1 Setting the scene for decarbonising buildings

This chapter sets the scene and offers a rationale for decarbonising buildings in cities and regions, and the challenges and opportunities this process presents. Buildings and construction are a central element in the transition to a low-carbon future. They account for nearly 40% of global energy-related CO_2 emissions and have the potential to generate co-benefits in health, energy affordability and jobs. Decarbonisation of buildings calls for subnational policy actions beyond new construction, in particular renovating existing buildings and reducing life-cycle carbon emissions. This report draws on the findings of a dedicated survey of global cities and regions. It documents why cities and regions are important, demonstrates key roles they can play and actions they can undertake, identifies key obstacles and provides policy guidance for scaling up and accelerating the efforts to embark on this transformation.

Buildings are central to the transition to a zero-carbon future

The built environment is one of the major policy areas driving the net-zero transition. Buildings account for about 28% of total final global energy consumption and 30% of end-use sector (carbon dioxide) CO_2 emissions from the operational energy used to heat, cool and power them, including indirect emissions from the electricity and heating (IEA, 2021[1]). Including emissions from materials and construction accounts for nearly 40% of global energy-related carbon emissions (UNEP, 2021[2]). Global energy-related emissions from the building sector increased by 25% over the period from 2000-17, as a result of the expansion of the floor area of buildings, despite gradual improvements in energy intensity (IEA, 2019[3]). In 2020, CO_2 emissions from buildings fell temporarily by 10%, due to the pandemic, but further progress in the building sector is needed to meet the targets of the Paris Climate Agreement. It is estimated that by 2030, the average energy intensity per square metre of the global buildings sector must be cut by 30% from the level that prevailed in 2015 (UNEP/IEA, 2017[4]). In fact, between 2015 and 2020, energy intensity fell by 5.7% and emissions intensity by 17.2%. Additionally, renewable energy only accounts for 14.3% of total energy demand in buildings and has increased by only 3.8% percentage points since 2009. In the period from 2009 to 2019, the growth rate in heating (2.6%) was particularly slow (REN21, 2021[5]).

Meanwhile, global urbanisation trends continue to boost the demand for buildings. It is estimated that the construction sector will more than double by 2060, with its materials use reaching nearly 84 gigatons (Gt) (OECD, 2019[6]). Given that current Nationally Determined Contributions (NDCs) in the aggregate are not sufficient to put the world on a path to limiting global temperature increase to well below 2°C, exploring the role of building policies in reducing CO_2 emissions has become an important task worldwide. At the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow in 2021, businesses and government networks announced 26 climate initiatives on the built environment, recognising the urgent need for bolder government action and deep cross-sectoral collaboration to reduce carbon emissions by half by 2030 (Global Alliance for Buildings and Construction, 2021[7]).

In addition to advancing the Paris Agreement, energy efficiency in buildings can generate multiple economic and social benefits in urban areas.

- The economic benefits include creating jobs, alleviating energy poverty and providing companies with strategic investment opportunities. Retrofitting buildings for energy efficiency can create jobs for low-skilled workers (OECD, 2013[8]). In addition, reducing energy bills by increasing energy efficiency in buildings can help tackle energy poverty, a pressing challenge in some OECD countries. Given the long lifespan of buildings, real estate companies that invest upfront in energy efficiency can become more competitive by cutting their energy expenditures and reducing future renovation costs. Participating in retrofitting projects offers a strategic opportunity for a wide array of businesses in their environmental, social and governance (ESG) investment portfolios.
- Major social benefits include improvements in housing and household health from reduced air pollution and adequate indoor temperatures. The residential sector accounts for 37% of global emissions of fine particulate matter ($PM_{2.5}$), particularly from heating with solid fuels, which can pose respiratory and cardiovascular risks for residents (OECD, 2021[9]). Indoor temperatures are critical for residents' health, since poorly managed indoor temperatures can lead to symptoms of sick building syndrome (SBS) (Jaakkola and Reinikainen, 2001[10]), Energy efficiency improvements in buildings can help remedy unhealthy living environments. Building retrofitting programmes for low-income populations can also improve the quality of housing (e.g. in heating water and insulation).

Energy efficient buildings have attracted interest in the context of the green deal and COVID-19 recovery.

- The European Commission (EC) launched a Renovation Wave initiative that aims to double annual rates of energy renovations in the next 10 years and create green jobs by supporting energy renovations with public funding (EC, 2020[11]). To meet the European Union (EU) target of a minimum 55% reduction in greenhouse gas emissions by 2030, from a baseline of 1990, the EC is proposing to revise the Energy Performance of Buildings Directive (EPBD). This includes a new definition of a "zero-emissions building", considering its life-cycle potential for global warming, minimum energy performance standards for existing buildings based on energy performance certificates (EPCs) and ending subsidies for fossil fuel boilers (European Union, 2022[12]).

- Many national recovery packages from OECD countries include energy efficiency renovations of buildings as their key components. France's EUR 100 billion recovery plan, launched in 2020, included EUR 6.7 billion in energy efficiency retrofits in homes and public buildings. Korea's Green New Deal of July 2020 promised to refurbish public rental housing and schools to make them zero-energy level.
- Cities and regions are also on the frontline on investing in buildings in their recovery efforts. In their recovery strategies from COVID-19, cities have prioritised energy efficiency retrofits. The Metropole of Lille in France, for example, announced a EUR 66 million recovery plan that includes investment in energy efficient renovation of 3 000 social housing units, more than 3 600 private homes and 600 student residences in the next three years. The aim is to promote both job creation in the construction sector and to advance the low-carbon transition (OECD, 2020[13]).

New construction alone cannot transform building stock

The major cause of the recent global rise in total energy use in buildings is attributed to the increase of the growth in floor area (an increase of approximately 65% from 2000 to 2017). This will accelerate given the rapid population growth and rising purchasing power of emerging economies, which are predicted to account for 85% of the global floor area growth by 2050 (IEA, 2019[3]). Once constructed, the environmental impact of energy consumption by buildings will continue, highlighting the pressing need for immediate public action to ameliorate energy intensity in new construction. One key policy lever is to extend the coverage of mandatory building energy codes. In 2021, only 54 countries had mandatory codes in place at the national level globally (IEA, 2021[14]) In developed countries, rapid action is required to apply net-zero-emission standards to new buildings, to avoid locking in inefficient building stock and costly future renovations. In the EU, the Energy Performance of Buildings Directive requires all new buildings to be nearly zero-energy buildings by 31 December 2020 (EC, 2019[15]) (Box 1.1). Whether this directive reduces carbon emissions will depend on how member countries transpose these requirements into national regulations.

Box 1.1. Zero-energy building

The energy balance of buildings and housing can be reduced to close to zero by reducing energy consumption and increasing the use of renewable energy. Examples can be found in several countries, but no international common definition has been agreed upon.

The EU defines "nearly zero-energy building" in Directive 2010/31/EU of the European Parliament and Council as "a building that has a very high energy performance", as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. Member states are required to ensure that 1) by 31 December 2020, all new buildings be nearly zero-energy buildings; and 2) that after 31 December 2018, new buildings occupied and owned by public authorities be nearly zero-energy. In December 2021, the EC proposed the revision of the Energy Performance of Buildings Directive, which includes a new definition of a "zero-emission building" as a building with very high energy performance, where the small amount of energy needed is fully met either by energy generated by the building itself or by locally generated renewable sources.

The U.S. Department of Energy and the National Institute of Building Sciences define a zero-energy building (ZEB) as “an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy” (National Institute of Building Sciences, 2015[16]) . Together with industry partners, the US Department of Energy provides a series of guidelines on achieving zero-energy performance in various building types and climate zones. By providing a broad definition on ZEB metrics and boundaries, the federal government aims to incentivise subnational governments, as well as utilities or private entities, to adopt ZEB measures based on local needs and conditions (U.S. Department of Energy, n.d.[17]).

In Japan, a zero-energy house (ZEH) is defined as a house designed to reduce its annual primary energy consumption to zero by 1) significant energy savings; 2) maintaining indoor air quality through improvement in thermal performance of the building envelope, 3) use of high-performance equipment, and 4) introducing renewable energy use. A ZEB is defined as a building that is designed to increase energy self-sufficiency as much as possible and to reduce annual primary energy consumption to zero. This is to be achieved by substantial energy savings; by maintaining indoor air quality through reduction of energy demands by advanced building design; by active use of natural energy by passive technologies and use of high-performance equipment; and by introducing the use of renewable energy. Japan’s government aims to achieve the energy performance of ZEH and ZEB for houses and buildings built after 2030.

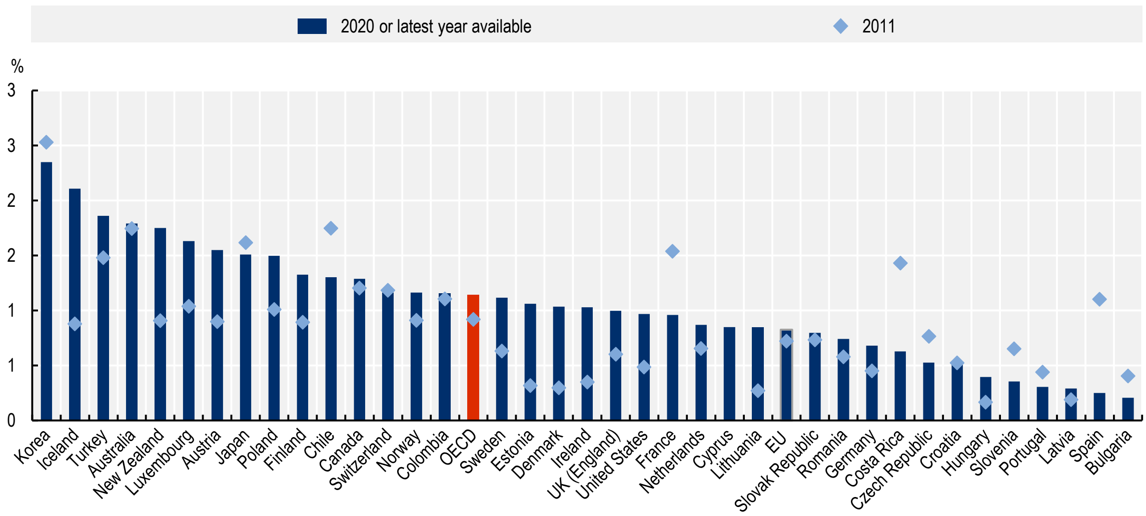
In 2016, Vancouver (Canada) introduced the Zero-Emissions Building Plan (ZEB). Zero-Emission Buildings refers to buildings that are highly energy efficient and use only renewable energy. The city of Vancouver plans to transition to zero-emissions buildings in all new construction by 2030, To achieve this, the city provides tools including limits on emissions and energy use in new buildings (City of Vancouver, 2022[18]).

Source: European Parliament and Council of the European Union (2010[19]), *Directive 2010/31/EU of the European Parliament and the Council of 19 May 2010 on the energy performance of buildings (recast)*, http://eurlex.europa.eu/LexUriS; U.S. Government (2010[20]), *Energy Independence and Security Act of 2007*, http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf; Committee on Following up ZEH Roadmap (2020[21]), *Report by the Committee on Following up ZEH Roadmap in 2019*, https://www.enecho.meti.go.jp/category/saving_and_new/saving/general/pdf/roadmap-fu_report2020.pdf (accessed on 9 February, 2022). Committee on Following up ZEB Roadmap (2018[22]), *Report by the Committee on Following up ZEB Roadmap*, https://www.enecho.meti.go.jp/category/saving_and_new/saving/enterprise/support/pdf/1805_followup_summary.pdf (accessed on 9 February, 2022); Government of Japan (n.d.[23]), *National Plan for Global Warming Countermeasures*, http://www.env.go.jp/earth/ondanka/keikaku/211022.html (accessed on 9 February 2022).

Developed economies have slow population growth, stable purchasing power and a low share of annual new construction in total building stocks (Figure 1.1). Strict regulations on new buildings, though, will have only a limited impact on the building stock as a whole. Older buildings in developed countries have much lower energy efficiency than newer ones. Public action will need to include more than “new” buildings.

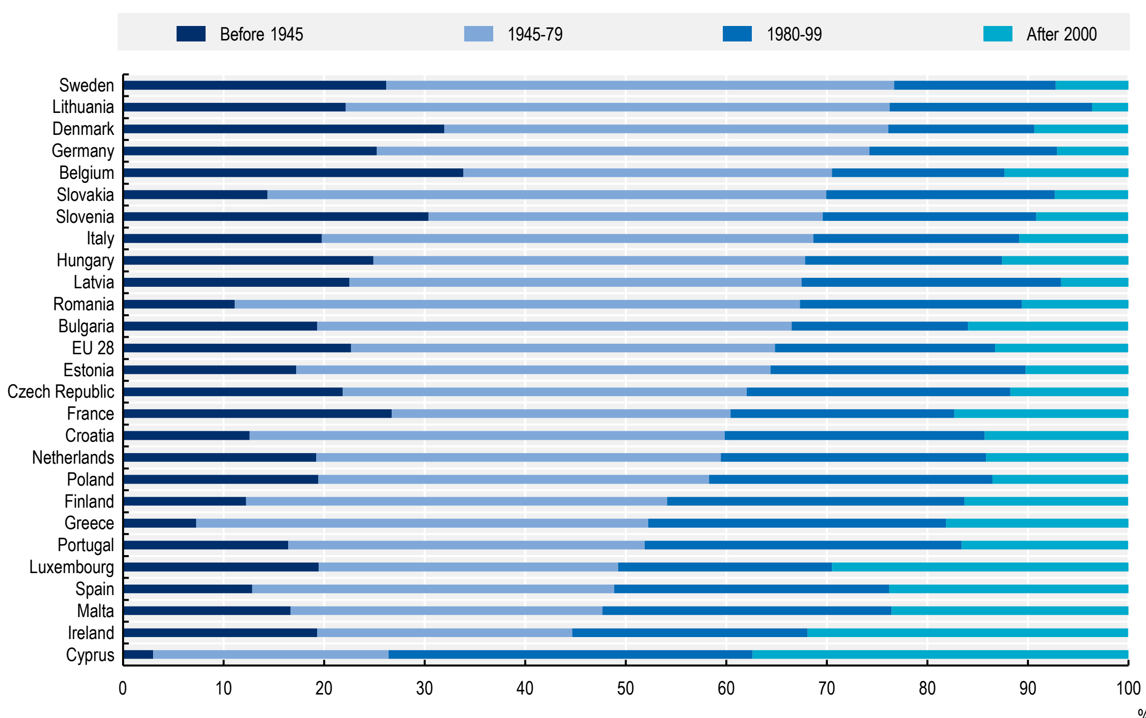
Given the large number of their existing buildings, OECD countries face different challenges. In the EU, buildings built before 1945 still account for 23% of all building stock, and their average insulation level (of external walls) is only a fifth of that of buildings built after 2010 (Figures 1.2 and 1.3) (EC, n.d.[24]). In general, a higher level of insulation reduces heat loss from buildings and thus offers both a more comfortable living space and energy savings. To achieve the reduction in carbon emissions required under the Paris Agreement, the rate of building energy renovations must be increased considerably, from rates of 1-2% of existing stock today to more than 2%-3% per year in the coming decade (UNEP/IEA, 2017[4]). OECD countries can thus not achieve zero-carbon transition in buildings without enhancing energy efficiency renovations in their building stock.

Figure 1.1. Share of new annual housing construction in total housing stock



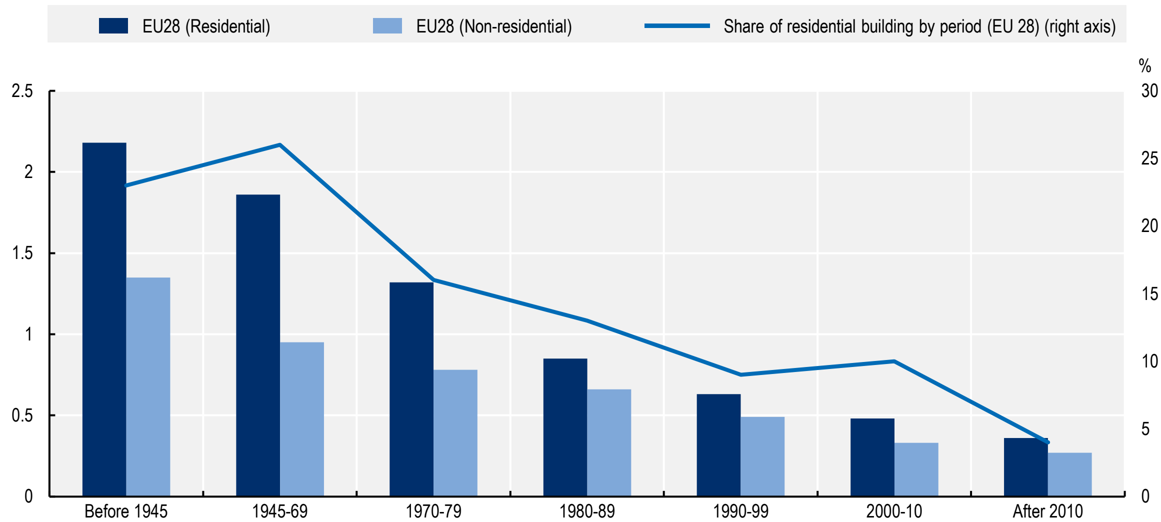
Source: OECD (2021[25]), *OECD Affordable Housing Database*, https://www.oecd.org/housing/data/affordable-housing-database/.

Figure 1.2. Breakdown of residential building by construction year



Source: EC (n.d.[24]), *EU Buildings Database*, https://ec.europa.eu/energy/eu-buildings-database_en.

Figure 1.3. Thermal transmittance value of external wall by building age (W/m2K), 2017



Source: EC (n.d.[24]), *EU Buildings Database*, https://ec.europa.eu/energy/eu-buildings-database_en.

In addition, energy consumption and carbon emissions need to be considered over the entire life cycle of a building, not only during the operational phase. The embodied carbon of buildings – all the CO_2 emitted in producing materials in the life cycle of buildings – includes all the emissions from the construction materials and building process and from deconstruction and disposing of the buildings (University College London, n.d.[26]). The embodied GHG emissions due to construction industries are approximately 5% to 10% of the entire energy consumption in developed countries and as much as 10% to 30% in developing countries (EBC, 2016[27]). These rates vary greatly depending on the country and region, but the carbon footprint of each phase of a building's life cycle should be taken into account. France has been one of the pioneers in pursuing ambitious policies to reduce embodied carbon of buildings. France's Environmental Regulation RE2020 requires the calculation of Life Cycle Assessment, which examines all materials and equipment used in a building from the construction and demolition phase. The regulation came into force in January 2022 (Ministère de la Transition Écologique, 2021[28]). In addition, incorporating circular economy approach will contribute to the decarbonisation of built environment through minimised material use and maximised reuse. Initiatives such as material passports, which provide digital data on materials used in buildings, or listing empty buildings, which could be used for promoting reuse and repurposing of buildings, can promote more efficient resource consumption and carbon emissions in buildings (OECD, 2020[29]).

Decarbonising buildings requires subnational policy actions

Decarbonising buildings means reducing energy consumption by upgrading insulation and installing high-performance equipment, as well as meeting energy demands with renewable sources as much as possible. Accelerating and scaling up the decarbonisation of buildings, involves a number of local policy considerations.

- First, buildings and construction vary across cities and regions, given that they have their own long histories of adapting to local meteorological conditions through local building materials and resources. Houses in colder regions typically have better insulated walls, while those in hotter regions traditionally include such features as longer eaves to reduce the heat gain. Urban areas have a large share of multifamily housing, while single-family, detached houses dominate housing stock in suburban and rural areas. The building stock of different cities and regions differs in age, size, tenure, usage and energy performance, and the strategies for tackling these buildings will necessarily differ. The rate of new construction and renovation is another important factor. Cities and regions will need to adopt different strategies depending on whether they have a large share of new construction. Urban areas, in particular metropolitan areas, provide greater opportunities for energy efficiency measures in new construction, given their population growth, while rural areas typically depend on refurbishing buildings to maintain their basic functions.

- Second, the policy environment also differs across cities and regions. Building owners include many private household owners, and policies to scale up building decarbonisation need to address housing and energy affordability. Housing affordability is an acute and pressing issue in large metropolitan areas, and the impact of decarbonisation policy on local housing prices and rents must also be considered. Housing quality is another consideration. The COVID-19 crisis has magnified the importance of inequalities in living conditions and access to housing in metropolitan areas. Low-income households were found to have higher risks of infection, due to poor housing conditions, lack of access to basic sanitation and limited living space, with three or more people in the same bedroom (UN Habitat, 2021[30]).
- Third, building decarbonisation needs neighbourhood- or larger-scale planning and co-ordination. For example, "zero energy buildings" or "net-zero energy buildings (NZEB)" have been gaining currency in many countries (Box 1.1). They need to be discussed at the neighbourhood or district level, because they involve district-scale energy infrastructure (e.g. a smart grid, energy storage, district heating), local renewable energy sources (e.g. solar panels) and innovative ecological building design (e.g. passive solar heating, natural lighting and ventilation). Developing mechanisms to finance building retrofits at the neighbourhood level is also needed in many countries. Cities and regions offer markets large enough to achieve economies of scale (e.g. mass production and financing mechanisms) as well as improvements in the quality of existing housing stock in many urban areas. Cities and regions can also take advantage of urban regeneration to accelerate the decarbonisation of their existing building stock. Decarbonisation of buildings also requires that construction and other relevant industries be prepared for the transition. Meanwhile, local authorities and institutions need to be conversant in code enforcement and certification of buildings.

Given the local nature of buildings and policy environments, countries cannot tap into the full potential for energy efficiency in buildings without subnational policy actions. Cities and regions have four major advantages in relation to the decarbonisation of buildings.

- First, cities and regions own public buildings themselves, and can use them as a catalyst for broader decarbonisation of buildings. They can promote exemplary pilot projects of low-carbon buildings, develop messages about their improved comfort and lower energy costs and pave the way for the private sector to invest in decarbonising buildings.
- Second, many cities and regions are responsible for building and zoning regulations. While building standards (energy efficiency, safety, etc.) are often regulated at the national level, local governments are responsible for local adjustment of the regulatory framework and for enforcement. Actions need to be taken throughout the entire building value chain to decarbonise the building sector. Local governments, especially cities, can develop ambitious regulations to promote decarbonisation, not only in new construction but also for existing buildings. In addition, local land use and zoning regulations determine what types of buildings can be built in which locations in urban areas. Cities are often better positioned than national governments to integrate these sectoral policies and generate synergies for achieving urban green growth (OECD, 2013[8]).
- Third, cities and regions are close to citizens and local businesses. Building decarbonisation requires a broad array of stakeholders, including from corporate property owners to individual households, and from local construction firms to energy advisers and local energy companies.

Cities and regions are in a good position to engage these stakeholders and coordinate to bundle dispersed renovation needs, including those of social housing, and to bring private investment into local renovation market.

- Fourth, cities and regions are familiar with the local building stock, whose characteristics and energy consumption vary greatly. They can take account of key local factors and develop tailored and strategic approaches to building stock. To unlock the potential for energy efficiency in buildings, a well-coordinated, whole-of-government and multilevel governance approach is urgently needed.

Objectives of the report

With this backdrop, this study aims to document the actual and potential roles of cities and regions in decarbonising new and existing buildings, and to discuss key issues and challenges towards an effective whole-of-government and multilevel governance approach that can contribute to the transition to a net-zero economy. More specifically, the study 1) documents why cities and regions are important for decarbonising buildings, 2) demonstrates key roles and actions of cities and regions, 3) identifies key obstacles that cities and regions are facing, and 4) provides policy guidance for upscaling and accelerating their efforts. This report is one of the first attempts to position the roles of cities and regions for decarbonising buildings in a global policy context and to discuss the importance of a whole-of-government and multilevel governance approach. The study is based principally on desk research (review of the literature, web-based public information), findings from a dedicated OECD Survey on Decarbonising Buildings in Cities and Regions carried out in co-operation with the European Committee of the Regions (Box 1.2), and the analysis of regional-level data provided by a specific case study on the Netherlands.

Box 1.2. OECD Survey on Decarbonising Buildings in Cities and Regions

To collect key data and information on the main trends, data and policies on energy efficiency in buildings in a range of cities and regions, and also on obstacles and good practices, the OECD conducted an online survey on Decarbonising Buildings in Cities and Regions, in co-operation with the European Committee of the Regions (CoR). The survey was conducted from mid-July to early October 2021 and primarily addressed authorities responsible for energy efficiency in buildings in municipalities and regional governments.

Table 1.1. List of responding cities and regions

Types of cities and regions	Cities and regions that responded
Regions (4)	Córdoba (Argentina), Emilia Romagna (Italy), North Holland (Netherlands), Tottori (Japan)
Intermediary entity (in countries with 3 levels of subnational government (1)	Scania (Sweden)
Municipalities (with more than 500 000 inhabitants) (8)	Rio de Janeiro (Brazil), Rotterdam (Netherlands), San Francisco (US), San Jose (US), Stockholm (Sweden), Toronto (Canada), Vienna (Austria), Yokohama (Japan)
Municipalities (of 200 000 to 500 000 inhabitants) (4)	Mannheim (Germany), Nilüfer (Turkey), Oakland (US), Tilburg (Netherlands)
Municipalities (of 50 000 to 200 000 inhabitants) (1)	Assen (Netherlands)
Municipalities (of under 50 000 inhabitants) (3)	Chorzele (Poland), Milanówek (Poland), Płońsk (Poland)

Source: OECD Survey on Decarbonising Buildings in Cities and Regions.

The survey consisted of questions on subnational policies and challenges and data inquiries on indicators related to energy efficiency in buildings and related local factors (Annex A). In total, 21 cities and regions responded to the survey, including 4 regions, 1 intermediary entity (in countries with 3 levels of subnational government: department, province, county, etc.) and 16 municipalities of all sizes (8 of more than 500 000 inhabitants, 4 of 200 000 to 500 000 inhabitants, 1 of 50 000 to 200 000 inhabitants and 3 of under 50 000 inhabitants).

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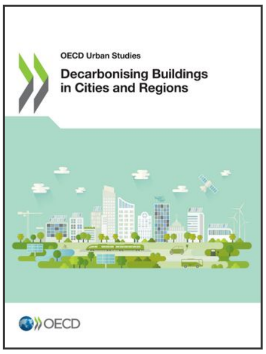

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