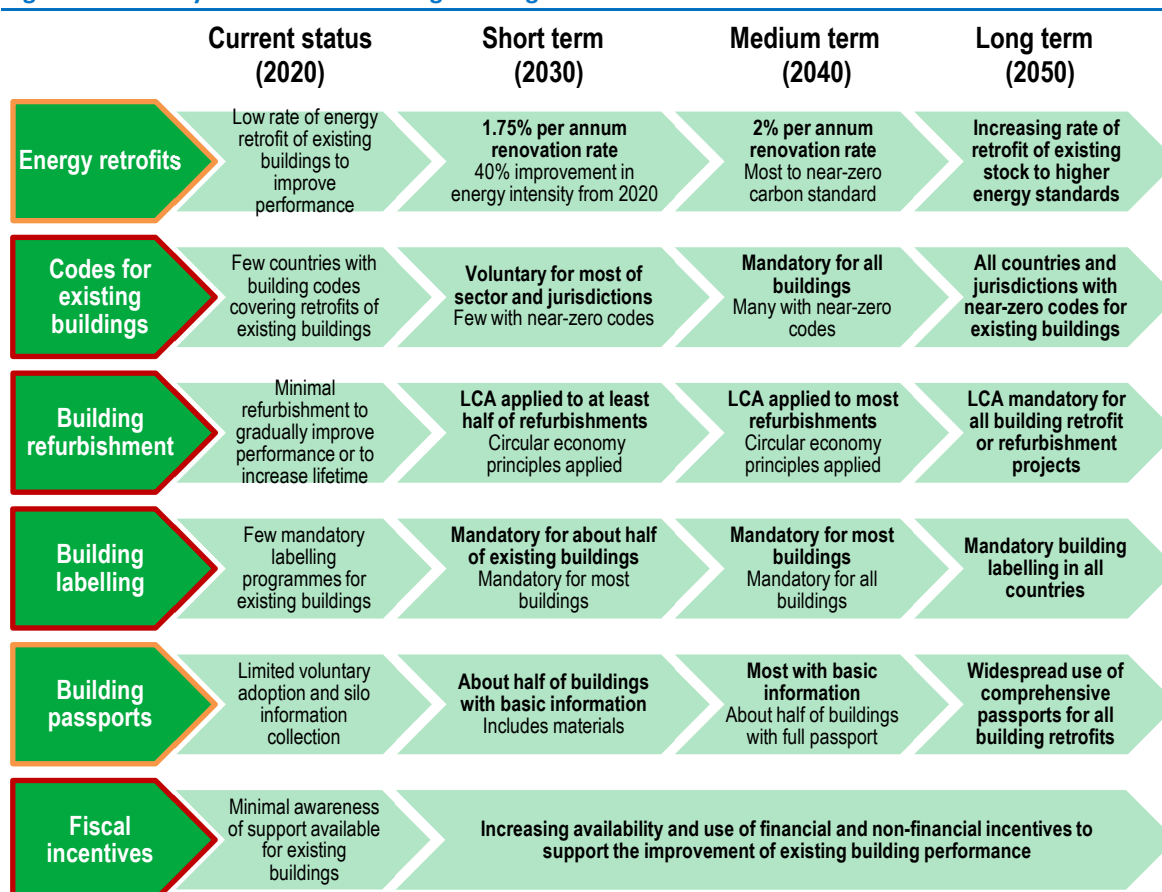
How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Policy for sustainable existing buildings

Policy for existing buildings can be developed to enable all buildings to become zero-emission, efficient and resilient. Policies that typically cover only new buildings or major planned retrofits need to be adapted to existing buildings. Within the targets for sustainable building retrofits, the sub-targets and timelines in Figure 21 offer more details:

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Figure 21 • Policy timelines for existing buildings in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for existing buildings are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Energy retrofits:** An energy retrofit can be defined as an undertaking of structural, architectural, mechanical or electrical works with the aim of improving the energy performance of an existing building. While these types of works are rarely carried out for their energy benefits alone, they should increasingly become widespread, and be

more ambitious in their energy savings. Buildings should be retrofitted to their cost-effective potential as quickly as they can, even if this happens over the course of several years.

- **[ambition gap] Codes for existing buildings:** These refer to standards requiring improvements to the building's envelope or systems in the event of significant works, whether they were part of an energy retrofit or not. Codes should be developed with respect to particular segments (e.g. commercial, multifamily residential, single homes) and should ensure that refurbishments are carried out to align the performance of existing buildings to their cost-effective potential. *Stakeholder feedback: There is strong consensus that the proportion of retrofits covered by a building code is low, but is only expected to increase to cover about half to most building retrofits.*
- **[ambition gap] Building refurbishment:** Refurbishment includes ongoing works a building owner or manager may carry out on an existing building, without being so substantial it would qualify as a retrofit. Existing buildings should be gradually refurbished to meet the performance standards of new buildings and maintained to increase their lifetime. Tools to assess the most cost-effective set of measures and plan for their implementation should be developed in order to facilitate planning of works (i.e. to assess whether works should be done step by step or in a deep energy retrofit). Labelling of components, incentives, LCA and energy management are examples of tools that will enable effective maintenance and refurbishment of existing buildings. *Stakeholder feedback: Consensus is that LCA in refurbishment is not common practice, nor is it expected it will become widespread for existing buildings.*
- **[ambition gap] Building labelling:** Quantitative building energy labelling can be used to assess building envelope and system characteristics on a scale of less to more efficient. Labelling enables increased information sharing and awareness for consumers and investors, and should become widespread in existing buildings as well as new buildings, and should increasingly disclose the embodied and operational carbon of buildings with reference to a benchmark (see "Activity 4: Building operations"). *Stakeholder feedback: Consensus is that labelling is not expected to become widespread for existing buildings.*
- **[data gap] Building passports:** These can be used to track information about the building, its materials, systems, energy use, renovations, sources of potential savings and other real estate information to improve decision-making processes. Basic information includes floor plans, floor area schedules, activity information, past retrofit or refurbishment works, and monthly energy consumption and peak demand. *Stakeholder feedback: There is divergence among the expected adoption of building passports in existing buildings, ranging from few to about half of retrofitted buildings obtaining building passports.*
- **[ambition gap] Fiscal incentives:** Financial and non-financial incentives such as increased scope or special permits can be significant enablers of the refurbishment and retrofit of existing buildings. *Stakeholder feedback: Very few countries expect incentives to become more available for retrofits of existing buildings.*

Box 9 • Regional examples of policy action for existing buildings

Mexico

In Mexico, a nationally appropriate mitigation action for sustainable housing retrofits was developed in 2015 to increase the overall number of existing energy-efficient homes, thus contributing to energy savings and mitigation of GHG emissions. The programme is focused on low- and middle-income households.

The National Commission for the Efficient Use of Energy of Mexico (Comisión Nacional para el Uso Eficiente de la Energía [CONUEE]) is carrying out renovation programmes for federal public administration buildings to promote the efficient use of energy, by supporting the development of projects and institutional capacities of states and municipalities for the identification, quantification and instrumentation of programmes and actions in terms of sustainable use of energy.

Peru

The Ministry of Energy and Mines developed in 2014 the Guide on the Efficient Use of Energy and Energy Diagnosis, focused on public administration buildings both new and existing. The guide is related to the Energy Efficiency Plan 2012-2040 that emphasises efficient use of energy and renewable energy and aims to reduce 15% of the total energy consumption of the sectors – residential, public, services and transport – by 2040. In turn, the energy diagnosis aims to establish a baseline of the benefits obtained as a result of the implementation of the recommendations and improvements.

Ecuador

In 2009 many voluntary standards were created in the country related to energy efficiency, among them one on energy efficiency in buildings that establishes the requirements for buildings to reduce their energy consumption to sustainable limits. This standard could be applied to new buildings and existing buildings whose renovations or rehabilitations are greater than 25%.

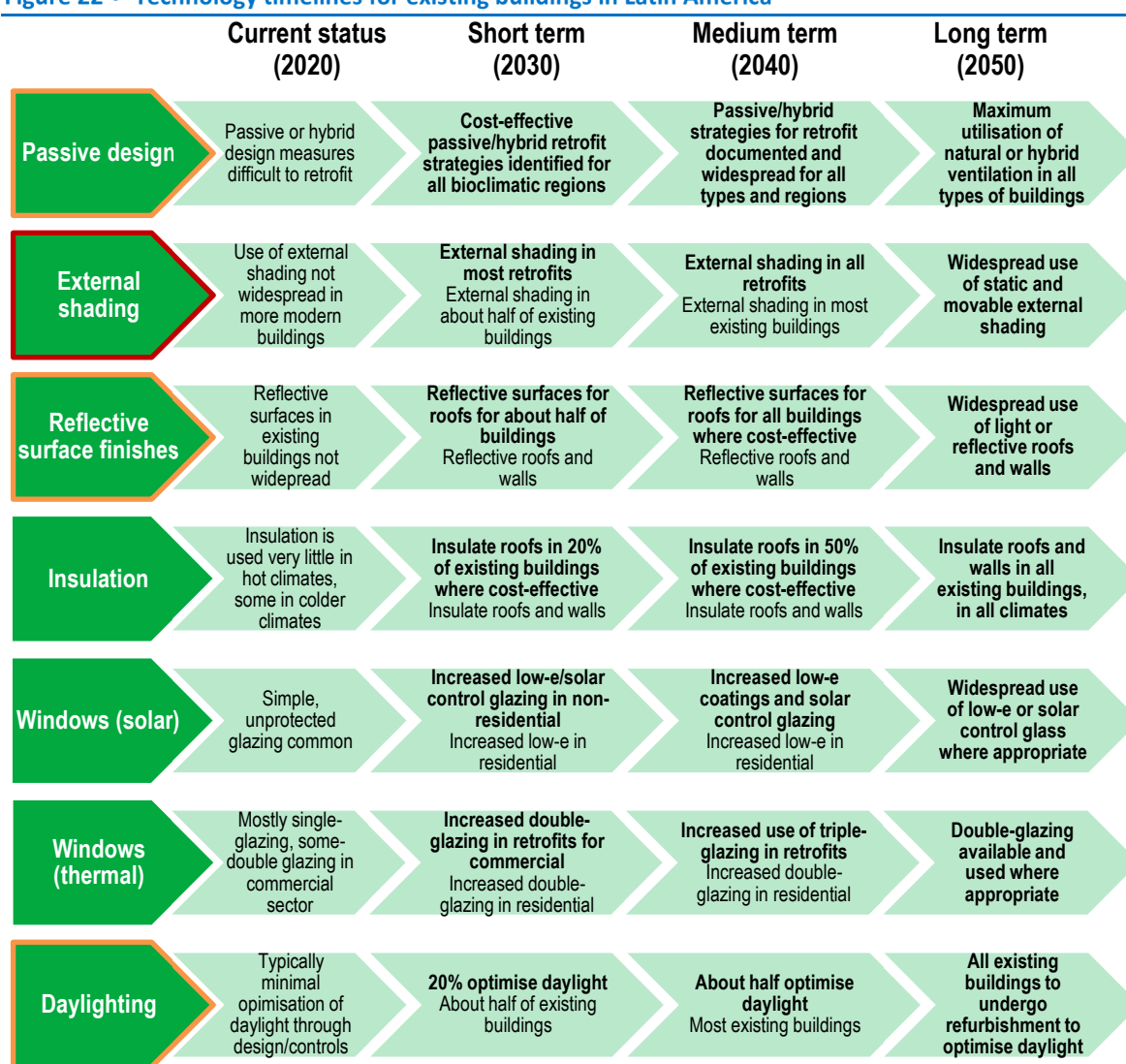
Technology for sustainable existing buildings

Energy use and emissions from existing buildings are influenced by whether the building has undergone a building retrofit, the quality of that retrofit with respect to design, choice of technologies and materials, and what gradual improvements it has undergone over time.

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Specific targets and timelines for sustainable existing building technologies are outlined in Figure 22:

Figure 22 • Technology timelines for existing buildings in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the technology targets for existing buildings are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is

highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Passive design:** Strategies for the most cost-effective implementation of passive design measures such as upgrade of the building fabric, control of solar gains and ventilation, and daylight are highly dependent on the building type, how it will be used, and the macro- and micro-climate in which it is situated. Therefore, passive design strategies should be developed for specific bioclimatic regions and specific building types, and special considerations should be taken when applied to existing buildings. These locally adapted design guidelines specific to the retrofit of existing buildings can ensure that passive strategies can be optimised before relying on active systems. In combination with fans or active systems, hybrid solutions can provide significant energy savings when compared with a 100% active solution.
- **[ambition gap] External shading:** External shading in the form of horizontal, vertical, fixed or movable elements can be the most cost-effective method of blocking out solar radiation. Good shading can have the same effect on reducing the SHGC of windows as solar-performance glass. *Stakeholder feedback: Slow progress in the inclusion of external shading to retrofits is expected between now and 2050.*
- **[data gap] Reflective surface finishes:** Light-coloured surfaces or surfaces with reflective pigments reflect incoming solar radiation. Reflective surfaces are most effective on the largest surfaces exposed to the sun, which normally will be the roof. Painting external building surfaces can also be an effective and relatively low-intrusion retrofit measure.
- **Insulation:** Insulation is one of the components of OTTV that should have specific targets for hot locations and cold locations. A material's insulation performance is determined by its thermal conductivity. "U-value" is also commonly used to express how much heat will transfer through a given thickness of a particular material, where the lower the U-value, the better the material is as an insulator. It is important to note that insulation is important in hot climates as well as in cold climates, and is most effective in the component of greatest surface area (i.e. the roof for low and flat buildings, walls for tall buildings). Note: the benefits of increased insulation should be assessed over a whole-life-cycle carbon assessment, given the high embodied carbon of most insulating materials. *Stakeholder feedback: There was consensus that insulation in retrofits is used little today and will increase to become widespread by 2050.*
- **Windows (solar):** The dominant source of heat transfer through windows is through solar radiation. This can be reduced with low-e and low-SHGC windows. Building design and advanced technologies can enable low solar heat gain during hot weather, while allowing visible light transmittance for natural daylighting; however, the most cost-effective way of avoiding excess solar gain is reducing the size of windows and providing shading. *Stakeholder feedback: There was consensus that low-e glazing is already available today and will become more widespread, while solar performance glazing will become more widespread for retrofits between 2040 and 2050.*
- **Windows (thermal):** Heat transfer by conduction through windows can be reduced through a transition to double- or triple-pane windows, which have lower thermal transmittance, or U-value. When produced at scale, these types of windows can be highly cost-effective. These windows also provide noise protection and improve thermal comfort and can enable passive architecture and natural ventilation. Note: the benefits of double- or triple-pane glazing should be assessed through a cost-benefit analysis over the whole life cycle (for example using building simulation tools), also assessing the impact on embodied carbon, given the high materials and energy costs of glass manufacturing. *Stakeholder feedback:*

There was consensus that double-glazing will become mainstream between 2030 and 2040, with triple-glazing becoming used from 2050 in some cases.

- **[data gap] Daylighting:** Access to views and to daylight is essential for building occupant well-being, health and productivity. Building design should ensure that all spaces have access to natural light and views, and have glare-free, adequate daylight levels for large portions of the day through improved control. However, there is a need to optimise the ingress of natural light with the control of excessive solar radiation.

Box 10 • Examples of regional technology action on existing buildings

Mexico

Mexico City is using green roofs as a strategy to reduce UHI effect and improve air quality. The government established the technical specifications for green roof systems through the creation of local environmental standard NADF-013-RNAT-2007. The government is investing in green roofs on public buildings such as hospitals and schools, and since 2011, a 10% reduction in property taxes has been provided for the implementation of green roofs on houses (USGBC, WorldGBC, C40 Cities, 2015).

Brazil

[Sustainable Campus](#) is a project of University of Campinas, which aims to be the leading research institution in renewable energy integration, energy efficiency, the Internet of things (IoT) and electric mobility in Brazil. The idea is providing the research community with its own “living test lab”, allowing for on-site studies regarding micro-generation, storage, energy measurements, load forecasting, IoT and many other areas.

A sub-project under the umbrella of the Sustainable Campus is the Retrofit of Buildings towards Energy Efficiency. The pilot project is in the Faculty of Mechanical Engineering and involves monitoring of energy consumption, temperature and noise levels, together with the replacement of several of the air-conditioning units. The idea is to illustrate what can be done in several of the buildings built during the 1980s, showing that there is plenty of space for improvements, mostly in illumination (automation and efficiency) and thermal (minimising thermal losses and replacing old air-conditioning systems).

Finance for sustainable existing buildings

Finance tools particularly relevant to existing buildings may include:

- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Energy performance/energy service contracts:** Contracts for services or delivered savings that typically are delivered by an energy services company (ESCO) and can include a range of energy efficiency services and products.

- **Green mortgages:** Prospective homeowners can solicit additional finance as part of their mortgage to install efficient features and technologies in their future homes.
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services, e.g. green lease. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.
- **On-bill/tax repayment:** An approach where any recurring bill, such as utility bills, insurance bills or home improvement store bills, can collect small amounts of money over a long period of time to pay for energy efficiency purchases in smaller payments. An offshoot of on-bill finance, tax repayment is where the tax authority uses recurring tax payments as a means for collecting money over time. The most common of these is called property-assessed clean energy (PACE) and is able to use low-interest-loan repayments on the property tax bill until the purchase is paid in full.
- **Community finance and crowdfunding:** Collective funding from many people connected either locally or through a call for funding.

Capacity building for sustainable existing buildings

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable building retrofits.

The types of capacity-building activities relevant to existing buildings are mapped in Table 9, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 9 • Capacity building for existing buildings in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training professionals:** Provide training programmes for service and product providers of buildings and construction (architects, engineers, contractors, building managers, etc.) regarding how to undertake the most cost-effective retrofits in buildings, and how to comply with policies for existing buildings, programmes or incentives for the retrofit of buildings. Develop educational programmes including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable buildings. Provide certification or accreditation for professionals in the sustainable construction sector.
- **Training the general public:** Develop information and awareness campaigns regarding the cost-effective building retrofit measures building owners or occupants can implement, including information and tools regarding how to access funding. Methods of increasing information to consumers include benchmarking programmes, certification programmes, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programmes.





Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits for sustainable existing buildings

Many benefits can be achieved through sustainable existing buildings, and many of these are aligned with the SDGs. In particular, Goal 7 (affordable and clean energy), Goal 11 (sustainable cities and communities), Goal 12 (responsible consumption and production) and Goal 13 (climate action).

Some of these benefits are described in Table 10, although many of them require further analysis to quantify them:

Table 10 • Multiple benefits of existing buildings

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Emissions reductions – energy retrofits to existing buildings can deliver GHG reductions through lowered energy consumption. • Air quality – sustainable energy retrofits to existing buildings can reduce air pollution. |
| | |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – energy retrofits to existing buildings deliver energy efficiency improvements. • Energy security – energy retrofits improve the energy efficiency of existing buildings and put less strain on energy systems. • Energy prices – sustainable retrofits to existing buildings reduce energy demand and peak loads, lowering network infrastructure and system costs. |
| | |
| | |
| Economy | |
|  | <ul style="list-style-type: none"> • Economic performance – energy retrofits to existing buildings can create employment for sustainability services and reduce building operation costs, freeing up resources to invest in other parts of the economy. • Productivity – retrofits to existing buildings can increase the productivity of occupants through improved thermal comfort, lighting and acoustic. • Employment – sustainable retrofits to existing buildings boost employment through new design and construction services for increased sustainability, including quality assurance and commissioning. • Asset value – sustainable retrofits to existing buildings make buildings more durable with lower O&M costs. |
| | |
| | |
| | |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – energy retrofits to existing buildings reduce building operation costs. • Health and well-being – retrofits to existing buildings can deliver increased thermal comfort, light, and acoustic and indoor air quality, improving physical and mental health and well-being. • Safety and security – retrofits to existing buildings can include features such as building automation, sensors and lighting that can deter crime, improving safety and security. |
| | |
| | |



Activity 4: Building operations

While the delivery of zero-emission, efficient and resilient new or renovated buildings is essential, it is equally important to ensure that buildings are operated efficiently. Behavioural and operational management influence the energy and emissions performance of a building.

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Box 11 • Building operations in Latin America: Trends and challenges

While there are efforts being taken towards the construction of energy-efficient buildings in Latin America, the region has no or very few mandatory policies in place related to building operations.

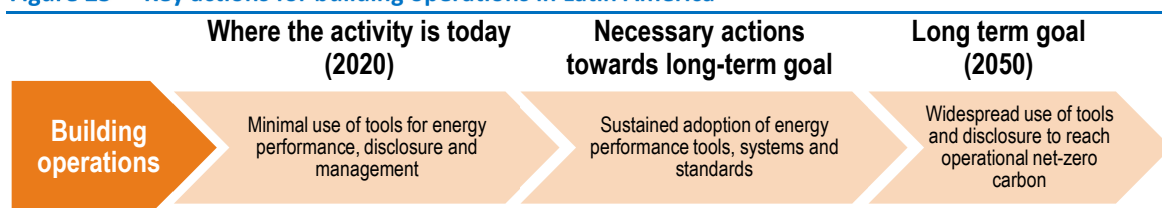
Energy management systems (EMS) and auditing procedures that identify opportunities for increased efficiency are still not mainstream, even in commercial or large energy-using buildings.

Benchmarking of operational energy use is also used very little, although some countries are making progress in establishing national evaluation tools, such as Brazil with the Operational Energy Performance Programme (Programa de Desempenho Energético Operacional). See Box 12 for more information.

Technologies such as BMS or smart sensors and controls are also underutilised mainly due to the high cost, lack of information regarding the available technologies, and low priority placed by businesses and governments.

Key actions for sustainable building operations

Figure 23 • Key actions for building operations in Latin America



Key actions to improve energy management of buildings include:

- **Rating tools and disclosure.** Develop national or subnational tools that enable the benchmarking and evaluation of a building's energy performance, develop disclosure schemes to enable comparison and incentivise improved performance. A number of tools exist in various countries in Latin America, such as the Housing Labelling Programme (Programa de Etiquetado de Viviendas) in Argentina, or PBE Edifica in Brazil or the Standardisation and Energy Efficiency Labelling Programmes (Programas de Normalización y Etiquetado de Eficiencia Energética) in Uruguay. Expanding these programmes and strengthening their adoption and reporting will provide a basis for improvement.
- **Energy audits.** Promote the use of regular energy audits to identify inefficiencies in building operations. Across Latin America, audits are not yet widely used and will provide a meaningful process for regular checking of system performance, particularly among large energy-using sectors.
- **EMS.** Provide tools and training for EMS and use energy management processes in all buildings, particularly non-residential buildings. In Latin America, the use of BMS is more common among large or prestige building types, but adopting these more widely will help better manage demand and current supply constraints.
- **Smart controls.** The use of digital sensors and controls is critical to better managing building operations, such as temperature, lighting and ventilation systems controls. Installing energy metering and linking with BMS and EMS will also enable better management. Across the region, smart controls were seen as a major area for potential. Implementing regulations on communication standards can help ensure these systems are well integrated across platforms.
- **Building passports.** Developing and supporting a system for regular information collection related to building system operations and energy use will support the availability and access to building information to current and subsequent owners and those who work with the building.

Stakeholders for sustainable building operations

In Latin America, the key stakeholders for existing building operations include those that can influence existing buildings and those that can deliver the results of low-emission, efficient and resilient buildings through operations. Additional stakeholders include those that can support the process through research, funding, training and making technologies available.

These stakeholders are mapped in Table 11, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 11 • Stakeholder mapping for building operations in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society ** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|------------------|
| | | | | | | | | | |

* of appliances and materials.

** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

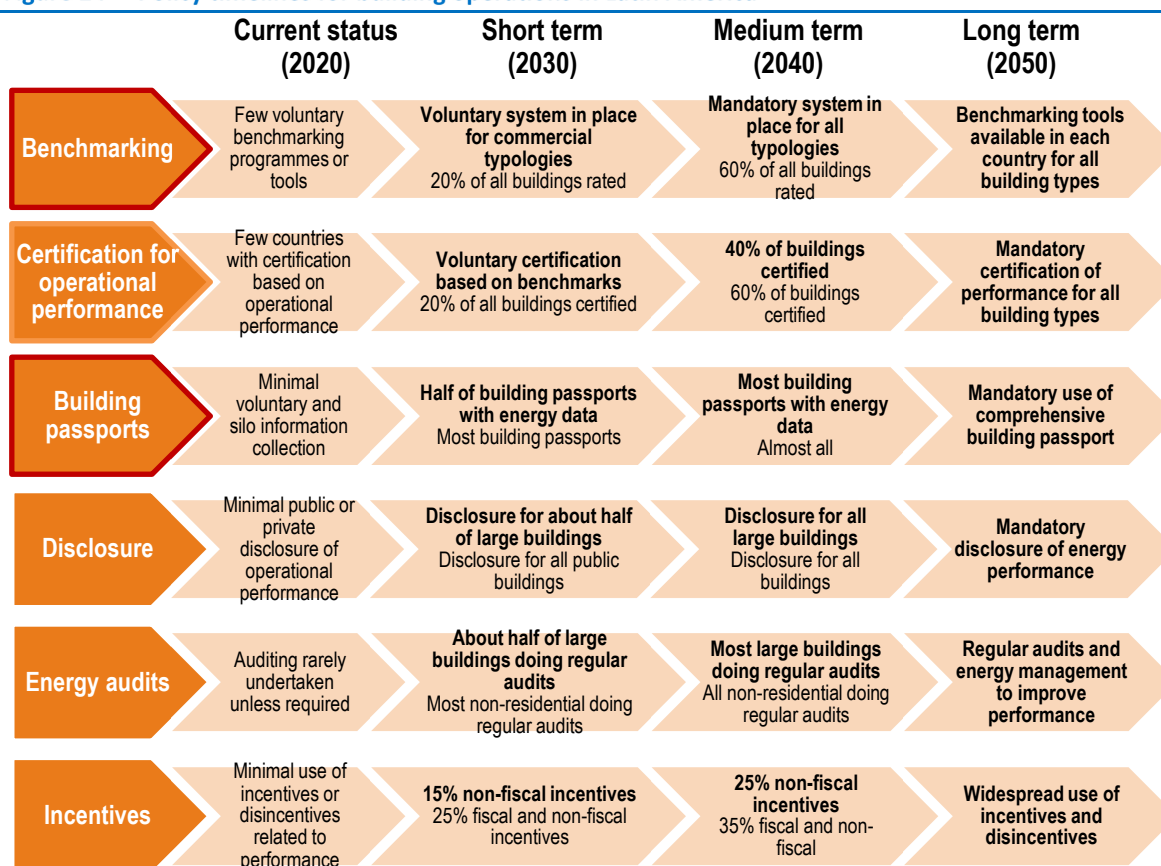
Policy for sustainable building operations

Policies can be developed to promote highly efficient building operations.

Within the targets for sustainable building operations, the policy sub-targets and timelines in Figure 24 offer more details:

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Figure 24 • Policy timelines for building operations in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for building operations are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[ambition gap] Benchmarking:** By tracking performance and comparing that performance with other buildings, sustainability managers can make educated investment decisions to improve the overall performance of the building operations. Benchmarking can also support energy disclosure, certification and building passport goals. *Stakeholder feedback: Few tools exist to assess operational energy performance, and consensus is that adoption will be slow to about half of buildings by 2050.*

- **[data gap] Certification for operational performance:** Building energy or sustainability certification and labelling can be used to disclose performance of the existing building and enforce performance requirements. The certification may be linked to benchmarking tools. The certificate or label can enable increased information sharing and documentation for consumers and financial decisions.
- **[ambition gap] Building passports:** Building passports can be used to track information about the building, materials, systems, energy use, renovations and other real estate information to improve decision-making processes with improved data that are tracked and stored. *Stakeholder feedback: There is a consensus that building passports will be a useful tool to monitor energy consumption, expected to be employed by only about half of buildings by 2050.*
- **Disclosure:** Mandatory disclosure of energy performance, certificates or benchmark rating of buildings can support improved data collection, decision-making and competition. *Stakeholder feedback: There was consensus that disclosure of performance will become widespread by 2050.*
- **Energy audits:** Regular energy audits are powerful tools to assess opportunities for energy-saving measures, and should be performed regularly, particularly in buildings with high energy consumption. *Stakeholder feedback: There was strong consensus that audits should be performed regularly, particularly in large energy users and eventually all non-residential buildings.*
- **Incentives:** Non-financial incentives, such as expedited permits or increased floor area allowances, should be the priority to encourage sustainable buildings and communities. Financial incentives should be used to enable the very best sustainable buildings, while finance support, such as loan guarantees, should enable private investment. *Stakeholder feedback: There was consensus that incentives are limited, but will become increasingly available over time.*

Box 12 • Regional examples of policy action for building operations

Mexico

The National Autonomous University of Mexico (UNAM) developed the UNAM Environmental Badge (Distintivo Ambiental UNAM). It is a system of integral evaluation of the environmental performance of buildings in four areas: 1) energy efficiency; 2) integral water management; 2) integral waste management; and 4) responsible consumption. The system provides recommendations to optimise environmental performance. It is aimed at companies and public and private institutions.

The Mexican standard, NOM-008-ENER-2001, requires non-residential buildings (new buildings and new extensions in existing buildings) to have a label disclosing estimated solar heat gain. The NOM-020-ENER-2011 requires that residential buildings have a label to disclose estimated solar heat gain, compared with reference buildings.

CONUEE, with support from the German Cooperation Agency (GIZ) and Mexico's National Ecology and Climate Change Institute, developed a rating system of energy performance for office buildings, based on the methodology of ENERGY STAR, which seeks to establish an energy performance labelling programme.

Chile

The Sustainable Building Certification (Certificación Edificio Sustentable [CES]) 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. The system evaluates five sustainability criteria: 1) interior environment quality; 2) energy; 3) water; 4) waste; and 5) management. The CES system consists of two stages: pre-certification, during the design stage, and certification, after the construction is completed. Additionally, it is possible to opt for the Plus Operation Seal, which evaluates the building's management during its operation.

Brazil

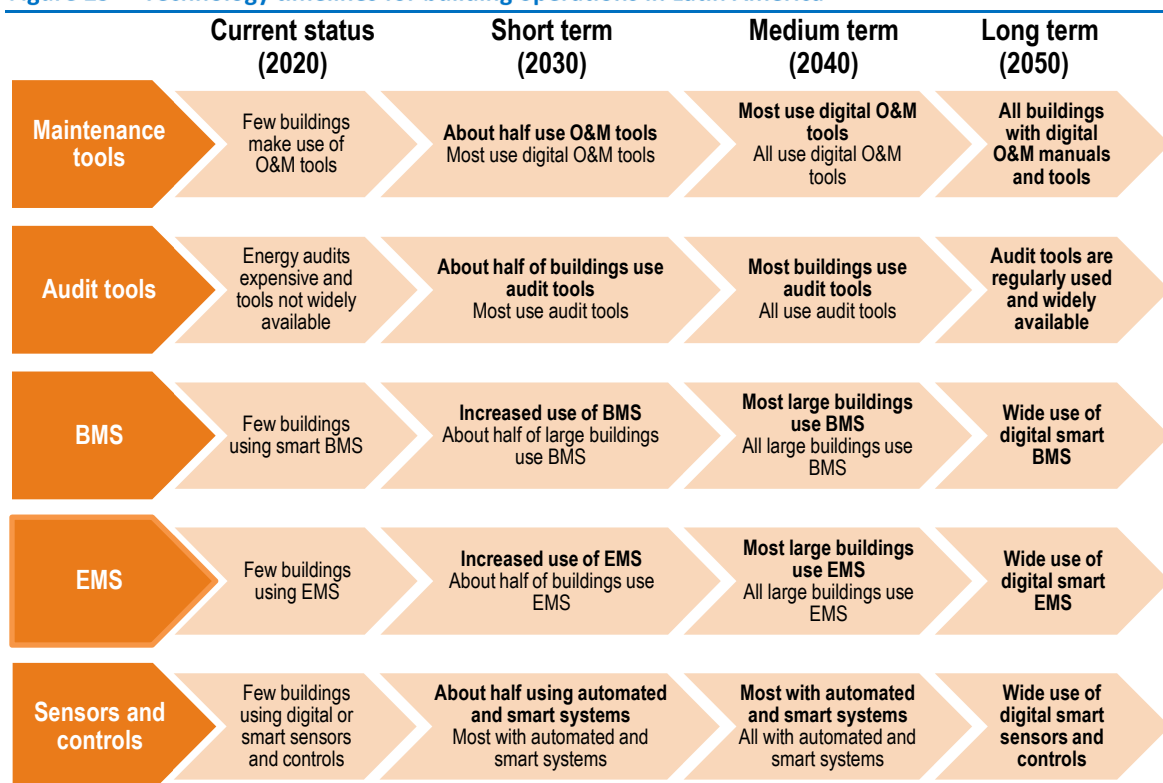
The Operational Energy Performance Programme (Programa de Desempenho Energético Operacional) is a Brazilian project focused on the energy efficiency of buildings in operation. It has recently released a benchmarking platform where building owners can compare the energy performance of their properties against other similar buildings. By selecting the building typology (i.e. corporate, public, bank agencies or others) and the location, the user inserts relevant data from the building such as floor area, number of floors, elevators, electricity consumption and others, and the platform will generate a report. This report estimates the building's energy consumption and how it performs in comparison with other similar buildings in the region.

Porto Alegre, Brazil, is part of a pilot programme under the BEA which is working on benchmarking municipal and school buildings to prioritise the buildings for investment. This programme is a part of the policy to launch funds for efficiency and renewables investment.

Technology for sustainable building operations

The energy use and emissions from buildings are influenced by the quality of building operations. Specific targets and timelines for sustainable building operation technologies are outlined in Figure 25:

Figure 25 • Technology timelines for building operations in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for building operations are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is

highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **Maintenance tools:** O&M manuals can support timely and active maintenance of the building with the schedules of specific periodic maintenance actions (e.g. cleaning or replacement of air intake filters). O&M manuals should increasingly be provided at the handover of a system after a retrofit or new installation and be actively used by building managers or operators. Active fault detection is a digital method for identifying maintenance needs and can increasingly be included in system installations and in BMS. *Stakeholder feedback: There was consensus that O&M tools will become widespread by 2050.*
- **Audit tools:** Building energy and/or sustainability audits provide an opportunity to systematically check the optimisation of system configurations and to identify priority retrofit measures. Audit tools (e.g. software, sensors and thermal cameras) can reduce the cost to conduct an audit and improve the rate of annual building audits. *Stakeholder feedback: There was consensus that audit tools will become widespread by 2050.*
- **BMS:** BMS can range from full-scale building software to simple controls that manage individual technologies within a building. Increasingly, digital tools are connecting multiple systems within a building with learning and fault detection to improve the overall management of the building system controls. *Stakeholder feedback: There was consensus that BMS would become widespread by 2050.*
- **[data gap] EMS:** EMS enable monitoring of energy consumption of systems, components and/or the building as a whole to identify anomalies and understand energy consumption trends. A network of digital energy meters or sensors or a simple smart meter can form the basis of an EMS.
- **Sensors and controls:** Sensors and controls are fundamental to smart maintenance, and can be useful to conventional maintenance, audit, energy management and building management. Control systems can range from fully centralised systems to simpler systems such as programmable thermostats. Sensors and controls are increasingly starting to incorporate machine learning to understand occupant behaviours and optimise system settings based on internal and external conditions. *Stakeholder feedback: There was consensus that smart sensors and controls could become widespread in most buildings by 2050.*

Box 13 • Examples of regional action on building operations technology

Mexico

In 2018 Mexico developed its first National Survey for Energy Consumption in the Household Sector. The survey was intended to generate statistical information about the use patterns of various energy sources at the residential level. The goal was to support the development of public policies and programmes tailored to specific needs and challenges across Mexico. The survey was carried out in 2018, and the first results were published in November 2018.

The International Exhibition and Convention Centre (Centro Internacional de Expos y Convenciones) was first awarded the Gold LEED Certification for Operations and Maintenance in 2013. After refurbishment, the building was recertified as Platinum in 2019. To improve energy efficiency, 1 040 lights were replaced, which led to a savings of 650 kilowatt-hours per day.

Torre Mayor, Mexico City, was recertified as Gold in 2018. Torre Mayor is considered an intelligent building, providing a productive and efficient work environment through the optimisation of the structure, systems, services and administration. The ventilation system is combined with CO₂ sensors that turn on the fans when the CO₂ levels are greater than 50 parts per million. The lighting in the common areas is controlled by a smart system to enable energy savings.

Brazil

The Green Building Council (GBC) of Brazil has developed the GBC Brazil Zero Energy Seal, which is being applied to both individual building developments and community sites. There are a growing number of developments in Brazil making use of the standards and using advanced smart monitoring systems to support achieving the net-zero energy balance needed to support the certification. For example, the [Petinelli Engenharia's headquarters](#) in Curitiba achieve this standard through the monitoring and highly controlled lighting and heating, ventilation and air-conditioning (HVAC) systems and through its Platinum rating under LEED v4 for Existing Buildings: Operations and Maintenance.

Argentina

The Buenos Aires Environmental Protection Agency started the [Energy Efficiency Programme in Public Buildings](#) in 2008. The programme entailed using energy management tools, conducting energy audits and an analysis of the buildings' O&M in order to track and monitor energy consumption in five public buildings in Buenos Aires. By 2015, the programme expanded to cover 20 buildings throughout the city, with the aim of reducing GHG emissions by 30% by 2030.

Finance for sustainable building operations

Finance can enable increased action towards zero-emission, efficient and resilient building operations. Specific finance sub-targets and timelines are outlined below:

Finance tools relevant to building operations may include:

- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Energy performance/energy service contracts:** Contracts for services or delivered savings that typically are delivered by an ESCO and can include a range of energy efficiency services and products.
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.

Capacity building for sustainable building operations

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable building operations.

The types of capacity-building activities relevant to building operations are mapped below, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 12 • Capacity building for building operations in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training professionals:** Provide training programmes for service and product providers of buildings operations (facilities managers, contractors, etc.) regarding how to undertake the most cost-effective operational measures in buildings, and how to comply with policies for existing buildings, programmes or incentives for the retrofit or efficient operation of buildings. Develop educational programmes including primary, secondary, vocational, university and adult education, to enable increased knowledge of how to efficiently operate buildings. Provide certification or accreditation for professionals in the sector.
- **Training the general public:** Develop information and awareness campaigns regarding the cost-effective building operational measures building owners or occupants can implement, including information and tools regarding how to access funding. Methods of increasing information to consumers include benchmarking programmes, certification programmes, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programmes.


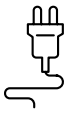


Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of sustainable building operations

Many benefits can be achieved through sustainable building operations. Many of them are aligned with the SDGs, in particular with Goal 7 (affordable and clean energy) and Goal 13 (climate action).

Some of these benefits are described in Table 13, although many of them require further analysis to quantify them:

Table 13 • Multiple benefits of sustainable building operations

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Emissions reductions – more sustainable building operations deliver GHG reductions through lowered energy consumption. • Air quality – sustainable building operations reduce air pollution. |
| | |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – sustainable building operations result in the more efficient use of building systems. • Energy security – sustainable building operations deliver reductions in energy use and put less strain on energy systems. • Energy prices – sustainable building operations reduce energy demand and peak loads, lowering network infrastructure and system costs. |
| | |
| | |
| Economy | |
|  | <ul style="list-style-type: none"> • Economic performance – sustainable building operations reduce operating costs, freeing up resources to invest in other parts of the economy. • Productivity – sustainable building operations can enable increased thermal, light and acoustic comfort, which can result in improved productivity of occupants. • Employment – sustainable building operations can grow employment through operational services for increased sustainability. |
| | |
| | |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – sustainable building operations result in lower costs. • Health and well-being – sustainable building operations can deliver increased physical and mental health through retro-commissioning and building management that increases thermal, light and acoustic comfort. • Safety and security – sustainable building operations can contribute to improved building management, operation and maintenance, avoiding, for example, system failure. |
| | |
| | |



Activity 5: Appliances and systems

Energy-consuming lighting, appliances and equipment systems commonly have a shorter lifetime than the buildings themselves and offer significant opportunity to reduce emissions in new and existing buildings. Aside from increasing appliances' efficiency, the human behavioural factors should also be considered: the manner in which users utilise appliances (e.g. operating air conditioners at temperature set points that are lower than required).

Box 14 • Appliances and systems in Latin America: Trends and challenges

Rising incomes and living standards are generating a greater demand for appliances and equipment.

Across the region, many standard appliances such as white goods (refrigerators, dishwashers and washing machines) as well as air conditioners, ovens and electrical appliances have mandatory MEPS, endorsement labels and/or label rating systems in place, and labels appear to be well understood by consumers.

The challenge will be to ensure that these standards and label thresholds are regularly revised so that they continue to push the market towards increased performance. For example, in the case of air conditioners, there is a large difference between the efficiency of the least- and best-performing models, suggesting that there is room for improving the MEPS and revising label thresholds (IEA/KCEP, 2019). By 2050, it is expected that the number of households owning an air conditioner will grow by a factor of more than six, becoming a major share of system peak loads (IEA, 2018a). It will therefore be critical to ensure that these additional air conditioners are efficient in order to limit the impact on grids and consumer bills.

Key actions for sustainable systems

Figure 26 • Key actions for systems in Latin America



Key actions to enable increased sustainability of systems in buildings include:

- **MEPS.** Further develop, enforce and strengthen standards that set product quality and performance requirements. Across Latin America, there are many good standards for minimum performance, such as Procel in Brazil, the Electric Energy Savings Trust (Fideicomiso para el Ahorro de Energía Eléctrica [FIDE]) in Mexico and the Energy Efficiency Labelling in Chile, and these can be further improved to eliminate inefficient goods and systems from the market along with raising consumer awareness.
- **Enable investment in clean and efficient systems.** Enable increasing use of sustainable products by increasing access to and use of finance to enable private investment. The rate of investment in Latin America in buildings energy efficiency needs to be increased across government and industry to support energy standards for appliances and systems.
- **Governments lead by example.** Develop policies that ensure all government buildings invest in low-emission and efficient systems. In the region, there is a strong presence of the public in owning and operating buildings, and through government action, the use of MEPS, labels and investment in energy efficiency systems will help create a stronger market.
- **Adopting efficient systems.** Following building fabric, making use of efficient systems makes the biggest impact on energy demand in a building. Across the region, adopting more high-performance systems for space heating and cooling, water heating, ventilation, and lighting is possible through MEPS and investment and with the support of government and industry.

Stakeholders for sustainable appliances and systems

In Latin America, the key stakeholders for sustainable systems include those that can influence technologies and those that can deliver the results of zero-emission, efficient and resilient buildings through the use of sustainable systems. Additional stakeholders include those that can support the process through research, funding and training.

These stakeholders are mapped in Table 14, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 14 • Stakeholder mapping for appliances and systems in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers, suppliers* | Labourers and installers | Building owners and occupants | Civil society ** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|--------------------------------------|--------------------------|-------------------------------|------------------|
| | | | | | | | | | |

* of appliances and materials (includes product testers and certifiers).

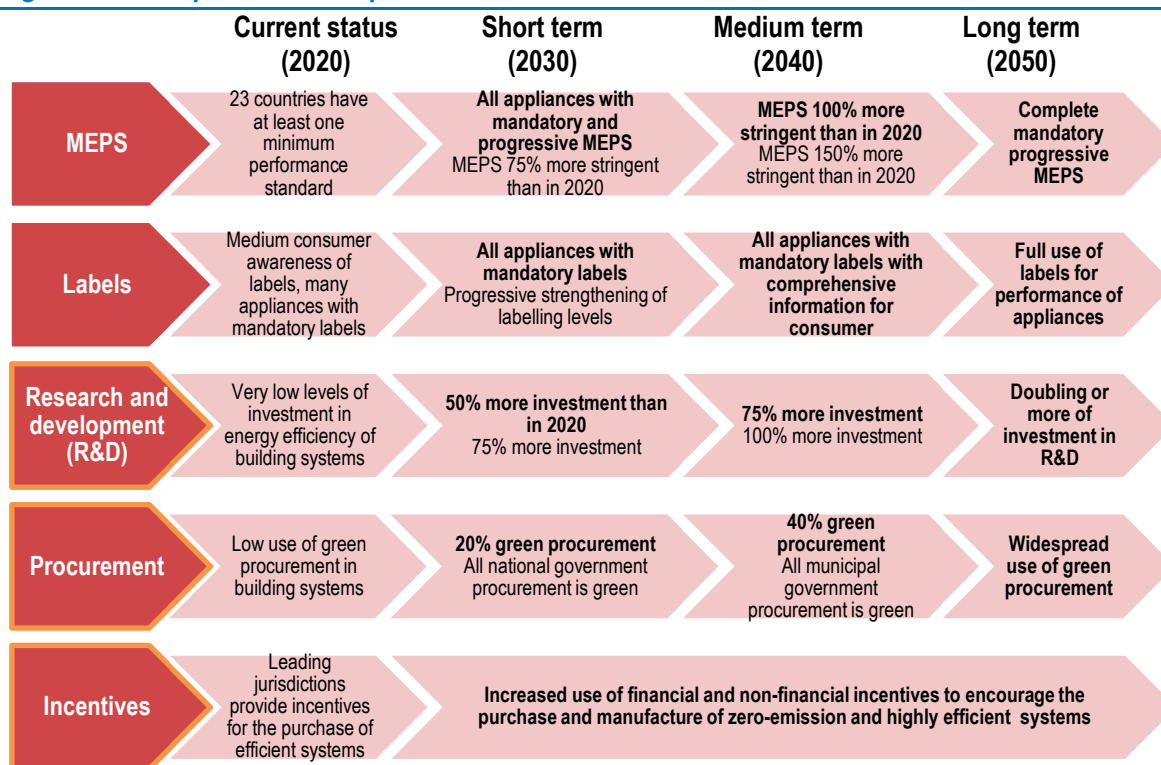
** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Policy for sustainable appliances and systems

Appliances and systems policy can support zero-emission, efficient and resilient buildings goals by enabling market transformation that increases the availability of sustainable products. Within the targets for sustainable systems, the sub-targets and timelines in Figure 27 offer more details:

Figure 27 • Policy timelines for systems in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for building appliances and systems are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **MEPS:** Lighting, appliance and equipment products commonly have standards in many countries. These standards need to be expanded to all countries and strengthened for higher performance requirements. Testing protocols and enforcement of MEPS are essential for MEPS to work effectively. MEPS should also be in terms of the most adequate performance metric – for example, MEPS for air conditioners are mostly in terms of the energy efficiency ratio (EER) in the region; however, there is a shift towards the use of a seasonal energy performance metric (such as the seasonal energy efficiency ratio [SEER] or cooling seasonal performance factor [CSPF]) as is being undertaken by Brazil and has already been taken up by Chile and Mexico. A seasonal metric is a more appropriate metric as it is more reflective of the appliance's actual consumption over the cooling season. This is a shift that other countries in the region should also follow. *Stakeholder feedback: There was consensus that MEPS for all appliances could be implemented as soon as 2030.*
- **Labels:** Product labels on systems and appliances can provide information on the performance of the products including their embodied energy and carbon and their life-cycle energy and carbon performance. This kind of information enables consumers to make choices on a life-cycle basis, but also facilitates the implementation of incentives, MEPS and phase-out programmes. Labelling programmes can be supported by educational efforts to increase the capacity for people to make better design, purchase and operational decisions. *Stakeholder feedback: There was strong consensus that labelling of main appliances could be mandatory by 2030 or earlier, and that consumers would have a good understanding of them by 2040.*
- **[data gap] R&D:** Increasing research funding can enable the invention of new products and services while also increasing the ability to get improved technologies to the market cost-effectively. *Stakeholder feedback: There was little consensus regarding the availability of resources for R&D and its evolution over time.*
- **[data gap] Procurement:** Public and private entities can purchase sustainable products and services to support the effort to phase out the use of unsustainable products and services. This effort should be done by both public and private entities and can include bulk procurement or minimum performance specifications for procurement rules. The target in the timeline above refers to increasing shares of “green” procurement, which is procurement based on minimum specifications such as minimum energy efficiency and/or other environmental standards.
- **[data gap] Incentives:** Non-financial incentives, such as expedited product approvals, should be the priority to encourage sustainable systems. Financial incentives should be used to enable the very best sustainable systems, while finance support, such as loan guarantees, should enable private investment in sustainable systems. *Stakeholder feedback: There was little consensus regarding the evolution of incentives to support the purchasing or manufacture of more efficient systems.*

Box 15 • Regional examples of policy action for appliances and systems

Mexico

The FIDE Seal in Mexico, which started as a voluntary initiative in 1992, is a badge awarded for highly energy-efficient products. In 2012, it was proposed to classify the seal in two categories: the FIDE Seal A is granted to electrical or electronic equipment (refrigerators, efficient light bulbs, etc.); the FIDE Seal B is awarded to products that do not use electricity directly, but are capable of creating conditions that lead to potential savings of electrical energy (thermal insulation, glass, etc.).

Mexico has several standards for systems and appliances, including NOM-011-ENER-2006 for SEER of central air systems; NOM-023-ENER-2010 for EER of split air conditioners; and NOM-017-ENER/SCFI-2012, NOM-028-ENER-2010 and NOM-030-ENER-2012 for lighting appliances. The standard for lighting systems for residential buildings (NOM-007-ENER-2014) sets the maximum lighting power density in new non-residential buildings and renovations with lighting equal to or greater than a 3 kilowatt load. The implementation of this standard has been possible because the Federal Electricity Commission requests the compliance certificate of the lighting system prior to the provision of the power service.

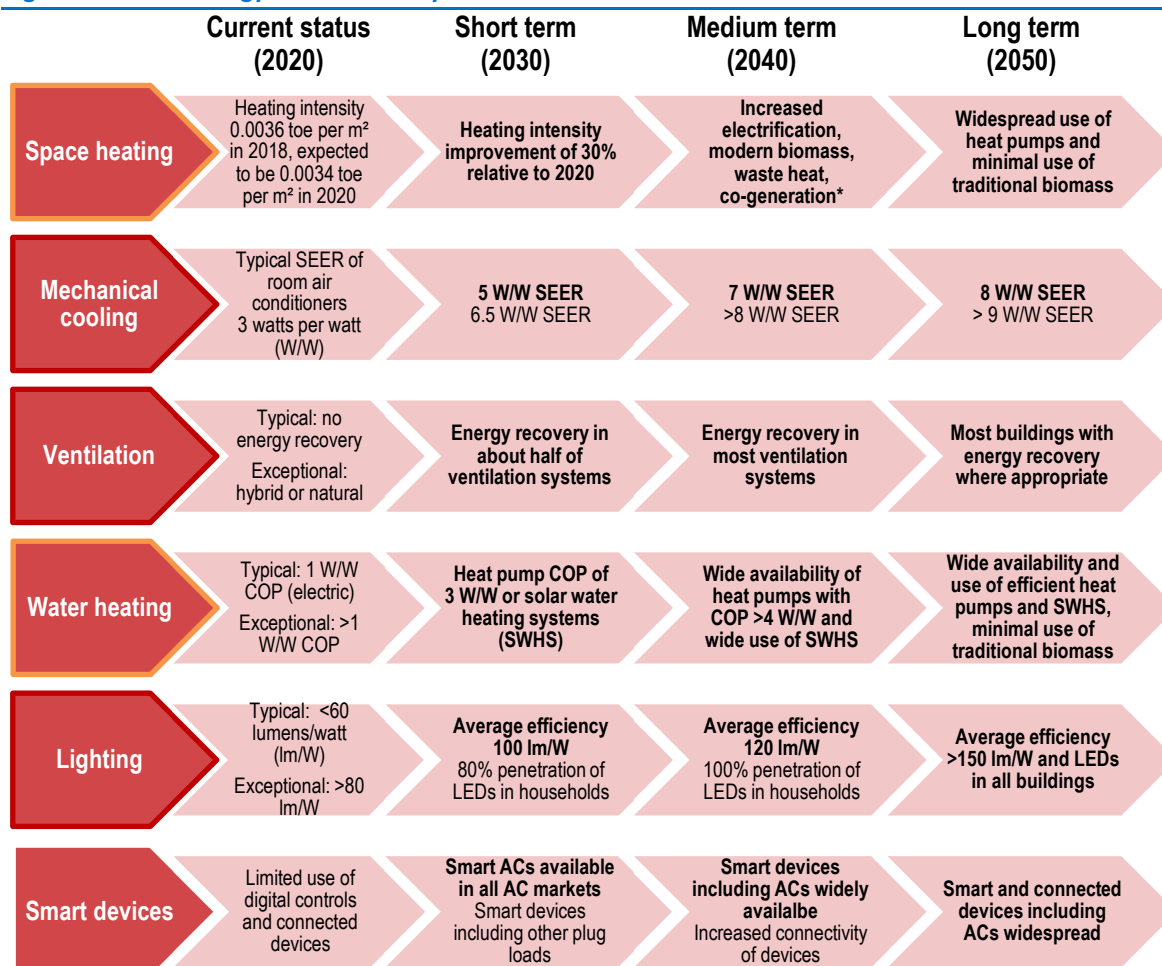
Brazil

Brazil's regulation on the minimum energy efficiency levels for window-type air conditioners and split-type air conditioners prohibits the manufacturing and import of non-compliant air conditioners from 30 June 2019, the marketing of non-compliant air conditioners by importers from 31 December 2019, and the marketing by wholesalers and retailers of non-compliant air conditioners as of 30 June 2020.

Technology for sustainable appliances and systems

The energy use and emissions from buildings are influenced by the systems used in the buildings. Specific targets and timelines for the sustainable system technologies are outlined in Figure 28:

Figure 28 • Technology timelines for systems in Latin America



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* Co-generation refers to the combined production of heat and power.

Notes: toe = tonnes of oil equivalent; COP = coefficient of performance; LEDs = light-emitting diodes; AC = air conditioner. The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the technology targets for building appliances and systems are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Space heating systems:** Heating technology can enable more efficient delivery of space comfort through improved system efficiency. Heating systems also offer an opportunity for decarbonisation in the transition from fossil fuel heating systems to

electricity or renewable energy heating systems. In Latin America, heating demand is generally low due to warmer climates, though heating intensities in regions that do have heating demand (in toe/m² floor area) still need to improve. The SDS will require improvements of up to 30% by 2030 for the region (IEA, 2019b). Key technologies to achieve these reductions are heat pumps, modern biomass stoves and boilers, and the phasing out of traditional biomass. *Stakeholder feedback: Very few data were obtained regarding the evolution of heating efficiencies and heating technologies.*

- **[ambition gap] Mechanical cooling systems:** While cooling is the fastest-growing end use in buildings globally, cooling technology can enable more efficient delivery of thermal comfort through improved peak demand efficiency (EER) and seasonal efficiency (SEER or CSPF). Alongside appropriate design strategies that minimise the need for cooling, adoption of hybrid cooling methods, such as evaporative cooling, ventilate cooling and other “free cooling” that uses ground or water temperatures, can support the increased overall efficiency. Overall system efficiency will also increase with the use of variable speed drives and improved thermal distribution efficiency. *Stakeholder feedback: The outlook for improvement of the efficiency of air conditioners in the region appears to be alarmingly slow, with efficiencies expected to reach only 4 W/W to 5 W/W SEER by 2050. The Future of Cooling by the IEA estimates that to accommodate the expected rise in cooling demand and stay on track of climate goals, new air conditioners in the region will have to have an average efficiency of over 9 W/W. This gap suggests much work needs to be done in this area. Projects such as the [Global Cooling Prize](#) are essential to demonstrate that a rapid increase in efficiencies through new technology is possible. It is worth noting that equipment of SEER of 12 W/W is already available today in the United States (IEA/KCEP, 2019).*
- **[ambition gap] Ventilation:** To improve indoor air quality, controllable ventilation is essential. The three primary ventilation types include mechanical, natural and hybrid. To increase both the ventilation efficiency and energy retention efficiency, buildings can shift increasingly to hybrid ventilation, which uses natural ventilation when feasible and mechanical ventilation when natural ventilation is not effective. To further improve the efficiency, when in mechanical ventilation mode the system should include energy recovery ventilation technology to enable air exchange with minimal heat and humidity transfer. Energy recovery ventilation efficiency will also need to improve from low-efficiency systems near 50% efficiency to high efficiency in the 80-90% efficiency range. *Stakeholder feedback: There was consensus that energy recovery will have a slow adoption, with few buildings expected to adopt it by 2050. With an increase in active cooling systems, energy demand increases. Energy recovery systems provide ventilation, minimising energy loss by transferring the energy from exhausted air.*
- **[data gap] Water heating systems:** Available heating technologies can enable more sustainable and efficient delivery of water thermal comfort through the use of modern renewable energy sources and improved system efficiency (COP). Efficient heat pumps, solar thermal water heaters, efficient modern biomass (woodchips or pellet) boilers, and the use of waste heat and co-generation offer effective solutions for decarbonisation in the transition from fossil fuel heating systems to electricity or renewable energy heating systems. Very little information was collected on the efficiency of water heating systems. *Stakeholder feedback: Very few data were obtained regarding the evolution of water heating efficiencies and technologies.*
- **[ambition gap] Lighting:** Lighting technology can enable more efficient delivery of visual comfort through improved lumens-per-watt efficiency. Lighting technology developments in more efficient solid-state lighting is improving the quality of light, efficiency,

maintenance and reducing costs. Daylight harvesting systems with intelligent controls, sensors and shading devices can also support the target for increased lumens per watt. Reaching efficiencies of 160 lm/W and a 40% penetration of LEDs in the residential sector by 2030 globally is needed to meet the SDS (IEA, 2019b). *Stakeholder feedback: There was strong consensus that lighting efficiencies would reach only 100-12 lm/w by 2050, which is far below what is needed in the SDS.*

- **Smart devices:** Ongoing digitalisation of electric appliances is unveiling new opportunities to improve resource efficiency and flexibility, and allow consumers to manage their consumption through demand-side response. Appliances such as air conditioners and other devices should increasingly be equipped with the capacity for smart or connected control. *Stakeholder feedback: There was consensus that smart sensors and controls could become widespread in most commercial buildings by 2050.*

Beyond the items above with specific targets, the following system technologies can also support increased sustainability in buildings.

- **Appliances:** Large and small appliances both have opportunities for increased sustainability. Development in appliance efficiency is needed to counter the surge in appliance usage from rising wealth and ownership. The most significant gains have been in refrigerators, with specific targets noted above, where increased efficiency continues through variable speed compressors, improved insulation and heat pump technologies. Other appliances such as dishwashers, clothes washers and dryers, televisions, and digital appliances will need to become more efficient and reduce standby losses and connectivity energy use through the use of sensors, controls and automation to enable low-power modes, load balancing, demand response and remote programming.
- **Energy storage:** Thermal energy storage for heating or cooling can enable load shifting, optimised heat transfer efficiency and integration with renewable energy, which will become ever more important with growing electrification and pressure on peak demand. Thermal energy storage systems can take the form of highly insulated water or refrigerant tanks, thermal mass, or phase change materials. Current research is focused on reducing the costs, reliability and lifetime of high-density storage. Electrical storage in the form of batteries may also become important with the rise of decentralised renewable electricity generation and the interconnectivity of electric vehicles and buildings.

Box 16 • Examples of regional action on systems technology

Cooling as a Service (CaaS) - Mexico

Cooling as a Service (CaaS) is a system where a customer pays for cooling (as a service), not for the physical cooling infrastructure (i.e. HVAC system, fan, air conditioner). CaaS is a financial instrument to address the upfront investment costs of cooling equipment. It is similar to current “pay as you save” (PAYS) programmes and already exists for a variety of technology such as software and photocopying services. The model has also been implemented for lighting products (eg. Lighting as a Service).

Under CaaS, a technology provider installs, maintains and owns the cooling equipment, and recuperates the cost through periodic payments from the end user. The technology provider maintains ownership throughout the total equipment life cycle, therefore shifting the investment focus from the purchase price of equipment to the life-cycle cost of the technology. The technology provider is also responsible for paying for the energy used, therefore is incentivised to have highly efficient equipment.

The Global Innovation Lab for Climate Finance is working on a CaaS programme, along with Kigali Cooling Efficiency Program and the Basel Agency of Sustainable Energy. The project is working towards implementation throughout the Dominican Republic, India, Jamaica, Mexico and South Africa.

Like many emerging economies, Mexico is currently experiencing increased demand for cooling. The CaaS programme in Mexico estimates that the installation and operation of high-efficiency chillers over a period of

seven years would lead to a reduction of nearly 18 000 tonnes of CO₂ emissions. Savings from a single system equates to energy use of 1 945 homes for one year.

Argentina

Argentina has launched the Efficient Lighting Plan (Plan Alumbrado Eficiente) to replace lights with more efficient LED lights on public roads. This programme saves up to 50% in electricity consumption in public lighting.

Chile

The Country Energy Efficiency Programme (Programa País de Eficiencia Energética) introduced [The Light Up Good Energy](#) project in 2008, distributing 3 million compact fluorescent lamps to low-income citizens. This led to a 25% savings in the monthly electricity bill (USGBC, WorldGBC, C40 Cities, 2015).

Buenos Aires – Light replacement

The Go for LED ([Pasate a LED](#)) lamp replacement programme, launched in mid-2018, promotes the installation of LED lighting. Go for LED is a continuation of a previous successful LED project, which ran from October 2017 to June 2018. The programme provides replacement services, as well as a disposal plan for the collected fluorescents. The old fluorescents undergo treatment to safely dispose of the mercury; the remaining, uncontaminated parts are then reused in Buenos Aires for tile manufacturing.

Due to the success of the project so far, the current scope has been expanded with the aim of replacing up to 3 million lamps with LED ones. The plan is to reach 325 000 homes in total; so far, 162 757 (as of January 2020) have had lamp replacements. Current savings equal 21 367 tonnes of CO₂ equivalent (tCO₂e) (out of the total projected 43 000 tCO₂e), with total energy savings of over 45 gigawatt-hours (GWh), equivalent to the energy consumption of 13 627 homes per year. Homeowners are experiencing 14% lower energy bills, and a collective savings of USD 3 million (total expected savings is projected to be as high as USD 100 million).

Finance for sustainable appliances and systems

Finance can enable increased action towards low-emission, efficient and resilient buildings through sustainable systems. Specific finance sub-targets and timelines are outlined below:

Financial tools particularly relevant to appliances and systems include:

- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Energy performance/energy service contracts:** Contracts for services or delivered savings that typically are delivered by an ESCO and can include a range of energy efficiency services and products.
- **Green mortgages:** Prospective homeowners can solicit additional finance as part of their mortgage to install efficient features and technologies in their future homes.
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.
- **On-bill/tax repayment:** An approach where any recurring bill, such as utility bills, insurance bills or home improvement store bills, can collect small amounts of money over a long period of time to pay for energy efficiency purchases in smaller payments. An offshoot of on-bill finance, tax repayment is where the tax authority uses recurring tax payments as a

means for collecting money over time. The most common of these is PACE, which is able to use low-interest-loan repayments on the property tax bill until the purchase is paid in full.

- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

Capacity building for sustainable systems

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Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable systems.

The types of capacity-building activities relevant to appliances and systems are mapped in Table 15, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 15 • Capacity building for appliances and systems in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training within government:** Provide training to central and local governments regarding the implementation of MEPS and labelling systems, the development of testing protocols, and how to co-ordinate with other government stakeholders and industry and obtain their buy-in, as well as training on how to monitor and evaluate the success of policies.
- **Training of product/material manufacturers:** Provide training to industry on how to comply with MEPS and labelling policies, including support for leveraging the benefits of producing more efficient equipment.
- **Training of general public:** Develop information and awareness campaigns regarding the benefits of more efficient and more sustainable appliances, including information and tools regarding how to access funding. Methods of increasing information to consumers include benchmarking programmes, certification programmes, labels, educational resources, and information on utility and government programmes.





Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of sustainable systems

Many benefits can be achieved through sustainable systems. Many of them are aligned with the SDGs, in particular with Goal 7 (affordable and clean energy) and Goal 13 (climate action).

Some of these benefits are described in Table 16, although many of them require further analysis to quantify them:

Table 16 • Multiple benefits of sustainable building systems

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Emissions reductions – sustainable appliances and systems deliver GHG reductions through lowered energy consumption. |
| | <ul style="list-style-type: none"> • Air quality – sustainable appliances and systems reduce air pollution through lower on-site emissions and lowered energy consumption. |
| | <ul style="list-style-type: none"> • Resource efficiency – sustainable appliances and systems should have a longer lifetime, therefore reducing the material demand in the production of appliances and systems. Appliance sharing or mutualisation can also reduce production volume. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – sustainable appliances and systems are more energy-efficient. |
| | <ul style="list-style-type: none"> • Energy security – sustainable appliances and systems use less energy and put less strain on energy systems. |
| | <ul style="list-style-type: none"> • Energy prices – sustainable appliances and systems reduce energy demand and peak loads, which can lower network infrastructure and system costs. |
| Economy | |
|  | <ul style="list-style-type: none"> • Productivity – sustainable appliances and systems can increase the productivity of students and employees through improved thermal comfort, lighting and noise. |
| | <ul style="list-style-type: none"> • Asset value – sustainable appliances and systems can improve the asset value of buildings. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – sustainable appliances and systems reduce building operation costs. |
| | <ul style="list-style-type: none"> • Health and well-being – sustainable appliances and systems deliver increased thermal comfort, light, noise and indoor air quality, improving physical and mental health and well-being. |
| | <ul style="list-style-type: none"> • Safety and security – sustainable appliances and systems can include features such as building automation, sensors and lighting, as well as features to improve and facilitate maintenance, which can prevent system failure. |

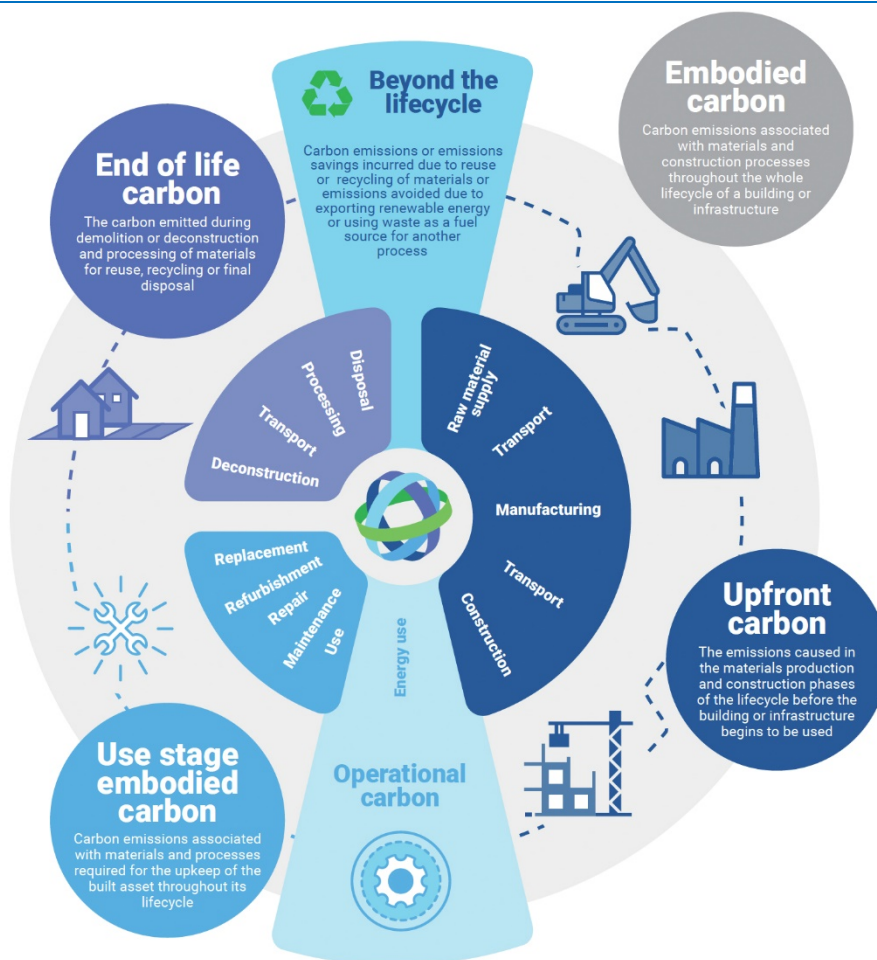


Activity 6: Materials

Construction activity in the buildings sector generates a major flow of materials in every country. The construction and demolition of buildings accounts for around one-third of global material consumption and waste generation. GHG emissions and energy consumption are linked to every phase of the life cycle of materials, from extraction or harvesting to manufacture, transport, construction, use and demolition. For instance, steel, cement bricks and non-certified wood (deforestation issue) are some of the major building product emitters of CO₂.

Embodied carbon is the sum impact of all the carbon emissions attributed to the materials throughout their life cycle (extracting from the ground, manufacturing, construction, maintenance and end of life/disposal), as shown in Figure 29.

Figure 29 • The WorldGBC's scope and definition of the building life cycle



Source: WorldGBC (2019), *Bringing Embodied Carbon Upfront: Coordinated Action for the Building and Construction Sector to Tackle Embodied Carbon*.

Currently, the carbon emissions associated with the extraction, manufacturing and construction of materials for buildings represents close to 11% of all global emissions. These include energy- and process-related emissions (GlobalABC/IEA/UNEP, 2019).

The factors that influence embodied carbon include the construction technique, material demand, durability, origin (recycled versus virgin and location), composition, manufacturing processes, and reusability or recyclability.

Globally, cement and steel are two of the largest sources of building material-related CO₂ emissions. Total cement production is responsible for around 7% of global CO₂ emissions, with steel contributing 7-9% of the global total, of which around half can be attributed to buildings and construction (WorldGBC, 2019).

Reducing the embodied carbon of major building components such as cement and steel will be key to decarbonising construction. It is recognised that these sectors are among the hardest to decarbonise, therefore it will require concerted action along multiple dimensions – from lowering the demand of material, promoting switches to low-carbon materials, to maximising energy efficiency in manufacturing and switching away from carbon-intensive sources of energy (Energy Transitions Commission, 2018). There are also significant opportunities in developing systems to enable the reuse and recycling of construction materials.

Actions include engaging all stakeholders along the value chain, the provision of clear information and robust data on embodied carbon, promoting the implementation of EMS in industry, revision of building standards and codes, use of building certification systems, green public procurement and virgin material taxation, developing and enforcing regulations on embodied carbon levels, ensuring the incorporation of consideration to embodied carbon in policy and planning instruments, and decarbonisation of the energy system (IRP, 2020).

Box 17 •Materials in Latin America: Trends and challenges

High construction rates due to increasing population, economic growth and evolution of lifestyles have led to more demand for construction materials, increasing the energy consumption and CO₂ emissions from material production.

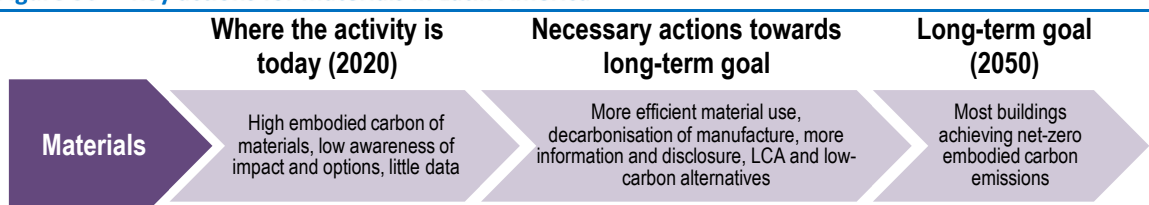
Production of materials is expected to increase by mid-century in the Americas compared with 2014 levels. Cement production is projected to rise by more than 60% and steel production by more than 45% (Energy Transitions Commission, 2018). Economies such as Brazil still have lower per capita consumption of materials than Europe, the United States and Canada. Steel per capita consumption in Brazil is half that of the United Kingdom and almost three times lower than the United States. Cement per capita consumption on the other hand is very similar in these three countries but almost four times smaller than China, revealing the wide differences in buildings and construction needs (IEA, 2019a).

The share of the informal construction sector in Latin America is high, both in rural and urban areas. Common types of construction use unreinforced masonry structures using fired-clay bricks with lime or mortar. Newer buildings are often confined masonry structures constructed with cast-in-place reinforced concrete. In the case of high-rise buildings in urban areas, reinforced concrete walls are often used (Yepes et al., 2017).

In Latin America, very few countries have mandatory or voluntary standards for construction materials that stipulate performance or environmental impact. The transition requires combined effort from the government, industry and the research community.

Key actions for sustainable materials

Figure 30 • Key actions for materials in Latin America



Key actions to enable increased sustainability of materials in buildings and buildings products include:

- **Collect data** on embodied carbon of building and construction materials; develop a database that can be accessed by all relevant stakeholders and that allows comparisons and calculations. Develop guidance on the use of methodologies and standards for making calculations and assessments.
- **Provide information and raise awareness.** Promote capacity on low-carbon materials and technologies (e.g. wood and earth constructions, innovative concrete) among professionals involved in the building design and construction process. Provide tools, training and capacity building; conduct or commission research into low-carbon materials and approaches. Carry out or commission case studies to convey the benefits of use of low-carbon materials and raise awareness.
- **Integrate considerations of embodied carbon in planning and building regulations,** require disclosure for all new construction and for large renovation projects, initiate low-carbon materials pilot projects, provide incentives to property and project developers.
- **Accelerate energy efficiency in manufacturing.** Develop measures to effectively speed up the implementation of energy efficiency in industries manufacturing building and construction materials. Promote energy management, develop best practice guides and support the adoption of BATs. Include building material manufacturing industries as part of demand-side management efforts.
- **Stimulate markets for low-carbon products and materials.** Implement policies that enable improved design and purchasing decisions based on embodied carbon and energy. This could be achieved combining push levers, such as carbon pricing, tax incentives, subsidies and regulations on production of materials, with pull levers, such as public procurement and regulations on the construction sector. Develop policies that ensure all government buildings invest in low-carbon and efficient materials based on LCAs.
- **Require embodied carbon assessments** or LCAs to be undertaken on all new major and public investments, disclose portfolio and/or asset-level embodied carbon emissions, provide financial products to incentivise low-carbon projects and business models, provide preferential loans or mortgages to stimulate a market for low-carbon materials.
- **Reduce demand.** Develop approaches for lowering the demand for building and construction materials through design briefs and construction approaches that reduce the need for added materials. This in turn will help to **reduce extraction** of key natural resources, e.g. sand for building materials.
- **Reuse and recycle.** Develop strategies for repurposing of buildings when appropriate. Mandate plans and systems for collection and reuse/recycling of construction and demolition waste. Improve deconstruction processes including via the development of guidelines or protocols for deconstruction and selective sorting of waste.
- **Support the development of material reuse and recycling processes** for products and materials that can reduce the life-cycle embodied energy and emissions¹³ and **increase the use of repurposed materials** in product manufacturing and in building and construction projects.
- **Promote a circular economy.** Develop cradle-to-cradle life-cycle approaches in the buildings sector to enable a systemic, material-neutral and performance-based approach and business models. Integrate whole-life-cycle carbon thinking into planning and design processes.

¹³ This has to be set cautiously as some materials can be reused only if the adequate processes are in place during the demolition phase (recovering un-hydrated cement can be achieved only if carefully designed processes are used to crush the concrete and separate the different constituent materials).

Stakeholders for sustainable materials

In Latin America, the key stakeholders for sustainable materials include those that can influence materials and those that can deliver the results of low-emissions, efficient and resilient buildings through the use of sustainable materials. Additional stakeholders include those that can support the process through research, funding and training.

While policies play a central role in accelerating a transition to zero embodied carbon, a range of different stakeholders can play an active part in the process. For instance, project and property developers can request disclosure on embodied carbon from material suppliers, and financial institutions can provide preferential financial products to projects that can demonstrate low embodied carbon. Manufacturing companies can start to voluntarily disclose information on embodied carbon of their products, and civil society organisations can play an important role in developing knowledge, raising awareness and providing capacity building.

These stakeholders are mapped in Table 17, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 17 • Stakeholder mapping for materials in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|-----------------|
| | | | | | | | | | |

* of appliances and materials.

** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

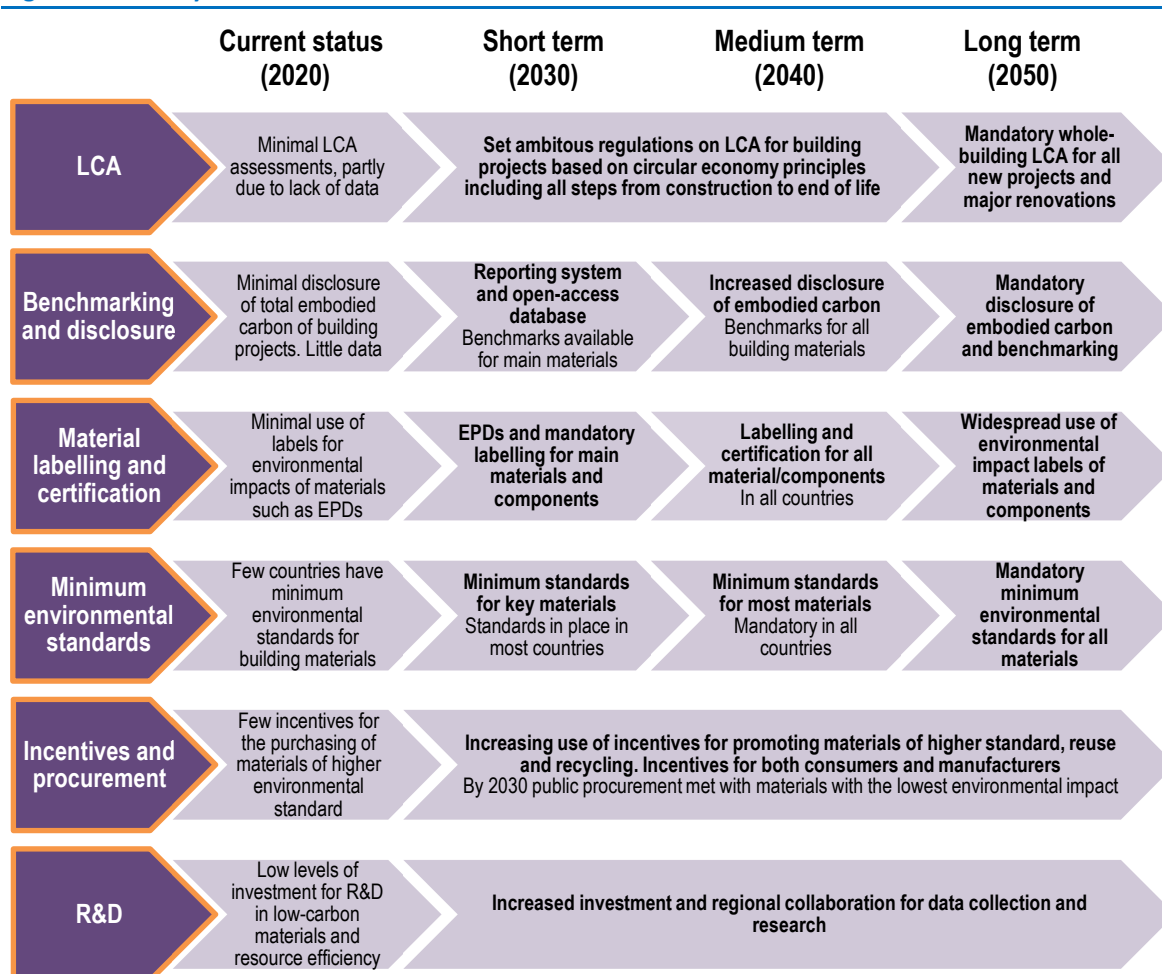
Policy for sustainable materials

Policy can support zero-emission, efficient and resilient buildings goals by enabling market transformation that increases the availability of sustainable products.

National, state and local governments are well positioned to spark action towards net-zero embodied carbon as they have the greatest powers to set standards and targets, implement legislation on materials and planning policies, invest in R&D, and deploy financial and fiscal measures that can shift the market. In particular, national governments may have the widest reach to facilitate value chain collaboration, stimulate market demand and integrate new holistic approaches such as circular principles in buildings and infrastructure.

Within the targets for sustainable materials, the sub-targets and timelines in Figure 31 offer more details:

Figure 31 • Policy timelines for materials in Latin America



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Notes: EPD = Environmental Product Declaration. The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for building materials are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] LCA**: LCAs seek to quantify environmental impacts from material extraction and product manufacturing through to end of life. Decisions regarding the building use, design and choice of materials should consider the entire lifetime of the building and its components. National, regional or international databases containing information on the embodied energy and carbon of construction materials will be necessary to undertake

comprehensive life-cycle impact analysis of design choices. All plans and designs should focus on lowering life-cycle impact. This means that all stages of projects should be considered and planned, from construction to demolition. In particular, plans on how waste will be reduced and managed should be established as early as possible in projects. A waste management plan reduces the construction and demolition waste that are usually disposed of in landfills or incinerated by providing options to recover, reuse or recycle the materials.

- **[data gap] Benchmarking and disclosure:** In order to monitor progress, understand best practices and facilitate better decisions at the design stage and in policy-making, benchmarking coupled with data disclosure will be of importance. Data disclosure requirements could build on experiences with material passports¹⁴ and other initiatives such as the CDP.¹⁵ Disclosure of the environmental impacts and efficiency levels of building projects should be developed in order to ensure a better enforcement of regulations.
- **[data gap] Material labelling:** Product labels on materials can provide information on the sustainability of the products, including their embodied energy and carbon and their life-cycle energy. EPDs and Health Product Declarations are some of the different voluntary labelling systems available currently supporting the information roll-out with educational efforts to increase the capacity for people to make better design, purchase and operational decisions.
- **[data gap] Minimum environmental standards:** The creation of EPDs for building and construction materials and products and their use in design is voluntary in most regions and countries. Some European countries, such as Finland, France and the Netherlands, are moving towards legislative adoption of LCA requirements for the construction industry, which is expected to be a catalyst for wider market penetration of EPDs (WorldGBC, 2019). The successive development and expansion of voluntary schemes towards mandatory minimum environmental standards for materials would effectively create markets for low-emission products. Testing protocols and standards for materials (including new materials) will have to be developed. Building codes, where in place, should include minimum environmental performance standards for materials to be used or via performance requirements encourage use of low-carbon materials. Stringency should be increased over time to continue to drive the market further towards low-carbon solutions.
- **[data gap] Incentives:** Financial incentives should be used to drive markets towards sustainable materials, while financial support, such as loan guarantees, should enable private investment in sustainable materials. Incentives should therefore address both sides: consumers and manufacturers of sustainable materials. These incentives will drive but also rely on procurement strategies: purchasing sustainable products and services should be done by both public and private entities and can include bulk procurement or minimum performance specifications for procurement rules. Public procurement should also include requirements for minimum recycled content and reusability or recyclability. Financial incentives should also be used to support new construction techniques that lower embodied carbon. Disincentives can also be used to penalise the use of particularly unsustainable materials, such as those responsible for unsustainable sand extraction.

¹⁴ Material passports include data on all the materials that are included in a construction and provide information on characteristics and highlight the potential for reuse and recycling.

¹⁵ Formerly known as the Carbon Disclosure Project, the CDP is a voluntary global system for investors, companies, cities, states and regions to manage their environmental impacts.

- **[data gap] R&D:** Increasing research funding can enable the development of local materials production and supply chains, improving processes, practices and services while also increasing their economic competitiveness and their diffusion. Collective R&D efforts fostering co-operation and collaboration instead of competition can enable better allocation of resources, and a faster uptake of innovation as research outcomes are shared across the different countries.

Box 18 • Regional examples of policy action for materials

Mexico

Materials including cement, aluminium and polyvinyl chloride (PVC) have voluntary standards for environmental performance. 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 the EPDs. A product declaration informs about environmental impacts such as acidification of water or soil or depletion of the ozone layer, the life cycle, water consumption, and consumption of resources and non-renewable energy.

Peru

In Peru, standards for bricks and cement, particulate, and gas emissions are formulated by the Ministry of Environment. The National Protocol for Continuous Emission Monitoring Systems is a proposal which seeks to standardise the process of continuous monitoring of emissions from stationary sources, establishing procedures for quality control and data transmission, in order to ensure the reliability and traceability of results.

Initiatives to promote circular design principles are being co-ordinated by the Ministry of Production, which through the National Innovate Peru Programme (Programa Innóvate Peru) has been co-financing projects related to the treatment of effluents and waste and to “green” industry and eco-innovation.

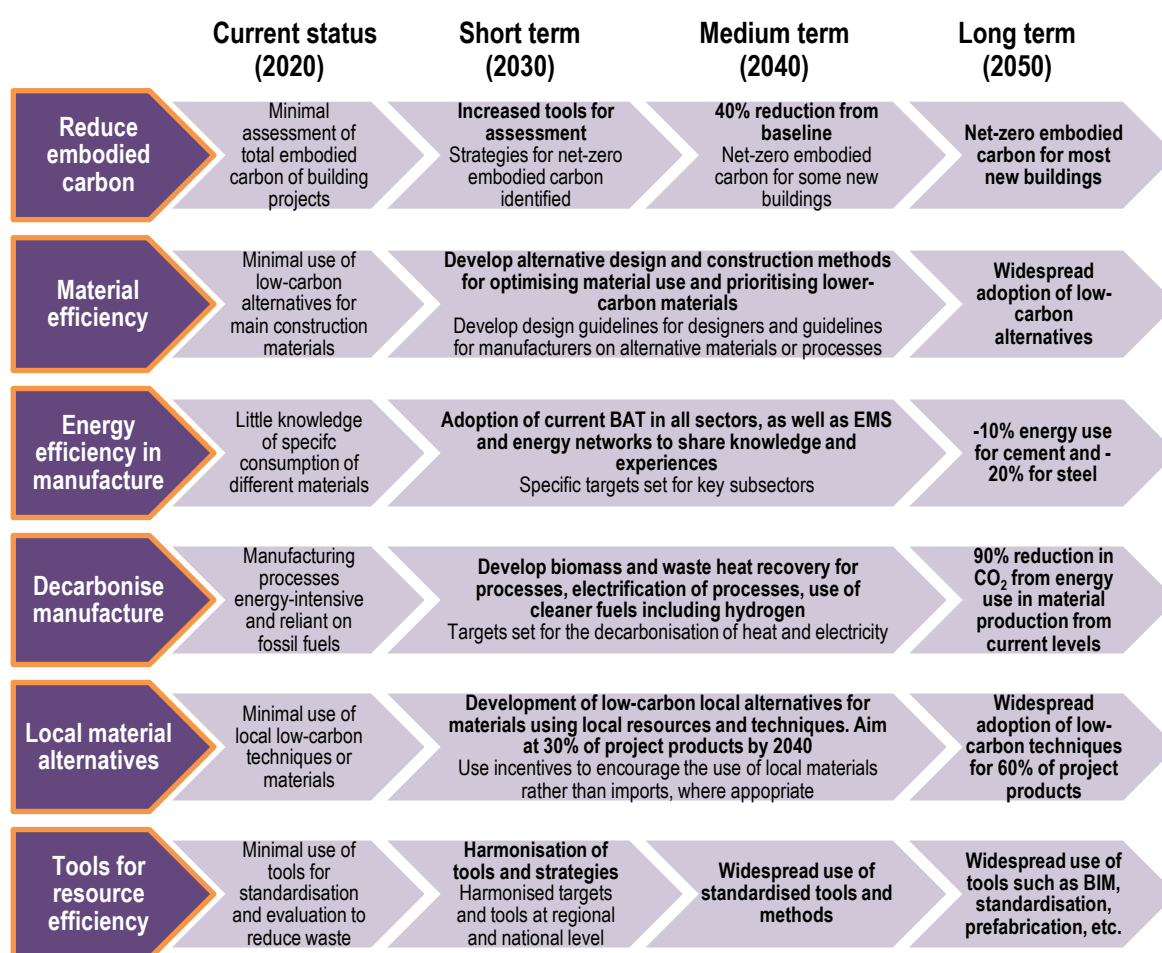
Argentina

The Argentine government has been focused on developing a local market for timber house construction using sustainable forest management practices, and mobilising the forest, wood processing and prefabrication industries to meet Argentina’s housing needs. In 2016 the Government of Argentina signed an ambitious strategy with forest-based industries, banks, R&D and academic institutions to finance and fast-track the construction of 100 000 timber houses through a value chain incorporating sustainable forest management. A national financing scheme, the Argentina Housing Bicentennial Credit Programme (Programa de Crédito Argentino del Bicentenario para la Vivienda Única Familiar [PROCREAR]) has also been established to promote the financing and construction of timber housing. The National Housing Fund is also aligning with PROCREAR to further support constructing homes and schools with timber products.

Technology for sustainable materials

Specific technology targets and timelines for sustainable materials are outlined in Figure 32:

Figure 32 • Technology timelines for materials in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the technology targets for building materials are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Reduce embodied carbon:** Develop a strategy to decarbonise building materials and set targets for overall embodied carbon/energy of building projects and EPDs. This strategy will need to rely on comprehensive data collection efforts and the development or adaptation of standardised tools and benchmarks to assess embodied carbon and set performance targets of reduction over baseline over time. Specific targets should be set for

the subsectors and in particular for the major materials used such as cement and steel, while promoting low-carbon and nature-based solutions for building materials.

- **[data gap] Material efficiency:** Reducing primary material demand through optimised design, optimised building techniques, the more intensive use of existing materials and the reuse of scrap material offer cost-effective measures to reduce embodied carbon of materials. In addition, low-carbon alternative materials already exist for several processes and usages (such as clinker substitutes for cement production or timber instead of steel in construction) and should be strongly encouraged and incentivised. Other examples include promoting concrete-steel composite construction, reducing cement content in concrete, lower clinker-to-cement ratio, etc. Precautionary steps would have to be taken in order to prevent negative effects (e.g. promoting the use of timber might increase demand for wood that would have to be met by sustainable harvesting).
- **[data gap] Energy efficiency in manufacture:** For all materials, indicators to monitor specific energy use for their production should be established, tracked and compared with BATs. This will allow manufacturers to set targets, and for the industry to develop minimum standards. Current BATs should be promoted across all sectors. Further measures to improve energy efficiency include making EMS (such as the ISO 50001) compulsory, promoting industry networks (to share best practices, identify energy efficiency potentials, set targets, etc.), and promoting access to and uptake of sustainable manufacturing technologies.
- **[data gap] Decarbonising manufacture:** The extensive use of renewable energy can be challenging in various industrial processes. However, by tracking the carbon embodied in materials, manufacturers will be encouraged to shift towards cleaner energy mixes (e.g. gas instead of coal, electrification of processes and use of hydrogen) and develop innovative solutions to maximise the use of waste heat and alternative sources of energy, or even waste material as fuel. These areas show great potential in sectors such as the cement or steel industry. There are at the moment few pilots to explore ways to decarbonise the heavy industry.¹⁶
- **[data gap] Local material alternatives:** Embodied carbon can be reduced by promoting the development of local low-carbon industry for the production of building materials where appropriate as determined by LCAs. This should be paired with new building methods, demonstration projects and case studies. Mapping of material flows and inventories of embodied carbon could support such a development.
- **[data gap] Tools for resource efficiency:** Measures should be taken to reduce manufacturing waste, develop materials and products that require fewer resources, and develop projects that require fewer material inputs. At the design stage: reducing oversizing and encouraging structural optimisation (such as lightweighting, drywall, etc.) may enable using fewer materials to provide the same service, as could, for instance, the use of precast concrete material, the development of 3D printing, prefabrication, BIM, modularity of buildings, etc.

¹⁶ The Swedish initiative HYBRIT for steel manufacturing and the Norwegian project in Brevik for cement are to be noted as examples of pilots across the world trying to reach net-zero manufacturing.

Box 19 • Examples of regional action on technology for sustainable materials

Argentina

HENIA, a company from Argentina, develops panels using straw bales, the residual material of crops which is usually burnt. The reuse of the straw avoids the CO₂ emissions into the atmosphere, and this new material has a thermal insulation which is seven times greater than double hollow brick wall. The panels are also fire- and earthquake-resistant.

Uruguay

A Sustainable School is an initiative from the Uruguayan non-profit organisation Tagma, in partnership with Earthship Biotecture, that aims to build a sustainable public school in every country in Latin America to create a network of symbolic examples in the region. The first one was constructed in 2016 in Uruguay. It is made up of 60% of recycled materials including plastic and glass bottles, tyres, cans and cardboard.

Colombia

Colombia uses thermoelectric power plants' ashes to replace cement during the manufacture of concrete.

Excellence in Design for Greater Efficiency (EDGE) uses the properties of the materials used in the building to calculate the embodied energy in materials. The materials considered include masonry, concrete, tiles, insulation, gypsum products, metal, timber, glass and windows. Grupo Bancolombia's headquarters in Colombia predicted 44% less embodied energy in materials for the EDGE certification. The six-story office building was built using precast concrete double-tee units for floor slabs and roof construction, honeycomb clay blocks and 3-D wire panels for external walls, and medium-weight hollow concrete blocks for internal walls.

Mexico

The 2017 earthquake in Mexico led to the loss of housing of several citizens. The community gathered together to initiate Bio Reconstruct Mexico, which used bio-construction to rebuild a more efficient, resistant and environmentally inclined community. The rubble was reused wherever possible and materials such as bamboo and earth were used for construction.

Finance for sustainable materials

Financial tools particularly relevant to sustainable materials may include:

- **Urban development funds:** Dedicated funding for urban development projects, which can prioritise sustainable urban development projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can prioritise sustainable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Carbon pricing:** In order to facilitate the uptake of materials with low embodied carbon, a carbon price could be implemented. This would be particularly relevant for cement and steel. It would encourage materials efficiency, reuse and recycling; promote R&D for alternative solutions; and promote the decarbonisation of materials.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).

- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to overcome high upfront costs or capital-intensive investments.
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

Capacity building for sustainable materials

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver sustainable materials.

The types of capacity-building activities relevant to materials are mapped below, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 18 • Capacity building for materials in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training within government:** Provide training to government about collecting data on embodied carbon of materials and building projects, and training on the development of an integrated policy portfolio towards zero-embodied-carbon buildings and construction. Provide training on how to develop information and assessment tools for project developers, designers and consumers such as embodied carbon disclosure, LCA, labelling and EPDs. These tools enable awareness among the building community and consumers, allowing them to make improved choices and promote lower-carbon design.
- **Training of professionals:** Provide training programmes for service and product providers of buildings and construction (architects, engineers, contractors, etc.) regarding how to design buildings with lower embodied life-cycle carbon in their materials. Include how to assess embodied carbon, how to use EPDs, how to perform LCAs, how to adapt design and construction techniques to lower embodied carbon in construction, how to correctly plan for end of life, and other circular design principles. This will require data collection and analysis to enable the creation of databases and resource platforms. Provide training on how to comply with policies such as labelling, EPDs, disclosure, LCA. Develop educational programmes including primary, secondary, vocational, university and adult education, to enable increased knowledge of sustainable building materials. Provide certification or accreditation for professionals in the sustainable construction sector.
- **Training of product/material manufacturers:** Provide training to industry regarding how to decrease the embodied carbon of materials and building, how to increase efficiency in manufacturing and construction processes, how to enhance the use of local materials, how to plan for end of life, how increase recycling and reuse, and other circular design principles. Provide training on how to comply with policies regarding labelling, EPDs, disclosure.





Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of sustainable materials

Many benefits can be achieved through sustainable materials, and many of them are aligned to the SDGs. In particular, Goal 12 (responsible consumption and production) and Goal 13 (climate action).

The descriptions in Table 18 describe some of the benefits; however, further analysis should be conducted to quantify them.

Table 19 • Multiple benefits of sustainable materials

| Environment | |
|---|---|
|  | <ul style="list-style-type: none"> • Emissions reductions – sustainable materials reduce embodied carbon emissions in building and construction through lowered energy consumption in manufacturing. |
| | <ul style="list-style-type: none"> • Air quality – sustainable materials can improve indoor air quality because of lower pollutants, and can improve outdoor air quality through lowered combustion and cleaner manufacturing processes. |
| | <ul style="list-style-type: none"> • Resource efficiency – sustainable materials improve the resource efficiency of the manufacturing and construction of buildings through increased resource recovery, reuse and recycling across the supply chain. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – sustainable materials can deliver energy savings in both the manufacturing process and in the operation of buildings. |
| Economy | |
|  | <ul style="list-style-type: none"> • Economic performance – sustainable materials can boost economic performance as the circular economy turns waste streams into new resource streams. |
| | <ul style="list-style-type: none"> • Productivity – sustainable materials will require the improvement of processes to meet targets for waste management and reuse. |
| | <ul style="list-style-type: none"> • Economic security – local sustainable materials would require the development of local industries to substitute imports. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – producing materials locally and training local populations can boost local economies. |
| | <ul style="list-style-type: none"> • Health and well-being – sustainable materials can be more natural and less toxic. |



Activity 7: Resilience

The concept of resilience has emerged in recent years as a crucial lens to look at the built environment. It promotes a holistic view of urban systems, embracing the interconnected and complex nature of cities' spatial configurations, physical assets, socio-economic functions and organisational structures. Resilience provides an overarching framework to classify the types of urban risks. Key factors influencing urban resilience include the "range and severity of hazards; the risk to lives and property; the vulnerability and exposure of human, social and environmental systems, and; the degree of preparedness of both physical and governance systems to any shock or stress" (United Nations Task Team on Habitat III, 2015). As recognised by Article 7 of the Paris Agreement, resilience is linked to both mitigation and adaptation.

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Through the Sendai Framework for Disaster Risk Reduction, countries are engaged in taking measures to reduce disaster risks through seven global targets aimed at: reducing mortality; reducing risks to livelihoods, economic assets and infrastructure; and strengthening governance and local capacity to develop disaster risk reduction strategies, multi-hazard early warning systems and disaster risk information (UNISDR, 2015).

Climate and climate change affect construction in two principal ways: 1) as the climate changes, buildings' and building materials' design standards will have to change in order to withstand new weather conditions; and 2) as the pattern of natural disasters changes, a change in the demand for rebuilding and repair will occur. Therefore, the objective is to upgrade the durability and resilience of all buildings by gradually addressing the most critical infrastructures (e.g. those with social and economic relevance, such as hospitals, emergency facilities, schools, power plants, hazardous material facilities), followed by the most vulnerable buildings (e.g. in vulnerable communities) and the rest of the building stock.

Buildings and the housing stock in cities are among the greatest causes of death and destruction in most disasters (OECD, 2018). When buildings or homes collapse in earthquakes, floods, mudslides or landslides, they injure or kill many people. Collapsed buildings have accounted for nearly two-thirds of all natural disaster fatalities since 1980 (Munich RE, 2018).

Box 20 •What is a resilient city?

[The Sendai Framework for Disaster Risk Reduction](#) 2015-30 defines resilience as: "The ability of a city exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2015).

The discontinued [100 Resilient Cities Initiative](#) of the Rockefeller Foundation laid out a City Resilience Framework: "The capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience".

In the context of cities, resilience has helped to bridge the gap between disaster risk reduction and climate change adaptation.

Box 21 • Resilience in Latin America: Trends and challenges

Latin America has a diverse range of climatic conditions with a majority of the populations concentrated along coastlines and rivers. This puts the region at a high risk of flooding and sea level rise. Global climate change has led to warming, changing rainfall patterns and tropical glacier retreat in the Andean countries, whereas the southern part is more prone to drought and flooding (Ashwill, Flora and Flora, 2011).

The Intergovernmental Panel on Climate Change (IPCC) Assessment Reports provide substantial evidence of the increase in extreme weather events in the region. During 2000-13, 613 weather and climate extreme events led to 13 883 casualties and 53.8 million people affected, with estimated losses of USD 52.3 billion. In southeastern South America, more frequent and intense rainfall have led to an increase in the occurrence of flash floods and landslides. These impacts are exacerbated in urban areas, especially where the expansion of urban areas has been unplanned (Magrin et al., 2014).

Currently, at least 15 cities in nine Latin American countries have developed resilience strategies (100 Resilient Cities, 2019). While few cities are currently equipped with such strategies, many countries understand the importance of developing a whole-of-society and holistic approach to resilience beyond a narrow view of disaster risk prevention and civil protection.

However, one of the main challenges that the region faces is progressing from a top-down vision to a bottom-up approach to resilience planning. Governments in the region are increasingly engaging citizens and local communities in policy-making processes, as local stakeholders are directly affected by floods, landslides and heatwaves and have deep understanding of their specific needs in terms of risk prevention.

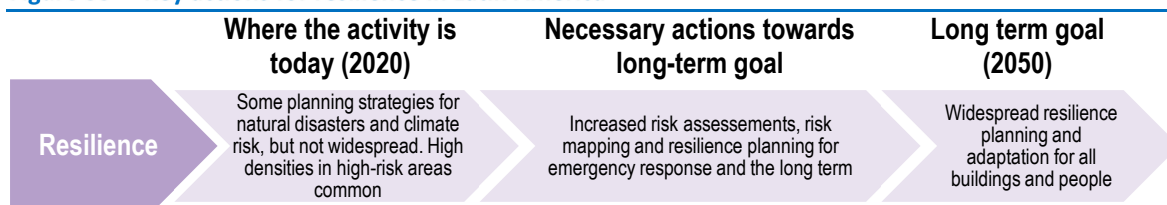
Information and awareness campaigns will be crucial to address the disconnect between the perception and the urgent need to have a resilient buildings and construction sector. As in many regions, there is a lack of effective co-ordination across different levels of government (federal, regional, state and local) as well as across sectors (water, transport, infrastructure, health, etc.), in addition to co-ordination across civil society organisations, academia and the private sector.

Following the Paris Agreement, the majority of NDCs submitted by Latin American countries emphasise adaptation priorities in sectors such as [water and infrastructure](#). Therefore, the implementation of NDCs is a crucial entry point for integrating resilience interventions in the built environment in the region.

In addition, given the importance of informal settlements in Latin American cities, the IPCC's Fifth Assessment highlighted that upgrading informal settlements is directly related to climate change adaptation. Most upgrading programmes have not explicitly pursued resilience to climate change, but there are significant synergies between many aspects of slum upgrading, disaster risk reduction and climate change adaptation (Satterthwaite et al., 2018).

Key actions for resilience

Figure 33 • Key actions for resilience in Latin America



Key actions to enable increased resilience of buildings include:

- **Urban planning and risk zoning.** Use data and information to document the potential risk exposure by location to enable effective urban planning through appropriate land-use planning, regulation, risk-sensitive investment and resource allocation decisions. This will lead to improved decision-making during the building and infrastructure design process.
- **Wind- and seismic-resistant construction.** Implement policies and use best practice design and strong materials and assembly processes to enable buildings to be resistant to natural disasters and extreme weather events.
- **Storm water management.** Require improved retention of storm water within properties to reduce the negative impact of water flowing to other properties and to surging waterways. Map areas of high population growth and evaluate topography and rainfall risks and avoid development in those areas.
- **Thermal-resistant construction.** Implement policies and use best practice design to increase the resistance of buildings to extreme temperatures and moisture. Make use of appropriate ventilation strategies.
- **Develop integrated assessment.** Work across governments and stakeholders to develop assessment plans that help to ensure resilience plans are holistic across jurisdiction and agencies.

Stakeholders for resilience

In Latin America, the key stakeholders for resilience include those that can influence the ability to make technologies and design approaches available to increase resilience of buildings and those that can deliver the results of resilient buildings.

Additional stakeholders include those that can support the process through research, funding and training, as well as emergency planners; ministries in charge of disaster recovery and resilience; state agencies with data, GIS or planning attributions; and energy and water planning offices.

These stakeholders are mapped below, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 20 • Stakeholder mapping for resilience in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society ** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|------------------|
| | | | | | | | | | |

* of appliances and materials.

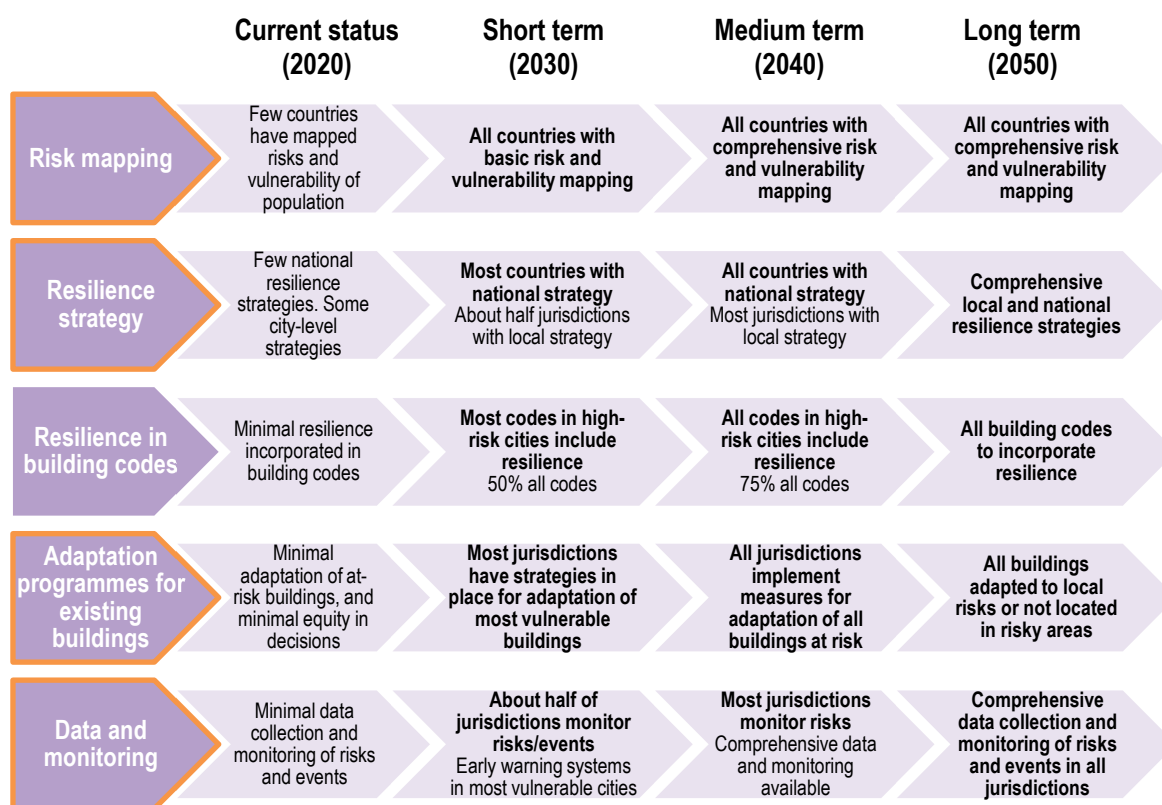
** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Policy for resilience

Within the targets for sustainable building resilience, the sub-targets and timelines in Figure 34 offer more details:

Figure 34 • Policy timelines for resilience in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for building resilience are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Risk mapping:** gather and document data related to: land-use plans incorporating natural hazards (e.g. landslides, earthquakes) and climate-related risks (e.g. flooding, heatwaves), emergency plans, existing community plans, ordinances and codes, maps and data on geographic location of critical infrastructure systems or facilities, community utility needs (e.g. energy, water and fuel use and generation), and climate preparedness plans. The South-South Research Network [ELLA Learning Alliance on Climate Resilient Cities](#) facilitates the learning exchange in which cities share their best practices and create technical and political guidelines for other cities to implement similar initiatives.

- **[data gap] Resilience strategy:** Develop a resilience strategy that identifies the list of policies and measures that can support increased resilience in an integrated manner, and addresses the potential for relocation and crisis plans for high-risk settlements. All countries should develop national resilience strategies, and all jurisdictions should develop local resilience strategies. Resilience strategies should include planning for critical infrastructure (hospitals, schools, water supply, energy supply, etc.). Resilience strategies should also include requirements for “building back better” during reconstruction after a disaster. In Santa Fe, Argentina, the municipal government used the risk of perennial flooding to create an integrated “resilience action plan” that redirected development to safer zones, and used the opportunity to make other improvements, such as connecting communities to transport networks (United Nations Task Team on Habitat III, 2015).
- **Resilience in building codes:** Incorporate measures in building codes to increase structural and thermal resilience, including passive measures that enable occupants to use buildings when energy services are not available in an extreme weather event or natural disaster. This includes insulating, shading, load-bearing roofs, wind- and seismic-proof walls, and water drainage and storage systems. Given the long life of the building stock under development, there is a unique opportunity to integrate the dimension of resilience in energy building codes within the next decade to ensure that new buildings as well as existing buildings will be able to withstand long-term climate change effects.
- **[data gap] Adaptation programmes for existing buildings:** In many cities, existing buildings in informal settlements are located on sites at high risk from floods or landslides or from other risks (for instance on unstable landfills) because the risks make them unattractive to developers. Upgrading informal settlements is particularly challenging because of the high degree of informality, and in order to change communities as a whole, rather than isolated projects, commitment from national and local governments is particularly important. Community members should be involved in the planning and implementation of resilience urban upgrading schemes to enhance their understanding of risks and harness their knowledge of the environment in which they live.
- **[data gap] Data and monitoring:** The Sendai Framework includes a specific target dedicated to “[s]ubstantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030” (UNISDR, 2015). Several initiatives, often led by grassroots organisations, use a combination of satellite imagery and community-led surveys to map and analyse the profile of specific neighbourhoods and informal settlements. Settlements are mapped using plane table methods that show plot boundaries. Spatial and socio-economic data are then entered into a GIS database. Using this information, municipal governments and communities are able to prepare upgrading and resilience plans by widening roads, installing flood protection and building new infrastructure.

Box 22 • Regional examples of policy action for resilience

Brazil

In Brazil, the city of Porto Alegre published its resilience strategy in 2016, the first of the Latin American region. The strategy contains a detailed list of actions with the current status, time frame (short, medium and long term), resilience value, responsible institution and related stakeholders for implementing the actions. In addition, it details the group of impact indicators for monitoring and control of the implementation of the [resilience strategy](#).

The case of Porto Alegre has the particularity of being supported by the local participatory budgeting policy implemented in the city where citizens are able to decide how municipal funds will be allocated

according to their needs and priorities. In the last few years, the city has proposed that the funds allocated via participatory budgeting go towards resilience infrastructure, including disaster preparedness and resettlement plans (Fundación IDEA, 2017).

Mexico

Mexico has an urban resilience guideline that describes step by step the methodology to obtain the Urban Resilience Profile of each local government or region. The [guideline](#) was developed by the Ministry of Agrarian, Territorial and Urban Development (SEDATU) in 2016 in co-ordination with UN-HABITAT (Government of Mexico, 2016).

In 2018, SEDATU allocated resources to support the development of local territorial planning instruments, including resilience profiles or diagnoses and action plans aimed at increasing the capacity to assimilate and recover from dangers in human settlements (SEGOB, 2018). The financial support could be also used to update building codes that establish the typology and construction technique according to the danger or risk of the area, always following the urban resilience guideline developed by SEDATU in 2016.

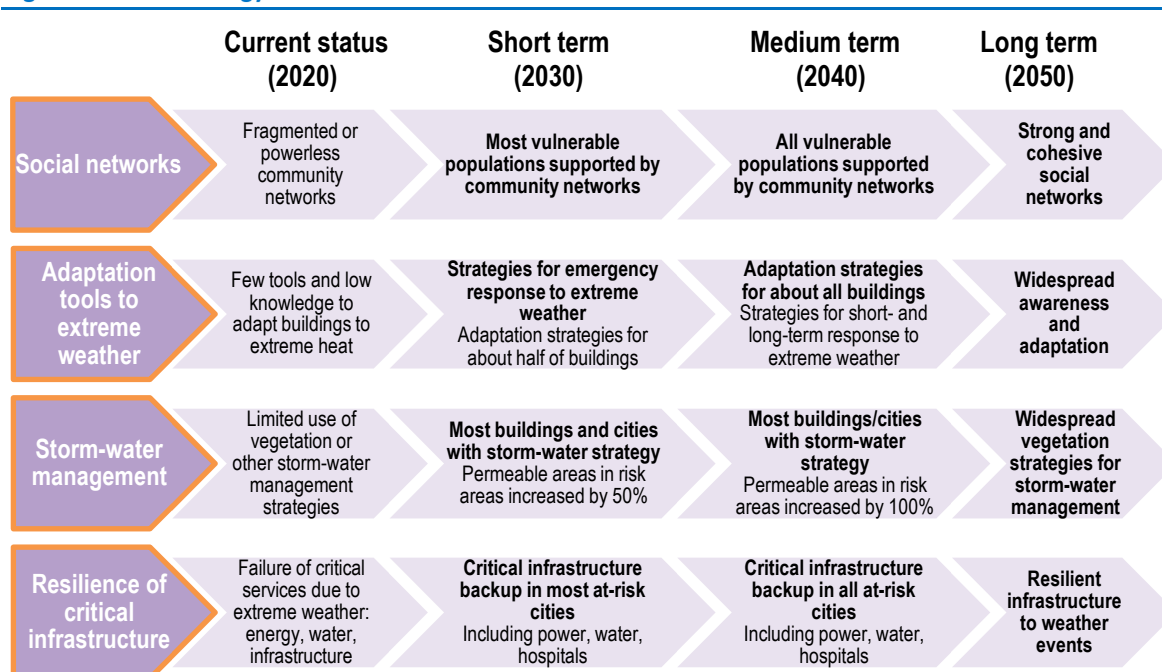
Other

Nearly 15 other Latin-American cities have developed their resilience strategies, such as Buenos Aires and Santa Fe in Argentina; Montevideo in Uruguay; Rio de Janeiro and Salvador in Brazil; Cali and Medellin in Colombia; Colima, Juarez and Mexico City in Mexico; Panama City; Quito, Ecuador; Santiago de Chile; and Santiago de los Caballeron in the Dominican Republic.

Technology for resilience

Technologies and strategies key to improve the resilience of the built environment are outlined in the timelines in Figure 35:

Figure 35 • Technology timelines for resilience in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the technology targets for building operations are outlined below.

For each item, in *italic* follows a description of the consensus among the consulted local building experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

- **[data gap] Social networks:** The promotion of cohesive and engaged communities is one of the drivers of urban resilience with the most robust empirical evidence (Therrien et al., 2018). As a result, many grassroots groups and local government authorities are actively promoting urban resilience by building tightly knit community networks, in particular in informal neighbourhoods. When community residents and neighbours form close relationships, they can better understand and respond to the changing needs of others, in particular the most vulnerable, the elderly and children. In the context of Latin American cities have documented a number of case studies showing the importance of social ties in various urban and geographical contexts (Carrizosa et al., 2019).
- **[data gap] Adaptation tools for extreme weather:** Each year, tens of thousands of people die from extreme heat and extreme cold. Heatwaves are estimated to cause 12 000 deaths annually across the world. The World Health Organization forecasts that by 2030 there will be almost 92 000 deaths per year from heatwaves, with that figure expected to rise in 2050 to 255 000 deaths annually unless national and local governments adapt to heat-related risks (WHO, 2014). Building envelope efficiency and thermal comfort systems can reduce the impact of extreme climate conditions. This includes achieving the targets for envelope thermal resistance, air sealing, heating, cooling and ventilation in other activities. Measures also include providing cool spaces for people to shelter from extreme heat. Furthermore, strategies for improved resilience to heavy rain, wind, land movements or any other hazards should be developed for relevant risk zones.
- **[data gap] Storm-water management:** In the wake of Hurricane Sandy and the increase in frequency and severity of climate impacts in urban areas, the paradigm of Design with Nature first conceptualised by Ian McHarg has generated new thinking and momentum. Impervious surfaces in urban areas such as asphalt and concrete constrain natural drainage, exacerbating peak flows and flood risks. In many coastal cities, wetlands are turned into hard surfaces and mangroves are cleared to make space for construction, removing important buffers against floods and storms. By safeguarding natural buffers to enhance ecosystems' protective functions and designing parks and green features (e.g. bioswales), urban planning and landscape design interventions can optimise rain-capture potential and enhance protection from extreme rains. In broader terms, "green infrastructure" (e.g. parks, greening of pedestrian corridors, permeable vegetated surfaces, street trees, community gardens and urban wetlands) is an important tool to enhance resilience through an ecosystem services approach (United Nations Task Team on Habitat III, 2015).
- **[data gap] Resilience of critical infrastructure:** Every city should have a resilient power strategy to ensure that critical public and private facilities (water systems, hospitals, roads) can keep operating, the communication systems running, and emergency services remaining functional in the event of a power disruption. Resilient power technologies such as solar plus battery storage to protect critical facilities from power outages now enable this function (NREL, 2018). Embedded microgrids, which include renewable energy distributed generation combined with energy storage, load management and smart

systems, can disconnect from the main grid through “adaptive islanding” in the event of major disruptions. These microgrid solutions are emerging as a key element of urban energy systems resilience (Ostefeld, Whitemeyer and Von Meyer, 2018).

Box 23 • Regional examples of technologies for resilience

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Colombia

Cali’s rapid growth and unplanned urbanisation since the 1970s has led large numbers of poor residents to construct self-built dwellings in flood-prone areas, such as the Aguablanca district. The original levees to protect Aguablanca from river flooding were built over 30 years ago and have deteriorated over time. To strengthen their structural integrity and ensure their robustness over the long term, local government authorities have recognised the importance of working in close collaboration with local communities. In particular, providing information about the risks associated with degrading infrastructure has allowed communities to better understand the value and functioning of the flood defence system. One of the benefits of this community engagement approach has been their “passive surveillance” of the levees, notably to prevent illegal dumping in the area (100 Resilient Cities, 2018).

Regional

The Climate Resilient Cities initiative ([Ciudades Resilientes al Clima en América Latina](#)), a strategic alliance between the International Development Research Centre, the Climate Development Knowledge Network and the Latin American Foundation for the Future (Fundación Futuro Latinoamericano), was carried out in 13 small and medium-sized cities in seven Latin American countries. The initiative was created to strengthen decision-making and scale up effective climate-resilient development to improve the livelihoods of those most affected by climate change in Latin America.

Finance for resilience

The sizeable gap between investment in resilience and conventional disaster response spending needs to be addressed. According to some estimates, for every USD 100 spent in Overseas Development Aid, only USD 0.40 is invested in anticipating and planning for the impact of disasters. At the same time, the cost of disasters in developing and emerging countries amounted to USD 862 billion between 2013 and 2015, which according to UN-Habitat is significantly underestimated (United Nations Task Team on Habitat III, 2015) – equivalent in value to one-third of all international development aid during the same period. Therefore, finance can enable increased action towards having resilient buildings. Specific finance sub-targets and timelines are outlined below.

Financial tools particularly relevant to funding resilience in buildings may include:

- **Insurance:** More intense or frequent extreme weather events will affect property insurance. Insurance providers can encourage action to reduce risk exposure by giving resilience ratings to buildings, which could lead to lower premiums (CISL, 2014). Insurance products can also be tailored specifically to clean technologies and emissions reduction activities (e.g. parametric climate insurance).
- **Urban development funds:** Dedicated funding for urban development projects, which can prioritise resilient urban development projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can prioritise sustainable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.

- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

Capacity building for resilience

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver resilient buildings.

The types of capacity-building activities relevant to materials are mapped in Table 21, where the darker the colour, the higher the impact that capacity-building type has for this activity.

Table 21 • Capacity building for resilience in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity-building type has for this activity.

Details regarding the most critical capacity-building activities are explained below:

- **Training within government:** Provide training to central and local governments about assessing climate risks, developing vulnerability maps and collaborating across multi-stakeholders regarding the development of integrated policies aiming at enhancing resilience in the built environment. Provide training regarding how to communicate the risks and the benefits associated with improved resilience. This will require data collection and analysis to enable the creation of databases, resource platforms and information campaigns.
- **Training of professionals:** Provide training programmes for service and product providers of buildings and construction (architects, engineers, contractors, installers etc.) regarding how to design buildings with increased resilience to climate risks. Provide training on how to comply with policies such as resilience requirements in building codes or urban plans. Develop educational programmes including primary, secondary, vocational, university and adult education, to enable increased knowledge of resilience.
- **Training of general public:** Provide training for the general public on how to monitor climate risks and respective adaptation strategies. In particular, provide access to information on measures and available resources (programmes, finance) to improve the resilience of living and working environments.


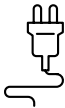


Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

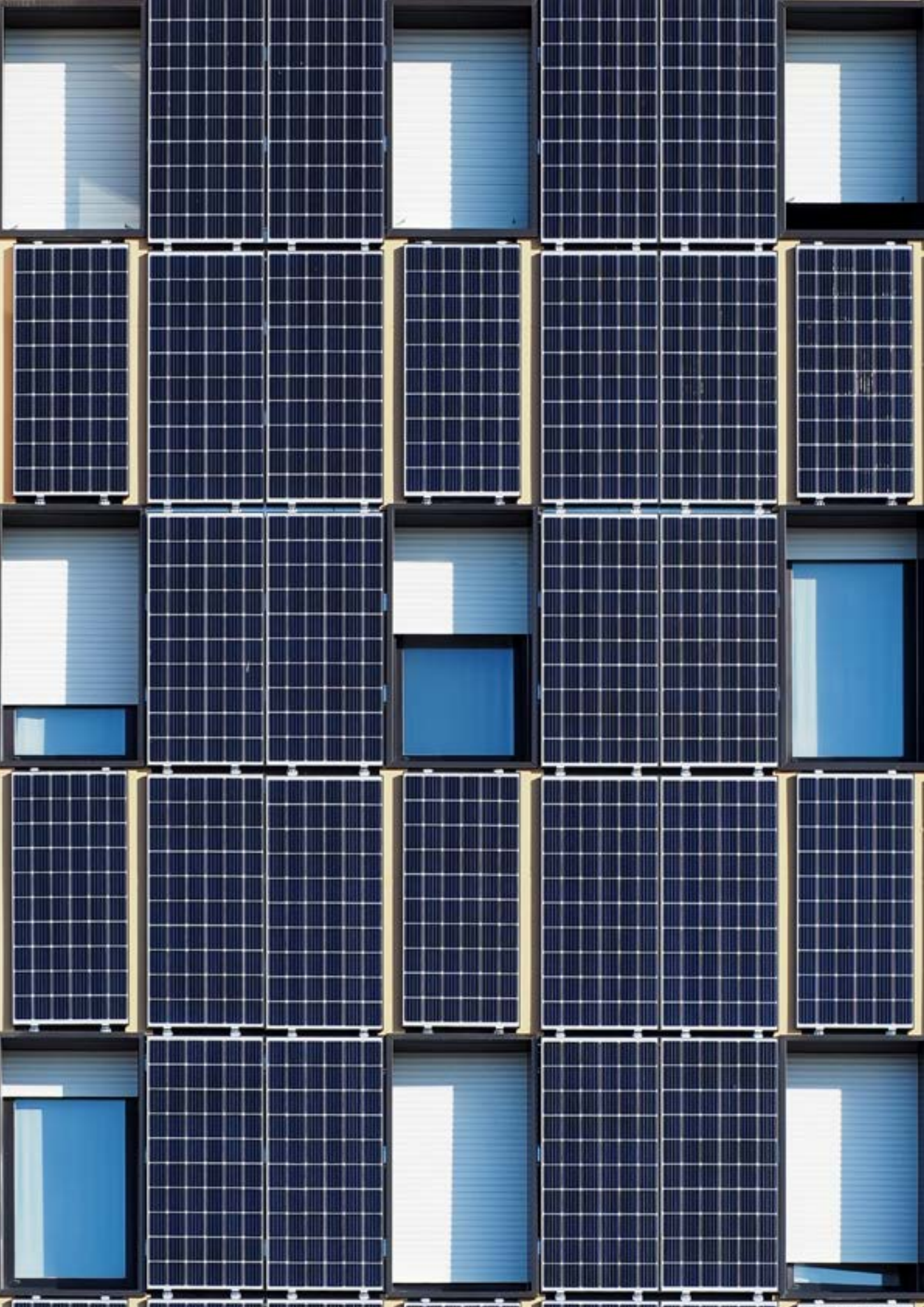
Multiple benefits of resilient buildings

Many benefits can be achieved through resilient buildings. Many of them are aligned with the SDGs, including Goal 7 (affordable and clean energy), Goal 11 (sustainable cities and communities), Goal 12 (responsible consumption and production) and Goal 13 (climate action).

Some of these benefits are described in Table 22, although many of them require further analysis to quantify them:

Table 22 • Multiple benefits of resilient buildings

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Resource efficiency – resilient buildings have a longer useful life. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy savings – buildings designed to withstand extreme heat and cold are more energy efficient; buildings resilient to natural disasters have a longer useful life. |
| Economy | |
|  | <ul style="list-style-type: none"> • Productivity – resilience reduces operational disruption to cities and services. • Asset value – resilient buildings have lower risk of damage due to extreme weather events or natural disasters, improving property values and reducing insurance costs. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – resilient buildings can better withstand extreme weather events or natural disasters, reducing loss of homes and infrastructure. • Health and well-being – resilient, durable buildings can withstand extreme weather events or natural disasters, delivering improved physical and mental health and well-being. • Safety and security – resilient buildings can withstand extreme weather, leading to increased safety and security of their occupants. |



Activity 8: Clean energy

Buildings in Central and South America account for 24% of final energy consumption, and good management of their energy supply and demand will be key to enabling a transition to clean energy. Shifting to clean energy sources allows for reduced fossil fuel dependency, greater energy autonomy, reduced environmental impacts, reduced GHG emissions and climate change mitigation, as well as providing employment opportunities. ESCOs can help overcome high upfront costs for renewable and energy efficiency companies, making their diffusion broader, while demand response and energy storage can play an important role in enabling a greater penetration of variable renewables in the energy mix.

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Box 24 • Clean energy in Latin America: Trends and challenges

Although Latin America is particularly rich in renewable energy resources, these meet only a small fraction of the demand in cities. The lack of development of regulatory mechanisms to open up markets around urban energy services, financial incentives, promotion programmes and the adoption of building codes to encourage the integration of on-site renewables are just some of the barriers to greater renewables uptake in Latin America.

Despite this, the resource availability has allowed several Latin American countries to reach cost parity with the grid in clean energy technology such as solar PV (DB, 2015). Moreover, countries of the region have been developing their own normative frameworks, allowing distributed generation to become an increasingly common practice, especially in new buildings.

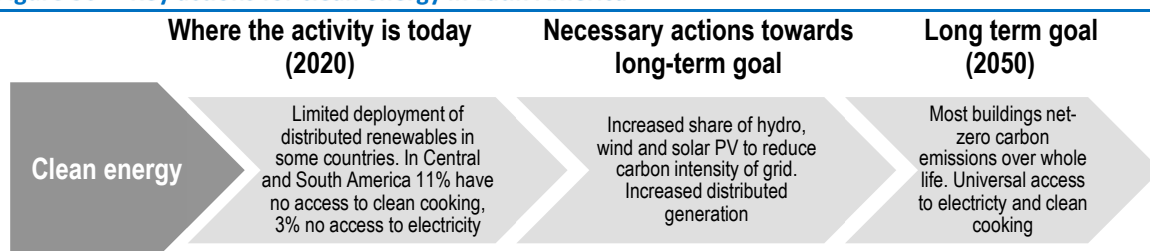
Sustainable building stock and district energy infrastructure, particularly district cooling solutions, will play a major role in the clean energy transition for Latin America. Regarding electricity production, the region seeks to reduce the use of fossil fuels, but also wants to migrate to a more resilient power generation mix by decreasing its dependence on water resources. In this sense, distributed solar PV and solar thermal on buildings in urban areas and renewable-based district energy systems have the potential to displace fossil-based power plants, and to diversify the electricity production mix. New technologies as battery energy storage systems (BESS) can also contribute to this transition by providing grid stability in a context of increasing shares of variable renewables.

In the IEA SDS, hydropower, wind and PV together account for over 80% of the region's renewable capacity additions until 2040, in roughly equal proportions (IEA, 2019a).

Although considerable progress has been achieved over the past decade (in particular by shifting from traditional uses of biomass to liquefied petroleum gas, 11% of the population still lacks access to clean cooking, a share that needs to be brought down to zero to meet SDG 7.1 of full access to clean cooking by 2030).

Key actions for clean energy

Figure 36 • Key actions for clean energy in Latin America



Key actions to enable the clean energy transition for buildings include:

- **Integration of on-site renewable energy.** Accelerate the adoption of decentralised renewable energy systems, such as PV, building integrated PV, solar thermal, micro-wind and energy storage projects in the planning and design of buildings and neighbourhoods. Lowering regulatory and financial barriers is key to widespread adoption of these technologies by building developers and households.
- **Update regulatory framework.** Many Latin American countries have liberalised electricity markets. Updates in the regulatory framework to incentivise utility-scale and distributed renewable energy developers would be necessary. Operative rules, remuneration schemes, incentives allocation, integration mechanisms and environmental goals at national and local levels can influence the uptake of renewable energy. Stable regulatory frameworks are key to providing investors with the long-term visibility needed for renewable investments.
- **Provide adequate financial incentives.** Value-added tax (VAT) exemptions and near-zero or zero-interest loan rates help spur investments towards clean energy. Measures such as feed-in tariffs encourage utility-scale investments, while establishment of net metering or peer-to-peer energy trading can boost distributed renewable energy investments. Developing a coherent and stable policy framework is key to providing investors with long-term visibility for renewable projects.
- **Green power procurement.** In cases where local distributed generation is not sufficient to meet local demand, buildings and neighbourhoods can buy clean energy from the grid through power purchase agreements (PPAs). Depending on the country's power sector structure, some regulatory changes might be needed to enable the conditions to allow for such procurement to take place.
- **Zero-carbon policies.** Create and implement zero-carbon policies in order to unify the different aspects of the buildings and construction life cycle towards a common goal of net-zero. This allows the different stakeholders to balance out the efforts towards material and energy efficiency, on-site clean energy production and carbon capture in an optimal way.

Stakeholders for clean energy

In Latin America, key stakeholders are those who either influence the availability of clean energy technologies and services or facilitate clean energy supply in buildings. Additional relevant actors include those who can support the process through research, funding and training.

These stakeholders are mapped in Table 23, where the darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Table 23 • Stakeholder mapping for clean energy in Latin America

| National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society** |
|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|-----------------|
| | | | | | | | | | |

* of appliances and materials.

** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

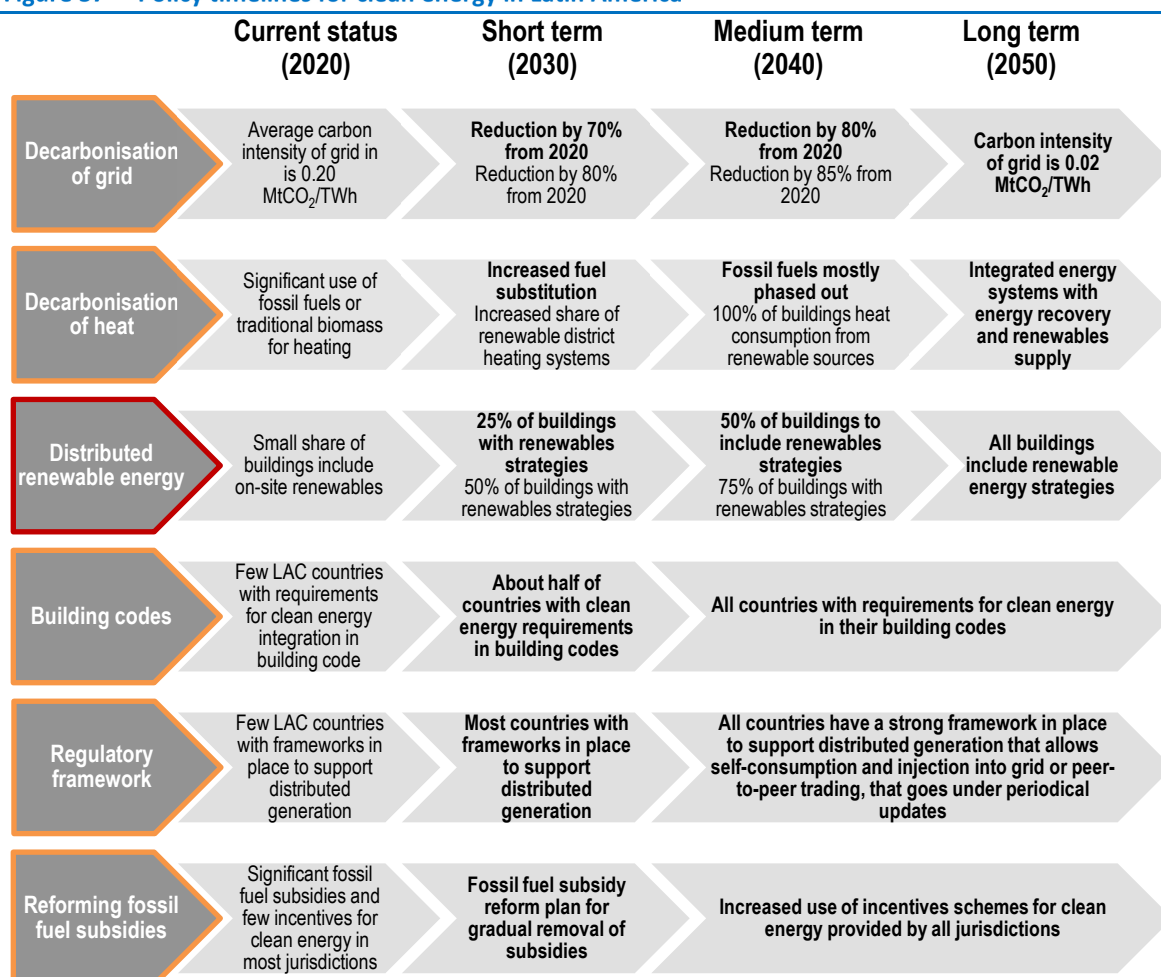
Policy for clean energy

Clean energy policy supports zero-emission, efficient and resilient buildings by enabling the decarbonisation of the energy used in buildings and in the production of their construction materials.

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Within the targets for clean energy, the policy timelines in Figure 37 offer more details:

Figure 37 • Policy timelines for clean energy in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for clean energy are outlined below. For each item, in *italic* follows a description of the consensus among the consulted local experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

Policy for clean energy target details:

- **[data gap] Decarbonisation of grid electricity:** Although some Latin American countries, such as Brazil, Panama, Paraguay, Peru and Uruguay, have high shares of renewable energy

in their electricity generation thanks to the exploitation of important water resources for hydropower, other countries' generation portfolios remain heavily fossil-dependant and consequently their power mixes have high carbon intensities. Argentina, Bolivia, Chile, Honduras and Mexico, for instance, belong to this latter category. In addition to utility-scale renewable conversion and new projects, the large-scale integration of distributed renewable power generation can play a significant role in decarbonising electricity. Distributed solar PV can be a cost-effective option in regions with high solar irradiation, which is the case for many countries in the Latin America region. Besides enabling local energy governance schemes, distributed generation and on-site production and consumption make it possible to reduce energy losses through transport in the grid.

- **[data gap] Decarbonisation of heat:** Decarbonisation of space heating will be possible thanks to increased penetration of renewable electricity systems, fuel substitutions away from fossil fuels, heat recovery and renewable district heating systems. Heating systems should aim to be fully integrated with the wider energy system, using heat and cold storage as flexibility mechanisms for the system.
- **[ambition gap] Distributed renewable energy:** At the building level, on-site renewable generation is one of the possible strategies to achieve net-zero energy and net-zero carbon standards. Buildings may fully or partially meet their energy needs with local heat and electricity generation systems (solar PV, solar thermal, biogas and geothermal, among others). Local production of renewable heat and electricity to displace fossil fuel consumption offers multiple benefits, including not only lower environmental impacts (e.g. GHG emissions, particulate emissions, etc.) but also energy diversification resulting in greater energy security and lower energy dependency for import countries, and greater possibilities of local energy governance at community level. The widespread adoption of distributed energy generation can be further encouraged through feasibility studies for the installation of on-site generation projects in new and existing buildings. *Stakeholder feedback: Many respondents expect on-site PV to become more widespread by 2050, though several also thought PV and wind would be installed in only "few" buildings.*
- **[ambition gap] Building codes:** Building codes can stipulate the incorporation of measures such as readiness for demand-side response measures, obligations for renewable energy systems or provisions for their future installation (e.g. structural integrity requirements). The codes should be developed jointly among national authorities, builders and other stakeholders so appropriate technologies are considered and mandatory requirements are applicable, enforceable and well-designed. Building codes also should include requirements on structural integrity or other requirements which will enable the safe inclusion of on-site renewable energy systems. *Stakeholder feedback: There was consensus that building code requirements for renewable energy systems were very rare. Some expected this to increase to "most" or "all" building codes, but many respondents said they did not know, or did not expect it to increase.*
- **[data gap] Regulatory framework:** Regulatory frameworks define operating rules, connection permits, and the use of networks for distributed resources, goals, incentives, market conditions, prices for surpluses and other factors that allow an easy adoption of on-site generation. In this sense, a clear, simple, well-designed, updated and consistent regulation framework can facilitate widespread adoption. Frameworks covering technical regulations and administrative provisions for multi-dwelling PV or solar thermal installations can also help increase uptake in dense urban environments.
- **[data gap] Reforming fossil fuel subsidies:** The environmental and health costs of fossil fuel usage should be accounted for when comparing the costs of fossil fuels to those of renewable energy sources. This would mean phasing out fossil fuel subsidies and setting

appropriate taxation wherever applicable. Rolling back subsidies may be complemented with more targeted social welfare measures, to mitigate the socio-economic impacts on the population, in particularly the most vulnerable. Similarly, incentives can be used to promote renewable energy. These incentives can be non-financial, such as expedited product approvals and permits, or financial. Non-financial incentives offer appropriate enabling conditions for the development of renewable energy technology, while financial incentives can substantially accelerate its deployment by encouraging private investment. *Stakeholder feedback: There was variation between countries in the supposed availability of incentives for renewable energy. Incentives for fossil fuels were cited by several respondents as a barrier to the deployment of renewable energy.*

Box 25 • Regional examples of policy action for clean energy

Chile

In 2013, the country developed the National Strategy for Sustainable Construction, which considers improvements in aspects such as energy, water, waste, health and management. Additionally, it proposes short-, medium- and long-term objectives, particularly regarding energy efficiency and distributed generation. For instance, from 2020, the construction sector must contribute with the national target of a 20% reduction of GHG emissions and follow Law No. 20 257 (NCRE Law), which requires 5% of electricity to come from non-conventional renewable energy sources such as geothermal, wind, solar, tidal, biomass and small hydroelectric plants. The obligation will reach 10% in 2024.

Colombia

In Colombia, Law 1715/2014 aims to promote the development of renewable energy sources in the national energy system, by integrating them into the electricity market and in other energy uses. It gives financial incentives to renewable and non-conventional energy projects (those using renewable and not widespread energy resources such as biomass, small hydro without reservoirs, wind, geothermal, solar and tidal). The beneficiaries are exempted from the VAT payment and can have taxes reduced by proving their projects are related to distributed-scale non-conventional power generation and measurement of the potential of non-conventional energy sources in the country.

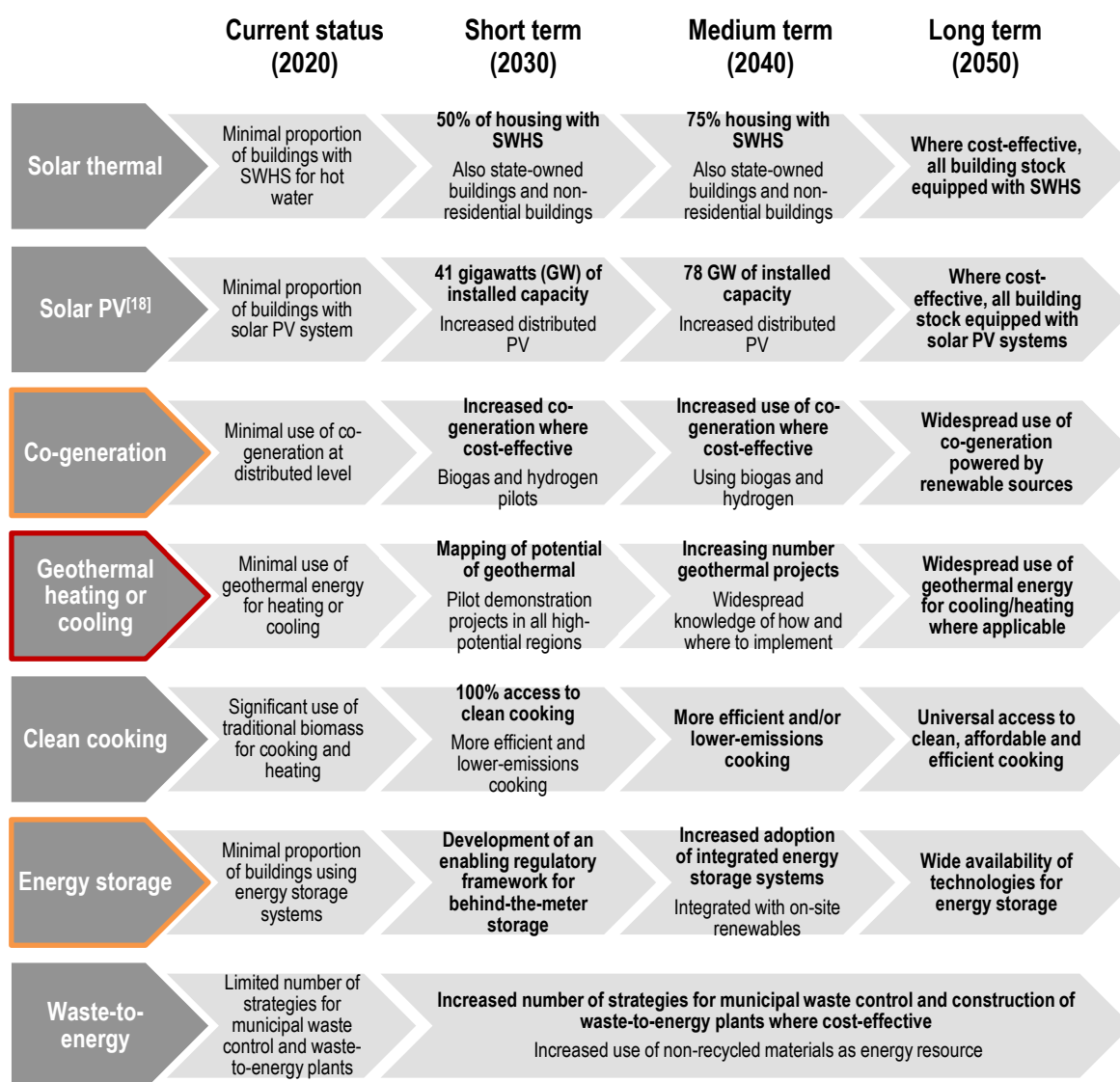
Costa Rica

The Costa Rican government introduced its long-term strategy for low-emission development under the [National Decarbonization Plan 2018-2050](#). Within the plan, the decarbonisation axis 5 has focused on the development of buildings of different uses (commercial, residential, institutional) under high efficiency standards and low-emission processes. This includes the creation and improvement of standards that promote low-emission sustainable construction practices and building integrated renewable energy with a vision of 50% of commercial, residential and institutional buildings to adopt low-emission standards supported by the use of renewable energy in cooking processes and water heating.

Technology for clean energy

The life-cycle energy and emissions for buildings are influenced by the energy used in buildings. Specific targets and timelines for clean energy are outlined in Figure 38:

Figure 38 • Technology timelines for clean energy in Latin America



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Notes: The **proposed regional target** is in **bold**. Below that is the proposed accelerated target. A red border indicates an ambition gap for that target (more details below); an orange border indicates a gap in data or consensus (more details below).

Details on the policy targets for clean energy are outlined below. For each item, in *italic* follows a description of the consensus among the consulted local experts regarding the evolution of the item between now and 2050. Where there was a significant gap between what was expected to be achievable by 2030, 2040 and 2050, the item is highlighted with a **red mark**, denoting that it is an area that will require particular action in its implementation. Where there was insufficient information, or insufficient agreement among responses, the item is highlighted with an **orange mark**, denoting that it is an area that requires additional information and consultation.

Clean energy technology target details include:

- **Solar thermal:** On-site solar thermal collectors produce hot water in a renewable way and should be encouraged in areas of high solar radiation. Solar thermal systems have significant potential to displace electricity consumption from electric residential hot water production at a competitive price. *Stakeholder feedback: There was consensus that solar thermal systems would be very widespread by 2050.*
- **Solar PV:** On-site building-integrated or roof-mounted PV can enable the generation of electricity for self-consumption. According to the size of the installed system, buildings could partially or totally meet their electricity needs on an annual basis. Coupling with BESS can provide off-grid buildings with the required flexibility to meet their electricity demand at times of no generation (e.g. at night). Surpluses can also be delivered to the power grid by bidirectional metering. Low-voltage direct current home solar systems also offer significant potential for increasing access to electricity. The targets outlined above are based on the global capacity of solar PV in the IEA SDS (IEA, 2019a). Given the high solar irradiation in many Latin American countries, distributed PV systems could be a very competitive solution for renewable energy development. In warm countries where cooling needs cannot be fully met passively by architectural designs, the combination of solar PV and air conditioners/heat pumps offers an interesting potential, as solar PV generation and cooling demand operate in a very complementary fashion (IEA, 2018b). *Stakeholder feedback: There was consensus that on-site PV systems are limited in their deployment, but many expect them to be used in “most” or “all” new buildings by 2050.*
- **[data gap] Co-generation:** Co-generation can provide significant gains in terms of energy efficiency and reduction of CO₂ emissions in buildings by recovering waste heat from electricity production and using it for water and space heating. Co-generation can use a variety of fuels, from fossil fuels to biogas, biomass and even hydrogen. Co-generation systems can be expanded using tri-generation (combined cooling, heat and power) to also produce chilled water for space cooling. *Stakeholder feedback: There was little consensus regarding how widespread co-generation systems would become.*
- **[ambition gap] Geothermal heating or cooling:** Geothermal systems exploit the earth or bodies of water as a heat sink, to provide heating or cooling. They can be used in combination with a heat pump, or where temperatures allow, in a direct circulation loop. Policy support in the form of risk guarantees or investment grants can help mitigate investment risks associated with high upfront costs and uncertain drilling operation outcomes. *Stakeholder feedback: Most respondents replied that they did not know how widespread geothermal systems would become, or that they would be used in only “few” or no cases.*
- **Clean cooking:** The use of traditional biomass for cooking is responsible for significant air pollution, deforestation and missed development opportunities. The benefits from switching from traditional biomass to clean energy for cooking are therefore multiple. In the IEA SDS, a 95% reduction of traditional biomass makes it possible to reduce particle matter emissions by 97% by 2040 compared with 2018 (IEA, 2019a). There is no single solution, and universal clean cooking can be achieved through a combination of switching to gas and electric cookers, efficient stoves and modern biomass, taking into account local circumstances and cultural acceptability.
- **[data gap] Energy storage:** With increasing shares of variable and non-pilotable renewable energy in the energy supply, energy storage becomes an important element for balancing supply with demand. Thermal energy storage can be implemented at the building or district scale, with higher cost-effectiveness at the latter. Coupled with solar thermal systems, heat

storage tanks can ensure a continued supply of hot water. Coupled with electric boilers or heat pumps, heat, chilled water or ice storage make it possible to avoid curtailment during periods of excess electricity production from variable renewable sources, and shift load to off-peak hours to lower the strain on the grid. BESS can store electricity for delayed uses, providing flexibility to off-grid buildings equipped with distributed variable renewable energy technologies, such as distributed PV. Time-of-use tariffs for electricity can incentivise the deployment of behind-the-meter BESS in connected buildings, as these BESS allow consumers to reduce grid-electricity consumption at peak hours and even potentially to sell electric surpluses to the grid, using bidirectional metering at the most profitable time. However, unless all BESS include bidirectional metering, on-grid storage offers a more economical and energy-efficient solution than behind-the-meter storage from a system perspective, due to 1) economies of scale; and 2) the smoothening effect from both demand and supply aggregation, which reduces the overall storage capacity needs, and the intensity of its use (IRENA, 2019). *Stakeholder feedback: There was little consensus from respondents as to the role of energy storage systems.*

- **Waste-to-energy:** Waste from buildings and construction that could not be avoided or recycled can be used as additional fuel input to municipal waste-to-energy plants. Although variability in the physical and chemical properties of waste makes it a less profitable combustible, waste-to-energy can provide a waste management alternative to landfill disposal. Landfill taxation and gate fees can help encourage the development of waste-to-energy. Lack of financial support and institutional barriers have undermined the development of municipal waste management, including waste-to-energy plants in Latin America (Hettiarachchi et al., 2018).

Other clean energy technologies that do not have specific targets above include:

- **Small-scale hydro:** Historically, small-scale hydro was an important energy source for buildings with high energy demand that were located near rivers. Currently, most small-scale hydro is directly fed into the power grid and not used on-site. It is common that these types of projects do not have storage capacity or water reservoirs, in contrast to large dammed hydroelectric plants. These projects are common in Latin America given the vast water resources in the region (IRENA, 2016).
- **Modern biomass:** Biomass use in modern equipment such as woodchip and pellet stoves and boilers offers a cost-competitive renewable option for space and water heating in some Latin American countries with large bioenergy resources. However, careful attention should be given to ensuring sustainable management of this biomass resource through adequate supply chains that do not impact biodiversity or harm local communities.

Box 26 • Examples of regional action on clean energy technology

Colombia

In Colombia, more than 70% of the urban areas are located in warm climates, implying high demand for air-conditioning services. The country has focused on promoting actions to reduce the use of inefficient air conditioners with high environmental damage potential. In 2013, the Ministry of Environment, Public Companies of Medellín (Empresas Públicas de Medellín) and the Swiss Secretariat for Economic Affairs developed a joint plan for the implementation of the District Heating and Cooling in Colombia pilot programme, the first district energy infrastructure in Latin America.

The programme is intended to open up the air-conditioning market towards more efficient and environmentally responsible solutions at district level, setting up the bases for sustainable cities in Latin America.

The district cooling system was built in La Alpujarra, Medellín, with a capacity of 3 600 tonnes of refrigeration per hour. It delivers chilled water to five state-owned buildings, generating energy savings of 20-30%. In addition, the system has reduced the building's CO₂ emissions by 30%.

Similar projects are currently under development in the cities of Bucaramanga, Bogotá, Cali and Cartagena, supported by the private and public sectors (EPM, 2016).

Mexico

In the borough of Milpa Alta of Mexico City, roughly 300 000 tonnes of prickly pears (*nopales* – a cactus used in Mexican cuisine) are produced annually, of which at least 60 000 are not suitable for selling. Due to the amount of organic material produced without any commercial value, the Secretariat of Science, Technology and Innovation, under the Programme for Integral Management of Solid Waste of Mexico, promoted the construction of a local biodigester to take advantage of the waste as an energy resource.

The facility is located next to the collection centre in Milpa Alta, so no additional transportation costs have to be covered by the municipality or local producers. The biomass is processed on-site to later supply the biodigester, which produces close to 170 cubic metres (m³) of biogas and a tonne of fertiliser per day. The system also uses solar heaters as an innovative way to control the temperature of the plant's internal processes.

The biogas is used to produce electricity using an internal combustion engine coupled to an electric generator, while the fertiliser is aimed for the development of local industry. It is estimated that the Milpa Alta biodigester mitigates roughly 124 tCO₂ (Government of Mexico City, 2017).

Chile

As part of Bimbo company's commitment to sustainable development and carbon footprint reduction, the production plant in Santiago inaugurated in 2019 the largest rooftop power plant in South America. The system consists of 6 500 solar PV panels, 57 power inverters and 1 charger station for electric vehicles, and it is intended to meet 27% of the industrial plant's electricity needs. The system produces 3 GWh per year, offsetting 1 310 tCO₂ in the same period.

The project is aligned with the goals of RE100, an agreement signed by Bimbo in 2018 in which the company committed itself to use 100% renewable electricity for its whole operation by 2025.

Along with the installed PV system, the plant has taken further actions in terms of efficiency. LED lighting; reductions in the use of electricity, water, gas and plastic; and paper and cardboard recovery processes have allowed the company to reduce 317 tCO₂ and save 13 000 m³ of water (Grupo Bimbo, 2019).

Finance for clean energy

Finance can enable increased action towards clean energy for buildings. Financial tools particularly relevant to financing clean energy for buildings may include:

- **Green power procurement:** Depending on the regulatory framework, large electricity consumers can go to the competitive market to procure electricity directly from renewable energy projects or green-electricity retailers. In this way, buildings can support renewable utility- or distributed-scale projects through the creation of demand. Green power procurement is a common practice in some cities around the world, where municipalities decide to meet the electricity demand of public buildings through PPAs linked to renewable projects.
- **Urban development funds:** Dedicated funding for urban development projects, which can be directed towards renewable energy projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can be directed towards sustainable renewable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a revolving loan fund, which collects repaid loans from renewable energy projects and reinvests them in additional energy efficiency or renewable energy projects.
- **Risk-sharing loan/loan guarantee:** Large organisations, such as a government, international bank or aid organisation, covering the risk of payment default to allow banks to fund a project with lower costs and better loan terms.

- **Green bonds:** Bonds that can be used to bundle funding associated with sustainable projects, including renewable energy projects.
- **Preferential tax:** Direct funding from the government to reduce or eliminate the tax for sustainable products and services, including renewable energy projects.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Energy performance/energy service contracts:** Contracts for services or delivered savings that typically are delivered by an ESCO and can include a range of energy efficiency or renewable energy services and products.
- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products or renewable energy technologies on a rental basis to overcome high upfront capital expenditure.
- **On-bill/tax repayment:** An approach where any recurring bill, such as utility bills, insurance bills or home improvement store bills, can collect small amounts of money over a long period of time to pay for energy efficiency purchases in smaller payments. An offshoot of on-bill finance, tax repayment is where the tax authority uses recurring tax payments as a means for collecting money over time. The most common of these is PACE finance, which is able to use low-interest-loan repayments on the property tax bill until the purchase is paid in full.
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.
- **Energy prices:** Cost-reflective pricing and subsidies are powerful influencers of how people consume energy. Pricing strategies should consider decarbonisation goals. Time-of-use and location-based pricing are other mechanisms by which pricing can influence consumption for a more robust integration of renewable energy.

Capacity building for clean energy

Information combined with capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver clean energy.

The types of capacity-building activities relevant to urban planning are mapped in Table 24, where the darker the colour, the higher the impact that capacity building type has for this activity.

Table 24 • Capacity building for clean energy in Latin America

| Training within government | Training of professionals | Training of product/material manufacturers | Training of financiers and developers | Training of general public |
|----------------------------|---------------------------|--|---------------------------------------|----------------------------|
| | | | | |

Note: The darker the colour, the higher the impact that capacity building type has for this activity.

Details regarding the most relevant capacity-building activities are explained below:

- **Training within government:** Build capacity and awareness in all levels of government on the benefits of clean energy production to the energy system, as well as broader benefits to infrastructure, public health and well-being, and the environment. Provide training on

the integration of clean energy in all relevant aspects of policy planning, design and implementation, including in integrated resource planning, investment decisions, and urban planning and buildings sector policies, among others. Strengthen capacity in co-ordination between relevant government and non-government organisations to enable improved policy coherence.

- **Training of financiers and developers:** Provide training to financiers and developers in identifying, assessing and financing clean energy projects, both at utility scale and distributed generation. Also build capacity in creating and nurturing stakeholder networks among policy makers, developers and financiers to build more project pipelines.


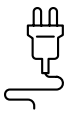


Further details regarding capacity-building activities are provided in the section “Roadmap support: Enablers”.

Multiple benefits of clean energy

Many benefits can be achieved through the clean energy transition. Many are aligned with the SDGs, including Goal 7 (affordable and clean energy), Goal 11 (sustainable cities and communities), Goal 12 (responsible consumption and production) and Goal 13 (climate action).

Some of these benefits are described in Table 25, although many of them require further analysis to quantify them:

Table 25 • Multiple benefits of clean energy

| Environment | |
|---|--|
|  | <ul style="list-style-type: none"> • Emissions reductions – clean energy reduces GHG emissions. • Air quality – many forms of clean energy produce no air pollution, improving air quality. |
| Energy | |
|  | <ul style="list-style-type: none"> • Energy security – local clean energy solutions improve energy security by reducing reliance on fuel imports. • Energy prices – cost-competitive clean energy can reduce energy prices as generation profiles often have a strong overlap with peak demand profiles. |
| Economy | |
|  | <ul style="list-style-type: none"> • Economic performance – clean energy delivers energy productivity improvements. • Employment – clean energy creates local jobs during the manufacturing, installation, and O&M of renewable energy systems. |
| Society | |
|  | <ul style="list-style-type: none"> • Poverty alleviation – increasing access to reliable electricity and to clean forms of cooking can bring significant economic opportunity benefits to households. • Health and well-being – reducing indoor air pollution caused by the use of solid fuels, and reducing time spent on energy collection or cooking activities, increase both health and well-being. |



Roadmap support: Enablers

Across all eight activity areas, a set of actions are key to enabling their successful implementation: capacity building, financing and multi-stakeholder engagement. **Capacity building** enables people to understand and act on information that can support the achievement of zero-emission, efficient and resilient buildings. **Financing** is critical to turning policy and project ideas into reality. **Multi-stakeholder engagement** incorporates feedback from implementers and those affected, builds trust, and creates strong community buy-in to maintain momentum through leadership transitions.

Box 27 • Enabling activities in Latin America: Trends and challenges

Awareness of sustainable buildings and construction is rising but there is still a need to inform about the key steps that can be taken to accelerate activities in the sector. For instance, while there are data collection efforts under way, there is a lack of co-ordination between public- and private-sector data collection. More efforts are needed to collect and centralise data, understand how best to use them, and balance data privacy and transparency.

Professional workforce training programmes are fairly common, especially of the construction workforce on topics such as green building materials and energy efficiency. However, there is low availability of green building curricula in universities.

With rising levels of activity in sustainable building and construction, institutional co-ordination is critical. There is a need to avoid duplication of initiatives across government institutions. In addition, with a growing number of coalitions and organisations supporting government action in the sector, co-ordination is critical to improve ease of government participation in these initiatives.

Financing options are available, but their use is still limited by seeing certified green buildings as the exception. These can be expanded by encouraging industry to see green buildings as the rule.

Capacity building

Capacity building is used to increase awareness, access and analysis of data and information. This includes data and tools to assess building emissions and energy consumption, information about co-ordination across institutions in the public sector or across sectors, awareness of green buildings in education and training curricula, and assessment of investment opportunities. Capacity-building activities can increase overall awareness, improve the decision-making process and encourage more sustainable choices. Training for professionals working directly with the built environment can enable increased resources and capacity to deliver zero-emission, efficient and resilient buildings.

Key actions for capacity building

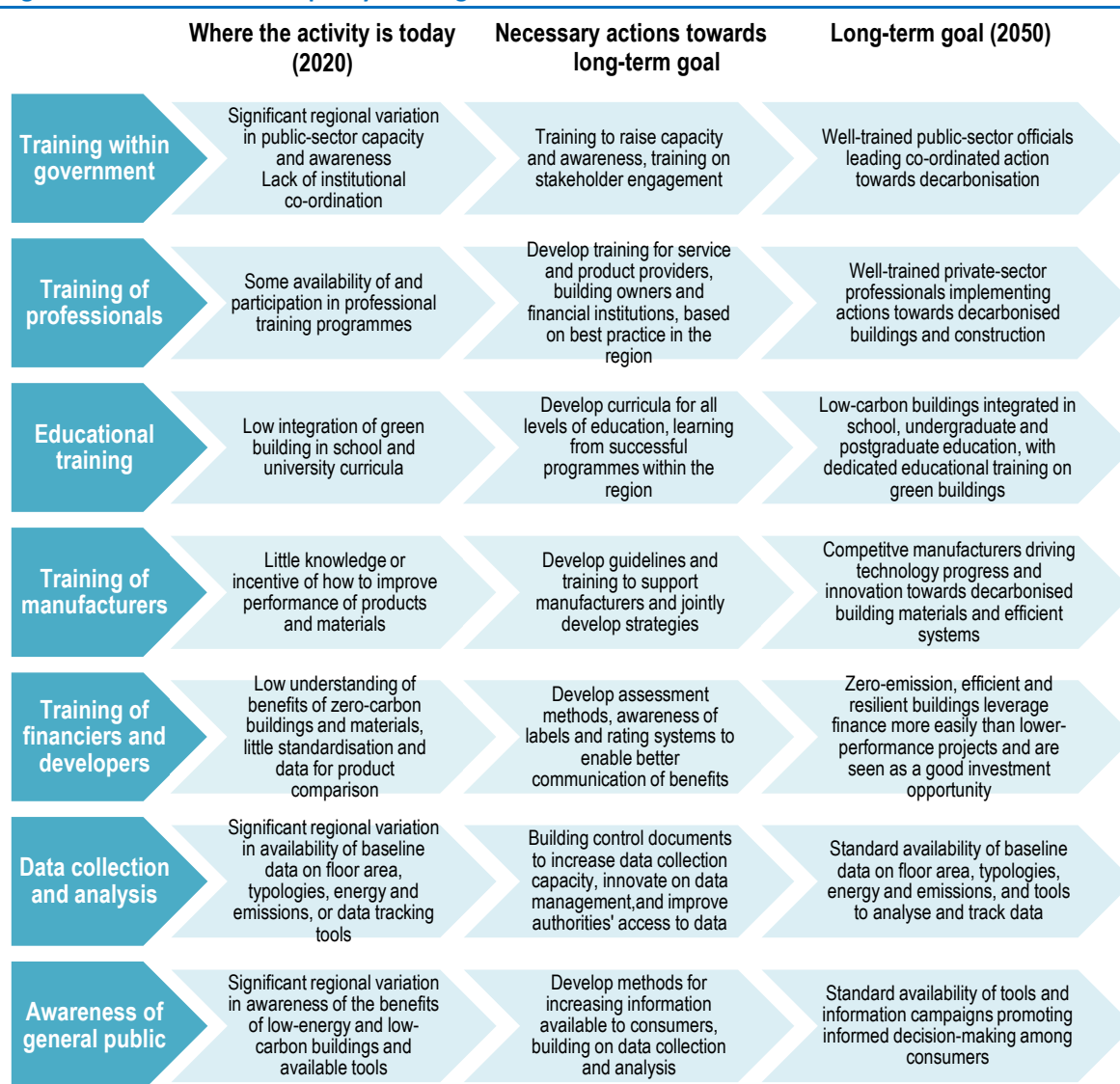
Figure 39 • Key actions for capacity building in Latin America

Key actions for capacity building in Latin America include:

- **Data collection, analysis and reporting.** Enable robust data collection where it is scarce, including data on the value of sustainable buildings investments, and address concerns about privacy and consequences for reporting high energy consumption as barriers to accurate data collection. Develop programmes to either make data sharing obligatory or to incentivise it if it remains voluntary, alongside collecting data on the value of sustainable buildings investments and developing flexible tools that can facilitate data analysis.
- **Institutional co-ordination.** Engage stakeholders especially across public-sector entities to increase co-ordination, clarify meaningful roles and responsibilities, and establish agreed-upon targets and an approach to reach them (see Box 30 and section “Multiple stakeholder engagement” for more details).
- **Government training.** Increase training of local government officials on different building measures to improve awareness and code compliance.

Specific capacity-building targets include:

Figure 40 • Timelines for capacity-building actions



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Capacity-building target details include:

- **Training within government:** Increased technical, financial and human resources in the public sector can improve the implementation and enforcement of policies. Building awareness is also crucial within government institutions on the benefits of green buildings and construction such as economic impacts, public health and well-being, and benefits to the energy sector and the environment. Shared goals and co-ordination within and among relevant government institutions and with NGOs can enable improved policy coherence. For example, national policy can create an enabling environment for local governments to accelerate action towards green buildings, and local policy is required for strong implementation.
- **Training of professionals:** Training programmes for service and product providers for buildings and construction (architects, developers, contractors, vendors, installers, etc.) and building owners increase awareness of green buildings and construction policies,

programmes or incentives for sustainable buildings and construction. This increases professionals' ability and willingness to implement these programmes.

- **Educational training:** Educational programmes including primary, secondary, vocational, university and adult education enable increased knowledge of green buildings. Certification or accreditation for professionals in the buildings sector can motivate more people to undertake educational training programmes, and increase awareness of who is trained to support green buildings and construction.
- **Training of product and material manufacturers:** This includes training for industry on how to comply with product and building standards as well as capacity building to enable the development and deployment of low-carbon solutions, such as increasing efficiency in manufacturing and construction processes and design, employing circular design principles, and strategies to increase recycling and reuse.
- **Training of financiers and developers:** Training and access to tools for financiers and developers to better identify, assess and finance investment opportunities in the zero-carbon, efficient and resilient buildings sector. Particularly important is a better understanding and assessment of the benefits of zero-carbon, efficient and resilient buildings within the broader context of climate risk exposure of buildings as assets. Moreover, capacity building is necessary to create stakeholder networks among policy makers, developers and financiers to set up project pipelines.
- **Training of the general public:** Information tools to increase awareness, improve decision-making and promote more sustainable choices by the general public. Methods of increasing information to consumers include benchmarking programmes, certification programmes, building passports, mandatory disclosure, labels, educational resources, and information on utility and government programmes.
- **Data collection and analysis:** Baseline data on building stock and typologies, energy consumption, and emissions is a critical first step to understanding the starting point and therefore how to improve to zero-emission buildings and calculate the multiple benefits there are to gain from the decarbonisation of buildings.

These elements of capacity building have differing relevance across the eight activity areas. A general indication of the relevance of each is mapped in Table 26, where the darker the colour of the box, the higher the impact that capacity-building type has for that activity.

Table 26 • Capacity building across activities

| | Training within government | Training of professionals | Training of product and materials manufacturers | Training financiers and developers | Training of the general public (incl. owners and occupants) |
|------------------------|----------------------------|---------------------------|---|------------------------------------|---|
| Urban planning | | | | | |
| New buildings | | | | | |
| Existing buildings | | | | | |
| Building operations | | | | | |
| Appliances and systems | | | | | |
| Materials | | | | | |
| Resilience | | | | | |
| Clean energy | | | | | |

Note: The darker the colour, the higher the impact that capacity building type has for that activity.

Box 28 • Examples of regional action on capacity building

Colombia

Bogotá has had abundant buildings data for years, but needed a push for increased awareness of the availability of data as well as ways to utilise it. With support from the BEA, the city is now developing a platform for collection and analysis of energy and water data.

Chile

Across Latin America, there is often duplication of initiatives within the public sector, with different ministries using different methodologies to do the same thing. Centralised platforms of information can help address this issue while also providing industry stakeholders access to aggregated information. In Chile, a platform for materials that include EPD has been developed to meet this purpose.

Finance

IFC estimates that global investments in green buildings in 2017 accounted for about 8% of the resources spent on buildings construction and renovation – USD 423 billion of a USD 5 trillion market (IFC, 2019). Looking ahead with a focus on emerging market cities, there is a cumulative climate investment opportunity of USD 29.4 trillion to 2030, of which 84% – USD 24.7 trillion – is in green buildings. Of this, USD 4.1 trillion is in LAC (IFC, 2019).

Zero-emission, resilient and efficient buildings and construction often face barriers because they require upfront investments from building owners for benefits that develop over several years. Those investments usually require incentives and financing to encourage buildings and construction stakeholders to make decisions in support of green buildings. And financiers have many requirements including stability, scale and standardisation that can slow their acceptance of buildings and construction projects that may not display these characteristics.

Key actions for finance

Figure 41 • Key actions for finance in Latin America

Key actions for finance in Latin America include:

- **Implementing financial tools:** Expand use of the financing mechanisms best suited to Latin America, which are already being used, by encouraging developers and other industry stakeholders to consider green buildings to be the norm, rather than the exception. Implementing a suite of financial tools – for example, revolving loan funds, grants and rebates, and infrastructure funds – can support investment in zero-emission, resilient and efficient buildings.
- **Rating tools and labelling:** Rating tools and labelling are important complementary policies for finance and incentive programmes, as they provide independent verification for performance-based incentives (which provide incentives linked to exceeding a minimum performance benchmark).
- **Data collection and reporting:** Build and deploy data collection and reporting systems, as weak or unreliable data availability lowers trust of financial institutions to lend to sustainable buildings and construction projects.
- **Sharing regional best practice:** Share case studies across the region about successes and lessons learned to accelerate the growth of knowledge among buildings practitioners.

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Financial tools relevant to financing zero-emission, resilient and efficient buildings include:

- **Urban development funds:** Dedicated funding for urban development projects, which can prioritise sustainable urban development projects.
- **Infrastructure funds:** Dedicated funding for infrastructure projects, which can prioritise sustainable infrastructure projects.
- **Dedicated credit lines:** Funding delivered through banks for a specific purpose, which can prioritise sustainable buildings, construction or development projects. Dedicated credit lines to national or local governments can also be used to establish a **revolving loan fund**, which collects repaid loans for energy efficiency projects and reinvests them in additional energy efficiency projects.
- **Risk-sharing loan/loan guarantee/concessional loan:** Large organisation (such as a government, international bank or aid organisation) covering the risk of payment default, offering below-market interest rates, or offering longer grace periods for repayment to enable banks to fund a project with lower costs and therefore better loan terms.
- **Green bonds:** Bonds that can be used to bundle funding for projects with climate or environmental benefits.
- **Preferential tax:** Direct funding from the government to reduce or eliminate taxes for sustainable products and services.
- **Grants and rebates:** Direct funding to overcome upfront cost barriers, provided by a government, organisation or programme either through a competitive process (grants) or during or after the purchase of a sustainable product or service (rebates).
- **Energy performance/energy service contracts:** Contracts for services or delivered savings that typically are delivered by an ESCO and can include a range of energy efficiency services and products.
- **Green mortgages:** Prospective homeowners can solicit additional finance as part of their mortgage to install efficient features and technologies in their future homes.

- **Procurement purchase and lease:** The purchase or lease of sustainable products and services. Leasing enables the use of energy-efficient products on a rental basis to reduce a capital expenditure.
- **On-bill/tax repayment:** An approach where any recurring bill, such as utility bills, insurance bills or home improvement store bills, can collect small amounts of money over a long period of time to pay for energy efficiency purchases in smaller payments. An offshoot of on-bill finance, tax repayment is where the tax authority uses recurring tax payments as a means for collecting money over time. The most common of these is PACE, which is able to use low-interest-loan repayments on the property tax bill until the purchase is paid in full.
- **Community finance and crowdfunding:** Collective funding from a large number of people connected either locally or through a call for funding.

Box 29 • Examples of regional action on finance

Brazil

The Brazilian Electricity Regulatory Agency made it mandatory for energy utilities to invest at least 0.5% of their net yearly operating revenue in energy efficiency initiatives. One of the resulting projects, Conviver Interior, focused on countryside settlements. In its [first two-year phase](#), a total of 95 municipalities benefited from the replacement of 858 934 incandescent light bulbs with compact fluorescent lamps; installation of 8 910 more efficient showers with heat exchangers; and 15 594 efficient refrigerators. These changes resulted in estimated energy savings of almost 47 000 megawatt-hours per year as well as reduced peak-hour demand.

Costa Rica

Costa Rica is moving forward with credit lines for certified buildings that meet new baseline requirements and has recently launched green bonds. The country is also moving from banks contributing financing at the building scale to community building through urban development funds.

Green bonds in Chile

In 2019, Chile issued [two sovereign green bonds](#) (with the assistance of the Inter-American Development Bank) to support its NDC targets, making it the first country in Latin America to issue sovereign bonds – reaching a total issuance of USD 6.2 billion in early 2020 with a third sovereign. Given regional interest, aided by historically low-level rates, both bonds were oversubscribed.

To facilitate green bond issuance for Chile's climate change strategy, the Chilean Ministry of Finance created a national Green Bond Framework. The framework is in line with the International Capital Markets Association green bond principles and defines national eligible green expenditures and use of proceeds.

While the majority of proceeds for the recent issuances will fund public transport projects, a portion will go towards energy-related projects, in particular for the sustainable design of public buildings. Future national issuance is projected to focus on energy efficiency in buildings.

Energy savings insurance – Latin America

One of the most identified barriers to energy efficiency investment is the perceived risk of projected savings of implemented energy efficiency measures. In recent years, international organisations and financial institutions have been developing insurance products designed to cover energy efficiency projects, making them more attractive to investors. Energy savings insurance (ESI) involves using a standardised contract between SMEs and service providers as a risk-sharing instrument, and has been used globally, with many pilot projects emerging.

The Global Innovation Lab for Climate Finance, the Danish Energy Agency, the Clean Technology Fund and the Inter-American Development Bank (along with local partners) have been working on [several ESI projects globally](#), with a focus on Latin American countries. ESI projects led by this consortium are currently under way in the following countries:

- In Colombia, the first ESI pilot project was launched in 2016 in collaboration with the local commercial bank, BANCOLDEX. A dedicated credit line was established to fund energy efficiency projects using a risk-sharing mechanism.
- In Mexico, a stimulus package of USD 25 million was established for the ESI project including a guarantee fund and dedicated credit line. The programme is well regarded by financial and governmental institutions throughout the country and continues to expand, covering a variety of energy efficiency technologies, including heat pumps,

LEDs, cooling systems and boilers (to name a few). The programme in Mexico is currently largely targeting agrobusiness.

- In El Salvador, the programme conducted a market assessment to identify risk management instruments, including performance contracts and validation mechanisms. The assessment drew significant interest from approximately 500 firms looking to invest in energy efficiency measures and identified a potential of nearly 37 500 tCO₂e/year of savings in the country. The project was approved for USD 21.7 million in funding for the project by the Green Climate Fund.
- In Peru and Brazil, market research is currently under way with local banks to identify potential target sectors. Current focus sectors include hotels, hospitals, clinics and SMEs.

Multiple stakeholder engagement

Engagement with stakeholders across sectors offers the opportunity to gain feedback from a variety of perspectives, especially those that will support implementation of the roadmap (especially across the private sector) and those that will be affected by the policies. Multi-stakeholder engagement also creates strong community buy-in to maintain momentum through leadership transitions.

Stakeholders to be engaged include:

- **National government:** National governments design and implement policies that enable or disable the uptake of sustainable building and construction. National governments act as regulators and can play an important role in facilitating partnerships among other stakeholders.
- **Subnational government:** Subnational governments play a critical role in developing, implementing and enforcing policy. In addition to their regulatory role, cities and states can convene actors across sectors, and can take action as owners of public buildings.
- **Utility companies:** Utilities have significant building data and valuable relationships with owners and tenants that already include payment and financing. In some cases, utilities also have to comply with legislation to reduce their emissions. Utilities can therefore be either a significant barrier or enabler to action on sustainable buildings and construction.
- **Property and project developers:** Developers make decisions about how property will be used, including cost-benefit assessments for different building and construction approaches. These early decisions can have far-reaching impacts into what options are considered in a building or construction project.
- **Financial institutions:** Financiers provide mechanisms to make the necessary upfront investments for sustainable buildings and construction, with repayment often coming from the energy-saving benefits that develop over several years.
- **Architects and engineers:** Professionals who lead on technical project design determine what is possible within the parameters set by developers. Professional and educational training provides these experts with the knowledge they need to develop sustainable building and construction designs.
- **Manufacturers and suppliers:** Companies that make equipment and systems determine what products are available on the market, and whether building upgrade solutions are sold with a systems view or more piecemeal replacements over time.
- **Labourers and installers:** Construction professionals must interpret project designs and bring them to life, and there are many risks for real-life installations to fall short of the sustainability envisioned in the designs on paper. Professional training is critical for

labourers and installers to achieve sustainable buildings and construction projects with the required level of quality.

- **Building owners and occupants:** Owners and occupants are responsible for the buildings energy service consumption, paying for any building upgrades and paying for energy bills, and get the benefit of improved energy services.
- **Civil society:** Civil society organisations, such as consumer and environmental advocates, or social service providers can provide analytical capacity and grounded expertise to inform all stakeholders and improve government decision-making. Civil society can represent the perspectives of communities and buildings' occupants and users that may otherwise be absent from buildings and construction dialogues.

Table 27 • Mapping of stakeholder types across activities

| | National government | Subnational government | Utility companies | Property and project developers | Financial institutions | Architects and engineers | Manufacturers, retailers and suppliers* | Labourers and installers | Building owners and occupants | Civil society ** |
|------------------------|---------------------|------------------------|-------------------|---------------------------------|------------------------|--------------------------|---|--------------------------|-------------------------------|------------------|
| Urban planning | | | | | | | | | | |
| New buildings | | | | | | | | | | |
| Existing buildings | | | | | | | | | | |
| Building operations | | | | | | | | | | |
| Appliances and systems | | | | | | | | | | |
| Materials | | | | | | | | | | |
| Resilience | | | | | | | | | | |
| Clean energy | | | | | | | | | | |

* of appliances and materials.

** including academia, NGOs, research institutions, social networks and community associations.

How to read: The darker the colour, the higher the impact that stakeholder group has on the activity and the more essential it is to delivering the roadmap targets.

Multi-stakeholder processes, involving civil society and users before and during policy design processes, enable government decision-makers to explore and assess the relevance and feasibility of different approaches, taking into consideration various needs and perspectives. Stakeholder engagement can also build relationships with key players, driving policy acceptance and improving participation and compliance.

Several approaches can facilitate stakeholder engagement. For instance, a **SWOT** (strengths, weaknesses, opportunities and threats) **analysis** can be facilitated collaboratively with stakeholders to better understand what will drive success of policy for sustainable buildings and construction and what threats to be aware of. The **PIE** (progress, impact, effort) **multi-matrix** (such as the "[Assessment tool for building efficiency policies](#)" [Becqué et al., 2016]) can seed stakeholder discussion to prioritise policies for action. Stakeholders can collaboratively use a responsibility

matrix such as **RACI** (responsible, accountable, consulted, informed) to clearly identify which roles are appropriate for each stakeholder throughout policy roadmap development and implementation.

Box 30 • Examples of mechanisms to facilitate institutional co-ordination

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The “green building” community has a powerful part to play in convening the relevant stakeholders and actors including academia, the private sector and civil society; providing training; and generally raising awareness of the benefits of green buildings. Green building communities are present and growing in many of the countries across the region. Two examples of these types of communities are described below:

Green building councils

Green building councils (GBCs) facilitate institutional co-ordination of public, private and civil society by advocating for a more sustainable built environment, developing the capacity of the industry to build better buildings and raising awareness of the benefits of green buildings. The global GBC network is developing tools, programmes and resources to accelerate uptake of net-zero carbon buildings towards sector decarbonisation goals.

Across Latin America, established GBCs include: Argentina, Brazil, Colombia, Costa Rica, Guatemala, Mexico, Panama and Peru. Emerging and prospective GBCs include Bolivia, Chile, El Salvador, Paraguay and Uruguay. (<https://www.worldgbc.org/our-regional-networks/americas>)

National alliances

The GlobalABC helps promote national alliances that bring together key public, private and civil society stakeholders, to overcome the fragmented value chain and jointly work towards a zero-emission, efficient, and resilient buildings and construction sector.

National alliances offer recommendations for policy makers and actively work to enhance economic activity. Typical pursuits range from awareness raising, training sessions and project assistance to legislative lobbying.

National alliances have been successfully established in France, Germany, Mexico, Morocco and Tunisia, in many cases inspired by GlobalABC. (<https://globalabc.org/our-work/fostering-collaboration-national-alliances>)

Conclusions and outlook

As shown throughout this document, buildings have a dominant role to play in the clean energy transition and towards reaching the SDGs and the New Urban Agenda. Yet the [2019 Global Status Report](#) highlights that this sector is not on track, as energy efficiency improvements are outpaced by rapidly expanding floor area and growth in demand for energy-consuming services. To counteract these trends, the global average building energy intensity per unit of floor area needs to be at least 30% lower than current levels by 2050 (IEA, 2019f), which means adopting both appropriate low-energy designs, and advanced building technologies and operation systems. Additionally, full decarbonisation of the sector will require a life-cycle approach to the built environment, looking into the whole life cycle of buildings and materials and their embodied carbon, and more sustainable and integrated urban planning and development, and adopting adaptation and resilience measures, among others.

This Latin America Roadmap is a collective framework for the buildings and construction sector to align with the objective of the Paris Agreement, i.e. to limit the risk of climate change above 1.5°C through a decarbonised built environment. Across eight activities, or segments of the buildings and construction sector – urban planning, new buildings, existing buildings, building operations, appliances and systems, materials, resilience, and clean energy – this roadmap provides key actions, stakeholder mapping, policy and technology actions, finance actions, capacity building, and their multiple benefits.

The Latin American building stock is characterised by a number of very large established urban centres across the region, which have continued to grow and adapt to an influx of rural and regional migration. Over the past two decades the growth in floor space and wealth have continued to increase energy demand, but with only modest improvements in energy intensity per square metre. Building codes and performance standards need to be further expanded and strengthened, alongside a shift in adoption of low-cost, low-energy technologies and designs, and policies that support technological and financial innovation and the adoption of more integrated planning policies and low-carbon materials.

This Latin America Roadmap can serve as a tool for countries across the region to adopt ambitious and effective buildings and construction sector actions when undertaking the 2020-25 NDC revisions, even supporting the monitoring, reporting and verification process for NDCs. It also supports organisations in determining their buildings investments strategies by identifying goals and milestones, and supporting detailed national or local buildings and construction roadmaps. By creating a common vision for the whole sector, these documents aim to facilitate co-operation among the entire value chain in the buildings and construction sector, and also between countries and regions. The key actions for Latin America across these activities set out the ingredients for policy and decision makers to include in their strategies and the elements needed to promote the development of a zero-emission, efficient and resilient building stock between now and 2050.

The path ahead is challenging but achievable. This document provides indicative targets and timelines for establishing a proposed pathway of improvement in the planning, development, operation, servicing and resilience of the building stock in Latin America, along with ambitious or “stretch” targets that allow countries and subnational entities to push further faster. It is the expectation that these documents, the themes, checklists, guides, recommendations, stakeholder mapping, examples and key actions, can help guide policy-making and raise awareness to help build political argument for more ambitious buildings and construction policies and market signals.

Yet there is still much work to do. Although the Latin America Roadmap is the product of extensive consultation and expert input, there are activities and action areas that need more data to ensure the proposed targets are set on a solid footing. There remains the need across the Latin American

buildings and construction sector to address information gaps and build the evidence base and support tools for zero-carbon development and planning, carbon and energy intensity of materials, and improving systems and processes to ensure buildings are resilient in the face of a changing climate. There is also the need to raise the level of ambition across all eight activities, in particular the adoption of high-performance technologies and use of low-carbon materials, for which all stakeholders along the building life cycle need to play their part.

Global effort in support of buildings and construction sector decarbonisation

Governments and stakeholders across the world are starting to take action towards buildings sector decarbonisation.

The [GlobalABC](#) was launched at COP21, as a voluntary partnership of national and local governments, intergovernmental organisations, businesses, associations, networks, and think tanks committed to a common vision: a zero-emission, efficient and resilient buildings and construction sector. The GlobalABC functions as an umbrella or meta-platform – a network of networks – that brings together initiatives and actors focusing on the buildings and construction sector.

Box 31 • The GlobalABC

By working with buildings and construction experts through a series of workshops, meetings, events and interactive dialogues, the GlobalABC with the IEA developed this roadmap that sets out actions towards decarbonising the sector through a comprehensive approach to buildings and construction. This document guides the GlobalABC in its efforts to raise ambition to meet the Paris climate goals and mobilise all actors along the buildings and construction value chain. Such efforts include:

- Keeping track of the sector through an annual buildings and construction global status report.
- Raising ambition levels by supporting countries in including ambitious, concrete buildings and construction climate actions into their NDCs (i.e. “A guide for incorporating buildings sector actions in NDCs”).
- Shaping the global agenda: showcasing the potential of the buildings and construction sector for mitigation and adaption by giving the buildings and construction sector a voice in the global climate change debate.
- Forging regional pathways towards zero-emission, efficient, and resilient buildings and construction through stakeholder-driven regional roadmaps, based on our Global Roadmap.
- Promoting national alliances: supporting national governments to overcome the fragmentation in the buildings and construction sector and ramp up the level of action. The GlobalABC so far has sparked three national alliances in Mexico, Morocco and Tunisia.
- Working with the GlobalABC-catalysed Programme for Energy Efficiency in Buildings (PEEB) and its first five partner countries Mexico, Morocco, Senegal, Tunisia and Viet Nam towards implementing actions towards decarbonising the buildings sector.

The GlobalABC, through these activities, aims to mobilise all actors along the value chain, identifying priorities and goals towards decarbonising the built environment, while fostering transparency, inclusion and co-operation. The Latin America Roadmap is a key step in this process

As part of the 2018 Clean Energy Ministerial, six GlobalABC member countries (Argentina, France, Germany, Mexico, Morocco and Switzerland) signed the [Global Call for Low-Carbon, Energy-Efficient and Resilient Buildings](#) to develop national strategies for buildings and construction in line with the Paris Agreement goals. Furthermore, multiple businesses, cities and regions have signed up to the [Net Zero Carbon Buildings Commitment](#), which challenges companies, cities, states and regions to reach net-zero operating emissions in their portfolios by 2030, and to advocate for all buildings to be net-zero in operation by 2050. And countries, the private sector and financial institutions have signed up to the [Zero Carbon Buildings for All initiative](#) as part of the UN Secretary-General’s Climate Summit in 2019.

While this Latin America Roadmap promotes a common language and vision, to accelerate progress, the approach of developing key actions and setting of targets across the buildings and construction sector illustrated by this roadmap can be cascaded to the regional, subregional, national and subnational levels to create locally owned and adopted roadmaps. To this end, the GlobalABC has cascaded the Global Roadmap to a series of Regional Roadmaps for Africa, Asia and Latin America, to serve as guidelines for regional and subregional action.

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Resources

The following are freely available resources that could be useful in developing a roadmap. Some of these resources have a broad view of the buildings sector while others include roadmaps for specific activities within the buildings sector, such as a roadmap for building codes or a roadmap for building renovation.

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Key resources:

- [Global Roadmap Towards Low-GhG and Resilient Buildings](#), Global Alliance for Buildings and Construction, 2016
- [Recommendation for a classification of measures and policies related to local conditions](#), Ecofys Germany GmbH, 2017
- [Science-based Targets for Buildings, A framework for carbon emissions management along the building and construction value chain](#), WBCSD, 2018
- [Capturing the Multiple Benefits of Energy Efficiency](#), International Energy Agency, 2014

Additional Resources:

- [Policy Pathway: Energy Performance Certification of Buildings](#), International Energy Agency, 2010
- [Policy Pathway: Modernising Building Energy Codes](#), International Energy Agency, 2013
- [Technology Roadmap: A Guide to Development and Implementation](#), International Energy Agency, 2014
- [Technology Roadmap: Energy-efficient Buildings Heating and Cooling Equipment](#), International Energy Agency, 2011
- [Technology Roadmap: Energy-efficient Building Envelopes](#), International Energy Agency, 2013
- [Transition to Sustainable Buildings](#), International Energy Agency, 2013
- [25 Energy Efficiency Policy Recommendations](#), International Energy Agency, 2011
- [Energy Efficiency Policy Recommendations: Arab-Southern and Eastern Mediterranean](#), International Energy Agency, 2014
- [Energy Efficiency Policy Recommendations: Latin American and Caribbean](#), International Energy Agency, 2015
- [Energy Efficiency Policy Recommendations: South East Asia Region](#), International Energy Agency, 2014

Additional roadmap projects that can be built on or used for inspiration:

- [Roadmap for Implementation of Energy Efficiency in Public Buildings of Kyrgyz Republic](#), World Bank, 2019
- [Super Low Energy Building Technology Roadmap](#), Singapore BCA, 2018
- [Nearly \(Net\) Zero Energy Building Roadmap](#), APEC, 2018
- [A Carbon Positive Roadmap for the built environment](#), Green Building Council Australia, 2018
- [Roadmap for Healthy Buildings – 1st step: Harmonisation of Health Criteria for Construction Products](#), German Environment Agency, 2018
- [Roadmap to Healthy Low-Carbon Lifestyles, Cities and Buildings](#), Science Council of Japan, 2018

- [A Roadmap for Retrofits in Canada: A detailed roadmap for reducing greenhouse gas emissions from large buildings](#), Canada Green Building Council, 2017
- [Zero Energy Building Pathway to 2035](#), National Grid, 2016
- [Policy Roadmap to 50% Energy Reduction in Chinese Buildings by 2050](#), LBNL, RMI and ERI, 2016
- [Roadmap to Resilient, Net-Zero Buildings in the Pacific Northwest, Pacific Northwest Economic Region](#), 2015
- [Washington State Energy Code Roadmap](#), NBI, 2015
- [Buildings modernisation strategy: Roadmap 2050](#), Poland and BPIE, 2015
- [Roadmap to Zero Emissions](#), Architecture 2030, 2014
- [NASA Net Zero Energy Buildings Roadmap](#), NREL, 2014
- [A Guide to Developing Strategies for Building Energy Renovations](#), BPIE, 2013
- [Strategy Roadmap for Net Zero Energy Buildings in India](#), USAID, 2011
- [Roadmap to Green Government Buildings](#), USGBC, 2011
- [Measurement Science Roadmap for Net-Zero Energy Buildings](#), NIST, 2010
- [Roadmap for a Transformation of Energy Use in Buildings](#), WBCSD, 2009
- [Going the distance: the low-carbon buildings roadmap](#), CBI, 2009
- [Roadmap for positive-energy and low-carbon buildings and building clusters](#), ADEME
- [Better Buildings Through Energy Efficiency: A Roadmap for Europe](#), Eurima, 2006
- [High-performance Commercial Buildings: A Technology Roadmap](#), US DOE, 2000
- [Model Regulation Guidelines: Energy Efficiency and Functional Performance Requirements based on International Standards](#), U4E, 2019

Acronyms, abbreviations and units of measure

Acronyms and abbreviations

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| | |
|-----------------|---|
| BAT | best available technology |
| BEA | Building Efficiency Accelerator |
| BESS | battery energy storage systems |
| BIM | building information modelling |
| BMS | building management systems |
| CaaS | Cooling as a Service |
| CES | Sustainable Building Certification (Certificación Edificio Sustentable) |
| CO ₂ | carbon dioxide |
| CONUEE | National Commission for the Efficient Use of Energy of Mexico (Comisión Nacional para el Uso Eficiente de la Energía) |
| COP | coefficient of performance |
| COP21 | 21st Conference of the Parties |
| CSP | concentrated solar power |
| CSPF | cooling seasonal performance factor |
| EDGE | Excellence in Design for Greater Efficiency |
| EER | energy efficiency ratio |
| EMS | energy management systems |
| EPD | Environmental Product Declaration |
| ESCO | energy services company |
| ESI | energy savings insurance |
| FIDE | Electric Energy Savings Trust (Fideicomiso para el Ahorro de Energía Eléctrica) |
| G7 | Group of Seven |
| GBC | Green Building Council |
| GDP | gross domestic product |
| GIS | geographic information system |
| GIZ | German Cooperation Agency (Gesellschaft für Internationale Zusammenarbeit) |
| GHG | greenhouse gas |
| GlobalABC | Global Alliance for Buildings and Construction |
| HVAC | heating, ventilation and air conditioning |
| IFC | International Finance Corporation |

| | |
|----------|--|
| IEA | International Energy Agency |
| IoT | Internet of things |
| IPCC | Intergovernmental Panel on Climate Change |
| IRAM | Argentine Institute for Standardisation and Certification (Instituto Argentino de Normalización y Certificación) |
| LED | light-emitting diode |
| LEED | Leadership in Energy and Environmental Design |
| LCA | life-cycle analysis |
| low-e | low-emissivity |
| MEPS | minimum energy performance standards |
| NDC | nationally determined contribution |
| NGO | non-governmental organisation |
| OTTV | overall thermal transfer value |
| O&M | operations and maintenance |
| PACE | property-assessed clean energy |
| PBE | Brazilian Labelling Programme (Programa Brasileiro de Etiquetagem) |
| PEEB | Programme for Energy Efficiency in Buildings |
| PIE | progress, impact, effort |
| PPA | power purchase agreement |
| PROCLEAR | Argentina Housing Bicentennial Credit Programme (Programa de Crédito Argentino del Bicentenario para la Vivienda Única Familiar) |
| PV | photovoltaic |
| R&D | research and development |
| RACI | responsible, accountable, consulted, informed |
| RTS | Reference Technology Scenario |
| SDG | Sustainable Development Goal |
| SDS | Sustainable Development Scenario |
| SEDATU | Ministry of Agrarian, Territorial and Urban Development (Secretaría de Desarrollo Agrario, Territorial y Urbano) |
| SEER | seasonal energy efficiency ratio |
| SHGC | solar heat gain coefficient |
| SMEs | small and medium-sized enterprises |
| STEPS | Stated Policies Scenario |
| SWHS | solar water heating system |
| SWOT | strengths, weaknesses, opportunities and threats |
| TOD | transport-oriented design |

| | |
|--------|---|
| UHI | urban heat island |
| UK | United Kingdom |
| UNAM | National Autonomous University of Mexico |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UN | United Nations |
| USD | United States dollar |
| VAT | value-added tax |

Units of measure

| | |
|--------------------|------------------------------------|
| GtCO ₂ | gigatonne of carbon dioxide |
| GW | gigawatt |
| GWh | gigawatt-hour |
| lm/W | lumens per watt |
| m ² | square metre |
| m ³ | cubic metre |
| MtCO ₂ | million tonnes of carbon dioxide |
| Mtoe | million tonnes of oil equivalent |
| tCO ₂ | tonne of carbon dioxide |
| tCO ₂ e | tonne of carbon dioxide equivalent |
| toe | tonne of oil equivalent |
| TWh | terawatt hour |

Annex

Annex A: List of stakeholder engagement events and organisations consulted for the Latin America Roadmap

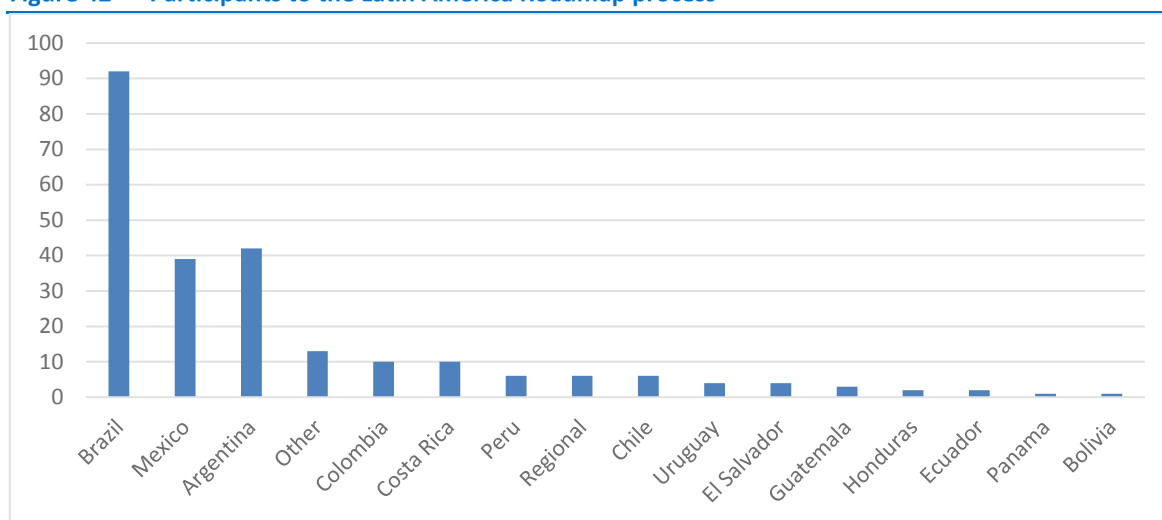
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This roadmap was the product of multiple workshops, webinars, surveying and conversations with experts across Latin America. The process involved deep consultation with over 250 individuals from different countries in Latin America over the course of the development of this regional roadmap.

The in-person events that have taken place and specifically gathered Latin America Roadmap inputs are listed below:

- **Argentina Roundtable, Buenos Aires, Argentina, October 2018.** This event formed part of the XXI Meeting of the Forum of Ministers of Environment of Latin America and the Caribbean. In their final declaration, Ministers of Environment of Latin America and the Caribbean endorsed the GlobalABC Regional Roadmaps: “To call on the governments of the region to promote models of inclusive, safe, resilient and sustainable cities and human settlements, for which support is requested to the United Nations Environment Programme and the Global Alliance for Buildings and Construction (GlobalABC) to analyse the development of a roadmap on buildings and low-emission, resilient and efficient construction”. In June 2019 the Ministry of Environment and Sustainable Development of Argentina hosted the "Foro de Vivienda Sustentable", where the declaration was reinforced in the context of the region.
- **IEA-GlobalABC Workshop on urban planning, clean energy and resilience** alongside Energy Transitions event in Rio de Janeiro, Brazil, November 2019.

Figure 42 • Participants to the Latin America Roadmap process



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