

OECD Regional Development Studies

A Territorial Approach to Climate Action and Resilience

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Preface

We are pleased to release this new OECD report on *A Territorial Approach to Climate Action and Resilience*. This report has been jointly produced by the OECD Centre for Entrepreneurship, SMEs, Regions and Cities (CFE) and the OECD Environment Directorate (ENV), with the support of the Government of Japan.

Global warming has already reached 1.1°C above pre-industrial levels, and at current warming rates, it is likely to breach the 1.5°C Paris Agreement target as early as in 2030. Risks of reaching climate tipping points, which will accelerate these trends and, potentially, result in irreversible changes to the climate system, are also increasing, as is the need for global actions. While the impacts of climate change, and mitigating actions, will inevitably differ across countries they will also differ within them, with the most vulnerable communities typically hit hardest, reinforcing the importance of local actions to complement national and global efforts. For instance, over the last five years, daytime summer temperatures in half of OECD cities have been 3°C warmer than in the surrounding areas, and in some cities this reaches 7°C.

Building on broader OECD work on climate, including the OECD International Programme for Action on Climate (IPAC) and the Inclusive Forum on Carbon Mitigation Approaches (IFCMA), this report offers two major tools to drive more effective climate action and strengthen resilience through a place-based approach. First, it proposes a novel OECD territorial climate indicator framework to assess where cities and regions stand vis-à-vis national and global climate goals and targets. Second, it puts forward a policy framework of nine actions to help both national and subnational governments reduce greenhouse gas emissions across places and better address local impacts.

This report illustrates the critical importance of leveraging synergies across different policy sectors and levels of government to deploy effective climate action and meet the goal of the Paris Agreement and, in turn, build climate resilience. The analysis of 36 leading practices of territorial approaches used across OECD countries highlights the dual need to integrate a place-based perspective into broader national and international climate policies on the one hand, and to integrate and mainstream climate objectives into urban, rural and regional development policies on the other.

We are confident that this report will contribute to a multi-sector and whole-of-government approach to accelerate climate action and resilience at all territorial scales. We stand ready to support and drive further progress on this journey.



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Foreword

This report presents the findings from the activities of the OECD Programme on "A Territorial Approach to Climate Action and Resilience", jointly conducted by the OECD Centre for Entrepreneurship, SMEs, Regions and Cities (CFE) and the OECD Environment Directorate (ENV). The Programme provides both national and subnational policymakers with granular data and tailored guidance to promote a place-based approach to climate mitigation and adaptation. Its activities include:

- measuring where cities and regions stand vis-à-vis global targets on climate change using the OECD territorial climate indicator framework,
- assessing national and subnational policies by applying a checklist to implement a territorial approach to climate and resilience initiatives, and
- supporting multi-level dialogue within and between countries to enhance co-ordinated action and disseminate best practices.

The report presents a set of 45 territorial climate indicators that are comparable across countries and levels of government, 9 recommended actions with a number of sub-actions, and a compendium of 36 leading practices from cities, regions and countries from across the globe.

The report aims to serve as a source of information and analysis for policymakers and professionals in the field of climate change as well as urban, rural and regional development, as it compiles the latest data and statistics on local greenhouse gas emissions and emission reduction potential, information on locally specific impacts and risks of climate change, and ongoing leading mitigation practices both at the national and subnational levels.

The report serves the 2023-24 Programme of Work and Budget of the OECD Regional Development Policy Committee (RDPC) and the OECD Environment Policy Committee (EPOC). It is also a contribution to the OECD Horizontal Project on Climate and Economic Resilience (Net Zero+), an OECD-wide flagship initiative to support governments in driving the swift transformational change needed to tackle climate change.

This publication was approved by the RDPC on 13 November 2023 and was reviewed by the EPOC and its Working Party for Climate Change.

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The publication was co-ordinated by Tadashi Matsumoto, Head of the National Urban Policy and Climate Resilience Unit, under the supervision of Aziza Akhmouch, Head of the Cities, Urban Policies and Sustainable Development Division, in the CFE. It was drafted by a team of policy analysts and experts:

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Abbreviations and acronyms

AFOLU	Agriculture, forestry and other land use
C40	C40 Cities Climate Leadership Group
CDP	Carbon Disclosure Project
CO₂-eq	Carbon Dioxide Equivalent
COFOG	Classification of the Functions of Government
COVID-19	Coronavirus disease 2019
CUT	Coalition for Urban Transformation
DG REGIO	Directorate-General for Regional and Urban Policy
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EDGAR	Emissions Database for Global Atmospheric Research
EEA	European Economic Area
ESC	Emerging and Sustainable Cities Initiative
EU	European Union
FUA	Functional Urban Area
FWI	Fire Weather Index
GlobalABC	Global Alliance for Buildings and Construction
GCoM	Global Covenant of Mayors for Climate & Energy
GHG	Greenhouse gas
GHS	Global Human Settlement
GIZ	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i> , German Agency for International Co-operation
GPC	GHG Protocol for Cities
GSF	Green space factor
ICLEI	ICLEI-Local Governments for Sustainability
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFCMA	Inclusive Forum of Carbon Mitigation Approaches
IPAC	International Programme for Action on Climate
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JRC	Joint Research Centre
LT-LEDS	Long-term low emissions development strategies
LULC	Land use and land cover

MLIT	Ministry of Land, Infrastructure and Transport of Japan
NAP	National Adaptation Plan
NAS	National Adaptation Strategy
NbS	Nature-based Solution
NUP	National Urban Policy
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NZE	Net-Zero Emissions
PSR	Pressure-State-Response Approach
PPM	Parts per million
RACA	Rural Agenda for Climate Action
REN21	Renewables in Cities 2021
SDGs	Sustainable Development Goals
SECAP	Sustainable Energy and Climate Action Programme
SURGe	Sustainable Urban Resilience for the Next Generation
SUV	Sport-utility vehicle
TACAR	Territorial approach to climate action and resilience
UCLG	United Cities and Local Governments
UN	United Nations
UNDRR	United Nations Office for Disaster Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Conference on Climate Change
UTCi	Universal Therman Climate Index
USF	Urban Sustainability Framework
WWF	World Wildlife Fund

Executive summary

This report proposes a policy framework to help decision makers develop more effective climate and resilience policies through a **“territorial approach”**. A territorial approach to climate action and resilience is defined as *‘a comprehensive policy framework that integrates a place-based perspective into national and subnational climate policies and mainstreams climate objectives into urban, rural and regional development policies, to effectively drive climate action at all territorial scales.’* Adopting a territorial approach is critical for national and subnational governments to tap into the full potential to reduce greenhouse gas (GHG) emissions across all places and better address locally specific climate impacts, which often hit the most vulnerable communities the hardest.

Key findings

Most OECD cities and regions are far from reaching net-zero. In 2018, only 61 out of the 432 OECD large regions (14%) had production-based emissions per capita below the threshold consistent with the IEA Net Zero Emissions (NZE) scenario (4.7 t CO₂-eq per capita) to reach net-zero in 2050. Metropolitan regions are generally performing better than non-metropolitan regions on a production per capita basis, with average emissions per capita half those in regions far from a metropolitan area. At the Functional Urban Area (FUA) scale, in 2018, almost half of OECD metropolitan areas with more than 500 000 inhabitants came in below 4.7 t CO₂-eq per capita. However, rather than seeing declines, on average, they saw their total emissions grow by 24% from 1990 to 2018.

The volume and source of GHG emissions vary significantly across geographical scales within countries, highlighting that the pathways to achieving a net-zero transition will also differ. For instance, renewables account for more than half of the electricity generation in remote regions and less than 20% in large metropolitan regions. Road-based emissions per capita in remote regions are, for example, on average more than three times higher than in large metropolitan regions. In addition, GHG-intensive activities, such as carbon-intensive power generation, are typically located outside of cities (reinforcing in turn the importance of complementary measures on, and policies to abate, emissions based on consumption). Moreover, in 80% of the OECD’s FUAs, the built-up area grew faster than population between 2000 and 2020.

There are non-negligible territorial disparities in terms of climate impacts. For instance, in 2021, cities with more than 250 000 inhabitants were on average 3°C warmer than their surrounding area, which is almost twice as high as in cities with less than 100 000 inhabitants. In 45 OECD regions located in 18 different countries, more than 20% of their population are at risk of river flooding. In Rotterdam, the Netherlands, more than 60% of its population is at risk.

Recommended actions

Drawing on an analysis of 36 leading practices from countries, regions and cities mainly in the OECD area, three types of actions are recommended.

Integrate a place-based perspective into climate policy:

- **Measure and monitor GHG emissions, climate risks and impacts at different territorial levels.** Standardised and common indicator frameworks can help quantify GHG emissions and

measure the distance of cities and regions with regard to local, national and global goals and targets, where applicable. Climate risk and vulnerability assessments should be made at more granular geographical scales, including cross-sectoral impacts, to better address territorial disparities. Developing subnational consumption-based emissions estimates can help cities and regions understand emissions embedded in consumption and, in turn, provide a metric to target the efficacy of demand-side mitigation policies.

- **Fully incorporate local action into national climate plans and strategies.** Although most national governments have incorporated local perspectives into their climate plans and strategies in one way or another, the extent to which they do so varies across countries. For example, only a limited number of Nationally Determined Contributions (NDCs) mention the emission reduction targets set by their regions or cities. Only a third of OECD countries mention the role of local authorities in measuring and evaluating adaptation progress in their National Adaptation Plans (NAPs) and National Adaptation Strategies (NAS).
- **Develop subnational climate goals and targets that reflect specific local needs and interests, in line with the Paris Agreement.** In 23 out of 38 OECD countries, at least one city or region has set a more ambitious net-zero or carbon neutrality target than that of their respective national government. However, in general, most cities and regions are still far from reaching net-zero as highlighted above. Indeed, many cities and regions are still without a target or climate plan, often reflecting technical and financial gaps. National government can play a critical role in bridging these. For example, Japan's Regional Decarbonisation Roadmap programme aims to provide financial and technical support to 100 Leading Decarbonisation Regions targeting net-zero by 2030.

‘Climate-proof’ regional development policy at all territorial levels:

- **Mainstream climate objectives in national urban, rural and regional development policies.** Regional development policies can also be leveraged to accelerate and incentivise locally specific pathways to net-zero. For example, Poland's National Urban Policy 2030 includes concrete actions to address climate-related risks and proposes legislative reforms on the introduction of a blue-green infrastructure plan as a tool to monitor and co-ordinate its development.
- **Promote climate action and resilience at the right territorial scale.** In particular, the functional-urban area approach can facilitate co-ordination among local authorities over land use and transport infrastructure to promote a low-emission spatial structure. For example, in Vancouver, Canada, the Regional Growth Strategy aims to reduce GHG emissions by 80% below 2007 levels by 2050, by stimulating development in urban centres and transit corridors, promoting working and playing close to home, and establishing mixed-use transit-oriented communities.
- **Support neighbourhood projects generating co-benefits and synergies beyond climate.** Neighbourhood climate projects can be particularly useful in addressing multiple local objectives, experimenting innovative decarbonisation solutions, and better targeting the most vulnerable communities through a participatory approach. For instance, in France, the “Eco-quartier” Programme supports the implementation of net-zero and resilience solutions at the neighbourhood scale, by using a labelling system which assesses projects not only on their environmental impact but on their economic and social impacts too (e.g. employment, safety). In the United States, the Community Development Block Grant Disaster Recovery Funds focuses on supporting disaster recovery efforts, including climate-related disasters, by actively involving residents in vulnerable neighbourhoods and prioritising their needs throughout the process.

Enable and scale-up local climate action and resilience:

- **Strengthen the legal and institutional environment** for local climate action and resilience, by clarifying roles and responsibilities for climate action, creating alignment and co-ordination mechanisms across levels of government, and building local capacity to engage all cities and

regions. For instance, Mexico passed the General Law on Climate Change in 2012, becoming the first large oil-producing economy that adopted climate legislation, and a 2018 amendment made it compatible with the Paris Agreement. The Law stipulates that municipalities should promote policies and actions to reduce emissions and establishes institutional frameworks to co-ordinate climate policies across levels of government.

- **Enhance funding and financing mechanisms** for local climate action and resilience. National governments should promote more diversified funding and explore the potential to facilitate access to external resources for cities and regions, including through green, social and sustainable municipal bonds and loans. Green budgeting and green public procurement can also help subnational governments better align their expenditure and revenues with climate and green objectives.
- **Engage local actors, build partnerships and share knowledge.** Co-producing national or subnational climate plans with local actors can make climate action more inclusive and effective and promote innovation and experimentation, as demonstrated in the Circular Economy Strategy of Umeå, Sweden, which was built on extensive multi-stakeholder partnerships. City-to-city collaborations can also help cities exchange knowledge, identify innovative solutions and replicate or tailor them to their own circumstances, as seen in the EU Net-Zero Cities Programme and the Climate Adaptation City Deal in the Netherlands.

1 Why adopt a territorial approach to climate action and resilience?

Global warming is likely to reach 1.5 degrees Celsius as early as 2030, with a growing risk of crossing “tipping points” that trigger potentially abrupt and irreversible changes to the environment. However, both national and subnational governments’ climate actions fall short of meeting the Paris Agreement goals. An untapped opportunity lies in adopting a territorial approach to climate action and resilience, which can both improve the effectiveness of national climate policy and accelerate local climate action. This chapter introduces the concept of a territorial approach and discusses how it can be a game changer in driving the net zero transition and building systemic climate resilience.

The climate emergency has complex and place-specific impacts

The current state of global warming

According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), the global surface temperature was 1.1 degrees Celsius (°C) above pre-industrial levels over 2011-20 and is likely to reach 1.5°C between 2030 and 2052 at current rates (IPCC, 2023^[1]). Total greenhouse gas (GHG) emissions were a record 54.4 gigatonnes of carbon dioxide equivalent (CO₂-eq) in 2019 and have increased by 1.5% per year over the last decade (UNEP, 2022^[2]). Atmospheric CO₂ concentrations reached 417 parts per million (ppm) in 2022, more than 50% higher than pre-industrial levels (NOAA, 2022^[3]).¹ Such historical levels of GHG emissions will have long-lasting consequences. Many changes already in motion, particularly regarding the ocean, ice sheets and global sea level rise, will likely last for centuries to millennia (IPCC, 2022^[4]).

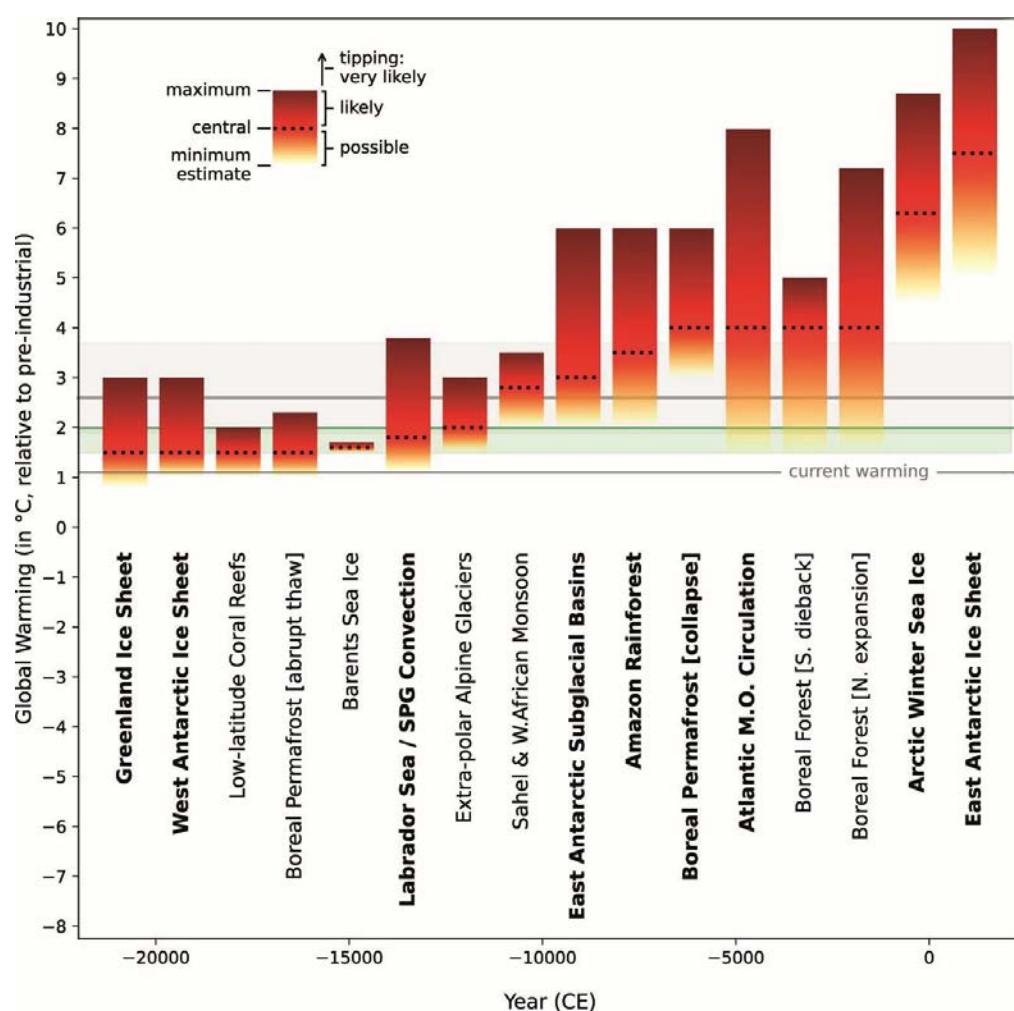
The urgency of the climate crisis is exemplified by the growing risk of crossing climate system tipping points. The IPCC defines these tipping points as “a critical threshold beyond which a system reorganises, often abruptly and/or irreversibly” (Chen, 2021^[5]). At certain levels of global warming, these “points of no return” for elements of the global climate system would result in potentially abrupt and irreversible changes to the environment. Figure 1.1 shows the temperature range at which a number of tipping elements may be triggered, i.e. ranges of temperature within which the tipping points self-propel. Key examples include: the collapse of the Greenland and West Antarctic ice sheets as well as the melting of the Arctic permafrost (cryosphere); the slowdown or collapse of the Atlantic Meridional Overturning Circulation (circulation patterns); and the dieback of the Amazon rainforest and destruction of coral reefs (biosphere) (OECD, 2023^[6]). Crossing tipping points could occur fast enough to defy the ability and capacity of human societies to adapt, leading to widespread and catastrophic impacts. The latest science also suggests that climate systems tipping points are likely to occur at lower levels of warming than previously thought.

Avoiding crossing tipping points requires a much faster transformation of economies and systems than has been achieved so far or is projected. It is not just about getting to net zero by any date; the shape of the pathway to get there matters hugely in lowering the risks of tipping points. Rapid and deep emission cuts are required in this decade, with a parallel emphasis on building systemic resilience to climate impacts. The cost of not acting now is likely to be prohibitive, as demonstrated later in this chapter.

Complex climate impacts across economic and social systems

Climate change not only has environmental effects but also poses significant risks to economic resilience, particularly in terms of threats to macroeconomic and fiscal sustainability resulting from climate-related shocks. In 2021 alone, it is estimated that extreme climate-related events had a global direct cost of EUR 265 billion (Munich Re, 2022^[7]). Modelling projections for a high-end sea level rise scenario (1.3 metres) indicate that coastal flooding may incur global annual damage costs of up to USD 50 trillion – i.e. nearly 4% of global gross domestic product (GDP) – by the end of the 21st century if no adequate adaptation measures are taken (OECD, 2019^[8]). Climate change is also causing massive displacements of people worldwide with enormous cost. In 2022, climate-related disasters in 151 countries were associated with a record 32.6 million internal displacements (IDMC/NRC, 2023^[9]). Another study shows that the global economic impact of internal displacement was estimated at USD 21 billion with about 55 million people² living in internal displacement in 2020, or USD 370 per internally displaced person (IDP). While this figure includes the cost of providing displaced people with support for their housing, education, health and security, and accounts for their loss of income, the limited data available on the financial costs and losses linked with internal displacement means this figure is likely to be a vast underestimate (IDMC, 2021^[10]).

Figure 1.1. Global warming threshold at which the crossing of climate system tipping points becomes likely



Note: Shaded in green is the 1.5°C-2°C Paris Agreement range of warming. The shaded area in grey shows the estimated 21st-century warming under current policies (horizontal line shows central estimates). Bars show the minimum (base, yellow); central (line, red); and maximum (top, dark red) threshold estimates for each tipping element (bold font, global; regular font, regional).

Source: McKay, D. et al. (2022^[11]), "Exceeding 1.5°C global warming could trigger multiple climate tipping points", <https://doi.org/10.1126/science.abn7950> in OECD (2023^[6]), *Net Zero+: Climate and Economic Resilience in a Changing World*, <https://doi.org/10.1787/da477dda-en>.

More generally, climate change creates cascading and compounding impacts on different systems in society and generates multiple interconnected consequences. *Cascading* impacts in cities are observed when a climate shock damages buildings and urban infrastructures and leads to a disruption of urban services such as transport, energy, water and food provision, resulting in impacts that are significantly higher than the initial impact. *Compounding* impacts in cities are observed when the impacts of a climate shock interact with pre-existing inequalities and vulnerabilities of urban residents, exacerbating the impacts (Matsumoto and Ledesma Bohorquez, 2023^[12]). In cities, for example, such impacts stem from alterations in economic systems (e.g. production, jobs), social systems (e.g. housing, health, education), ecological systems (e.g. forests, agriculture, biodiversity, water) and urban infrastructure systems (e.g. transport, energy, water and sanitation) (Table 1.1).

Table 1.1. Different impacts of climate shocks in cities

Shocks (from fast to slow onset)	Direct (single) impacts	Indirect, cascading and compounding impacts	Asymmetric impacts across places and/or people
Floods and storms	- Damages to urban infrastructure (e.g. roads, energy) and housing - Damages to schools and public health facilities - Disruption of urban services (e.g. water, energy, transport) - Damages to agricultural land - Degrading coastal ecosystems, such as mangroves or coastal reefs	- Disruption of urban services (e.g. health, food supply) due to damages to urban infrastructure (e.g. energy and transport) - Impacts on manufacturing supply chains (e.g. hard-disk drive manufacturing, food supply chains) - Locational and investment decisions of firms (in the long term) - Emergence of waterborne diseases - Changes in the demand for goods and services - A disruption in manufacturing supply chains that may affect places other than the one where a flood/storm is occurring - Loss of cultural assets and artefacts - Loss of sense of security among citizens - Displacements due to climate migration that create a higher demand for public services and increase the population living in informal settlements	- Economically and socially marginalised communities (living near rivers) may be more vulnerable to floods and damage to urban infrastructure. - Migration induced by floods affects the most vulnerable. - Children affected and more vulnerable to waterborne diseases. - Where mangroves are already affected, there is increased vulnerability of coastal communities.
Heatwaves	- Heat stress on human health - Pressure on energy, water infrastructure and supply - Damage to urban infrastructure	- Decrease of general labour productivity for both manual and cognitive tasks - Extended fire weather seasons (i.e. periods of time where weather conditions are conducive to the outbreak of wildfires) - Increased morbidity from vector-borne diseases	- Children and the elderly are more vulnerable to heat stress. - Low-income households living with inadequate housing conditions (e.g. without air conditioning) are more vulnerable. - Psychological or mental health impacts on the most exposed population.
Droughts	- Impacts on food supply system in cities - Water shortages affecting the population's access to safe drinking water	- Limiting the hydropower capacity of dams - Changes in ecosystems' functioning - Changes in labour and agricultural productivity - Land degradation - Impacts on food production leading to rise in food prices	Disruption of agricultural production leads to severe and more chronic food insecurity, increasing the propensity for malnutrition, as well as the rise of food prices. This problem is strongly concentrated in vulnerable populations.
Biodiversity loss	Loss of ecosystem services, such as carbon sequestration and the capacity to further adapt to climate change	Limitations for the discovery of potential treatments for diseases and health problems	Food and nutritional security impacts may disproportionately affect vulnerable populations.
Sea level rise	- Potential damages to urban assets in coastal areas - Impacts on urban land use and infrastructure investment strategies - Accelerated coastal erosion	- Coastal defences become increasingly expensive to adapt and maintain over time - Decrease of tourism-related activities	Vulnerability is higher in Small Islands Developing States, where the most vulnerable area is the low-lying coastal zone.

Source: (Matsumoto and Ledesma Bohorquez, 2023^[12]), *Building Systemic Climate Resilience in Cities*, OECD Publishing, Paris.

A striking illustration of the complex cascading and compounding effects of climate-related shocks is the historic cold wave and winter storm in February 2021, which hit the south-central part of the United States, including the city of Houston, Texas, and many regions within the Southern Plains such as Arkansas and Oklahoma. Despite skyrocketing heating needs, the cold had a significant impact on exposed equipment such as wellheads, thereby affecting electricity generation. The accumulation of thick ice on trees and power lines caused over 1 000 power generator outages and deratings across the region, leaving more than 10 million people without electricity for several days. The power outage cascaded into water treatment and medical services. Moreover, homeless people, whose living conditions were already challenging, faced severe difficulties to feed and warm themselves, as some shelters shut down due to power failure. Another example is the extreme heat that swept across Europe in the summer of 2022, which caused around 4 500 deaths in Germany, more than 1 000 in Portugal, 4 000 in Spain, and more than 3 200 in the United Kingdom (WHO, 2022^[13]). In London (United Kingdom), Luton Airport had to restrict flights after its runway had melted (Lombardi, Rodas and Ledesma, 2022^[14]), causing unexpected economic impacts. The poorest neighbourhoods often bear the worst consequences, as they often have higher density and lack shade, green space, ventilation and air conditioning (Matsumoto and Ledesma Bohorquez, 2023^[12]).

The disruptive events of recent years, including the COVID-19 pandemic and the wide-ranging implications of Russia's war of aggression against Ukraine, have also demonstrated the social and economic vulnerability of human systems and the threat that socio-economic disruptions can pose to climate policy resilience (OECD, 2023^[6]). Recovery spending following the COVID-19 pandemic has presented an opportunity to enhance climate policy efforts, as OECD data show that 33% of total COVID-19 recovery spending was environmentally friendly as of April 2022, up from 21% in September 2021. However, 14% of total recovery spending still went towards mixed or environmentally harmful activities (OECD, 2022^[15]). Moreover, in February 2022, Russia's war of aggression against Ukraine generated additional systemic impacts while throwing global economic recovery prospects from the COVID-19 pandemic off track. It pushed prices up substantially, especially for energy. The war has shed further light on the world's dependency on fossil fuel consumption, especially oil and gas, and has amplified calls for accelerating the energy transition by diversifying the energy matrix and improving energy efficiency (Matsumoto and Ledesma Bohorquez, 2023^[12]).

Climate impacts hit differently across places and people

The rapidly changing climate, particularly climate-induced risks, has profound implications across different places and people. The climate risks are determined by a combination of hazards, exposure and vulnerability, which are highly context-specific, as they rely on a wide range of local environmental and socio-economic factors. First, past, current and future climate-related hazards vary considerably from one place to another. Second, the degree of exposure to climate events depends on the characteristics of the local area and the elements – people, assets, biodiversity – that might be located in this area (Cardona et al., 2012^[16]). Last, vulnerability – the degree to which a community or system is susceptible to harm from climate change – relies on a range of local socio-economic and environmental factors (Cardona et al., 2012^[16]).

Different cities and regions within a country may face different types of hazards. For example, in 2022, Australia had to tackle both extreme droughts and floods simultaneously, with certain states (South Australia, parts of Victoria) affected by droughts, while the northeastern region (parts of New South Wales and Queensland) experienced its highest amount of rainfall on record (May, 2022^[17]). Geographic characteristics can also influence the climate-related risk faced by two neighbouring municipalities within the same region. For example, the French Riviera has a lower valley that faces serious flood risk due to its topography, while municipalities in the river delta are prone to landslides and beach erosion (Anthony, 2007^[18]). Within cities, different neighbourhoods may be exposed to different challenges related to climate change due to varying levels of urban heat island effects, vulnerability to flooding and access to green

spaces, among others. For example, some urban centres are 5-7°C warmer than their surrounding areas due to the urban heat island effect (OECD, 2022^[19]).

Marginalised communities often bear the brunt of climate impacts. Segments of the population that are marginalised due to gender, race, age, disability, income or geographic location are particularly vulnerable, both globally and within countries (OECD, 2021^[20]). Low-income population groups often live in areas prone to climate change hazards or ill-equipped to face climate risks. Thus, they are likely to have a lower capacity to recover from climate shocks (OECD, 2017^[21]). This challenge occurs even in countries with high average levels of economic development (OECD, 2015^[22]). For example, in Europe, there are pronounced regional differences in social vulnerability and exposure to climate-related hazards. Regions with lower average socio-economic status and higher proportions of elderly people in Southeast Europe experience greater exposure to high temperatures. Moreover, some regions tend to have higher average levels of nitrogen dioxide (NO₂), mostly because of the concentration of traffic and industrial activities in these locations, and poorer communities still tend to be exposed to these higher levels (EEA, 2018^[23]).

From the climate mitigation point of view, the level of GHG emissions, mitigation potential and enabling conditions to achieve the net zero transition also vary across different places. This variation is influenced by factors such as differing levels of capabilities and political commitment (IPCC, 2023^[1]). Moreover, the nature of economic activities driving GHG emissions can also exert a significant influence. For example, industrial regions have to undergo deep transformations to meet climate neutrality goals (OECD, 2022^[19]). Furthermore, the skillsets required to drive progress towards net zero can profoundly impact a region's capacity to implement effective measures. Within OECD countries, a recent study highlighted that approximately 18% of workers engage in roles involving a substantial portion of green tasks directly contributing to environmental sustainability or GHG reduction. However, the share of those “green tasks” differs widely across regions, ranging from 7% in some regions, such as Western Greece, to around 30% in metropolitan regions such as Paris (France), Vilnius (Lithuania) and Stockholm (Sweden) (OECD, 2023^[24]).

Governments at all levels are facing challenges in transitioning towards net zero and enhancing climate resilience

Despite the climate emergency, it is widely recognised that policy responses from national and subnational governments are not on track to meet the Paris Agreement goals. This section lays out the main gaps that both national and subnational governments are facing on their journey towards the net zero transition and in terms of enhancing climate resilience, highlighting the lack of a “place-based” perspective in climate policy as well as the lack of climate objectives in traditional “place-based” policies (i.e. urban, rural and regional development policies).

Challenges for national governments

The alarming global warming trend underscores the critical need for immediate and drastic measures to curb emissions so that they reach their peak before 2025 at the latest and drop by 43% by 2030, in accordance with the commitment set by countries in the Paris Agreement (UNFCCC, 2015^[25]). Since the adoption of the agreement in 2015, 130 countries, collectively responsible for 90% of global GHG emissions, have committed to carbon neutrality³ by mid-century. However, as of today, national governments' climate pledges still fall collectively short of the Paris Agreement goals. It is estimated that they can only potentially limit global warming to around 2.5°C by the end of the century – missing the Paris Agreement's 2.0°C or 1.5°C goal (OECD, 2021^[26]; 2023^[6]). Regarding climate adaptation, even though over 80 countries have established adaptation plans, strategies, laws and policies (OECD, 2023^[6]), many of these rely heavily on scarce international climate funds and multilateral finance (UNEP, 2022^[27]).

National governments have a crucial role in setting and implementing a national policy framework that translates global commitments into ambitious national goals and targets. However, several key challenges have been identified from the literature review:

- **A silo approach and related trade-offs.** National climate action mainly occurs on a sector-by-sector basis, which can lead to conflicting policies, competing priorities and unintended consequences, ultimately undermining overall policy effectiveness. For example, investing in renewable energy, such as solar farms, may conflict with efforts to protect forests and agricultural land. Moreover, inconsistent regulations and incentives (e.g. building codes, fossil fuel subsidies) across sectors can create confusion for subnational governments, businesses, residents and other stakeholders who must navigate a complex policy landscape.
- **Data and knowledge gaps.** There is a lack of comparable data that could help better understand locally specific GHG emission reduction potential as well as locally specific climate impacts and risks. Although 22 OECD countries have carried out climate risk assessments at the national level (OECD, forthcoming^[28]), it is claimed that downscaled climate data are often lacking (Tuhkanen, Vilbiks and Piirsalu, 2020^[29]). While common methodologies are gaining ground (see Chapter 4), not all cities use a standard methodology to report GHG emissions, even within the same country, which can hinder comparability and alignment between and across levels of government and sectors. This may also affect the ability of national governments to tailor their climate policies to local contexts, undermining the effectiveness of national climate policies.
- **Disconnect with cities and regions.** There is a lack of integration and engagement of local and regional governments in national efforts towards the net zero transition and enhancing resilience. For instance, among the 193 nationally determined contributions (NDCs) that exist globally, 70 have little or no urban content (UN-Habitat, 2022^[30]). This may imply that national governments have not always recognised the potential of local climate action. The limited place-based response to climate impacts, or a one-size-fits-all approach in climate policy across a whole country, may not be effective and could potentially lead to an unequal or inefficient distribution of resources for the implementation of climate plans and strategies. Moreover, engagement of local and regional governments is limited or not systematically integrated into national climate action. This highlights a strategic need for national governments to strengthen their engagement with cities and regions by removing barriers against, setting incentives for, coordinating with, and scaling up innovative climate action by cities and regions.

Challenges for cities and regions

Addressing climate change is a global challenge that has local impacts based on specific local conditions. It requires immediate, transformative and co-ordinated action from all levels of government and in co-operation with diverse stakeholders. Cities and regions have already been playing a critical role. For example, in 2019, local and regional governments accounted for 63% of climate-significant public expenditure and 69% of climate-significant public investment in 33 OECD countries and European Union (EU) countries (OECD, 2022^[31]).

However, despite the increasing evidence that climate change is affecting people's lives in every corner of the world, tackling climate change is not necessarily a priority for all levels of government, especially for local and regional governments if climate change is perceived as a solely global issue. Many cities and regions still do not consider climate as a top priority in their agendas (CDP, 2021^[32]). For example, according to the Net Zero Tracker (2023^[33]) – a global initiative that tracks more than 1 100 cities with a population over 500 000 inhabitants – net zero target setting has not yet spread widely beyond high-income countries in Asia, Europe and North America. Moreover, not all cities and regions are equally equipped to implement climate action, partly due to gaps in knowledge, capacity and funding. Small- and

medium-sized cities and towns also tend to have less support from higher levels of government and fewer direct opportunities for peer learning (OECD, 2020^[34]).

Major challenges for cities and regions that do not always engage in implementing national climate goals include the following, identified from the literature review:

- **Competing priorities and weak political buy-in.** Cities and regions juggle many urgent priorities (e.g. job creation, the cost of living crisis, housing affordability, etc.), which can prevent them from allocating sufficient resources to the climate agenda. In some cities and regions, climate mitigation, in particular, is still considered a purely global issue, as reducing GHG emissions may not bring immediate and tangible benefits to local constituencies. On the climate adaptation front, the process of planning and implementing adaptation measures can be subject to significant local political influences and varying priorities. Most decisions of local representatives are made according to the expectations of their constituents, which may differ from the imperative of climate adaptation, especially since public awareness of climate risks is relatively low (Khatibi et al., 2021^[35]). Lobbying at the local level often targets decisions related to actions such as land development or zoning (CoE, 2017^[36]), which can undermine adaptation measures or increase the vulnerability of people and infrastructure (e.g. construction in high-risk areas) (UNEP, 2017^[37]). For example, mayors may want to expand their cities by building housing estates and permeabilising soils when their cities are already prone to flooding or are exposed to other climate risks. Even when the risks are understood, politicians tend to focus on short-term emergency responses rather than on long-term adaptation solutions due to financial implications and political consequences (Ray Biswas and Rahman, 2023^[38]). These resilience-diminishing choices can be partly explained by the dichotomy between the short-term electoral cycles and the long-term outcome of adaptation measures (Averchenkova, Plyska and Wahlgren, 2022^[39]). Little interest from local decision makers in climate change can result in the absence of a dedicated department in the municipal administration, limited knowledge about the issue and the perception that climate-related matters have to be addressed at the national level (Zea-Reyes, Olivotto and Bergh, 2021^[40]; OECD, 2023, forthcoming^[41]).
- **Lack of alignment and co-ordination among and across levels of government.** Local climate action is sometimes hampered in a broader regional and national context. National standards and regulations may not be adapted to local issues or undermine local adaptation actions. For example, in Hungary, nature-based solutions are not integrated into infrastructure planning and regulation at the national level, which hinders their deployment (OECD, forthcoming^[42]). The lack of a mandate or unclear allocation of the responsibility and role of local authorities in climate action can also prevent them from taking action. For example, while local authorities could invest in adaptation measures to limit damages from climate events, they may not assume such a role due to a lack of explicit mandate stipulated in legal frameworks. Moreover, post-disaster damage is often covered by national entities, which does not encourage local authorities to bear the cost of climate adaptation (OECD, 2023, forthcoming^[41]). Moreover, limited co-ordination across municipal departments such as land use, transport, environment and housing can undermine the implementation of policies set at the national level. This issue is further exacerbated by horizontal fragmentation within municipalities, especially in large metropolitan areas (see more detailed discussion in Chapter 4).
- **Capacity gaps.** Many cities and regions struggle to translate declared ambitions into concrete climate actions and measures that speak to the local context and the needs of local communities and stakeholders. This gap stems from various factors, including limited resources, inadequate guidance and a perceived rigidity in policy frameworks (LGA, 2022^[43]). Cities and regions are often seeking specialised assistance and technical expertise in climate finance and investment planning, given the complexity of funding and financial frameworks. They are also in need of peer-to-peer learning networks to increase their knowledge and operational capacity for local climate action

(Liakou et al., 2022^[44]). In addition, there are stark disparities in subnational government climate-significant expenditure and investment across OECD countries, with a lack of funding and financing for subnational climate action in general (see more detailed discussion in Chapter 4).

- **Data and knowledge gaps** exist not only at the national level but also at the local and regional levels. The lack of comprehensive GHG emission monitoring and reporting frameworks at the local and regional levels is an obstacle to demonstrating to national policy makers that subnational governments can make a significant contribution to national targets. On adaptation, the lack of localised data makes it difficult to raise awareness among local policy makers and citizens about climate-related risks and the need for a net zero transition and enhancing climate resilience. Local authorities often lack adequate data to carry out climate risk assessments at the local level. The lack of data and information regarding local future climate threats is one of the main barriers faced by local authorities when planning adaptation actions. Projection of future climate impacts at the local level remains very challenging as it requires strong meteorological and modelling skills (Matsumoto and Ledesma Bohorquez, 2023^[12]). Moreover, poor understanding of the potential or perceived negative impacts of climate action at specific locations can raise questions on the fairness of climate action. For example, cities and regions that are specialised in energy-intensive industries (e.g. cement, steel) may face difficulties in dealing with high levels of emissions, waste and pollution (OECD, 2019^[45]). Some cities and regions (as well as countries) may feel that it is unfair to apply global and national targets to their domestic/local conditions as every climate action creates differentiated impacts across places and people and it is a challenging task to reach a consensus on a “fair” transition.

Definition and potential benefits of a territorial approach to climate action and resilience

The climate emergency, the insufficient level of climate action at all levels of government and the lack of a “place-based” perspective in climate policy call for a renewed approach. An immediate and untapped opportunity lies in adopting a territorial approach to climate action and resilience, which can both improve the effectiveness of national climate policy and accelerate local climate action. This section presents the concept of a territorial approach and discusses how it can help respond to complex climate challenges, drive the net zero transition and enhance climate resilience.

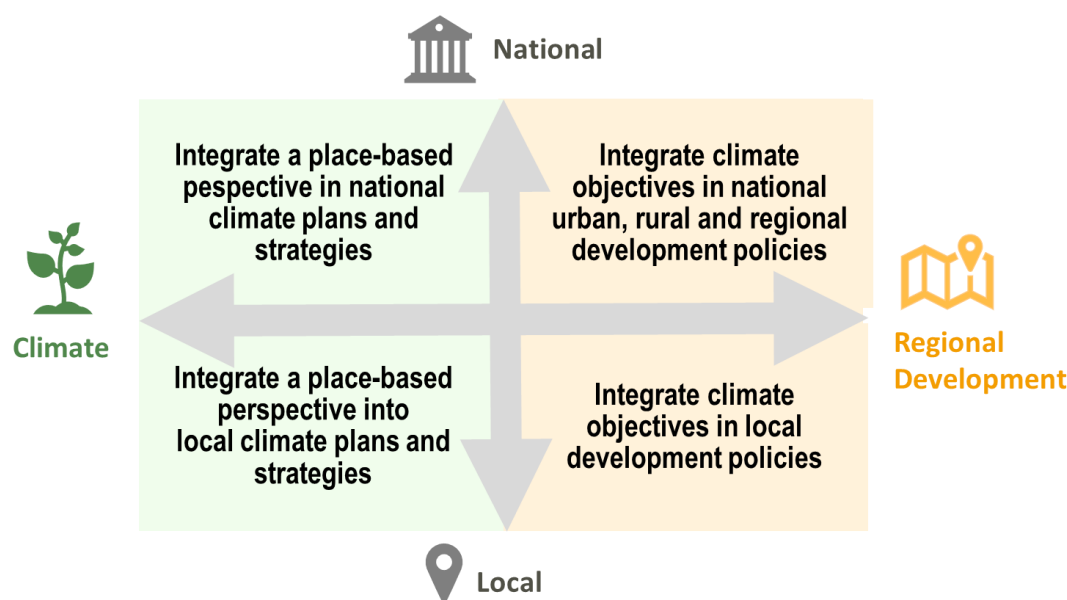
Definition

A territorial approach to climate action and resilience is defined as a comprehensive policy framework that integrates a place-based perspective of national and subnational climate policies and mainstreams climate objectives in urban, rural and regional development policies to effectively drive climate action at all territorial scales (Figure 1.2).

Place-based policies incorporate a set of co-ordinated actions specifically designed for a particular city or region, making the most of their unique assets and strengths (OECD, 2021^[26]). Therefore, integrating a place-based perspective into climate policies means that governments shift away from sectoral and one-size-fits-all measures and move towards multi-sectoral and context-specific measures. A prerequisite to adopting such a place-based perspective is to better understand local GHG emissions and reduction potential, as well as place-specific climate impacts and risks. Localising national climate goals, targets and strategies, i.e. developing a set of climate goals, targets and strategies at the regional and local scales, which are coherent with national ones but are also adapted to the local circumstances, is also an essential element of a territorial approach.

Mainstreaming climate objectives into urban, rural and regional development policies implies that urban, rural and regional development can become climate-proof. This can sometimes mean a fundamental shift in development priorities, including allocating resources towards climate-proof developments. For instance, in urban areas, this entails initiatives such as retrofitting buildings for energy efficiency and integrating nature into urban infrastructure development. In rural areas, a possible focus lies in ensuring sustainable mobility and building on the competitive advantages of rural regions in producing renewable energy.

Figure 1.2. A conceptual diagram of a territorial approach to climate action and resilience



Climate change must be tackled through all levels of government and thus, effective local climate action cannot be conceived in isolation from national policies. A territorial approach aims to combine top-down and bottom-up measures to maximise policy performance at different territorial scales. Implementing a territorial approach to climate action and resilience requires effective multi-level governance mechanisms, including setting and implementing ambitious national goals and targets that integrate local climate action by defining clear roles and responsibilities of subnational governments, national legal and institutional frameworks that allow for innovative local climate action, stronger funding and financing mechanisms to support and scale up subnational climate action, and a subnational enabling environment that facilitates partnerships and mutual learning.

How can a territorial approach respond to climate challenges?

A territorial approach to climate action and resilience can be a “game changer” by responding to the challenges described in the previous section. Key benefits of a territorial approach identified via a literature review are summarised below (Table 1.2).

- First, a territorial approach helps promote integrated climate action across sectors and thus makes a more efficient use of public expenditure and investments compared with a silo approach. In particular, place-based climate action can help link mitigation and adaptation measures and generate synergies, including between cities and neighbouring peri-urban and rural areas. For instance, a territorial approach can integrate measures regarding habitat restoration (wetlands, coastal and marine areas), “sponge” infrastructure such as retention ponds and permeable surfaces, sustainable and circular use of resources and land, energy efficiency retrofits or local

nature-based solutions that boost biodiversity, while enhancing human well-being and reducing exposure to climate-related extreme events, including sea level rise and extreme heat and precipitation (Bush and Doyon, 2019^[46]; OECD, 2021^[47]). For national governments, it is thus essential to engage cities and regions and to support their climate action, as it can enhance the overall effectiveness of climate action at the national scale.

- Second, a territorial approach grounded in a more granular understanding of climate impacts and risks can enhance systemic climate resilience for the most vulnerable people and places. Due to structural inequalities in terms of exposure to climate risks, the poor, elderly and economically vulnerable populations and places are likely to be hit the hardest by climate change impacts. By applying a territorial approach to climate action, national governments can identify areas and people with the greatest needs, whether to climate risks or to changes in employment and economic structure due to the net zero transition, minimise disproportionate negative impacts and ensure the net zero transition is just.
- Third, a territorial approach can help seize co-benefits and synergies through cross-sectoral and integrated climate projects that serve multiple policy objectives, enabling stronger political buy-in. Channelling green investment towards the right location not only contributes to environmental sustainability but can also boost local economic growth potential, which is even more important in light of the recovery from COVID-19. For example, local green jobs can be created by implementing low-carbon policies such as retrofitting existing building stock for improved energy efficiency and deploying renewable energy installations, both of which would build systemic climate resilience (OECD, 2023^[24]). The net zero transition will also place new demands on workers and firms, especially where local economies, such as extractive industries, are heavily dependent on fossil fuels, which can create a new growth potential, such as creating new jobs. This requires a concerted effort towards reskilling and upskilling the workforce for emerging green industries. National governments can foster innovation and entrepreneurship by supporting green clusters that build on local knowledge as well as existing industries and workers.
- Finally, a territorial approach can help shape a policy environment that is more conducive to ambitious climate action from cities and regions in stronger collaboration with upper levels of government. By fostering co-ordination and collaboration across different levels of government, this approach enables the pooling of resources, knowledge and expertise. This, in turn, facilitates the development and implementation of innovative climate strategies at the local and regional levels, ultimately leading to a more effective and integrated response to climate change. It can also bridge local governments' capacity gaps by facilitating localised data and knowledge exchange across cities. Moreover, cities and regions can apply a territorial approach within their own geography to tailor their climate policies to further disaggregated territorial scales such as neighbourhoods, districts and communities to address their specific needs and improve overall policy impact.

Table 1.2. How can a territorial approach to climate action and resilience benefit national, regional and local governments?

Governments	Policy challenges to drive the net zero transition and enhance resilience	How a territorial approach can help respond to the challenges
National	• A silo approach and related trade-offs • Data and knowledge gaps • Disconnect with cities and regions	• A territorial approach can promote integrated climate action across sectors and thus make public investment more efficient, e.g. linking mitigation and adaptation measures and generate synergies. • A territorial approach can enhance a more granular understanding of local GHG emissions, local challenges and exposure to climate risks, which can enhance systemic climate resilience for the most vulnerable people and places. • Engaging and supporting cities and regions can enhance the overall level of climate action as a country.
Regional and local	• Competing priorities and weak political buy-in • Lack of alignment and co-ordination among and across levels of government • Capacity gaps • Data and knowledge gaps	• A territorial approach can help seize co-benefits and synergies through cross-sectoral/integrated climate projects which serve multiple policy objectives at specific locations. • A territorial approach can provide them with a more favourable policy environment to take ambitious climate action. • A territorial approach can foster co-ordination and collaboration across different levels of government, which enables the pooling of resources, knowledge and expertise.

A territorial approach can be applied in different policy fields of climate action and resilience. Below is a selection of fields of opportunities for an innovative territorial approach, both on climate mitigation and adaptation and both at the national and subnational scales, which will be further discussed in Chapter 4:

- Integrating **land use, housing and transport policies**, including within and across urban and rural areas. The enforcement (or lack) of local land use planning has critical impacts on mitigation (e.g. urban sprawl, renewable energy on rooftops or at the urban periphery, transport planning and service delivery in cities, between rural and urban areas and in low-density areas) as well as on the degree to which climate-related extreme weather events affect local communities and economies. However, climate-friendly and risk-sensitive land use (e.g. denser urban areas, mixed-use development, home-job proximity, land use restrictions in hazard-prone areas) may not always be fully taken into consideration in other sectoral policies. For example, housing policy may often prioritise the supply of affordable housing units with less consideration of their location by placing large housing developments in poorly serviced areas on the urban periphery and neglecting core concepts such as transit-oriented and resilient development. Similarly, climate change mitigation policies that aim to reduce emissions across the board, without considering local contexts or the need for a just transition, may promote place-blind and sectoral outcomes that negatively impact local economies, undermine local support and hinder climate action.
- Investing in **nature-based, climate-resilient infrastructure** to address location-specific climate challenges. Cities and regions can transition from predominantly ubiquitous “grey”, human-built infrastructure to “green”, nature-based solutions, which can enhance systemic resilience to extreme weather events such as heatwaves and flooding and address water scarcity and water security, while yielding well-being and environmental co-benefits (OECD, 2020^[48]). For example, cities have a broad range of financial tools and incentives (e.g. property taxes, value capture tools, congestion charges and parking fees) at their disposal to enhance climate-resilient urban infrastructure (OECD, 2019^[49]; 2021^[26]).
- Promoting **energy efficiency retrofits in residential and office buildings**. Buildings are a major source of final energy consumption in urban areas. In 2021, buildings accounted for 33% of global energy-related and process-related CO₂ emissions (8% from the use of fossil fuels in buildings, 19% from the generation of electricity and heat used in buildings and 6% from the manufacture of

materials used in buildings construction) (IEA, 2022^[50]). In most countries, national governments oversee the process of setting a framework for energy efficiency investments, including building standards. Such national efforts, of which many have seen an important increase as part of COVID-19 recovery efforts, can be complemented with effective subnational actions based on the ability of subnational governments to factor in local elements and leverage policy authority over buildings. Examples of such subnational actions include tailored urban standards and energy efficiency retrofit projects, such as the emissions limit in New York, United States, for existing large buildings, retrofitting government-owned buildings in Berlin, Germany, and the large-scale tower renewal programme in Toronto, Canada.

- **Scaling up the generation and use of clean energy** in cities and rural areas. As the costs of renewable energy generation have plummeted in recent years, more and more cities and regions around the world are deploying clean energy technologies at varying scales. Subnational governments, especially municipal authorities, cannot always directly decarbonise energy supply and consumption and may instead rely on measures taken by the national government (CUT, 2019^[51]). However, they can often engage in other means of procuring clean energy, for instance through power purchase agreements with third-party renewable producers, leveraging publicly owned utilities, or through decentralised on-site generation of electricity (e.g. rooftop photovoltaics) and heat (e.g. biogas at local landfill sites and wastewater treatment plants). Rural regions, particularly remote areas, are at the forefront of renewable electricity production, as a larger group of individuals are becoming owners of renewable energy production facilities and potentially increasing profit margins.

The OECD's ongoing initiatives related to a territorial approach to climate action and resilience

The OECD has played a key role in analysing the global, national, subnational and sectoral dimensions of climate change, with a place-based dimension always being an essential element. The following initiatives represent some of the most recent and relevant efforts:

- The **International Programme for Action on Climate** (IPAC). Since 2021, the programme has been supporting countries in monitoring and evaluating climate policies with the goal of strengthening and co-ordinating their climate action. The subnational dimension has not yet been part of the monitoring framework but is within the scope of future development (OECD, 2022^[52]).
- The **Inclusive Forum on Carbon Mitigation Approaches** (IFCMA). Established in January 2023, this initiative is designed to help improve the global impact of emissions reduction efforts around the world through better data and information sharing, evidence-based mutual learning and inclusive multilateral dialogue. It brings together all relevant policy perspectives from a diverse range of countries around the world, participating on an equal footing basis, to take stock of and consider the effectiveness of different carbon mitigation approaches (OECD, 2023^[53]).
- The **Horizontal Project on Climate and Economic Resilience in a Changing World**. The project draws on the multidisciplinary reach of the OECD to support governments in driving the swift transformational change needed to tackle climate change. The first phase of the programme concluded in 2023 with the launch of the OECD report *Net Zero+: Climate and Economic Resilience in a Changing World* (2023^[6]). The report discusses, among other issues, the role of cities and regions in building resilience to climate shocks and provides a framework for understanding and enhancing systemic climate resilience in cities. The report offers state-of-the-art evidence-based analysis and guidance for governments on developing effective planning, financing, and policy co-ordination mechanisms to help them better mitigate, prepare for, recover from and adapt to economic and social shocks related to climate change (OECD, 2023^[6]).
- The **National Urban Policy Programme** (NUPP). This joint initiative of the OECD, the United Nations Human Settlements Programme (UN-Habitat) and the Cities Alliance aims to support the

development and implementation of national urban policies (NUPs) globally. The programme monitors NUPs through a global survey. The latest edition was launched in 2021 and analysed the extent to which NUPs address climate adaptation and mitigation, and related challenges and co-ordination mechanisms. In particular, the report has revealed that climate action features prominently in most NUPs within traditional urban planning priorities (e.g. the built environment) and a growing share of NUPs is exploring innovative mechanisms, such as local GHG emission inventories. Countries have also recognised that urban climate interventions generate multiple related benefits such as more sustainable mobility and reduced pollution. Countries have highlighted knowledge gaps and the lack of co-ordination as key challenges in integrating climate change issues in NUPs (OECD/UN-Habitat/Cities Alliance, 2021^[54]).

- The **OECD Subnational Government Climate Finance Hub**.⁴ This initiative aims to provide a one-stop shop that compiles qualitative and quantitative information to provide a comprehensive picture of regional and local climate finance on both the expenditure and revenue sides at the macro and micro levels. It has three main objectives: better measuring how much subnational governments spend and invest in climate action; better understanding how subnational climate action is funded and financed, in other words, better identifying the different sources of revenue that can help meet the needs of the green transition (international, national and own-revenue sources); and identifying how additional public and private sources of funding and financing can be mobilised. The hub comprises a new and unique database with data on subnational climate-significant expenditure and investment in 33 OECD and EU countries. It also includes a compendium of fiscal tools – mainly provided by international and national governments – that support subnational climate action for adaptation and mitigation in the OECD and the European Union (e.g. climate or green funds). It also proposes a set of six guidelines with concrete recommendations to help regions and municipalities develop a green budgeting practice. This is accompanied by an inventory of existing subnational green budgeting practices in OECD countries and the European Union, case studies and a self-assessment tool.
- The **OECD Principles on Rural Policy**. Adopted by the Regional Development Policy Committee in 2019, the rural principles crystallise over 20 years of the OECD's work on rural development and were developed through a comprehensive review process with OECD member countries and key stakeholders. They are targeted at national ministries dealing with rural areas, rural policies and sustainable development, subnational levels of government and stakeholders involved in or affected by rural policy (e.g. from civil society, the private sector, academia or financial institutions). Several principles, including Principle 1 "Maximise the potential of all rural areas", Principle 4 "Set a forward-looking vision for rural policies" and Principle 8 "Strengthen the social, economics, ecological and cultural resilience of rural communities", recognise the role of rural areas in tackling climate change (OECD, 2019^[55]).
- The **OECD Principles on Urban Policy** and its **Implementation Toolkit**. Adopted by the Regional Development Policy Committee in 2019, the principles consolidate the lessons from the past 20 years and more of work on cities to guide policy makers in building smart, sustainable and inclusive cities. The principles were welcomed by mayors and ministers during the 7th OECD Roundtable of Mayors and Ministers held on 19 March 2019 in Athens, Greece. Mayors, ministers and partner institutions are committed to supporting the implementation of the principles through the Athens Pledge. Principle 5 "Leverage the potential of cities of all sizes for advancing environmental quality and the transition to a low-carbon economy" explicitly recognises the pivotal role of cities in addressing climate change. Moreover, the Implementation Toolkit, launched in 2022, aims to support cities, regions and countries in their efforts to use the principles as a driver of policy reform in diverse urban policy contexts. It includes a self-assessment tool that provides guiding questions and indicators to assess the state of play of urban policy frameworks and a policy database which offers a selection of more than 60 leading examples of national and subnational governments using the principles to reshape urban policy (OECD, 2019^[56]; 2022^[57]).

The **OECD Recommendation on Regional Development Policy**. Adopted in 2023, the OECD recommendation provides countries with a comprehensive policy framework to support the design and implementation of effective regional development policies. It considers that regional development policy is a long-term, cross-sectoral, multi-level policy that aims to improve the contribution of all regions to national performance and reduce inequalities between places and between people. The recommendation also calls for mainstreaming climate action into regional development agendas. It underscores the relevance of urban, rural and regional climate action as a major driver in achieving net zero carbon emissions and facilitating the green transition (Box 1.1).

Box 1.1. The OECD Recommendation on Regional Development Policy

The OECD Recommendation on Regional Development Policy, adopted on 8 June 2023 by the OECD Council at Ministerial Level, provides countries with a comprehensive policy framework to support the design and implementation of effective regional development policies. It considers that regional development policy is a long-term, cross-sectoral, multi-level policy that aims to improve the contribution of all regions to national performance and reduce inequalities between places and between people. The recommendation will be used to review regional development policy frameworks in OECD member countries and beyond.

The recommendation rests on ten complementary pillars of regional development policy. These are: i) designing and implementing a regional development strategy; ii) targeting the appropriate territorial scale; iii) engaging with communities and stakeholders to co-produce; iv) making regions more resilient; v) promoting territorial data; vi) establishing sound multi-level governance systems; vii) strengthening capacities; viii) mobilising financial resources; ix) promoting integrity; and x) fostering performance management.

The recommendation acknowledges the role of regional development policy to address the asymmetric impact of global megatrends and shocks and deliver a sustainable and just green transition.

Figure 1.3. Ten pillars of regional development policy



Source: OECD (2023^[58]), *Recommendation of the Council on Regional Development Policy*, <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0492>.

This report builds on the overall OECD work on climate and urban policy to further advance the understanding of the crucial role played by cities and regions in addressing climate change. To do so, the rest of the report proposes a new territorial climate indicator framework (Chapter 2) and applies it to conduct a comparative analysis of GHG emissions, climate impacts and vulnerabilities at the subnational scale (Chapter 3). The report also assesses current climate policies at different levels of government and presents recommended actions to enhance climate action through a territorial approach (Chapter 4).

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Notes

¹ Prior to the Industrial Revolution, CO₂ levels were consistently around 280 ppm for almost 6,000 years of human civilization. CO₂ levels are now comparable to the Pliocene Climatic Optimum, between 4.1 and 4.5 million years ago, when they were close to, or above 400 ppm. During that time, sea levels were between 5 and 25 meters higher than today and temperatures then averaged 7 degrees Fahrenheit higher than in pre-industrial times (NOAA, 2022_[3]).

² The assessment was made for 18 countries with 55 million people living in internal displacement in 2020 as a result of conflict, violence and disasters, including climate-related disasters (IDMC, 2021_[10]).

³ In this report, “carbon neutrality” refers to having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing CO₂ from the atmosphere and then storing it is known as “carbon sequestration” (European Parliament, 2019^[62]). “Net zero” involves multiple GHG emissions and places much more focus on reducing carbon emissions as much as possible first and only offsetting unavoidable, residual GHG emissions.

⁴ See <https://www.oecd.org/regional/sngclimatefinancehub.htm>.

2 Introducing the OECD territorial climate indicator framework

Building on the OECD Regional and Metropolitan Databases, the OECD indicator framework on localising the United Nations Sustainable Development Goals (SDGs) and the OECD International Programme for Action on Climate (IPAC), this chapter presents a territorial climate indicator framework designed to monitor climate action and resilience efforts in cities and regions in a globally comparable manner. The framework also incorporates a method to measure the distance of cities and regions to net zero objectives. The chapter provides technical guidance on how to use the framework as a tool to better understand the diversity of local greenhouse gas emissions and emission reduction potential, as well as locally specific impacts and risks of climate change, all of which can help inform place-specific climate strategies.

Introduction: Why measure local climate action?

A comprehensive understanding of climate challenges and opportunities at different territorial scales is a prerequisite for a territorial approach to climate action and resilience. As discussed in Chapter 1, a more granular understanding of how much greenhouse gas (GHG) is emitted and which climate impacts and risks exist in cities and regions is crucial for national governments to tailor their policies and strategies across places and redirect budgets towards the right locations. For local and regional governments, a comparative assessment of where they stand with regard to global and national climate targets, as well as against their peers, allows them to set priorities and allocate resources accordingly.

Typically, national governments use sector-based climate data at the national level in developing and implementing their climate policies, both for mitigation and adaptation. However, national averages tend to mask territorial disparities, which may hamper the effective implementation of climate policy interventions. Emerging evidence demonstrates that there are non-negligible territorial disparities in terms of climate impact in different places (Chapter 3). For example, during the past 5 years, daytime temperatures in half of OECD cities were 3 degrees Celsius (°C) higher than in the surrounding areas during the summer (OECD, 2022^[1]). Some cities were even 7°C warmer. The diversity of local climate impacts implies that some of the climate systems tipping points (as discussed in Chapter 1) can be reached much faster in some geographical locations, creating potentially abrupt and irreversible changes to the environment. Moreover, place-specific climate impacts and risks are often people-specific, as most vulnerable groups in society tend to be more exposed to the impacts of climate change.

Only limited information about how cities and regions fare with regard to global and national climate targets is available. For example, the OECD's ongoing research on localising the United Nations Sustainable Development Goals (SDGs) has demonstrated that none of the OECD regions has achieved the suggested outcomes for SDG 13 on climate action but they stand, on average, one-third of the way from accomplishing the suggested outcomes. Likewise, a majority (98%) of OECD cities have not achieved the target values of less than 111 tonnes of carbon dioxide equivalent per gigawatt-hour (tCO₂-eq/GWh) and no increase in the demand of energy to cool buildings, measured as cooling degree days (OECD, 2020^[2]). Developing more data in this area in a globally comparable manner will be instrumental for both national and subnational governments to understand where they stand and take necessary policy action.

Against this backdrop, this chapter presents an OECD territorial climate indicator framework designed to better understand locally specific climate trends and challenges as well as to monitor climate action and resilience efforts of cities and regions. This framework allows the unveiling of territorial disparities in terms of GHG emissions and trends, as well as climate impacts and risks. Furthermore, the framework incorporates a method to measure the “distance” of cities and regions from achieving net zero objectives, with emphasis on facilitating international comparisons. The objective of the chapter is to provide national and subnational governments with technical guidance on how to use the OECD territorial climate framework as a tool to advance place-based climate action and resilience policies.

Taking stock of existing climate-related indicator initiatives

Existing initiatives measuring local climate action

A handful of initiatives have developed indicator frameworks to measure GHG emissions, climate impacts and risks at the subnational scale and provided technical support and guidance for cities and regions (Table 2.1). A stocktaking exercise on such initiatives has led to the following key findings:

- Initiatives such as the Carbon Disclosure Project (CDP) Cities, States and Regions Open Data Portal specifically emphasise climate action, while others, such as the European Bank for

Reconstruction and Development (EBRD) Green City Methodology, extend their scope to wider sustainability.

- Regarding the scope, many initiatives provide a self-assessment and reporting methodology for cities and regions. Such examples include the CDP-ICLEI Open Data Portal, the Global Covenant of Mayors (GCoM) Sustainable Energy and Climate Action Plan (SECAP), C40's "Measuring progress in urban climate change adaptation" and the World Bank Urban Sustainability Framework. They assist cities in gathering data and reporting their climate action planning and implementation. Most of the initiatives focus on climate mitigation although there is an emerging trend to measure adaptation (e.g. the International Organization for Standardization [ISO] Sustainable Cities and Communities).
- Most initiatives rely on the voluntary participation of cities in terms of data collection. For example, the GCoM SECAP compiles and discloses data reported by participating cities and regions. Very few initiatives (e.g. Net Zero Tracker) collect and disclose data by themselves.
- Many initiatives allow flexibility in terms of reporting data, so cities and regions can customise indicator frameworks to their specific circumstances. For instance, the ERDB Green City Methodology and C40 Climate Change Adaptation Monitoring, Evaluation and Reporting (CCA MER) allow cities to select the most suitable indicators for their needs.
- Some initiatives assist cities in keeping track of the outcomes of their climate action plans, such as the C40 CCA MER, so cities can determine the success or failure of their climate adaptation efforts. Others aim to visualise the distance of cities and regions to achieving climate targets. The Green City Methodology encourages cities to benchmark their mitigation performance in different sectors against national targets to identify areas of priority for mitigation investment through a traffic light system. None of the initiatives provide a tool to compare cities and regions with global climate targets.
- Very few initiatives target metropolitan areas or functional urban areas (FUAs) beyond municipal administrative borders. SECAP offers the possibility of a joint action plan developed collectively by a group of neighbouring local authorities, aiming to achieve more effective results together than isolated. This joint initiative is targeted at small municipalities, inter-municipal networks and urban agglomerations such as a metropolis and its suburbs, among other cases.
- The application of these indicator frameworks is primarily local and they are not designed for aggregation or disaggregation of climate data across different territorial scales. This means the indicators essentially lack standardisation or compatibility across places. For example, although a common measurement framework is provided to estimate GHG emissions, cities can choose different methodologies, thereby limiting data comparability as well as the possibility of aggregation and disaggregation of data.

While these key findings confirm the need for and usefulness of such indicator initiatives, they also demonstrate a lack of comparability and compatibility across cities, regions and countries.

Table 2.1. Mapping of international initiatives supporting the development of subnational climate data

Name	Organisation and year	Mandate/objective	Scope (adaptation/mitigation)	Type of data (official statistics, geospatial data, self-reported)	Geographical coverage	Data collected	Source
Cities, States and Regions Open Data Portal	Carbon Disclosure Project (CDP) in collaboration with the International Council for Local Environmental Initiatives (ICLEI), referred to as CDP-ICLEI, 2019	Enable cities to report their climate commitments, provide guidance and support in enhancing their climate targets and benchmark the progress over time in climate risks, hazards, emissions and sector-specific data (i.e. transport, water and waste), while facilitating the assessment of financial implications and co-benefits of climate actions such as improved health, biodiversity and social inclusion.	Mitigation, adaptation	Self-reported data by cities and regions	Global	Self-reported environmental data from over 20 000 entities, including governance (targets, adaptation and mitigation plans) and primary environmental data (emissions, resource consumption).	(CDP, 2023 ^[31])
Sustainable Cities and Communities	The International Organization for Standardization (ISO), 2016	Streamline city comparisons and enable alignment with other global action initiatives by establishing a standardised framework for evaluating urban sustainability based on city preparedness and resilience, using indicators that are tailored to foster resilient and smart cities.	Mitigation, adaption	Does not collect data, provides a methodology to carry out data collection and defines indicators	Global	Indicators for environmental, social and governance critical infrastructure, disaster, hazard mapping, water, resilience, resilient city stress, vulnerability and risk.	(ISO, 2020 ^[41])
Net Zero Tracker	Energy and Climate Intelligence Unit, Data-Driven EnviroLab, NewClimate Institute, Oxford Net Zero, 2021	Increase transparency and accountability of targets for net zero emissions pledged by national and subnational governments (including cities and regions).	Mitigation	Data collected from publicly available sources	Global	Information for each target, including the year of adoption, gas coverage, if there is any publicly available plan, reporting mechanism, if the net zero target is adopted by law, in a policy document, declaration/pledge or is proposed/in discussion.	(Net Zero Tracker, 2023 ^[51])
Geospatial Indicators Dashboard	UrbanShift; Cities4Forest, 2022	Enable urban decision makers, researchers and stakeholders to utilise a data-driven approach to urban issues and opportunities and ensure alignment with global climate change initiatives, such as the SDGs.	Mitigation, adaptation	Open-source data, geospatial data	Participating cities	Indicators across seven key sustainability themes, including air quality, flooding, extreme heat, biodiversity, greenspace access, land protection and restoration and climate mitigation.	(Mackres, Shabou and Wong, 2023 ^[61])

Name	Organisation and year	Mandate/objective	Scope (adaptation/mitigation)	Type of data (official statistics, geospatial data, self-reported)	Geographical coverage	Data collected	Source
Green City Methodology	European Bank for Reconstruction and Development (ERDB), 2018	Assess and prioritise environmental challenges to develop an action plan to tackle the challenges through policy intervention and sustainable infrastructure investments, facilitate and stimulate public or private green investments in water and wastewater, urban transport, district energy, energy efficiency in buildings, renewable energy, solid waste and climate resilience, and provide technical support to city administrators to ensure that infrastructure investments are implemented effectively.	Mitigation, adaptation	Does not collect data	Global	Environmental, social and technical indicators across sectors (transport, buildings, industry and energy), including emissions, energy consumption, efficiency indicators, resilience and waste. Other data also include health quality indicators (air, water and soil quality).	(EBRD, 2022 ^[7])
Urban Climate Change Adaptation (CCA) Monitoring, Evaluation, and Reporting (MER) Framework	C40, 2019	Assess and monitor cities' climate change adaptation plans and evaluate their results to make a case for adaptation, secure funding and implement plans as effectively as possible.	Adaptation	Does not collect data, provides a methodology to carry out data collection and defines indicators	Global, but mainly C40 cities	Output, outcome and impact.	(C40 Cities/Ramboll/Ramboll Fonden, 2019 ^[8])
Sustainable Energy and Climate Action Plan (SECAP)	Global Covenant of Mayors for Climate and Energy (GCoM), 2015	Provide a comprehensive strategy for both climate mitigation and adaptation plans, streamlining the process of formulating these plans through a harmonised data compilation and reporting framework available for all GCoM signatories.	Mitigation, adaptation	Does not collect data, provides a methodology to carry out data collection and defines indicators	GCoM signatories, cities and regions (joint SECAP)	Environmental, social, and corporate governance (ESG) indicators.	(EC, 2018 ^[9])

Source: Based on sources listed in the respective column.

Existing climate-related indicator frameworks developed by the OECD

The OECD has a well-established expertise in generating data across a wide range of social, economic and environmental domains, including climate change. To ensure a more granular understanding of territorial disparities and allow international comparison, the OECD has developed several indicator frameworks with national and subnational climate data.

At the national level, the OECD International Programme for Action on Climate (IPAC) has developed a dashboard to support countries' efforts in monitoring progress towards net zero emissions and a more resilient economy by 2050. The dashboard builds on the extensive availability of climate statistics from the OECD, the International Energy Agency (IEA) and the International Transport Forum (ITF). At the subnational level, the OECD Regional Database and the OECD Metropolitan Database provide a unique set of comparable statistics and indicators on 2 000 regions and 650 metropolitan areas across OECD countries. In addition, while not exclusively centred on climate, the OECD localised indicator framework for the SDGs incorporates relevant indicators at the subnational level within the broader SDG framework (Table 2.2).

Table 2.2. Existing OECD climate-related indicator frameworks

Indicator framework	Description	Geographical coverage	Data sources
IPAC Dashboard	The selection of indicators for IPAC builds on the conceptual frameworks and guidance elaborated for the development, measurement and use of environmental and green growth indicators adapted to climate change issues. The IPAC framework uses an adapted "pressure-state-response" model to structure the indicators. This adapted model integrates the topics covered in the assessments of the IPCC and is used in the United Nations Statistics Division (UNSD) and United Nations Economic Commission for Europe (UNECE) indicator frameworks. The criteria used for selecting the indicators and validating their choice are those developed with OECD member countries and already used for the OECD's environmental and green growth indicators: policy relevance and utility for users, analytical soundness and measurability.	National level	Statistics from the OECD, IEA, ITF, Nuclear Energy Agency (NEA) and other international sources, including the United Nations Framework Convention on Climate Change (UNFCCC)
OECD localised indicator framework for the SDGs	The OECD localised framework for the SDGs is a unique, internationally comparable SDG indicator framework for cities and regions. It aims to support cities and regions in OECD and partner countries in measuring their distances towards achieving the SDGs. The indicator framework allows for documenting the share of OECD cities and regions that are on track with respect to the 2030 goals and quantifies the average distance that these cities and regions must travel in order to reach the desired outcomes. To do this, it normalises the SDG indicators from 0 to 100 – where 100 is the suggested end value of an indicator to be achieved by 2030 – and aggregates headline indicators that belong to the same goal to provide an index score towards each of the 17 SDGs. The distance to each SDG is defined as the number of units the index needs to travel to reach the maximum score of 100.	Subnational level – TL2, TL3 and FUAs	Statistics of the OECD Regional and Metropolitan Databases and data from large international databases (e.g. Gallup World Poll, Global Power Plant Database)

Indicator framework	Description	Geographical coverage	Data sources
	The indicator framework includes more than 130 indicators and covers more than 600 regions and 600 cities in 65 out of the 105 SDG targets where regional and local governments are considered instrumental (although the regional and city coverage can vary widely from one indicator to another). It includes six indicators under SDG 13 on climate and several other climate-related indicators (e.g. percentage of total electricity production that comes from renewable sources on SDG 7; percentage of population with access to at least 1 hectare of green urban areas on SDG 11; and municipal waste rate [kilos per capita] on SDG 12).		
OECD Regional Database	The OECD Regional Database provides a unique set of comparable statistics and indicators on about 2 000 regions in 36 OECD countries, plus Brazil, the People's Republic of China, Colombia, India, Peru, the Russian Federation, South Africa and Tunisia. It currently encompasses yearly time series for more than 100 indicators of demography, economic accounts, labour market, social and innovation themes in OECD member countries and other economies. The OECD classifies its regions on two territorial levels, reflecting the administrative organisation of countries. The 398 OECD large (TL2) regions represent the first administrative tier of subnational government, for example, the Ontario Province in Canada. The 2 251 OECD small (TL3) regions correspond to administrative regions, with the exception of Australia, Canada and the United States. These TL3 regions are contained in a TL2 region, with the exception of the United States, for which the economic areas cross the states' borders. For New Zealand, TL2 and TL3 levels are equivalent and defined by regional councils. All regions are defined within national borders. This classification – which, for European countries, is largely consistent with the Eurostat NUTS 2013 classification – facilitates greater comparability of geographic units at the same territorial level. Indeed, these two levels, which are officially established and relatively stable in all member countries, are used as a framework for implementing regional policies in most countries.	Subnational level – TL2, TL3	Input from member states and data from large international databases
OECD Metropolitan Database	The OECD Metropolitan Database provides a set of economic, environmental, social, labour market and demographically estimated indicators on the 649 OECD metropolitan areas (FUAs with 250 000 or more inhabitants). The database relies on a consistent definition of FUAs applied across countries, which was developed in collaboration with the European Union. Using population density and travel-to-work flows as key information, an FUA consists of a densely inhabited city and a surrounding area (commuting zone) whose labour market is highly integrated with the city. The ultimate aim of the OECD-EU approach to FUAs is to create a harmonised definition of cities and their areas of influence for international comparisons as well as for policy analysis on topics related to urban development. Using FUAs allows designing policies at the right scale, for example, for mobility and accessibility to services. At the same time, FUAs provide a harmonised methodology to compare similar urban units in size and function. This is particularly relevant in the context of the SDGs, a universal global agenda that requires comparability across the globe in order to track progress towards sustainable development.	Subnational level – FUAs	Input from member states and data from large international databases
OECD database on subnational government structure and finance	The OECD database on subnational government structure and finance provides data on territorial organisation at subnational levels and public finance. Financial data cover the general government and subnational government (state and local government levels) sectors in OECD member countries and in the European Union. Four main dimensions are presented: expenditure (including investment), revenue, budget balance and debt. The database is updated annually.	Subnational level – TL2, TL3	Data from OECD, International Monetary Fund (IMF) and Eurostat databases

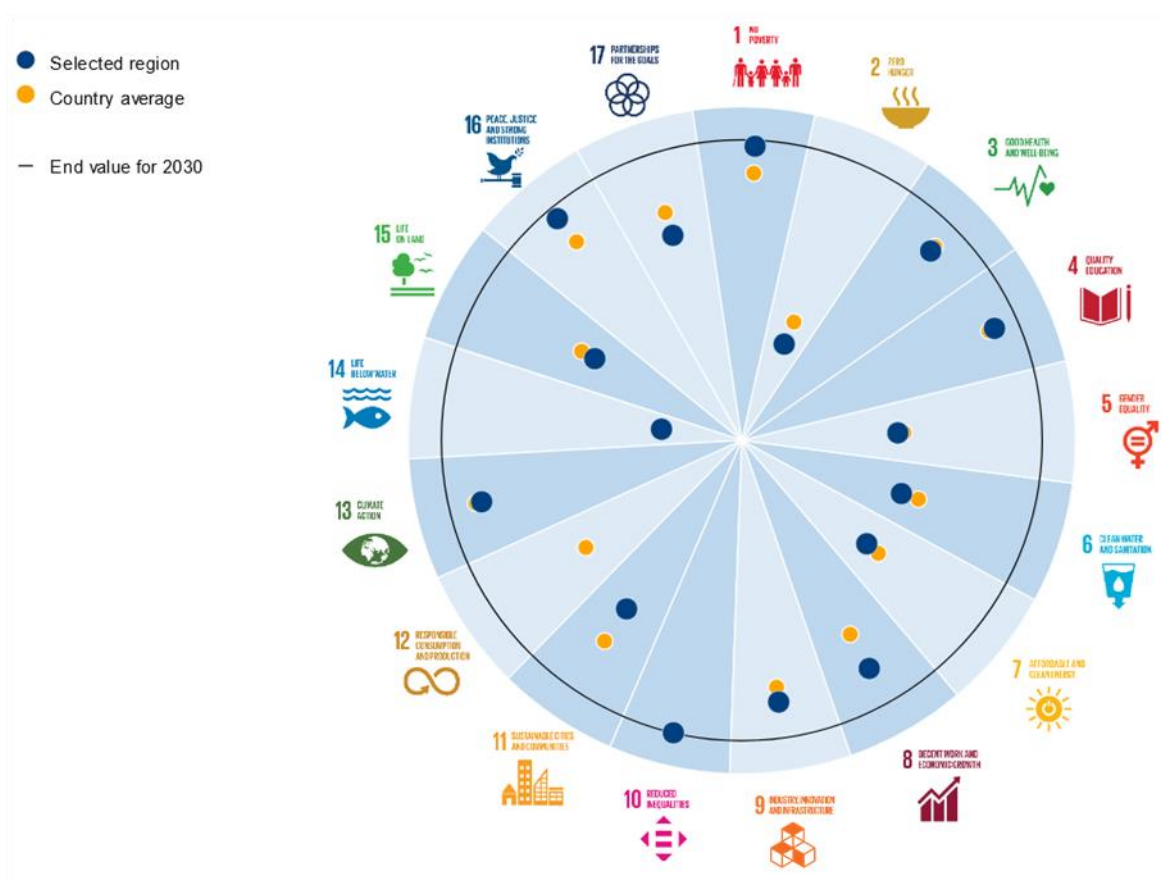
Indicator framework	Description	Geographical coverage	Data sources
OECD-United Cities and Local Governments (UCLG) World Observatory on Subnational Government Finance and Investment	The World Observatory on Subnational Government Finance and Investment (SNG-WOFI) is a joint endeavour led by the OECD and UCLG. It provides subnational government finance data at the global level, covering 135 countries worldwide in the latest 2022 edition. The data are updated every three years. For federal countries, the database differentiates between local and state/provincial government data. For unitary countries, the data concern the consolidated subnational government sector as a whole.	Subnational government sector	Input from member states and statistics from national databases
OECD database on subnational government climate finance	The OECD database on subnational government climate finance provides data on subnational government climate-significant expenditure and investment for 33 OECD and European Union (EU) countries, from 2001 to 2019. Data were collected using a standardised pioneer methodology based on national accounts data. For federal countries, the database differentiates between local and state/provincial government data.	Subnational government sector, TL2	Data from OECD, IMF and Eurostat databases
Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries	The Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries provides an overview of some climate-related public revenue sources from higher levels of governments (the European Union, central governments and federal governments in federal countries) available to subnational governments (as of 2022). The compendium is complemented by an analysis of the diversity of climate-related revenue sources available to subnational governments and the gaps that exist.	National	Input from member states

Source: Based on OECD (2022^[10]), *International Programme for Action on Climate*, <https://www.oecd.org/climate-action/ipac/>; OECD (2020^[2]), *A Territorial Approach to the Sustainable Development Goals: Synthesis Report*, <https://doi.org/10.1787/e86fa715-en>.

The OECD localised indicator framework for the SDGs is particularly inspiring for designing a global territorial climate indicator framework in two aspects. First, it allows international comparability across countries, cities and regions. As it uses the indicators for cities and regions in OECD member and partner countries that are consolidated in the OECD Metropolitan and Regional Databases, the indicator framework provides greater comparability of geographic units at the same territorial level across the OECD countries and beyond. Second, the OECD localised indicator framework for the SDGs allows cities and regions to measure their distances to global and national targets. It defines “end values” for 2030 based on the global targets of the SDGs to create a composite index by SDG. The composite index helps to visualise and communicate the distance each region must travel to reach the end value. The index by goal is estimated as the aggregation of normalised indicators that take values from 0 to 100, where 0 is the worst possible outcome and 100 is the end value of the goal. As featured in the example for the region of Flanders (Belgium), the index shows how far the region and the country are from reaching the suggested end value for each SDG (Figure 2.1).

The IPAC Dashboard also measures the annual difference between GHG emissions and nationally determined contribution (NDC) 2030 target and GHG emissions levels in comparison with the NDC target to provide an overview of the emission trajectory towards GHG neutrality.

Figure 2.1. Measuring the distance to achieving global and national targets of the SDGs: Example of the region of Flanders, Belgium



Source: OECD (2022^[11]), *Measuring the Distance to the SDGs in Regions and Cities*, <https://www.oecd-local-sdgs.org/index.html>.

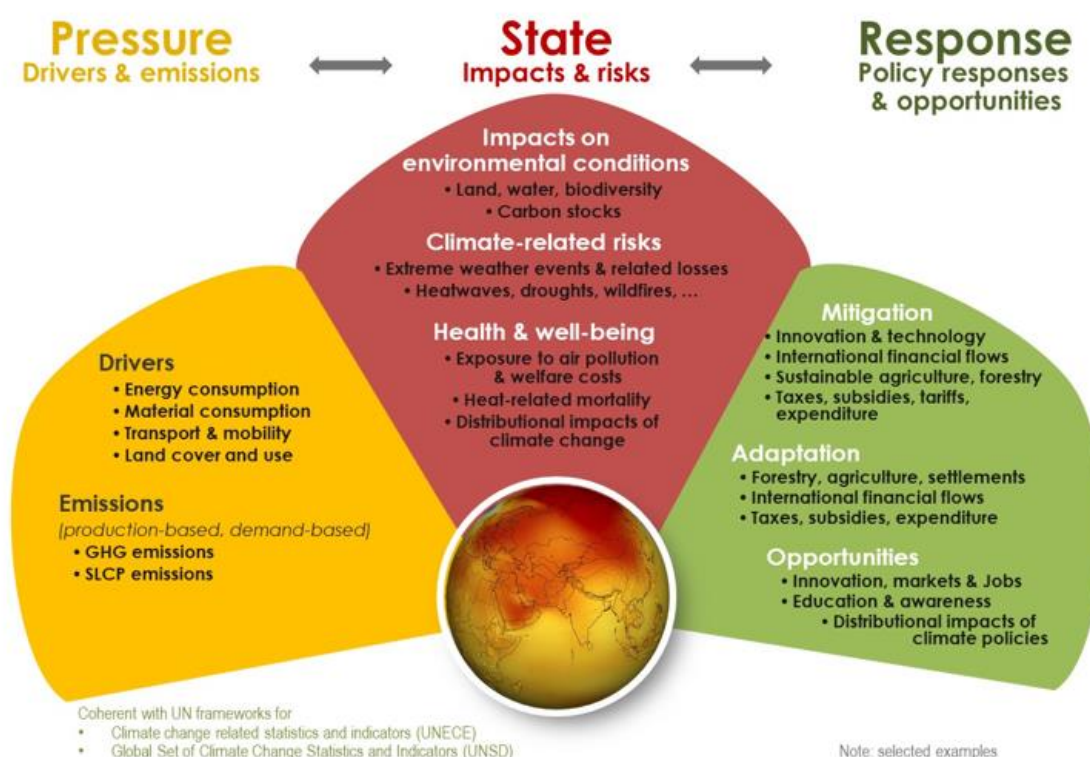
Overview of the OECD territorial climate indicator framework

This section offers a comprehensive overview of the OECD territorial climate indicator framework, highlighting its essential characteristics and distinctive attributes, including international comparability, the ability to aggregate and disaggregate climate data across various geographical scales and the possibility of measuring progress towards achieving global and national climate targets. The framework draws on the insights from existing OECD climate-related indicators presented in the previous section.

A “pressure-state-response” approach

The OECD territorial climate indicator framework uses the “pressure-state-response” approach to structure the indicators, aligning with the OECD IPAC Dashboard (Figure 2.2) as well as with the assessment reports of the IPCC. “Pressure indicators” primarily cover aspects related to climate mitigation, encompassing trends and drivers of GHG emissions. Conversely, “state indicators” predominantly feature indicators associated with climate adaptation and resilience, including the exposure to climate-related hazards and socio-economic factors driving vulnerability. “Response indicators” focus on actions and opportunities to address climate challenges. To enhance clarity, the framework is hereinafter presented under three categories: i) climate mitigation; ii) climate adaptation and resilience; and iii) actions and opportunities.

Figure 2.2. The pressure-state-response approach used in the IPAC indicator framework



Source: OECD (2021^[12]), "International Programme for Action on Climate (IPAC) - Proposal for a first edition of the indicator dashboard", OECD, Paris.

The selection of indicators under each category is determined by the availability of data sources, their measurability and their policy relevance at the subnational level. The indicator framework consists of 45 indicators: 19 climate mitigation indicators, 20 climate adaptation and resilience indicators, and 6 indicators for actions and opportunities (Table 2.3). The rationale for each indicator is provided in the next section of this chapter and a complete list of territorial climate indicators and references are found in Annex 2.A. For 41 of the 45 indicators, data were available and collected via publicly available data sources. Although data are still to be estimated (i.e. either to be identified or computed) for the remaining six indicators, they are included in the framework due to their importance. They include indicators of consumption-based GHG emissions (Indicator 5), energy mix in total energy supply (Indicator 8), total final energy consumption by source (Indicator 9), and existence of subnational mitigation and adaptation targets and compliance with national targets (Indicator 40).

Table 2.3. OECD territorial climate indicator framework by category

Climate mitigation (19)	Climate adaptation and resilience (20)	Actions and opportunities (6)
1. Total GHG emissions, level and % change 2. GHG emissions per capita, level and % change 3. GHG emission intensities per unit of gross domestic product (GDP), level and % change 4. GHG emissions by sector: share of total emissions, level, per capita and % change 5. Consumption-based GHG emissions (to be estimated) 6. Electricity generation by source 7. Carbon intensity of electricity generation 8. Energy mix in total energy supply (to be estimated) 9. Total final energy consumption by source (to be estimated) 10. Emission intensity of the manufacturing industry 11. Access to public transport 12. Private vehicle ownership 13. Electric and hybrid vehicle adoption 14. Cooling and heating degree days, levels and change, residential built-up volume 15. Built-up area growth 16. Built-up area per capita 17. Difference between built-up area growth and population growth 18. Waste generation 19. Waste recovery	Exposure to climate hazards 20. Air temperature and change 21. Number of hot days and change 22. Number of tropical nights and change 23. Number of icing days and change 24. Heat stress exposure 25. Urban heat island intensity (daytime and night-time) 26. Population exposure to fires 27. Burnt area by land cover type 28. Forest exposure to wildfire danger 29. Population exposure to river flooding 30. Population exposure to coastal flooding 31. Agricultural drought 32. Cumulated precipitation and change 33. Extreme precipitation days and change 34. Built-up exposure to violent storms Socio-economic factors driving vulnerability 35. Population density 36. Population aged < 5 37. Population aged > 70 38. Unemployment rate 39. Poverty rate	40. Existence of subnational mitigation and adaptation targets and compliance with national targets (to be estimated) 41. Citizens' satisfaction with efforts to preserve the environment 42. Green areas in cities 43. Climate-significant expenditure and investment 44. Existence of climate-related funds, grants and subsidies for subnational action 45. Patent applications in climate mitigation and adaptation technologies as % of total technologies

International comparability across territorial scales

The OECD territorial climate indicator framework offers a unique approach that enables international comparability of cities and regions. Based on the OECD territorial classification and FUA methodology,¹ the indicator framework allows countries, cities and regions to monitor and evaluate GHG emissions, climate impacts and risks using a standardised set of territorial climate indicators.

Among the 45 indicators included in the framework, 36 are available at TL2 level, 35 at TL3 level and 25 at the FUA level (Table 2.4). This harmonised and standardised set of indicators establishes a common language for national and subnational governments. It equips both with an integrated overview across territorial scales and a more in-depth analysis of specific regions or cities. This helps national governments to customise their analysis to suit specific contexts and needs, whether for national-level assessments, regional comparisons or targeted interventions within smaller geographic areas. For some indicators such as urban heat island intensity and green areas, this framework can also be extended to a more granular geographical level within FUAs corresponding to municipalities, counties or districts depending on countries, and referred to as small area units (SAUs).

Table 2.4. Geographical resolution and coverage of the OECD territorial climate indicator framework

Indicator	TL2 (36)	TL3 (35)	FUA (25)
Climate mitigation			
1. Total GHG emissions, level and % change			(*)
2. GHG emissions per capita, level and % change			(*)
3. GHG emission intensities per unit of GDP, level and % change			
4. GHG emissions by sector: share of total emissions, level, per capita and % change			(*)
5. Consumption-based GHG emissions (to be estimated)	To be defined		
6. Electricity generation by source carbon intensity of electricity generation			
7. Carbon intensity of electricity generation			
8. Energy mix in total energy supply (to be estimated)	To be defined		
9. Total final energy consumption by source (to be estimated)	To be defined		
10. Emission intensity of the manufacturing industry			
11. Access to public transport			(**)
12. Private vehicle ownership			
13. Electric and hybrid vehicle adoption			
14. Cooling and heating degree days, levels and change, residential built-up volume			
15. Built-up area growth; built-up area per capita			
16. Built-up area per capita			
17. Difference between built-up area growth and population growth			
18. Waste generation			
19. Waste recovery			
Climate adaptation and resilience			
20. Air temperature and change			
21. Number of hot days and change			
22. Number of tropical nights and change			
23. Number of icing days and change			
24. Heat stress exposure			
25. Urban heat island intensity (daytime and night-time)			
26. Population exposure to fires			
27. Burnt area by land cover type			
28. Forest exposure to wildfire danger			
29. Population exposure to river flooding			
30. Population exposure to coastal flooding			
31. Agricultural drought			
32. Cumulated precipitation and change			
33. Extreme precipitation days and change			
34. Built-up exposure to violent storms			
35. Population density			
36. Population aged < 5			
37. Population aged > 70			
38. Unemployment rate			
39. Poverty rate			

Indicator	TL2 (36)	TL3 (35)	FUA (25)
Actions and opportunities			
40. Existence of subnational climate mitigation and adaptation targets and compliance with national targets (to be estimated)	National scale		
41. Citizens' satisfaction with efforts to preserve the environment			
42. Green areas in cities			(***)
43. Climate-significant expenditure and investment	National scale		
44. Existence of climate-related funds, grants and subsidies for subnational action	National scale		
45. Patent applications in climate mitigation technologies as % of total technologies			

Note: (*) FUAs of more than 500 000 inhabitants; (**) metropolitan areas but only the largest metropolitan area in each OECD country; (***) FUA's urban centre.

Compatibility with existing OECD climate-related indicator frameworks

The OECD territorial climate indicator framework is fully aligned with existing OECD climate-related indicator frameworks. Most importantly, the framework aims to complement the IPAC Dashboard on the subnational dimension. To this end, the indicator framework carefully selects indicators from the IPAC Dashboard that hold relevance at the local and regional scales, thereby offering a subnational perspective within the broader national context. Notably, out of the 29 indicators currently featured on the IPAC Dashboard, the OECD territorial climate indicator framework incorporates 18, with 13 of them already computed at the territorial level. Furthermore, the OECD territorial climate indicator framework integrates 11 climate-related indicators already defined in the OECD localised framework for the SDGs. This encompasses not only indicators under SDG 13 on climate action but also those under other goals such as SDG 1 on no poverty, SDG 7 on affordable and clean energy, SDG 8 on decent work and economic growth, SDG 11 on sustainable cities and communities, and SDG 12 on responsible consumption and production. Table 2.5 provides a breakdown of which indicators are part of the IPAC Dashboard, the OECD localised framework for the SDGs, or are included in both frameworks.

Table 2.5. Alignment of OECD territorial climate indicator framework with other OECD climate-related indicator frameworks

Indicator	OECD localised indicator framework for the SDGs (11)	IPAC Dashboard (18)
Climate mitigation		
1. Total GHG emissions, level and % change		
2. GHG emissions per capita, level and % change		
3. GHG emission intensities per unit of GDP, level and % change		
4. GHG emissions by sector: share of total emissions, level, per capita and % change		
5. Consumption-based GHG emissions (to be estimated)		
6. Electricity generation by source	SDG 7	
7. Carbon intensity of electricity generation	SDG 13	
8. Energy mix in total energy supply (to be estimated)		
9. Total final energy consumption by source (to be estimated)		
10. Emission intensity of the manufacturing industry		
11. Access to public transport		
12. Private vehicle ownership		

Indicator	OECD localised indicator framework for the SDGs (11)	IPAC Dashboard (18)
13. Electric and hybrid vehicle adoption		
14. Cooling and heating degree days, levels and change, residential built-up volume	SDG 13	
15. Built-up area growth	SDG 11	
16. Built-up area per capita	SDG 11	
17. Difference between built-up area growth and population growth	SDG 11	
18. Waste generation	SDG 12	
19. Waste recovery	SDG 12	
Climate adaptation and resilience		
20. Air temperature change		
21. Number of hot days and change		
22. Number of tropical nights and change		
23. Number of icing days and change		
24. Heat stress exposure		
25. Urban heat island intensity (daytime and night-time)		
26. Population exposure to fires		
27. Burnt area by land cover type		
28. Forest exposure to wildfire danger		
29. Population exposure to river flooding		
30. Population exposure to coastal flooding		
31. Agricultural drought		
32. Cumulated precipitation and precipitation change respective to the 1981-2010 climatology		
33. Extreme precipitation days and change respective to the 1981-2010 climatology		
34. Built-up exposure to violent storms		
35. Population density		
36. Population aged < 5		
37. Population aged > 70		
38. Unemployment rate	SDG 8	
39. Poverty rate	SDG 1	
Actions and opportunities		
40. Existence of subnational climate mitigation and adaptation targets and compliance with national targets (to be estimated)		
41. Citizens' satisfaction with efforts to preserve the environment	SDG 13	
42. Green areas in cities		
43. Subnational government climate finance database: climate-significant expenditure and investments		
44. Existence of climate-related funds, grants and subsidies for subnational action		
45. Patent applications in climate mitigation technologies as % of total technologies		

Source: Based on OECD (2022^[10]), *International Programme for Action on Climate*, <https://www.oecd.org/climate-action/ipac/>; OECD (2020^[2]), *A Territorial Approach to the Sustainable Development Goals: Synthesis Report*, <https://doi.org/10.1787/e86fa715-en>.

Measuring the distance of cities and regions to achieving global and national targets

The indicator framework also allows measuring the distance of cities and regions to reaching specific reference points for each indicator. It thus mirrors the structure of the SDG localised indicator framework, facilitating an understanding of how much progress a region or city needs to make to reach the desired outcome. The OECD territorial climate indicator framework attributes specific reference points 28 out of its 45 indicators (Table 2.6). For climate mitigation indicators as well as actions and opportunities indicators, the reference points correspond to policy targets, shedding light on the progress of cities and regions towards achieving climate neutrality. They are based either on sectoral knowledge or on “best performers”, which correspond to the simple average of the top performer region or city of each OECD country. In the case of climate adaptation and resilience indicators, the reference points refer to normality and provide insights into how distant cities and regions are from “climate normal”, which are based on the 1981-2010 baseline climatology.

Table 2.6. Reference points of the OECD territorial climate indicator framework

Indicator	Reference point
Climate mitigation	
1. Total GHG emissions, level and % change	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13]) multiplied by 2030 population projection
2. GHG emissions per capita, level and % change	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13])
4. GHG emissions by sector: share of total emissions, level, per capita and % change	The 2030 emissions per capita target by sector, defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13]): agriculture 0.1 tCO ₂ -eq/capita; buildings 0.4 tCO ₂ -eq/capita; industry 1.7 tCO ₂ -eq/capita; power 1.3 tCO ₂ -eq/capita; transport 1.3 tCO ₂ -eq/capita
5. Consumption-based GHG emissions	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13])
6. Electricity generation by source	100% of electricity generated from low-carbon sources
7. Carbon intensity of electricity generation	Carbon intensity of electricity generated by the lowest emission-intensive source, i.e. 11 grams of carbon dioxide equivalent per kilowatt-hour (gCO ₂ -eq/kWh) (wind)
11. Access to public transport	100% of the population with access to public transport
12. Private vehicle ownership	Best performers, i.e. 385 vehicles for 1 000 inhabitants
13. Electric and hybrid vehicle adoption	100% of electric or hybrid vehicle adoption
16. Built-up area per capita	Best performers, i.e. 65 square metres per capita for metropolitan areas
18. Waste generation	Best performers, i.e. 350 kg per capita per year
19. Waste recovery	100% of recycled municipal waste
Climate adaptation and resilience	
20. Air temperature change	Mean air temperature over 1981-2010
21. Number of hot days and change	Mean number of hot days over 1981-2010
22. Number of tropical nights	Mean number of tropical nights over 1981-2010
23. Number of icing days	Mean number of icing days over 1981-2010
24. Heat stress exposure	Mean number of days of different heat stress levels over 1981-2010
26. Population exposure to fires	Reference point defined as 0%
27. Burnt area by land cover type	Reference point defined as 0%

Indicator	Reference point
28. Forest exposure to wildfire danger	Reference point defined as 0%
31. Agricultural drought	Mean cropland soil moisture over 1981-2010
32. Cumulated precipitation respective to the 1981-2010 climatology	Mean cumulated precipitation over 1981-2010
33. Extreme precipitation days respective to the 1981-2010 climatology	Mean extreme precipitation days over 1981-2010
34. Built-up exposure to violent storms	Mean exposure over 1981-2010
Actions and opportunities	
40. Existence of subnational climate mitigation and adaptation targets and compliance with national targets	100% of subnational governments (e.g. TL2, TL3 levels) with climate mitigation and adaptation targets complying with national targets
41. Citizens' satisfaction with efforts to preserve the environment	Best performers
42. Green areas in cities	Best performers
43. Climate-significant expenditure and investment	Best performers
45. Patent applications in climate mitigation technologies as % of total technologies	Best performers

Note: Reference points are yet to be defined for the following indicators: GHG emission intensities per unit of GDP, level and % change (Indicator 3), energy mix in total energy supply (Indicator 8), total final energy consumption by source (Indicator 9), emission intensity of the manufacturing industry (Indicator 10), built-up area growth (Indicator 15), difference between built-up area growth and population growth (Indicator 17), urban heat island intensity (daytime and night-time) (Indicator 25), population exposure to river flooding (Indicator 29), population exposure to coastal flooding (Indicator 30), existence of subnational mitigation and adaptation targets and compliance with national targets (Indicator 40) and existence of climate-related funds, grants and subsidies for subnational action (Indicator 44). Reference points are not applicable for the following indicators: cooling and heating degree days, levels and change, residential built-up volume (Indicator 14), population density (Indicator 35), population aged < 5 (Indicator 36), population aged > 70 (Indicator 37), unemployment rate (Indicator 38) and poverty rate (Indicator 39).

Indicators in detail: Relevance, data sources and reference points

This section provides a detailed discussion of the indicators under the OECD territorial climate indicator framework. Each subsequent sub-section further explains the relevance of measuring a particular indicator at the subnational level. It also explains the data sources used to estimate the indicator and the suggested reference points. The details of each indicator can also be found in Annex Table 2.A.1.

Climate mitigation indicators

GHG emissions (Indicators 1 to 5)

Global GHG emissions continue to rise and contribute to climate change. Average annual GHG emissions during the 2010-19 period were higher than in any previous decade, although the growth rate between 2010 and 2019 was lower than between 2000 and 2009 (Shukla et al., 2022^[14]). Even though global CO₂ emissions dropped by 5.8% in 2020 with the coronavirus disease 2019 (COVID-19) pandemic, they rebounded by 5% in 2021, approaching the peak in 2018-19 (IEA, 2022^[15]). Reducing emissions implies co-ordinating mitigation policies at different territorial levels and this calls for a better understanding of the breakdown of emissions by sector at the local level.

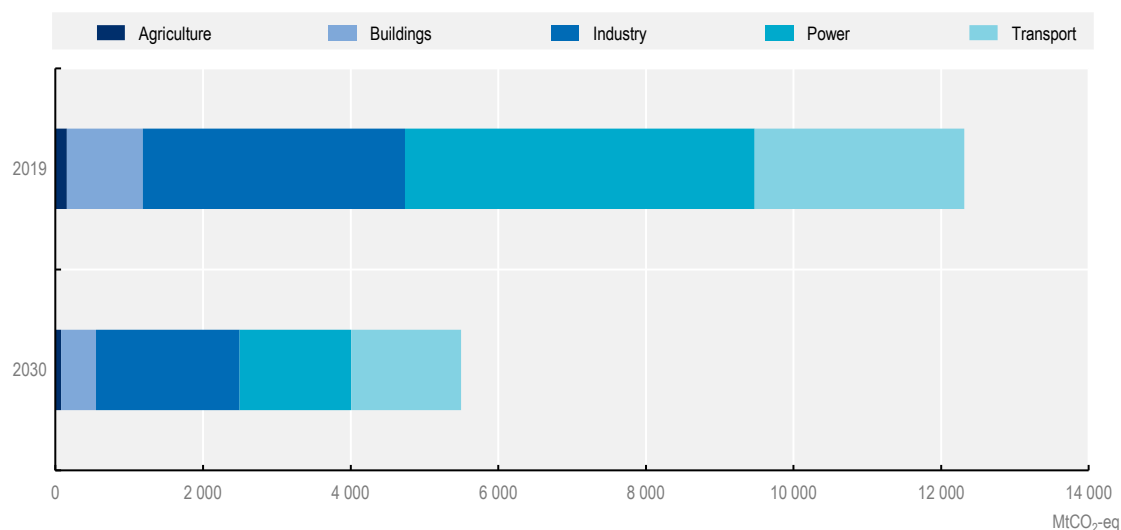
In the IEA NZE Scenario (IEA, 2021^[13]), CO₂ emissions from energy-related and industrial processes in advanced economies, i.e. in OECD and EU 27 countries, drop from 12.3 gigatonne (Gt) of CO₂-eq to around 5.5 GtCO₂-eq in 2030, which corresponds to a drop from 8.8 tCO₂-eq per person in 2019 to 3.8 tCO₂-eq per person in 2030. In this scenario, advanced economies reduce their emissions faster than emerging markets and developing economies. The share of CO₂ emitted by global energy-related and industrial processes from advanced economies falls from 34% to 26%. Given that CO₂ from fossil fuel and industry, methane (CH₄) and nitrous oxide (N₂O) account for respectively 12.8 GtCO₂-eq, 2.2 GtCO₂-eq and 0.8 GtCO₂-eq of net anthropogenic GHG emissions in advanced economies (Crippa et al., 2021^[16]), if

we assume the same distribution of GHG in 2030, GHG emissions per capita, as defined in the framework, would have to drop to 4.7 tCO₂-eq per person in 2030. Consequently, the indicator framework sets a reference point of 4.7 tCO₂-eq per person for per capita production-based GHG emissions.

The IEA NZE Scenario also provides global CO₂ emission profiles by sector until 2050, allowing the definition of a GHG emissions target by sector for 2030. Figure 2.3 shows total fossil fuel and industry CO₂ emission reduction targets for 2030 in advanced economies. In the NZE Scenario, the power sector witnesses the largest reduction in emissions, with a 68% decrease in emissions from 2019 to 2030 for advanced economies, mainly due to significant reductions from coal-fired power plants. Emissions from buildings are cut by 54% from 2019 to 2030 by retrofitting and phasing out fossil fuel boilers. Emissions from transport, industry and agriculture fell by 48%, 45% and 49% respectively over this period. In terms of CO₂ emissions per capita, this corresponds to 1.3 tCO₂-eq for the power sector, 0.4 tCO₂-eq for buildings, 1.7 tCO₂-eq for industry, 1.3 tCO₂-eq for transport and 0.1 tCO₂-eq for agriculture. To estimate the progress of OECD cities and regions towards achieving net zero, these per capita targets are applied to sectoral GHG emissions at the different territorial levels. It is worth noting that waste is excluded, as the IEA NZE Scenario does not include emission scenarios for this sector. It is also worth noting that, in the current indicator framework, these targets are used as a reference point and do not correspond to actual policy targets for cities and regions, as they do not account for regional variations in population density, economic sectors and technologies or regional typology. For instance, in a country achieving the 2030 IEA NZE emission targets in terms of absolute GHG emissions, a remote region may still exhibit higher per capita emissions in agriculture and transport than a metropolitan region. For simplicity, the framework assumes a uniform convergence and applies the same sector per capita targets to all territorial scales.

Figure 2.3. Sectoral emission reduction targets for 2030

CO₂ from fossil fuel and industry in 2019 and 2030 in advanced economies (OECD and EU27 countries) as described in the IEA NZE Scenario



Note: OECD computations based on the IEA NZE Scenario (IEA, 2021^[13]) combining total fossil fuel and industry CO₂ emissions projections in advanced economies and global CO₂ emissions projections by sector.

Although all OECD countries report annual production-based GHG emissions by sector at the national level, subnational inventories are either lacking or not consistent across and within countries. The Emissions Database for Global Atmospheric Research (EDGAR) (Crippa et al., 2021^[16]) developed by the European Commission Joint Research Centre (JRC) attempts to fill this data gap. It is an independent,

global database of anthropogenic GHG and air pollutant emissions and provides 0.1-degree resolution (approximately 11 kilometres, km) gridded maps at the global level, with yearly and monthly data from 1970 to 2018. These grids are obtained by disaggregating national inventories at the local level, using spatial proxies such as road networks, population density, built-up areas, power plants, cement plants, etc. Such gridded maps can then be aggregated at different territorial levels. However, the low resolution of the grids can lead to a misallocation of emissions when aggregating values for granular territorial units compared to the size of grid cells. Estimates for larger regions (TL2) are thus more accurate than for smaller units such as small regions (TL3) or FUAs. This data source covers the three most potent gases (CO₂, CH₄ and N₂O). Fluorinated gases will be included in the future. The different sectors and subsectors covered are:

- **Agriculture:** Enteric fermentation, manure management, agricultural waste burning, agricultural soils, indirect N₂O emissions from agriculture.
- **Power industry:** Electricity generation.
- **Industry:** Combustion for manufacturing, chemical processes, iron and steel production, non-ferrous metals production, non-energy use of fuels, solvent and product use, non-metallic minerals production, oil refineries and transformation industry, fuel exploitation (oil, coal, natural gas).
- **Buildings:** Energy for buildings.
- **Waste:** Wastewater handling, solid waste landfills, solid waste incineration.
- **Transport:** Road transport, aviation, shipping, railways, pipelines, off-road transport.
- **Other:** Fossil fuel fires, indirect emissions from nitrogen oxides (NO_x) and ammonia (NH₃).

Emissions from land use and land cover change (LULCC) are not included for the moment.

The proposed framework of indicators uses EDGAR for the following indicators:

- Total GHG emissions, level and percentage change.
- GHG emissions per capita, level and percentage change.
- GHG emissions per unit of GDP: level and percentage change.
- GHG emissions by sector.
- Emission intensity of the manufacturing industry.

The proposed framework focuses on production-based territorial emissions, as subnational consumption-based inventories are unavailable for most countries. Consumption-based emissions account for emissions embedded in trade and ensure that cities and regions are not simply outsourcing their emissions outside their territorial boundaries to meet climate neutrality targets.

Energy (Indicators 6 to 9)

In 2019, approximately 34% (20 GtCO₂-eq) of total net anthropogenic GHG emissions came from the energy supply sector (Shukla et al., 2022^[14]). It is consequently a key sector to focus on to reduce GHG emissions.

Although national energy statistics are very detailed, subnational energy data are often lacking. Tracking progress towards achieving net zero targets at the local level would require looking at both energy consumption and supply. Final energy consumption by sector (residential, transport, agriculture, industry, commercial and public services) and fuel type (electricity, natural gas, coal, oil and petroleum products, biofuels and waste) would enable tracking changes in consumption, electrification and phasing out from fossil fuels in each sector to better accompany local areas and sectors not meeting the net zero targets. However, international databases on subnational final energy consumption data are lacking. Only a few countries, such as France and the United Kingdom, provide such data.

On the energy supply side, the indicator framework proposed in this paper includes power generation by source and the carbon intensity of electricity generation at the TL2 and TL3 levels. This enables tracking the shift towards low-carbon electricity. Subnational-level data on electricity production are also scarce but these indicators can be estimated from national statistics and the geolocation of power plants together with their technical characteristics. The proposed indicator framework uses the Global Power Plant Database (GPPD) (GEO, 2021^[17]), the IEA electricity and heat database, and the harmonised global dataset of wind and solar farms (GWS) (Dunnett, Sorichetta and Taylor, 2020^[18]) locations and power capacity.

The GPPD (GEO, 2021^[17]) provides information on power plants located in 167 countries all over the world, including the 38 OECD countries. For each power plant, the GPPD provides the geographic co-ordinates, the energy source (e.g. nuclear, gas, wind, etc.) and the capacity. As the coverage of wind and solar power plants in the GPPD is not exhaustive, the proposed indicator framework used the harmonised GWS (Dunnett, Sorichetta and Taylor, 2020^[18]) farm locations and power instead to get the locations of wind and solar power sources. Electricity production at the power plant level was disaggregated from national-level electricity generation data by energy sources (IEA, 2022^[19]), based on the capacity of the power plant relative to the total installed capacity for the same energy source. Regional indicators correspond to the aggregation of plant-level electricity generation data.

To assess the progress of OECD cities and regions towards achieving clean electricity generation, the proposed indicator framework sets a target of 100% of low-carbon electricity and carbon intensity of electricity generation corresponding to the lowest emission-intensive source, i.e. wind with a carbon intensity of 11 gCO₂/kWh (IPCC, 2014^[20]).

Industry (Indicators 4 and 10)

In 2019, approximately 24% (14 GtCO₂-eq) of global net anthropogenic GHG emissions came from industry. Since 2000, industry emissions have been growing faster than emissions in any other sector, driven by increased basic materials extraction and production (Shukla et al., 2022^[14]).

In OECD countries, the manufacturing sector is the third largest contributor to territorial emissions after the energy and transport sectors, accounting for 20% of total emissions (including oil refineries and the transformation industry). Within the manufacturing industry, emissions are particularly concentrated in four subsectors: the manufacture of coke and petroleum products, chemicals and chemical products, non-metallic mineral products (i.e. cement) and of basic metals (i.e. steel). In EU27 countries, these 4 sectors account for 80% of total manufacturing GHG emissions. In the IEA NZE Scenario (IEA, 2021^[13]), CO₂ emissions in the industry sector in advanced economies are cut by 45% from 2019 to 2030.

The proposed indicator framework includes emissions per unit of gross value added (GVA) in TL2 regions to assess how emission-intensive the manufacturing sector is. To assess the distance of cities and regions to achieving 2030 targets, the indicator framework sets a target of a 45% reduction in industry emissions, which corresponds to 1.7 tCO₂-eq per capita.

Buildings (Indicators 4 and 14)

In 2021, buildings accounted for 33% of global energy-related and process-related CO₂ emissions (8% from the use of fossil fuels in buildings, 19% from the generation of electricity and heat used in buildings and 6% from the manufacture of materials used in buildings construction) (IEA, 2022^[21]). In the IEA NZE Scenario (IEA, 2021^[13]), CO₂ emissions from buildings are cut by 54% from 2019 to 2030 in advanced economies.

The indicator framework proposed in this publication includes direct building emissions per capita based on EDGAR (Crippa et al., 2021^[16]) at the TL2 and TL3 levels. This dataset only covers direct building emissions related to onsite combustion. Consequently, the carbon intensity of purchased electricity and heat used in buildings and the manufacturing of construction materials are not included. To assess the

distance of cities and regions to 2030 targets, the indicator framework sets a target of a 54% reduction in building emissions, which corresponds to 0.4 tCO₂-eq per capita.

Space heating is the main source of residential energy consumption. Across OECD countries, it accounts for 58% of total energy use (IEA, 2022^[22]). Energy consumption for space cooling accounted for 16% of buildings' final electricity consumption in 2021 and has more than trebled since 1990 (IEA, 2022^[23]). To reflect building energy consumption drivers, the framework of indicators includes both cooling and heating degree days (level and change compared to the reference period 1981-2010) as well as residential built-up volume per capita.

Transport (Indicators 11 to 13)

In 2019, approximately 15% (8.7 GtCO₂-eq) of global net anthropogenic GHG emissions came from transport (Shukla et al., 2022^[14]). Unlike the energy supply and industry sectors, where average annual GHG emissions growth between 2010 and 2019 slowed down compared to the previous decade, those in the transport sector continued to rise by about 2% per year (Shukla et al., 2022^[14]). In 2018, 45% of the transport CO₂ emissions came from passenger road vehicles, 29% from road freight vehicles, 12% from aviation, 11% from shipping and 1% from rail (IEA, 2022^[24]). Since 2010, sport utility vehicles (SUVs) have been the second-largest contributor to the increase in global CO₂ emissions after the power sector but ahead of heavy industry, trucks and aviation (IEA, 2019^[25]). In the IEA NZE Scenario (IEA, 2021^[13]), CO₂ emissions in the transport sector in advanced economies are cut by 48% from 2019 to 2030, which corresponds to 1.3 tCO₂-eq/capita. Reaching climate neutrality and cutting oil use in transport requires making public transport more accessible, reducing private car use in large cities and accelerating the adoption of electric and more efficient vehicles (IEA, 2022^[26]). Electric vehicles powered by low-emissions electricity offer the largest decarbonisation potential for land-based transport on a life cycle basis (Shukla et al., 2022^[14]).

The proposed indicator framework consequently looks at the number of private vehicles per capita and the share of electric and hybrid vehicles at the TL2 level provided in the OECD Regional Database. It also includes public transport accessibility in the largest OECD cities by looking at the share of the population in cities within a ten-minute walk of public transport (bus, metro and tram). Public transport stop locations are extracted from open geographic database OpenStreetMap and walking times from each transport stop were calculated using Mapbox API. To assess the progress of OECD cities and regions towards achieving clean transport systems, the proposed indicator framework sets a target of 100% for the share of electric or hybrid vehicles and for public transport accessibility. As for the number of private motor vehicles per capita, the target corresponds to the “best performers”, i.e. 385 vehicles for 1 000 inhabitants.

Other relevant indicators that are not covered by the proposed indicator framework but that would also enable tracking progress in the transport sector include the average distances travelled per person per year, the modal share associated with each transport type (public transport, private car, walking, biking, etc.) and access to charging stations.

Agriculture, forestry and other land use (AFOLU) (Indicators 15 to 17)

In 2019, approximately 22% (13 GtCO₂-eq) of global net anthropogenic GHG emissions came from AFOLU. AFOLU emissions originate mostly from deforestation and agricultural emissions from livestock, soil and nutrient management (Shukla et al., 2022^[14]). The mitigation potential in the AFOLU sector is derived both from a reduction in emissions through better management of land and livestock, as well as from enhanced removal of GHG through carbon sinks. Consequently, the AFOLU sector offers significant near-term mitigation potential at a relatively low cost and can provide 20-30% of the 2050 emissions reduction described in scenarios that likely limit warming to 2°C or lower. The largest share of mitigation potential in the sector corresponds to measures in forests and natural ecosystems, followed by agriculture and demand-side measures (Shukla et al., 2022^[14]).

Several indicators enable tracking climate action and resilience in the AFOLU sector. Natural carbon sinks, i.e. forests, peatlands, coastal wetlands, savannas and grasslands, can be monitored and their areas can be quantified at different territorial levels using land use and land cover (LULC) maps. These maps include the NASA MCD12Q1 MODIS yearly global land cover data at 500-metre (m) resolution (2001-20) (Friedl and Sulla-Menashe, 2019^[27]) or the ESA Climate Change Initiative (CCI) yearly dataset at 300-m resolution (1992-2020) (ESA, 2019^[28]). More recent initiatives exploit Sentinel satellites, which provide multispectral (Sentinel-2) and RADAR (Sentinel-1) images at a much higher resolution (10 m) and a frequent time revisit (every 5 to 6 days), as well as automated image processing pipelines based on deep learning models to produce near real-time LULC estimates. The ESA WorldCover map (Zanaga et al., 2021^[29]) provides yearly land cover mapping for 2020 at a 10-m resolution. Similarly, the Dynamic World dataset (Brown et al., 2022^[30]) developed jointly by Google and the World Resources Institute provides near real-time LULC data at a 10-m resolution with a 5-day revisit (June 2015 to present). Using the ESA CCI land cover dataset, the proposed indicator framework includes tree cover changes in TL2 regions.

Urban sprawl and soil artificialisation contribute to the loss of natural carbon sinks. Comparing the growth and levels in built-up areas and in population enables to assess the anthropogenic pressure on lands, as highlighted in SDG target 11.3.1. The proposed indicator framework uses the Global Human Settlement population count (GHS-POP) (Schiavina, Freire and MacManus, 2022^[31]) and built-up surface (GHS-BUILT-S) layers (Pesaresi and Politis, 2022^[32]). The framework sets a target for built-up area per capita based on the “best performers”, which corresponds to 65 square metres per capita for metropolitan areas.

Agriculture is also an important driver of GHG emissions, accounting for 9% of total production-based emissions in 2018 in OECD countries. Emissions in this sector are mainly due to the CH₄ (65%) emitted by animals and rice cultivation and N₂O (33%) released from pastures and crops using nitrogen fertilisers. These 2 gases have a much higher global warming potential than CO₂ (28 for CH₄ and 265 for N₂O over 100 years). The proposed indicator framework includes agriculture emissions based on EDGAR (Crippa et al., 2021^[16]) at the TL2 and TL3 levels.

Waste (Indicators 18 to 19)

Lowering material consumption, reducing waste and recycling more also play an important role in the net zero transition. In this field, the proposed indicator framework includes two indicators at the TL2 level: the mass of municipal waste per inhabitant and the share of municipal waste treated with recovery operations (recycling, composting and incineration with energy recovery). The proposed indicator framework sets a target of 100% for the share of recovered municipal waste. As for the mass of municipal waste per capita, the framework sets a target corresponding to the “best performers”, i.e. 350 kilograms (kg) per capita per year.

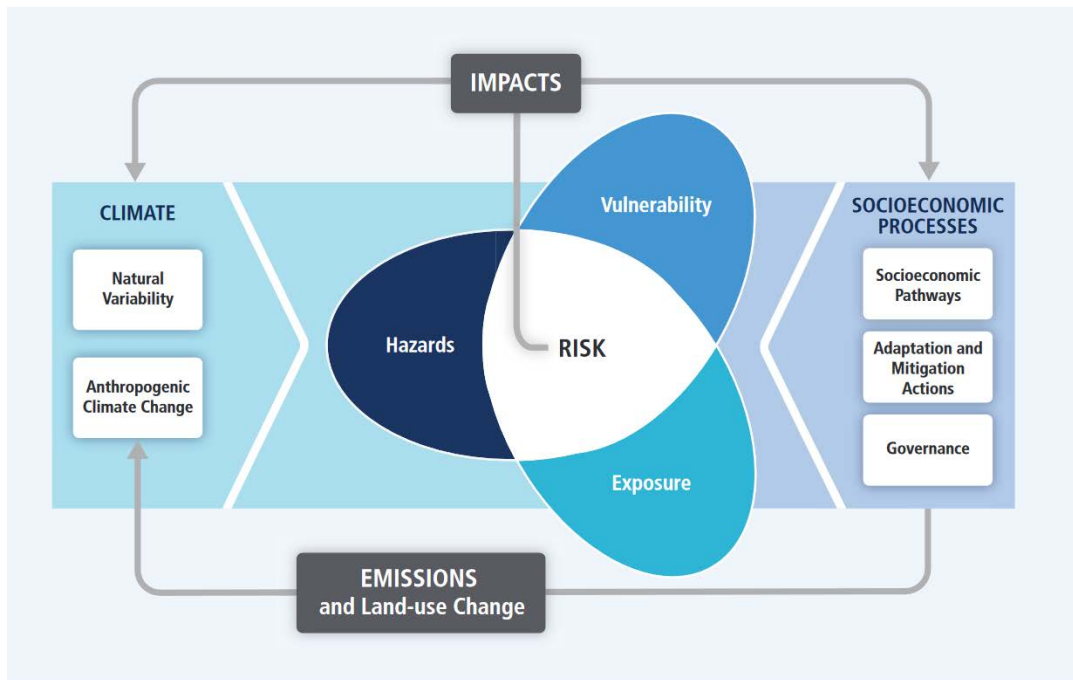
Climate adaptation and resilience indicators

This section provides a summary of the state indicators and data sources used in the localised framework of indicators. Due to data availability, this framework of indicators mostly focuses on climate risks and does not include indicators of economic impact, casualties and displaced populations resulting from climate change. Following the IPCC risk assessment framework (Figure 2.4), climate-related risks are based on three pillars:

- **Hazard** is the potential occurrence of climate-related physical events or trends that may cause loss and damage.
- **Exposure** is the presence of people, settlements, infrastructure or ecosystems in areas where climate hazard events could occur.

- **Vulnerability** is the propensity to suffer adverse effects when impacted by climate hazard events. It includes a wide range of concepts such as weaknesses, sensitivities and incapacity to adapt.

Figure 2.4. The IPCC risk assessment framework



Source: IPCC (2014^[33]), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects*, https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf.

Different temporal perspectives can also be considered to assess risks by looking at either historical data or projections by shared socio-economic pathways or representative concentration pathways.

The proposed indicator framework mostly looks at climate risk exposure and hazard dimensions. These indicators are consistent with the IPAC framework of indicators and follow the methodology described in (Maes et al., 2022^[34]). This framework covers a wide range of indicators enabling the assessment of the cities and regions most exposed to certain climate hazards, which can be used as a basis to define policy priorities to adapt such places to the consequences of climate change.

Temperature trends, heat and cold (Indicators 20 to 25)

Climate change has led to an overall increase in temperatures but also to longer, more frequent and intense heat-related events worldwide. These periods of exceptional heat combined with other atmospheric conditions such as humidity and wind can have strong impacts on human health. It is estimated that 365 000 people died around the world in 2019 because of extreme heat (The Lancet, 2021^[35]). The indicator framework includes six indicators related to temperature trends, heat and cold:

- air temperature
- number of hot days
- number of tropical nights
- number of icing days
- population exposure to heat stress
- urban heat island intensity.

Temperature trends are measured based on the annual mean of 2 m air temperature from ERA5-Land Monthly Averaged Data (Muñoz Sabater, 2019^[36]). Hot days correspond to days during which the daily maximum temperature exceeds 35°C, tropical nights correspond to days during which the daily minimum temperature exceeds 20°C and icing days correspond to days during which the daily maximum temperature does not exceed 0°C. These indicators are also based on ERA5-Land (Muñoz Sabater, 2019^[36]).

Population exposure to heat stress is measured by using the universal thermal climate index (UTCI), which considers air temperature, wind, solar radiation and humidity. Different levels of heat stress are defined: strong heat stress corresponds to UTCI values between 32°C and 38°C, very strong heat stress ranges between 38°C and 46°C, and extreme heat stress corresponds to UTCI values above 46°C. Population exposure to heat stress is measured by looking at the population-weighted average number of days per year with UTCI values corresponding to strong, very strong or extreme heat stress. To assess the distance of cities and regions to their respective climate normals, the indicator framework sets 1981-2010 averages as reference points.

In cities, the urban heat island effect can amplify the intensity of heat waves. Densely populated urban areas tend to be warmer than their lower-density surrounding areas due to reduced ventilation, the proximity of tall buildings, heat generated from human activities, the properties of urban building materials and the limited amount of vegetation (Masson-Delmotte et al., 2021^[37]). The centres of Paris, France, and London, United Kingdom, for example, regularly record temperatures of around 4°C higher than rural surroundings at night. In Athens, Greece, this difference can reach 10°C during the summer. In Sydney, Australia, surface temperatures of the built environment can grow up to 16°C warmer in the sun than in shaded areas (Lombardi, Rodas and Ledesma, 2022^[38]). The proposed indicator framework quantifies the intensity of the urban heat island effect in OECD FUAs following the methodology described in Chakraborty and Lee (2019^[39]), which is based on MODIS Aqua and Terra (Wan, Hook and Hulley, 2021^[40]) land surface temperature data as well as MODIS Land Cover (Friedl and Sulla-Menashe, 2019^[27]) data. The urban heat island intensity corresponds to the average difference in the land surface temperature between urban lands and non-urban lands² within FUAs. Averages are computed for summer days, from 1 June to 31 August for the Northern Hemisphere and from 1 December to 28 February for the Southern Hemisphere, at daytime, for 10.30 am and 1.30 pm.

Wildfires (Indicators 26 to 28)

Increasing heat stress combined with droughts has made vegetated land more vulnerable to wildfires. Wildfires can lead to large losses of forests and agricultural lands but also represent a security risk for settlements and populations. The proposed indicator framework defines exposure to fires in OECD regions in terms of forest and cropland area burnt and in terms of population at risk. Burnt area perimeters are extracted from the JRC's global wildfire dataset (Artes Vivancos et al., 2019^[41]). Burnt forest and cropland areas are derived by overlapping burnt areas with the Copernicus CCI land cover³ dataset (ESA, 2019^[28]). The exposed population is defined as those living within 5 km of a burnt area and is derived from the Global Human Settlement (GHS) population grid for 2015 (Schiavina, Freire and MacManus, 2019^[42]).

To also assess the likelihood of a wildfire starting, the indicator framework includes the share of forest exposed to at least three consecutive days of very high or extreme fire danger. Fire danger is defined using the Fire Weather Index (FWI) (EC, 2019^[43]), which is a meteorologically based index developed in Canada and used globally to estimate fire danger. This index accounts for fuel moisture and the influence of wind on fire behaviour and spread. An FWI greater than five corresponds to a very high fire danger and one greater than six to an extreme fire danger.

River and coastal flooding (Indicators 29 to 30)

Changes in water cycles, combined with land artificialisation, can lead to more frequent and intense river flooding. River floodings are usually characterised by their return period, which corresponds to the average time between two flooding events of the same magnitude. The proposed indicator framework uses the River Flood Hazard Maps dataset to assess river flooding exposure in OECD regions and FUAs (Dottori et al., 2021^[44]). The dataset provides the extent of flooded areas for events of different return periods, ranging from 10 to 500 years. River flooding risk was assessed in OECD cities and regions using the 100-year return period. The extent of such floods is estimated from past events but 100-year return floods are likely to happen more than once per century in the future. Flood risk is increasing the most rapidly in Asia, Europe and North America, but without higher flood protection standards, flood events are projected to rise in all continents (Alfieri et al., 2017^[45]). Flooded area extent maps were combined with the GHS population grid for 2015 (Schiavina, Freire and MacManus, 2019^[42]) and Copernicus CCI land cover data (ESA, 2019^[28]) to assess population and built-up area exposure.

Coastal regions are particularly exposed to climate change as they face rising sea levels, more frequent coastal storm surges and soil erosion. By 2050, more than 500 coastal cities will face a sea level rise of at least 0.5 m, putting over 800 million people at risk (C40 Cities, 2018^[46]). The proposed indicator framework assesses coastal flood exposure using the World Bank Global Coastal Flood Hazard maps (Muis et al., 2016^[47]). The maps present a global reanalysis of storm surges and extreme sea level events based on hydrodynamic modelling for different frequencies of occurrence. Population exposure to coastal flooding is measured by using the GHS population grid for 2015 (Schiavina, Freire and MacManus, 2019^[42]) and the built-up area exposure using Copernicus CCI land cover data (ESA, 2019^[28]).

Droughts (Indicator 31)

Changes in precipitations and other atmospheric conditions can lead to longer, more frequent and severe droughts, increasing pressure on agriculture, infrastructures and ecosystems. The agricultural sector can be particularly affected by droughts, as water scarcity has serious impacts on crop yields. To measure agricultural droughts in OECD regions, the proposed indicator framework includes the change over time in the water content of the superficial layer of croplands' soil, which is important for water supply and vegetation health (Copernicus Global Land Service, n.d.^[48]). The Copernicus CDS ERA5-Land monthly average data product (EC, 2022^[49]) provides volumetric surface soil moisture, which corresponds to the volume of water in the surface soil layer of 0 to 7 centimetres deep, expressed as cubic metres (m³) of water per m³ soil. The Copernicus CCI land cover data (ESA, 2019^[28]) is used to select only cropland⁴ areas. For each OECD region, changes in drought conditions are measured by comparing the surface soil moisture in cropland areas to the reference period 1981-2010.

Precipitation (Indicators 32 to 33)

Climate change is impacting precipitation patterns and distributions, disturbing the water cycle and influencing ecosystems, communities and economic activities. While some regions experience more frequent or extreme rainfall, others are facing prolonged droughts and reduced water availability, which can impact food security and heighten the risks of flooding, landslides and erosion. In cities, extreme precipitation can also lead to a higher risk of flash floods that overwhelm drainage systems and streets, posing significant challenges to infrastructures and people's safety. The proposed indicator framework includes several precipitation indicators based on ERA5-Land data (Muñoz Sabater, 2019^[36]). First, the total yearly precipitation (in millimetres, mm) and change with respect to the 1981-2010 climatology allow for the assessment of the impact of climate change on precipitation patterns. Then, the number of days with more than 20 mm of total precipitation and the change compared to 1981-2010 allows for measuring extreme precipitation days and the impact of climate change on their frequency.

Socio-economic indicators driving vulnerability (Indicators 35 to 39)

Certain population groups are particularly vulnerable to the impacts of climate change, as they may face increased health risks from heat stress, have less mobility during climate-related events or have fewer resources to adapt. The indicator framework consequently includes different socio-economic and demographic indicators on population density, the share of population under 5 years old and above 70 years old, as well as poverty and unemployment rates.

Actions and opportunities indicators

Existence of subnational climate mitigation and adaptation targets and compliance with national targets (Indicator 40)

Subnational climate mitigation and adaptation targets are among the key instruments used to implement a territorial approach. For subnational governments, such targets can clearly demonstrate their climate commitments and priorities to their constituencies, guide the allocation of resources accordingly and help monitor the progress of their climate action. Subnational climate targets can also inform national governments and help them define their own targets. The existence of GHG emission inventories, reduction targets and targets related to climate adaptation at the TL2 and TL3 levels would enable to assess if these targets are compliant with NDCs, long-term low emissions development strategies (LT-LEDS), national adaptation plans (NAPs) and national adaptation strategies (NAS).

The framework sets a target of 100% for this indicator, i.e. all the subnational governments (e.g. TL2 and TL3 levels) have climate mitigation and adaptation targets complying with national targets. However, it has not been estimated yet and will be investigated in future work, as estimating the indicator will require full understanding of the currently available national and subnational mitigation and adaptation targets. For instance, careful consideration is required to define how to measure the compliance between national targets (e.g. NDCs, LT-LEDS, NAPs, NAS) and subnational targets, as national targets vary from one country to another and can take different forms. This is particularly the case for climate adaptation, as defining adaptation targets is a complex task in itself.

Citizens' satisfaction with efforts to preserve the environment (Indicator 41)

Environmental conditions can influence how people feel and how they evaluate their lives and even affect their happiness. Notably, 74% of respondents of the 2019 Gallup World Poll perceive global warming as a very serious or somewhat serious threat to them and their families, and 65% believe that climate change will make their lives harder (Krekel and George, 2020^[50]). The proposed indicator estimates the percentage of the population satisfied with efforts to preserve the environment by using data from the Gallup World Poll (2019^[51]). The framework sets a target corresponding to the “best performers” for this indicator.

Green areas in cities (Indicator 42)

Adaptation policies to mitigate the impact of heat waves in cities include expanding vegetated areas to increase the number and extent of cooler areas. The proposed indicator framework includes two indicators on green areas in cities, one on the presence of green space and the other on accessibility.

The first indicator corresponds to the share of green areas in urban centres. It estimates the number of green areas (both private and public) in FUAs' urban centres by using the high-resolution ESA WorldCover dataset (Zanaga et al., 2021^[29]). The 10-m resolution dataset captures different kinds of green areas (trees, shrublands and grasslands) of different sizes, going from large parks to trees along main roads. To ensure comparability across OECD cities, only FUAs' urban centres, as defined in the GHS degree of urbanisation methodology (EU et al., 2021^[52]), were considered.

However, a large share of green areas in a city does not imply equal access to public green spaces across the city. The second indicator consequently corresponds to access to green areas in cities using a methodology adapted from Poelman (2018^[53]). It is defined for FUAs' urban centres as the share of the population with access to public green areas of at least 1 hectare (ha) within 400 m distance. Public green areas are delineated using OpenStreetMap (OpenStreetMap, 2023^[54]). Urban green areas correspond to the following tags in OpenStreetMap: amenity: grave_yard; land use: cemetery, forest, recreation_ground, village_green; leisure: nature_reserve, park, playground, recreation_ground, garden; tourism: zoo; natural: wood, scrub, heath, grassland, wetland. The reference population grid used to get the share of the population within a 400 m distance is GHS-POP 2020 (Schiavina et al., 2023^[55]). The framework sets a target corresponding to the “best performers” for both the share of green areas and the access to public green spaces.

Climate-significant expenditure and investment (Indicator 43)

In many countries, especially federal countries, subnational governments can have extensive responsibilities in environmental protection, climate mitigation and adaptation. However, despite the importance of subnational expenditure and investment to drive the net zero transition, their magnitude remains relatively unknown and difficult to assess due to a lack of granular data at the national and subnational levels related to important methodological challenges. For several years now, the OECD has been leading initiatives to better assess subnational government finance in general and, more particularly, subnational climate-related financial indicators.

The OECD provides data on subnational government finance at several scales. First, the OECD database on subnational government structure and finance provides data for OECD and EU countries (updated annually). Then, the OECD-UCLG World Observatory on Subnational Government Finance and Investment (SNG-WOFI) provides subnational government finance data at a larger scale, covering 135 countries worldwide in the latest 2022 edition (the data are updated every three years) (OECD/UCLG, n.d.^[56]). Finally, the forthcoming OECD Regional Government Finance and Investment Database (REGOFI) and OECD Municipal Finance Database (MUNIFI), to be launched in 2024, will provide data on the finance of regional governments and municipal governments in an aggregated and disaggregated manner (for individual regions and municipalities) for OECD and EU countries with available data.

These three databases use the same methodology to collect finance data based on the international classification of national accounts. Among other financial indicators, they provide data on the classification of expenditure and investment by functions (Classification of the Functions of Government, COFOG Level 1). COFOG classifies expenditure and investment into ten categories, including “environmental protection”, which covers waste management, wastewater management, pollution abatement and protection of biodiversity and landscape, and scientific research and development on environmental issues, which both relate to climate mitigation and adaptation (OECD, 2022^[57]). However, this category does not record the entire set of environmental expenditures undertaken by governments, as climate and the environment have been increasingly acknowledged as a cross-cutting theme, and many other government expenditures have environmental protection as a secondary purpose (e.g. in transport, agriculture, housing, etc.).

In order to overcome this gap and develop a common terminology and understanding of subnational climate finance, the OECD developed a pilot methodology in 2022 to track subnational government climate expenditure and investment in the framework of a project in collaboration with the European Commission (EC) Directorate-General for Regional and Urban Policy (DG REGIO) called Financing Climate Action in Regions and Cities (OECD, n.d.^[58]). This work resulted in the OECD Subnational Government Climate Finance Database, which provides comparable data on subnational public climate-significant expenditure and investment, which are defined as follows (OECD, 2022^[57]; 2022^[59]):

- **Climate-significant expenditure** covers both current and capital expenditure. Current expenditure consists of staff expenditures, intermediate consumption, non-capital subsidies and tax expenditure. Interest expenditures are not included. Capital expenditure refers to indirect investment (capital transfers and capital subsidies) and direct investment (gross fixed capital formation [GFCF] minus disposals of non-financial, non-produced assets).
- **Climate-significant investment** refers to a subset of capital expenditure, specifically direct investment (GFCF) minus disposals of non-financial, non-produced assets. Measuring investment provides a way to focus on the amounts invested in climate-related infrastructure specifically. Using this subset also provides a more accurate estimate of climate-related infrastructure investment spending than the overall spending category could provide.

The methodology relies on a more refined approach to the COFOG classification. Using the EU taxonomy for sustainability activities,⁵ 3 first-level COFOG functions (economic affairs, environmental protection, and housing and community amenities) and 13 second-level COFOG functions (e.g. transport and energy, environmental protection, waste, water management, housing development) were identified as being “climate-significant”, meaning that expenditure in these areas contributes, to some extent, to climate adaptation or mitigation objectives. Then, in order to identify the share of expenditure and investment in each second-level COFOG function that could be considered climate-significant, proxy coefficients derived from internationally comparable datasets were then applied to each function, for all the OECD and EU countries included in the database. The framework sets a target corresponding to the “best performers” for this indicator. Data are presented in Chapter 4.

*The existence of climate-related funds, grants and subsidies for subnational action
(Indicator 44)*

Supporting subnational government climate action requires a better understanding of existing financial programmes and instruments available to them. The OECD Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries was developed in 2022 in the framework of a project in collaboration with the EC DG REGIO on Financing Climate Action in Regions and Cities (OECD, n.d.^[58]). It provides qualitative information on public sources of revenue available to subnational governments in OECD and EU countries to fund and finance their climate action.

The compendium lists a total of 311 public sources of funding that subnational governments can mobilise to fund climate-related activities. It includes instruments provided by higher-level governments: the European Union, central governments, federal and state governments (in federal countries), regional governments (in some specific cases for unitary countries) and government-owned banks. Instruments range from grants to loans, loan guarantees, contractual agreements, funds and more.

Climate-related innovation (Indicator 45)

To assess climate-related innovation, the proposed localised framework includes patent applications in climate change mitigation and adaptation technologies as a percentage of total technologies. These are essential in the deployment of low-carbon technologies and the transition to net zero. The European Patent Office Worldwide Patent Statistical Database (PATSTAT) database (OECD, 2023^[60]), which contains worldwide bibliographical and legal event patent data, is used to estimate this indicator. To assess the distance of regions to climate-related innovation, the indicator framework sets a target corresponding to the “best performers”.

Conclusions

Comparable and robust indicator frameworks can help both national and subnational governments unveil territorial disparities and distances to global and national targets on climate and help policy makers make informed decisions that effectively address the specific challenges and opportunities present in different cities and regions. This chapter has presented the OECD territorial climate indicator framework, which offers national, regional and local policy makers a tool to better understand where cities and regions stand with regard to global and national climate targets, as well as against their peers. It has also demonstrated that the proposed indicator framework can help policy makers structure and adjust their policies to the complexity and multi-faceted local climate-specific challenges and opportunities.

The indicator framework represents a key tool to advance multi-level governance and improve policy co-ordination for climate action and resilience, as it offers a common language for multi-level action by using comparable and standardised indicators. The framework can serve as a powerful tool to promote both vertical (e.g. across levels of government) and horizontal collaboration (e.g. across sectors or policy areas) in the design and implementation of climate-related policy reforms. It offers the possibility for more comprehensive assessment and policy responses since it combines data at different scales, ranging from those related to administrative boundaries (the unit for political and administrative action) to those related to functional approaches (the economic geography of where people live and work), which can provide the evidence base to enhance inter-municipal and rural-urban co-operation. The use of the indicator framework can benefit both national and subnational governments:

- **National governments** can use the indicator framework to align policy priorities, incentives and objectives across national, regional and local governments, as well as rethink their climate action and resilience agenda through a bottom-up approach. It can also help national governments identify local aspects of climate mitigation and resilience that are not yet targeted by public policies. The use of the indicator framework can also help identify areas in need of support to target and allocate the resources for the implementation of national policies more fairly and efficiently, which is particularly important in times when public finances are constrained due to concomitant crises. Such resources are needed for infrastructure investments and for capacity development. For example, a city may need more support in terms of flood prevention and protection, while in another, heat stress and its resulting urban heat island effect could be a more pressing challenge. National governments can also use the indicator framework to compare GHG emissions trajectories and climate vulnerabilities between different cities and regions and identify trends that might not be visible otherwise. Consequently, the indicator framework can help standardise how climate data are collected and reported, minimising the potential bias of information and increasing data comparability.

Building on the results of the localised indicator framework, national governments can also adapt national climate policy frameworks such as the NDCs and NAPs to the specific needs and characteristics of different cities and regions. An important option is to disaggregate net zero targets and adaptation goals in NDCs and NAPs by regions/cities, recognising and valuing disparities of climate change impacts and exposure to climate risks. Similarly, the indicator framework can help policy makers consider and reflect local contexts in NAPs (e.g. more granular risk vulnerability assessment), although NAPs are relatively more advanced in recognising the importance of subnational actions. Most importantly, national governments can raise the ambition of climate targets/plans by leveraging the potential of subnational climate action. They can also stimulate stronger ownership of national climate policies from subnational actors by jointly developing climate targets so that they are widely accepted.

- **Subnational governments** can improve their understanding of climate change impacts on their territories and adjust their policies and strategies accordingly. They can also identify whether their climate-related investments are addressing the most relevant climate challenges. Subnational

governments can identify common areas of concern with other neighbouring cities and/or cities facing similar challenges and problems. This would allow them to exchange information on potential solutions to climate challenges and enhance partnerships. Furthermore, subnational governments can better understand how they contribute to climate action and analyse whether their targets align with those of national governments.

While the proposed indicator framework can already facilitate multi-level dialogue, localise national policy frameworks and promote efficient public expenditure, the indicator framework can be further extended to provide a more comprehensive assessment of the local climate challenges and opportunities. Major potential areas for future work can be summarised as follows:

- **Estimating more indicators.** The indicator framework provides a comprehensive set of 45 comparable indicators. Out of these 45, 41 have already been estimated at different geographical levels based on publicly available data sources. Further work is required to make the remaining indicators available for analysis, including consumption-based GHG emissions.
- **Defining/refining reference points.** The indicator framework attributes specific reference points 28 out of its 45 indicators to assess the progress of OECD cities and regions. Future research should explore the possibility of defining reference points for the remaining indicators. In addition, the proposed reference points can be further refined to adjust to the evolving global and national targets and to reflect local specificities.
- **Making indicators available at more granular territorial scales** (e.g. FUA level). The proposed indicator framework aims to provide national and subnational governments with a tool to go beyond national averages. However, the geographical resolution/coverage varies depending on the geographical unit to which each indicator is associated. While 36 and 35 indicators are available for regions at TL2 and TL3 levels, respectively, only 25 indicators in the framework are currently available for cities (FUAs). Indicators with more granular territorial scales would allow a better understanding of territorial disparities, which can lead to more locally tailored and more effective policies.
- **Providing a visualisation tool.** The indicator framework can draw inspiration from the SDG localised indicators. This includes a web tool to visualise the performance of cities and regions in comparison to national averages. It also indicates the remaining distance to the suggested end values required to reach the 2030 goals. This tool not only provides valuable insights into crucial policy areas but also identifies cities and regions encountering similar opportunities and challenges.
- **Developing more indicators under the “actions and opportunities” category.** The indicator framework can be improved to provide a more comprehensive understanding of actions and opportunities at the subnational scale. An option is to develop indicators to examine institutional and governance dimensions (e.g. horizontal co-ordination mechanisms across departments in subnational governments). Another option is to develop indicators to measure policy impacts and effectiveness (e.g. cost efficiency of different policy instruments).

Annex 2.A. Complete list of territorial climate indicators and reference points

Annex Table 2.A.1. OECD territorial climate indicator framework

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
Climate mitigation: Pressure indicators (19)					
1. Total GHG emissions, level and % change	Emissions Database for Global Atmospheric Research (EDGAR) (Crippa et al., 2021 ^[16])	Total GHG emissions, expressed in tonnes of CO ₂ equivalents by considering the 3 main GHGs, namely CO ₂ , CH ₄ and N ₂ O and a 100-year global warming potential (GWP). CO ₂ emissions from land use, land use change, forestry and fluorinated gases are excluded.	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	1970-2018, yearly	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13]) multiplied by 2030 population projection
2. GHG emissions per capita, level and % change	EDGAR (Crippa et al., 2021 ^[16]) and Global Human Settlement Population (Schiavina, Freire and MacManus, 2019 ^[42])	GHG emissions per capita, expressed in tonnes of CO ₂ equivalent per capita by considering the 3 main GHGs, namely CO ₂ , CH ₄ and N ₂ O and a 100-year GWP. CO ₂ emissions from land use, land use change, forestry and fluorinated gases are excluded.	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	1970-2018, yearly	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13])
3. GHG emission intensities per unit of GDP, level and % change	EDGAR (Crippa et al., 2021 ^[16]) and OECD Regional Database	GHG emission intensities per unit of GDP, expressed in tonnes of CO ₂ equivalent per unit of GDP in USD thousands in 2015 prices and purchasing price parity.	TL2 and TL3 regions	2000-18, yearly	To be defined
4. GHG emissions by sector: share of total emissions, level, per capita and % change	EDGAR (Crippa et al., 2021 ^[16])	GHG emissions by sectors: agriculture, buildings, industry, power and transport.	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	1970-2018, yearly	The 2030 emissions per capita target by sector, defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[13]): agriculture 0.1 tCO ₂ -eq/capita; buildings 0.4 tCO ₂ -eq/capita; industry 1.7 tCO ₂ -eq/capita; power 1.3 tCO ₂ -eq/capita; transport 1.3 tCO ₂ -eq/capita
5. Consumption-based GHG emissions (to be estimated)	To be defined	GHG emissions embodied in goods and services consumed in a particular territory.	To be defined	To be defined	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
					Scenario for advanced economies (IEA, 2021 ^[13])
6. Electricity generation by source	Global Power Plant Database (GPPD) (GEO, 2021 ^[17]) Harmonised global dataset of wind and solar farms (Dunnett, Sorichetta and Taylor, 2020 ^[18])	Renewable energy sources include hydropower, wind, waste, biomass, wave and tidal, geothermal and solar. Fossil fuels include coal, oil, petroleum coke and natural gas.	TL2 and TL3 regions	2019	100% of electricity generated from low-carbon sources
7. Carbon intensity of electricity generation	GPPD (GEO, 2021 ^[17]) Harmonised global dataset of wind and solar farms (Dunnett, Sorichetta and Taylor, 2020 ^[18])	Carbon Intensity of electricity generation corresponds to the amount of GHG emitted per unit of electricity produced (in gCO ₂ -eq/kWh).	TL2 and TL3 regions	2019	Carbon intensity of electricity generated by the lowest emission-intensive source, i.e. 11 gCO ₂ -eq/kWh (wind)
8. Energy mix in total energy supply (to be estimated)	To be defined	This energy mix refers to all the primary energies consumed by an area to meet its needs. It is important to distinguish the energy mix from the electricity mix, which only covers the energy consumed to generate electricity.	To be defined	To be defined	To be defined
9. Total final energy consumption by source (to be estimated)	To be defined	The final energy consumption is the total energy consumed by end users, such as agriculture, industry, services or the residential sector.	To be defined	To be defined	To be defined
10. Emission intensity of the manufacturing industry	EDGAR (Crippa et al., 2021 ^[16]) and OECD Regional Database (OECD, 2022 ^[61])	The emission intensity of the manufacturing industry corresponds to the GHG emissions per unit of GVA (tCO ₂ -eq/USD thousands) in the sector. Manufacturing industry emissions include the combustion for manufacturing, oil refineries and transformation industry, chemical processes, non-metallic minerals production, iron and steel production, non-ferrous metals production, non-energy use of fuels and solvents and products use.	TL2 and TL3 regions	2017	To be defined
11. Access to public transport	Open Street Map (Haklay and Weber, 2008 ^[62]) and Mapbox Isochrone API	Access to public transport is defined as the share of people having a public transport stop (metro, tram or bus) within a ten-minute walk.	Metropolitan areas (only largest metropolitan area in each OECD country)	2022	100% of the population with access to public transport
12. Private vehicle ownership	OECD Regional Database (OECD,	Private vehicle ownership is measured as the number of	TL2 and TL3 regions	2021	Best performers, e.g.. 385 vehicles for

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
	2022 ^[63])	motor vehicles per 1 000 inhabitants. Motor vehicles include road vehicles, other than motorcycles, intended for passengers and designed for fewer than nine persons, including the driver.			1 000 inhabitants for TL2 regions
13. Electric and hybrid vehicle adoption	OECD Regional Database (OECD, 2022 ^[63])	Adoption of electric and hybrid vehicles is measured as the share of private electric or hybrid vehicles in total private vehicles.	TL2 and TL3 regions	2021	100% of electric or hybrid vehicle adoption
14. Cooling and heating degree days, levels and change, residential built-up volume	High-resolution Historical Global Gridded Dataset Of Annual Cooling And Heating Degree Days (Mistry, 2019 ^[64]), Global Human Settlement Built-up Volume (Pesaresi and Politis, 2022 ^[32]).	Heating degree days (respectively cooling) measure the heating needs of buildings. It is the sum of the differences between the mean outdoor temperature and a standard temperature (15°C). As space heating is the main source of residential energy consumption in OECD countries, heating degree days can be used as a proxy of residential pressure on energy consumption. The volume of residential buildings that need to be heated or cooled is also a measure of pressure on building energy consumption.	TL2 and TL3 regions, FUAs	1970-2019	Not applicable
15. Built-up area growth	Global Human Settlement Population (Schiavina et al., 2023 ^[55]) and Built-up Surface Grid (Pesaresi and Politis, 2023 ^[65])	Land use pressure is measured by looking at the built-up area % change, the level of built-up area per capita and at the difference between built-up area growth and population growth.	TL2, TL3 regions, FUAs	1975-2030 (5-year interval)	To be defined
16. Built-up area per capita	Global Human Settlement Population (Schiavina et al., 2023 ^[55]) and Built-up Surface Grid (Pesaresi and Politis, 2023 ^[65])	Land use pressure is measured by looking at the built-up area % change, the level of built-up area per capita and at the difference between built-up area growth and population growth.	TL2, TL3 regions, FUAs	1975-2030 (5-year interval)	Best performers, e.g.. 65 square metres per capita for metropolitan areas
17. Difference between built-up area growth and population growth	Global Human Settlement Population (Schiavina et al., 2023 ^[55]) and Built-up Surface Grid (Pesaresi and Politis, 2023 ^[65])	Land use pressure is measured by looking at the built-up area % change, the level of built-up area per capita and at the difference between built-up area growth and population growth.	TL2, TL3 regions, FUAs	1975-2030 (5-year interval)	To be defined

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
18. Waste generation	OECD Regional Database (OECD, 2022 ^[63])	Waste generation corresponds to the amount of municipal waste per capita (in kg/capita).	TL2 and TL3 regions	2020	Best performers, e.g. 350 kg per capita per year for TL2 regions
19. Waste recovery	OECD Regional Database (OECD, 2022 ^[63])	Waste recovery corresponds to the share of municipal waste that is treated with recovery operations. This includes waste that undergoes material recycling, composting, incineration with energy recovery and other forms of recovery. Landfilling is excluded.	TL2 and TL3 regions	2020	100% of recycled municipal waste

Climate adaptation: State indicators (10)

Exposure to climate-related hazards

20. Air temperature and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	The air temperature corresponds to the annual average temperature at 2 m above the surface of the Earth. The change is defined with respect to the baseline 1981-2010 climatology.	TL2 and TL3 regions, FUAs	1981-2022	Mean air temperature over 1981-2010
21. Number of hot days and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	Hot days correspond to days during which the maximum daily temperature exceeds 35°C. The change is defined with respect to the baseline 1981-2010 climatology.	TL2 and TL3 regions, FUAs	1981-2022	Mean number of hot days over 1981-2010
22. Number of tropical nights and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	Tropical nights correspond to days during which the minimum daily temperature is higher than 20°C. The change is defined with respect to the baseline 1981-2010 climatology.	TL2 and TL3 regions, FUAs	1981-2022	Mean number of tropical nights over 1981-2010
23. Number of icing days and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	Icing days correspond to days during which the maximum daily temperature does not exceed 0°C. The change is defined with respect to the baseline 1981-2010 climatology.	TL2 and TL3 regions, FUAs	1981-2022	Mean number of icing days over 1981-2010
24. Heat stress exposure	Copernicus thermal comfort indices derived from ERA5 reanalysis (ERA5-HEAT), Universal Thermal Climate Index (UTCI)	Population exposure to heat stress is defined using the UTCI, which measures the impact of atmospheric conditions on the human body. UTCI values between 32°C and 38°C correspond to strong heat stress, 38°C to 46°C to very strong heat stress and above 46°C to extreme heat stress.	TL2 and TL3 regions, FUAs	1981-2021, yearly	Mean number of days of different heat stress levels over 1981-2010

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
25. Urban heat island intensity (daytime and night-time)	MODIS Aqua and Terra Land Surface Temperature and MODIS Land Cover Data	The urban heat island intensity measures the difference in temperatures between the city and its surrounding area. The urban heat island intensity is here defined for a FUA as the difference in land surface temperature between the built-up area and its surroundings.	FUAs, SAUs	2012-21, yearly	To be defined
26. Population exposure to fires	JRC's Global Wildfire Dataset and Global Human Settlement Population (Schiavina, Freire and MacManus, 2019 ^[42])	Wildfire population exposure is calculated as the population located within a 5 km buffer around fires.	TL2 and TL3 regions	2000-21	Reference point defined as 0%
27. Burnt area by land cover type	JRC's Global Wildfire Dataset and ESA CCI Land Cover Data (ESA, 2019 ^[28])	Burnt area by land cover type (forests and croplands) are measured as the share of forest area burnt as a share of the total forest area.	TL2 and TL3 regions	2000-21	Reference point defined as 0%
28. Forest exposure to wildfire danger	Copernicus Climate Data Store Fire Danger Indices Historical Data (EC, 2019 ^[43])	Forest exposure to wildfire danger is measured using the Fire Weather Index (FWI) System and enables the identification of forests in areas at risk of burning and which have not necessarily burnt.	TL2 and TL3 regions	2000-21	Reference point defined as 0%
29. Population exposure to river flooding	JRC River Flood Hazard Maps (Dottori et al., 2021 ^[44]), and Global Human Settlement Population (GHS-POP) Layer (Schiavina, Freire and MacManus, 2022 ^[31])	Population exposure to river flooding is calculated for 100-year return period for river and coastal flooding. A return period refers to the recurrence of floods with a similar intensity.	TL2 and TL3 regions, FUAs	2015	To be defined
30. Population exposure to coastal flooding	World Bank Global Coastal Flood Hazard (Muis et al., 2016 ^[47]) and Global Human Settlement Population (GHS-POP) Layer (Schiavina, Freire and MacManus, 2022 ^[31])	Population exposure to coastal flooding is calculated for 100-year return period for river and coastal flooding. A return period refers to the estimated time interval between floods of similar intensity.	TL2 and TL3 regions, FUAs	2015	To be defined

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
31. Agricultural drought	ERA5-Land (Muñoz Sabater, 2019 ^[36]) and ESA CCI Land Cover Data (ESA, 2019 ^[28])	Droughts are defined in terms of cropland soil moisture anomaly, i.e. the percentage change in soil moisture compared to the reference period 1981-2010.	TL2 and TL3 regions	1981-2021, yearly	Mean cropland soil moisture over 1981-2010
32. Cumulated precipitation and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	Cumulated precipitation refers to the accumulated liquid and frozen water, including rain and snow, that falls to the Earth's surface. The change is defined with respect to the baseline 1981-2010 climatology.	TL2, TL3 regions, and FUAs	1981-2021, yearly	Mean cumulated precipitation over 1981-2010
33. Extreme precipitation days and change	ERA5-Land (Muñoz Sabater, 2019 ^[36])	Extreme precipitation days correspond to days when the total amount of precipitation exceeds 20 mm. The change is defined with respect to the baseline 1981-2010 climatology.	TL2, TL3 regions, and FUAs	1981-2021, yearly	Mean extreme precipitation days over 1981-2010
34. Built-up exposure to violent storms	Copernicus Climate Data Store (CDS) ERA5 Hourly Data on Single Levels	An area is considered exposed to violent storms or worse if, for at least 1 hour, the wind gust speed > 28.6 metres per second (threshold based on the Beaufort scale).	TL2 and TL3 regions	2000-21	Mean exposure over 1981-2010
<i>Socio-economic factors driving vulnerability</i>					
35. Population density	OECD regional and metropolitan databases	Areas with high population density are, in general, more vulnerable to climate-related impacts, as they experience increased resource and infrastructure stress, higher health risks and challenges related to migration and adaptation.	TL2, TL3 and FUAs	2000-22	Not applicable
36. Population aged < 5	OECD regional and metropolitan databases	Young children are particularly vulnerable to heat stress, diseases and malnutrition exacerbated by climate change.	TL2, TL3 and FUAs	2000-22	Not applicable
37. Population aged > 70	OECD regional and metropolitan databases	Elderly population often face increased health risks from extreme heat and limited mobility, which makes them particularly vulnerable to the impacts of climate change.	TL2, TL3 and FUAs	2000-22	Not applicable
38. Unemployment rate	OECD regional and metropolitan databases	High unemployment rates lead to limited access to resources, increased social vulnerability and limited adaptive capacities to climate change impacts.	TL2, TL3 and FUAs	2000-22	Not applicable

Indicator	Data source	Description	Geographical resolution, coverage	Temporal resolution, coverage	Reference point
39. Poverty rate	OECD regional and metropolitan databases	Poverty rate is the ratio of the number of people whose income falls below the poverty line, defined as 60% of the median household income after taxes and transfers, over the total population.	TL2, TL3 and FUAs	2007-22	Not applicable
Actions and opportunities: Response indicators (6)					
40. Existence of subnational climate mitigation and adaptation targets and compliance with national targets (to be estimated)	To be defined	Local emission reduction targets by 2030 would enable the assessment of their compliance with NDCs.	National scale	2030, 2050 targets	100% of subnational governments (e.g. TL2, TL3 levels) with climate mitigation and adaptation targets complying with national targets
41. Citizens' satisfaction with efforts to preserve the environment	OECD based on the Gallup World Poll (Gallup World Poll, 2019 ^[51])	The percentage of the population satisfied with efforts to preserve the environment by using data from the Gallup World Poll (2019 ^[51]).	TL2 regions	2008-18	Best performers
42. Green areas in cities	ESA World Cover 2020 (Zanaga et al., 2021 ^[29]) and Global Human Settlement Urban Centre Database (Florczyk et al., 2019 ^[66]), Access to Green Urban Areas in Europe (Poelman, 2018 ^[53])	Green areas in cities, measured in two ways: - Share of green areas in urban centres using land cover data. Green areas correspond to trees, shrublands and grasslands. - The share of the population with access to public green areas of more than 1 ha within a 400 m walk.	FUA's urban centres, SAUs	2021	Best performers
43. Climate-significant expenditure and investments	Subnational Government Climate Finance database, OECD Regional Statistics (database) (OECD, 2022 ^[59])	Subnational government investment and expenditure in environmental protection and climate are important instruments for both climate mitigation and adaptation (OECD, 2022 ^[57]).	National scale	2009-19	Best performers
44. Existence of climate-related funds, grants and subsidies for subnational action	OECD Compendium of Fiscal Tools for Subnational Climate Action (OECD, 2022 ^[67])	Qualitative information on public sources of revenue available to subnational governments in OECD and EU countries to fund and finance their climate action.	National scale	2022	To be defined
45. Patent applications in climate mitigation and adaptation technologies as % of total technologies	PATSTAT database (OECD, 2023 ^[60]), European Patent Organisation	Patent applications in climate mitigation and adaptation technologies are essential in the deployment of low-carbon technologies and in the transition to net zero.	TL2 and TL3 regions, FUAs	To be defined	Best performers

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Notes

¹ The OECD large regions (TL2) represent the first administrative tier of subnational government, such as provinces in Canada and states in the United States. The OECD small regions (TL3) correspond to administrative regions, except for Australia, Canada and the United States. An FUA is composed of a city and its commuting zone, encompassing the economic and functional extent of cities based on people’s daily movements.

² Urban lands refer to built-up areas and non-urban lands refer to all other land cover classes, except water bodies.

³ Forests include the following Copernicus annual 300 m land cover (CCI-LC) classes: 50, 60, 61, 62, 70, 71, 72, 80, 81, 82, 90, 100 and 160.

⁴ Croplands include the following Copernicus annual 300 m land cover (CCI-LC) classes: cropland, rainfed, irrigated or post-flooding; mosaic cropland (>50%)/natural vegetation (tree, shrub, herbaceous cover) (<50%); and mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%)/cropland (<50%).

⁵ Here we refer to expenditure and investment directed towards the economic activities the EU Technical Expert Group on Sustainable Finance (TEG) identified as significantly contributing to climate change adaptation and mitigation in their March 2020 report *Taxonomy: Final Report of the Technical Expert Group on Sustainable Finance*.

3

Analysing local greenhouse gas emissions, climate impacts and vulnerabilities across OECD countries: Key findings

This chapter provides an initial assessment of local climate greenhouse gas (GHG) emissions, climate impacts and risks, applying the territorial indicator framework presented in Chapter 2 to OECD countries at different subnational levels. The chapter analyses 21 out of the proposed 45 indicators. It provides an overview of where OECD regions and cities stand in their journey toward climate neutrality by 2050, along with a discussion of the associated impacts and risks of climate change. The results reveal large territorial disparities within countries in terms of GHG emissions, mitigation potential as well as vulnerability to climate change. Such results reiterate the need for a territorial approach to climate and resilience policies.

Introduction: Applying the OECD territorial climate indicator framework to cities and regions

This chapter analyses the current trends and challenges of climate change in OECD cities and regions by applying the OECD territorial climate indicator framework presented in Chapter 2. It aims to provide an overview of where OECD regions and cities stand in their journey toward climate neutrality by 2050, along with an examination of the associated risks they encounter. Out of the proposed 45 indicators in the framework, this chapter analyses 21 indicators (14 climate mitigation indicators, 7 climate adaptation and resilience indicators). “Actions and opportunities” indicators will be discussed in Chapter 4. Sixteen out of these 21 indicators were calculated for Territorial Level 2 regions (TL2) and Level 3 regions (TL3)¹, and 5 for functional urban areas (FUAs)² (Table 3.1). The selection was made according to the principle of data availability. For each indicator, where relevant, the distance of cities and regions to achieving the global targets is measured and assessed.

Table 3.1. The list of indicators analysed in this report

Indicator	Unit of analysis	Reference point
Climate mitigation		
1. Total greenhouse gas (GHG) emissions, level and percentage change	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[11]) multiplied by 2030 population projection
2. GHG emissions per capita, level and percentage change	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	The 2030 emissions per capita target (4.7 tCO ₂ -eq) defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[11])
4. GHG emissions by sector: share of total emissions, level, per capita and percentage change	TL2 and TL3 regions, FUAs of more than 500 000 inhabitants	The 2030 emissions per capita target by sector, defined based on computations derived from the IEA NZE Scenario for advanced economies (IEA, 2021 ^[11]): agriculture 0.1 tCO ₂ -eq/capita; buildings 0.4 tCO ₂ -eq/capita; industry 1.7 tCO ₂ -eq/capita; power 1.3 tCO ₂ -eq/capita; transport 1.3 tCO ₂ -eq/capita
6. Electricity generation by source	TL2 and TL3 regions	100% of electricity generated from low-carbon sources.
7. Carbon intensity of electricity generation	TL2 and TL3 regions	Carbon intensity of electricity generated by the lowest emission-intensive source, i.e. 11 grams of CO ₂ -eq per kilowatt-hour (kWh) (wind).
10. Emission intensity of the manufacturing industry	TL2 and TL3 regions	To be defined.
11. Access to public transport	Metropolitan areas (only largest metropolitan area in each OECD country)	100% of the population with access to public transport.
12. Private vehicle ownership	TL2 and TL3 regions	Best performers, e.g.. 385 vehicles for 1 000 inhabitants for TL2 regions.
13. Electric and hybrid vehicle adoption	TL2 and TL3 regions	100% of electric or hybrid vehicle adoption.
15. Built-up area growth	TL2, TL3 regions, FUAs	To be defined.
16. Built-up area per capita	TL2, TL3 regions, FUAs	Best performers, e.g.. 65 square metres per capita for metropolitan areas.
17. Difference between built-up area growth and population growth	TL2, TL3 regions, FUAs	To be defined.
18. Waste generation	TL2 and TL3 regions	Best performers, e.g. 350 kg per capita per year for TL2 regions
19. Waste recovery	TL2 and TL3 regions	100% of recycled municipal waste.

Indicator	Unit of analysis	Reference point
Climate adaptation and resilience		
24. Heat stress exposure	TL2 and TL3 regions, FUAs	Mean number of days of different heat stress levels over 1981-2010.
25. Urban heat island intensity (daytime and night-time)	FUAs, SAUs	To be defined.
27. Burnt area by land cover type	TL2 and TL3 regions	Reference point defined as 0%.
28. Forest exposure to wildfire danger	TL2 and TL3 regions	Reference point defined as 0%.
29. Population exposure to river flooding	TL2 and TL3 regions	To be defined.
30. Population exposure to coastal flooding	TL2 and TL3 regions	To be defined.
31. Agricultural drought	TL2 and TL3 regions	Mean cropland soil moisture over 1981-2010.

Climate mitigation

Most OECD regions are far from reaching climate neutrality

Recent GHG emission trends differ largely across and within OECD countries. From 1990 to 2018, production-based emissions in Chile, Israel, Korea and Türkiye more than doubled, while those in the Baltic states and the United Kingdom decreased by more than 40%. In 40% of OECD large regions, emissions dropped, while in 25% of the regions, emissions increased by more than 50%. For example, in Korea, emissions in the Chungcheong region have increased 3 times since 1990, while those in Jeju increased by 38% (Figure 3.1 and Figure 3.2).

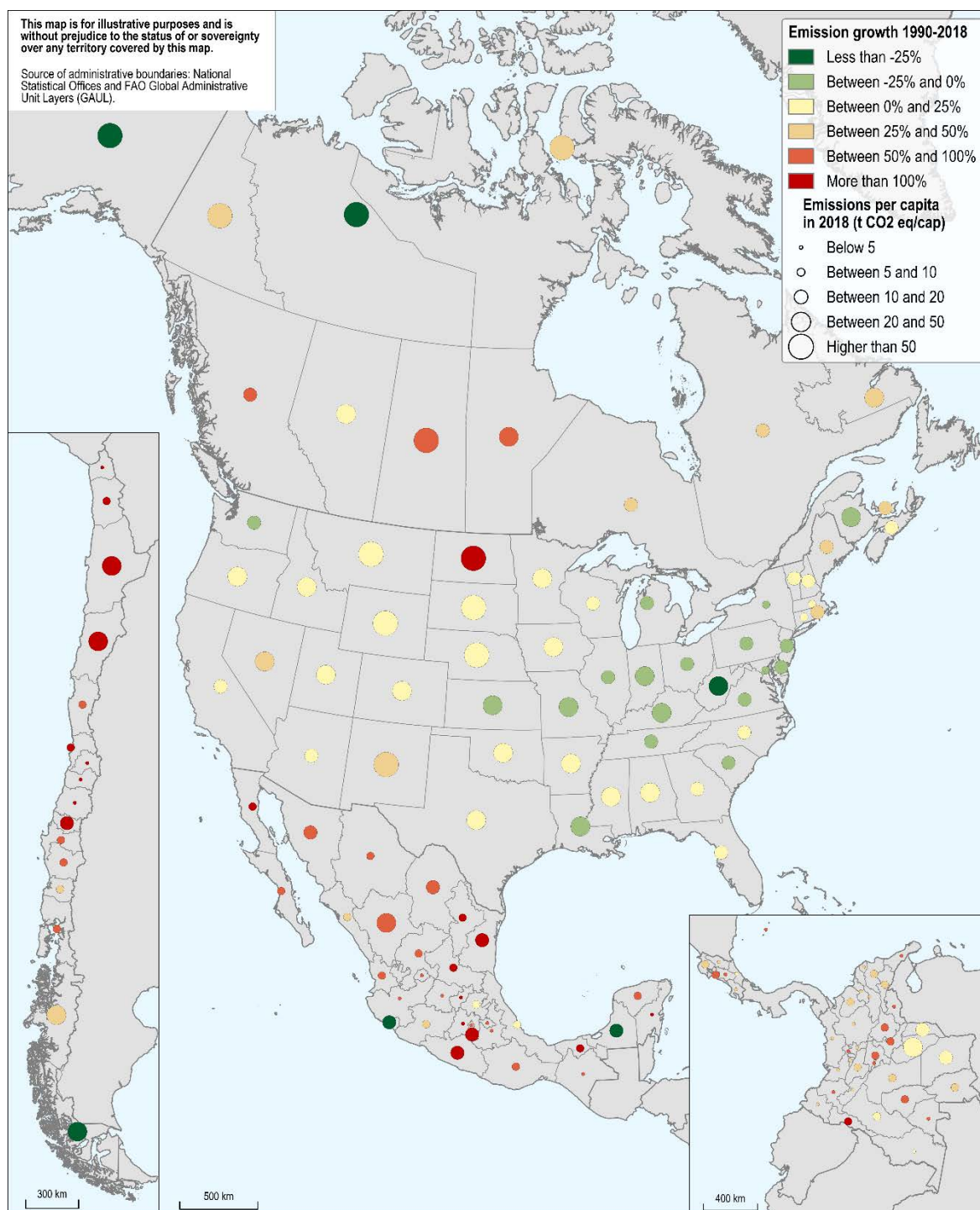
When comparing emission trends in OECD regions with the nationally determined contributions (NDCs) set at the national level, OECD large regions will have, on average, to cut their emissions by 35% by 2030 compared to 2018. This assumes the same regional distribution of emissions in 2030 as in 2018. When now looking at the more ambitious target of 4.7 tCO₂-eq per person derived from the IEA NZE Scenario, OECD regions will have, on average, reduced their emissions by a factor of 2.8 by 2030. In 2018, only 61 out of the 432 OECD large regions registered lower production-based emissions per capita than the required 4.7 tCO₂-eq per capita. In 40% of the regions, emissions per capita were higher than 10 tCO₂-eq.

Regional disparities are particularly important in the United States, where emissions per capita ranged from 3.6 tCO₂-eq in the District of Columbia to 180.7 tCO₂-eq in North Dakota (the latter probably due to its shale oil industry). Large regional disparities in emissions per capita also exist in other OECD countries, such as Canada, the Netherlands and New Zealand (Figure 3.1 and Figure 3.2).

The diverse levels of GHG emissions across regions are mainly attributed to the type of regions (urban or rural) and the existence of the power and industry sectors. In almost all OECD countries, emissions per capita are lower in metropolitan regions than in other types of regions (Figure 3.3.). On average, emissions per capita are twice as low in metropolitan regions as in regions far from a metropolitan region. In European OECD countries, metropolitan regions witnessed the largest decline across types of small regions. Emissions per capita per year reached 7 tCO₂-eq in 2018, i.e. 27% lower than in 1990. Metropolitan regions in South American OECD countries registered the lowest emissions per capita in 2018, with 2.9 tCO₂-eq. However, these regions experienced the largest relative increase in emissions across the OECD (+80%) since 1990 (Figure 3.4.).

Figure 3.1. Most OECD regions are far from reaching climate neutrality, Americas

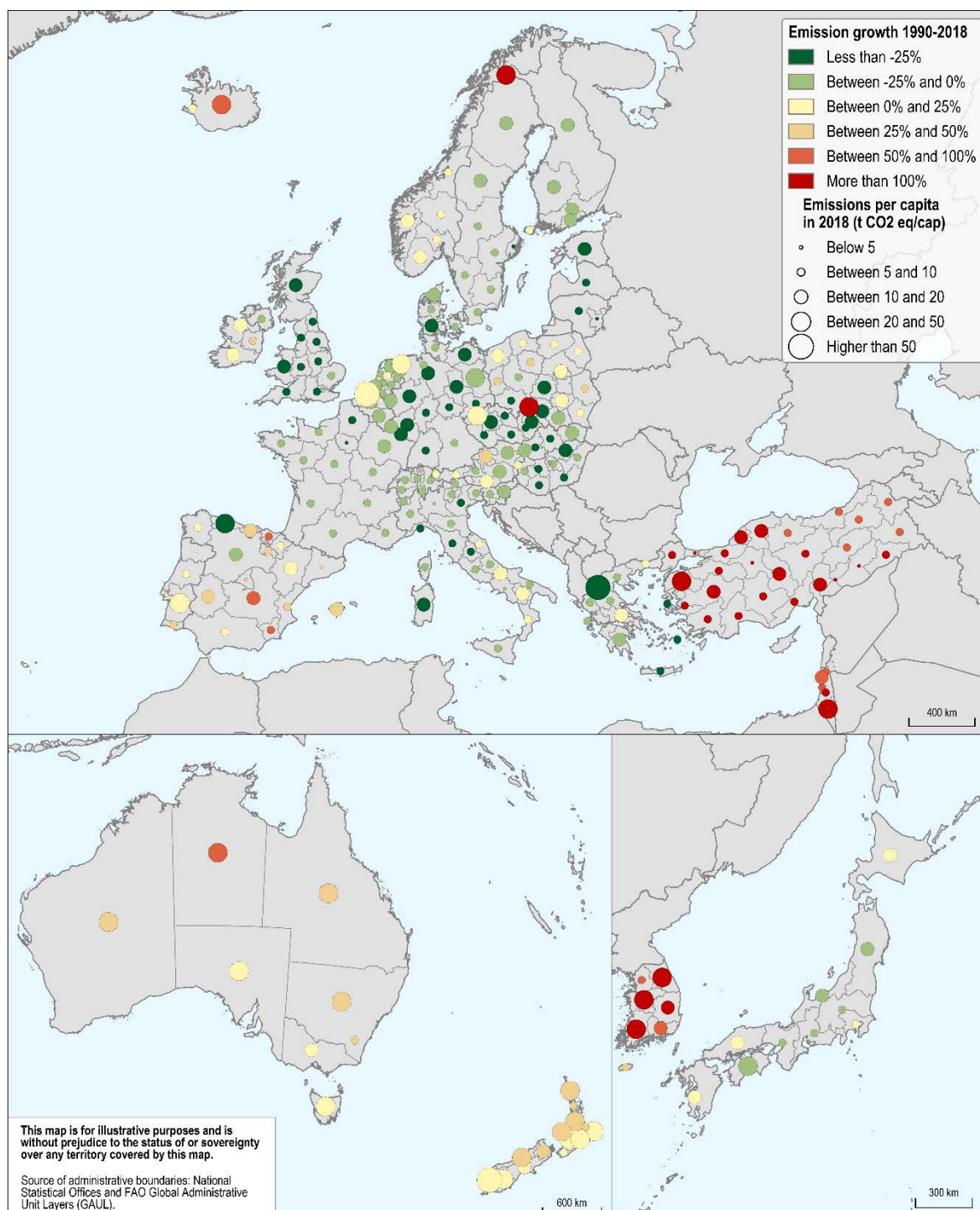
Total production-based GHG emissions (tCO₂-eq) per capita, 2018; emission growth (%) 1990-2018, OECD large regions (TL2)



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

Figure 3.2. Most OECD regions are far from reaching climate neutrality, Europe, Asia, Pacific

Total production-based GHG emissions (tCO₂-eq) per capita, 2018; emission growth (%) 1990-2018, OECD large regions (TL2)

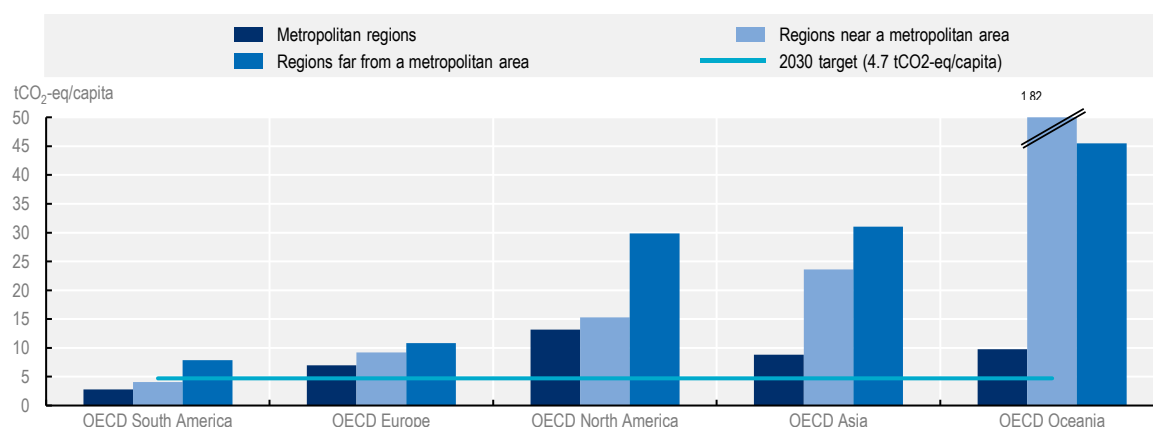


Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

The distribution of emissions by sector also varies across types of regions. In large metropolitan regions, buildings account for a larger share of total emissions than in other types of regions. Similarly, in regions near a metropolitan area, emissions in the power industry are relatively higher. The same trend applies to agriculture in remote regions (Figure 3.5).

Figure 3.3. Metropolitan regions register lower emissions per capita than other types of regions

Emissions (t CO₂-eq) per capita, 2018, by type of small regions (TL3)

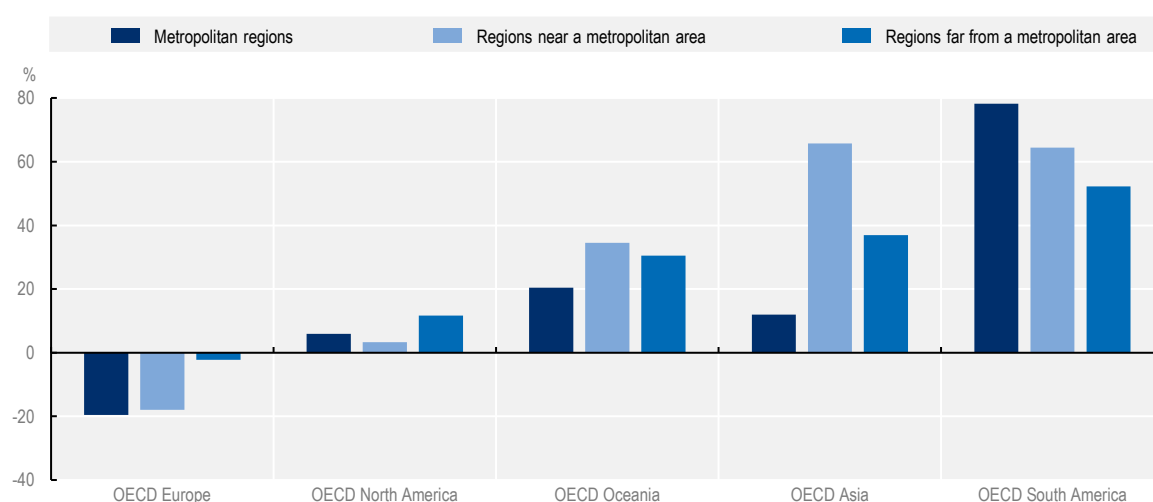


Note: Estimates based on OECD computations.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

Figure 3.4. Emissions declined the most in metropolitan regions in OECD Europe

Emissions growth, 1990-2018 (%), by type of small regions (TL3)

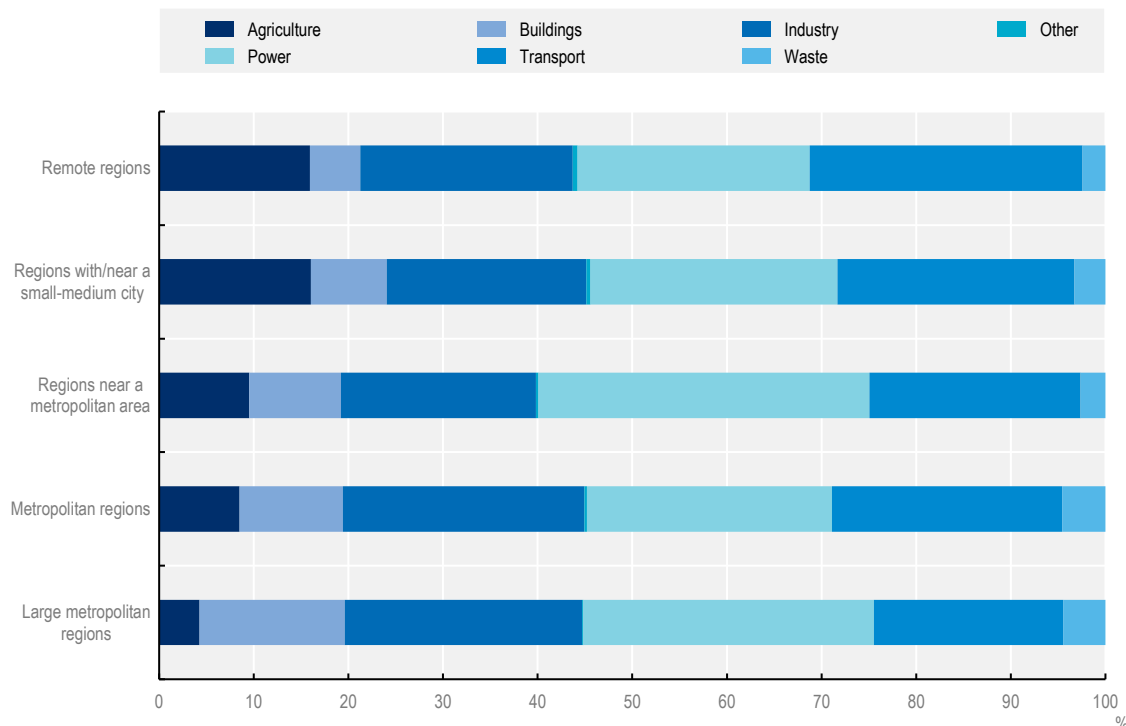


Note: Estimates based on OECD computations.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>.

Figure 3.5. The sectoral distribution of emissions varies across types of small regions

Distribution of GHG emissions by sector in OECD small regions (TL3), 2018



Note: Estimates based on OECD computations.

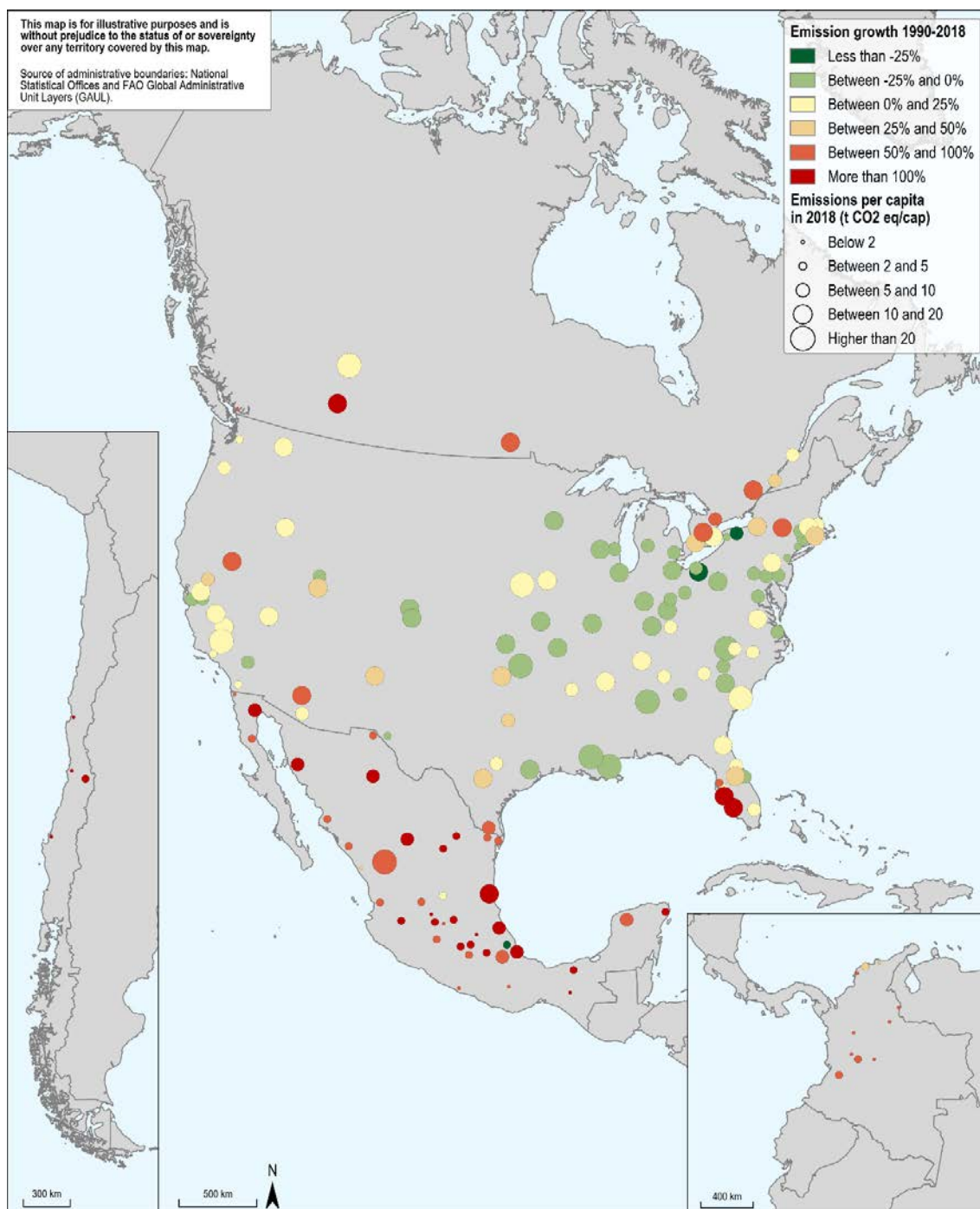
Source: Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>.

OECD cities also record high levels of GHG emissions, challenging climate neutrality

OECD metropolitan areas record high levels of GHG emissions per capita, with wide disparities across countries. On average, metropolitan areas of more than 500 000 inhabitants had per capita emissions of 6.9 tCO₂-eq in 2018 and experienced an emission growth of 24% from 1990 to 2018 (Figure 3.6). Disparities across metropolitan areas are particularly important. The Ruhr metropolitan area in Germany recorded close to 19.2 tCO₂-eq/capita in 2018, whereas Istanbul in Türkiye recorded a significantly lower level of 0.2 tCO₂-eq/capita (Figure 3.8). In 2018, almost half of OECD metropolitan areas with more than 500 000 inhabitants recorded production-based emissions per capita lower than the target of 4.7 tCO₂-eq per person. To reach this target, the remaining metropolitan areas will have to cut their emissions by an average of 44% by 2030.

Figure 3.6. GHG emissions per capita in OECD metropolitan areas illustrate wide disparities across countries, Americas

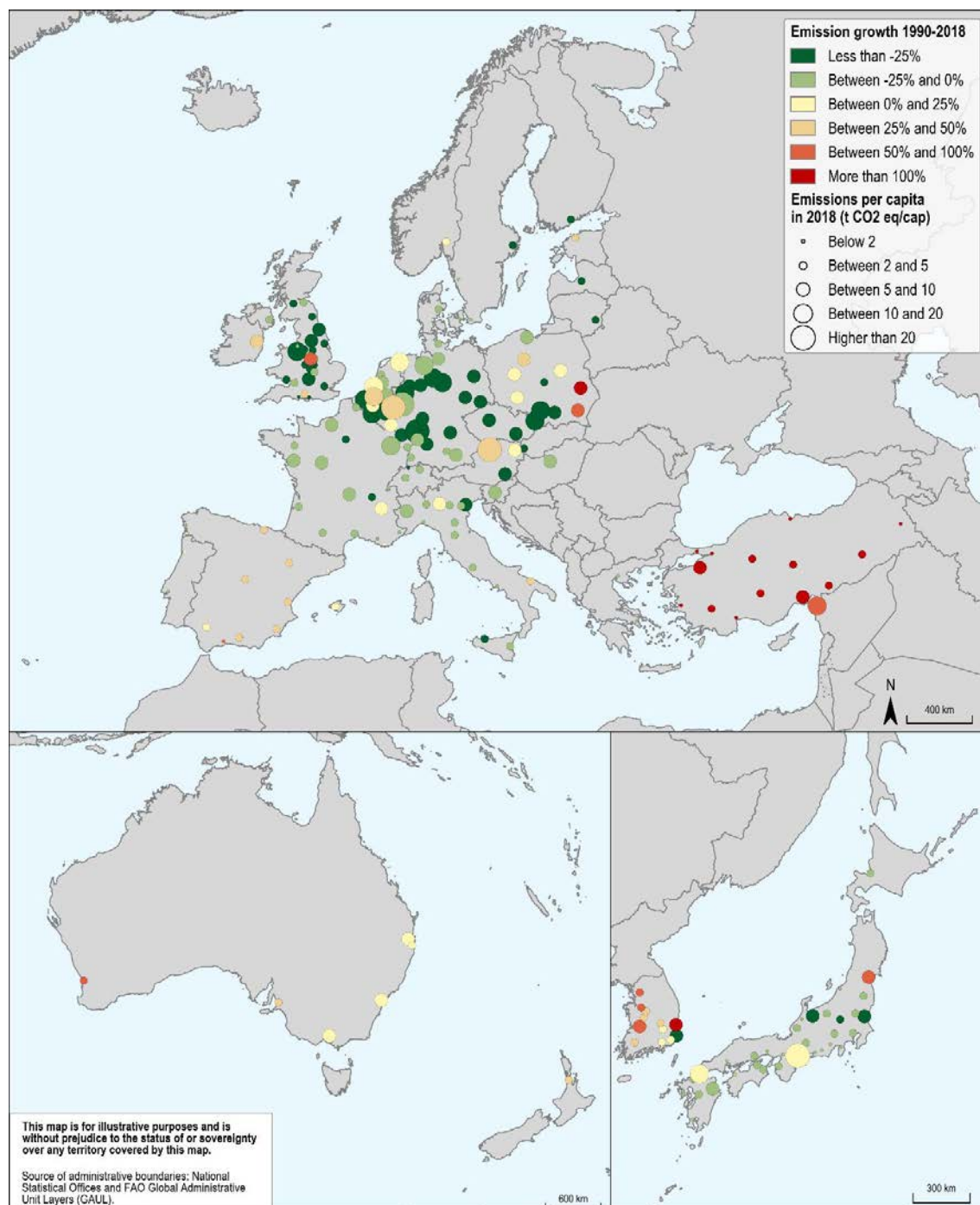
Total production-based GHG emissions (tCO₂-eq) per capita, 2018; emission growth (%) 1990-2018, OECD metropolitan areas of more than 500 000 inhabitants (FUA)



Source: Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

Figure 3.7. GHG emissions per capita in OECD metropolitan areas illustrate wide disparities across countries, Europe, Asia, Pacific

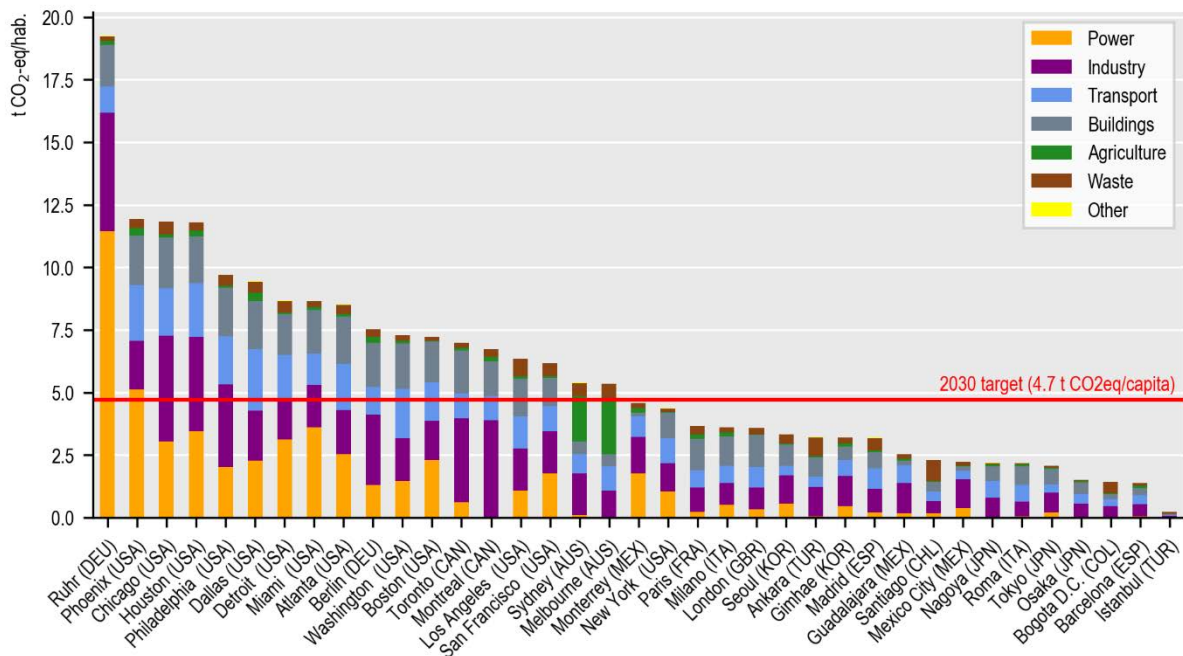
Total production-based GHG emissions (tCO₂-eq) per capita, 2018; emission growth (%) 1990-2018, OECD metropolitan areas of more than 500 000 inhabitants (FUA)



Source: Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

Figure 3.8. Among the most populated OECD metropolitan areas, Ruhr (Germany) records the largest emissions per capita

Emissions per capita by sector in OECD metropolitan areas of more than 4 million inhabitants, 2018



Note: Estimates based on OECD computations.

Source: Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

OECD regions show strong disparities in low-carbon power supply and manufacturing industry

Many OECD regions are still far from reaching low-carbon electricity generation. More than 50 regions spread across 19 OECD countries still rely heavily on coal for power generation. However, over one-third of regions generate most of their power from low-carbon sources (nuclear or renewables) (Figure 3.9). Quebec (Canada), Auvergne-Rhône-Alpes (France) and Scotland (United Kingdom) are the largest producing regions in their respective countries and rely for more than 90% of their electricity on low-carbon sources. Power generation in these regions emits less than 100 gCO₂-eq. per kWh, which is more than 3 times below the OECD average (350 gCO₂-eq/kWh) (Figure 3.10).

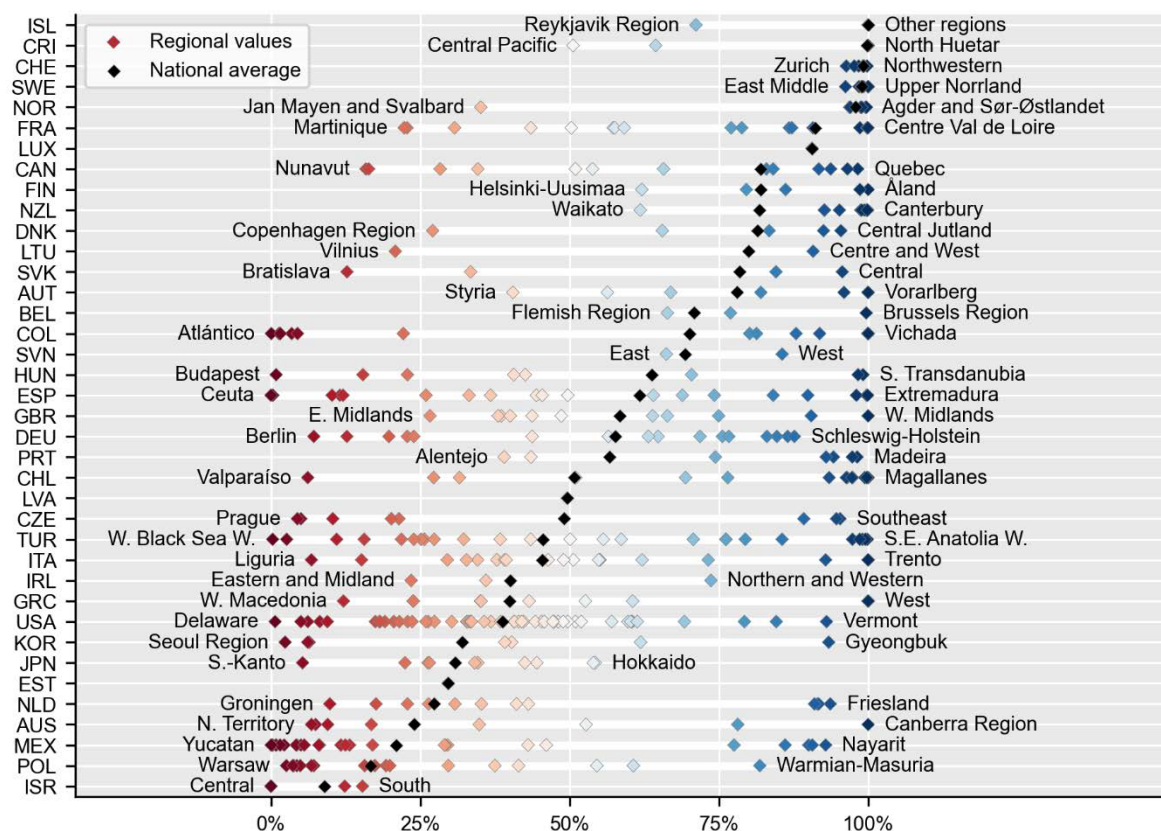
Remote regions tend to generate cleaner energy. Renewables account for more than half of the electricity generation in remote regions and less than 20% in large metropolitan regions. Metropolitan regions tend to produce more carbon-intensive electricity. Almost half of the power in large metropolitan regions is generated from natural gas (Figure 3.12).

Emissions in the manufacturing industry mostly declined in metropolitan regions (-31%) and increased in remote regions (+7%). Emissions in this sector are concentrated in a few subsectors, such as the manufacturing of cement or steel, which can drive important disparities in emissions within countries. For example, in the Netherlands, the manufacturing emissions per unit of gross value added (GVA) in the region of Zeeland are more than six times higher than in Limburg. The manufacturing industry is an important sector in both regions as it accounts for more than 20% of total GVA but emissions in Zeeland

are particularly concentrated in the manufacture of chemicals and chemical products. Large disparities are also observed in Australia, Mexico and the United States (Figure 3.13).

Figure 3.9. Over one-third of OECD regions generate their electricity from low-carbon sources

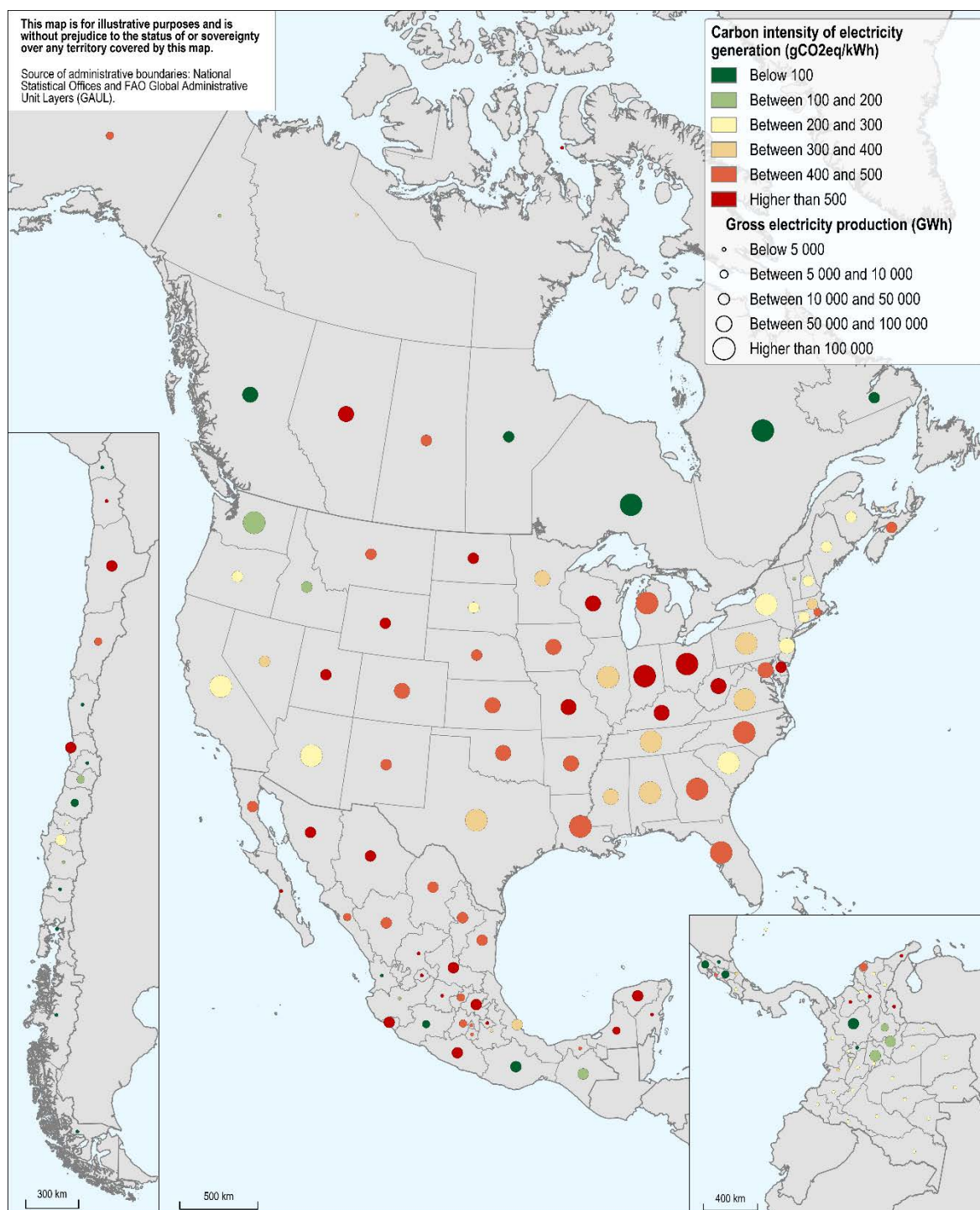
Share of electricity generated from low-carbon sources (renewables or nuclear), OECD large regions (TL2), 2019



Source: Estimates based on Byers, L. et al. (2021^[5]), *A Global Database of Powerplants*, <https://www.wri.org/research/global-database-power-plants>; IEA electricity and heat database (2023^[6]); Dunnett, S., A. Sorichetta and G. Taylor (2020^[7]), "Harmonised global datasets of wind and solar farm locations and power", *Scientific Data*, Vol. 7/1, p. 130.

Figure 3.10. Many OECD regions still lag behind in clean power generation, Americas

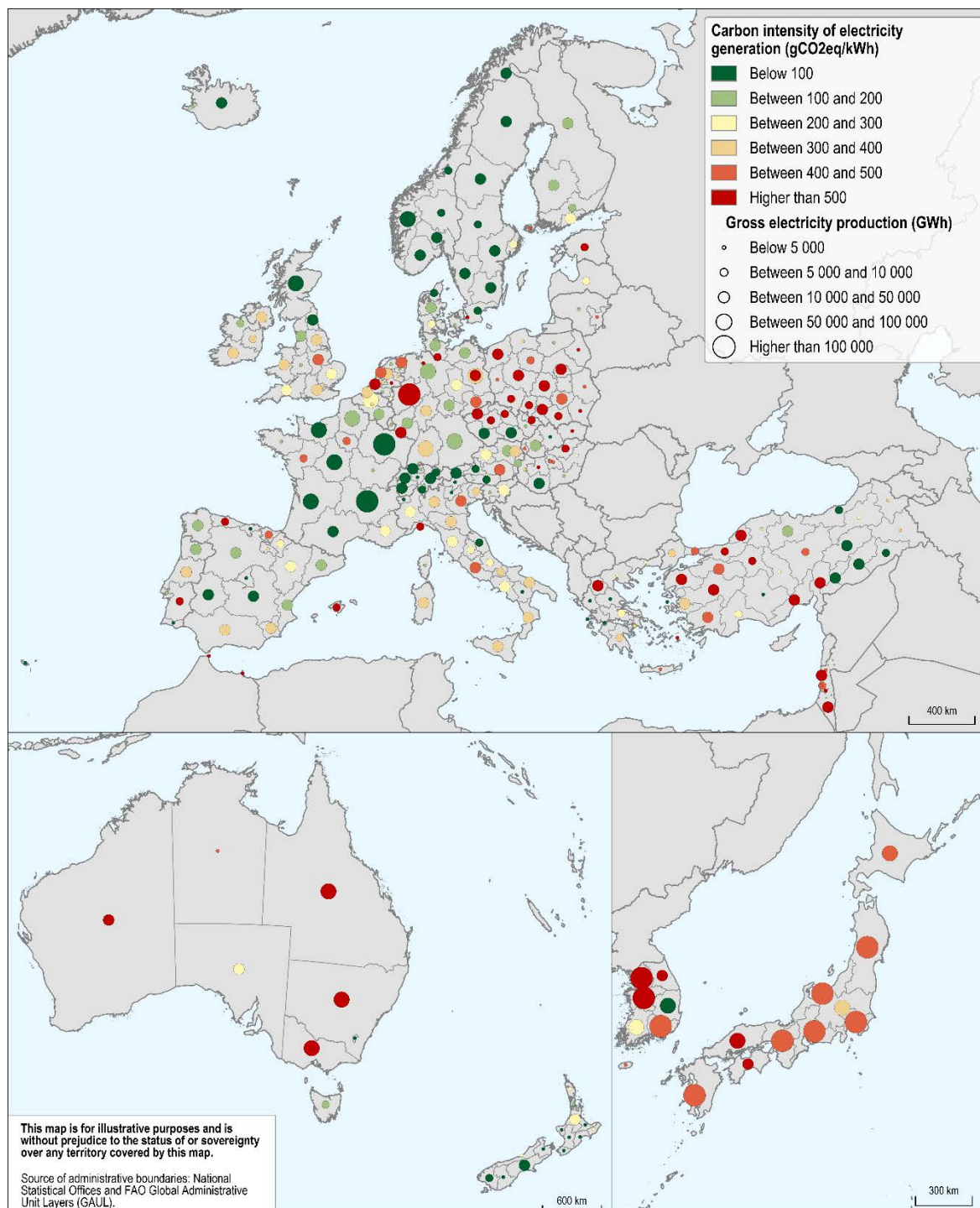
Gross electricity production (GWh) and carbon intensity of electricity generation (gCO₂-eq/kWh), OECD large regions (TL2), 2019



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Byers, L. et al. (2021^[5]), *A Global Database of Powerplants*, <https://www.wri.org/research/global-database-power-plants>; IEA electricity and heat database (2023^[6]); Dunnett, S., A. Sorichetta and G. Taylor (2020^[7]), "Harmonised global datasets of wind and solar farm locations and power", *Scientific Data*, Vol. 7/1, p. 130.

Figure 3.11. Many OECD regions still lag behind in clean power generation, Europe, Asia, Pacific

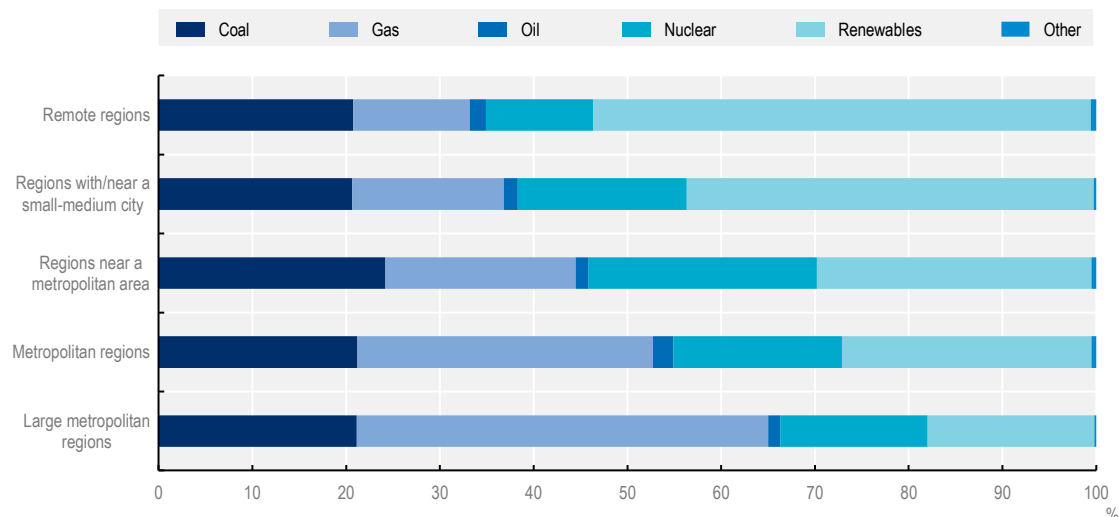
Gross electricity production (GWh) and carbon intensity of electricity generation (gCO₂-eq/kWh), OECD large regions (TL2), 2019



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Byers, L. et al. (2021^[5]), *A Global Database of Powerplants*, <https://www.wri.org/research/global-database-power-plants>; IEA electricity and heat database (2023^[6]); Dunnett, S., A. Sorichetta and G. Taylor (2020^[7]), "Harmonised global datasets of wind and solar farm locations and power", *Scientific Data*, Vol. 7/1, p. 130.

Figure 3.12. Remote regions generate cleaner electricity

Power generation by source (2019), by type of small regions (TL3)

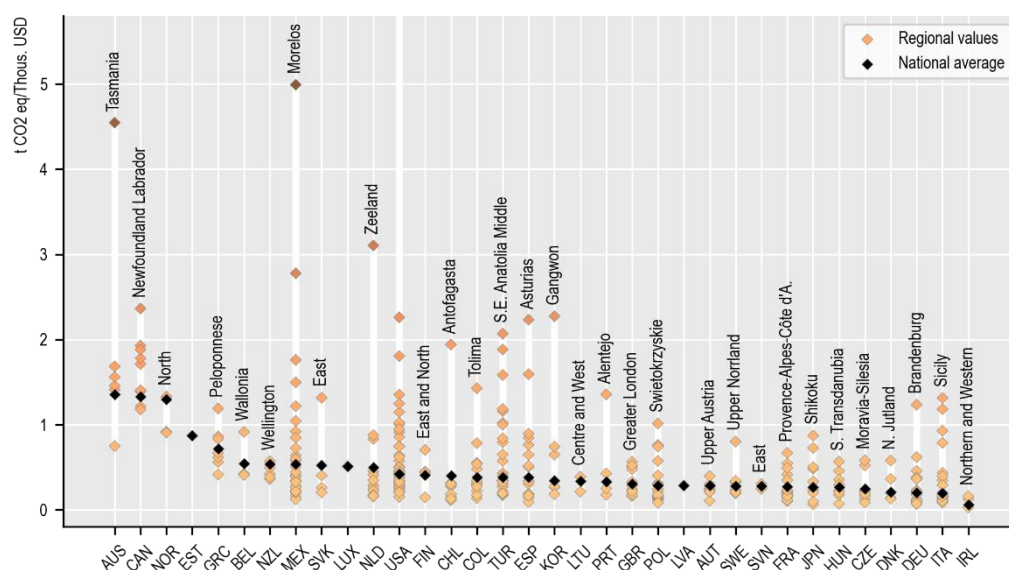


Note: Estimates based on OECD computations.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Byers, L. et al. (2021^[5]), *A Global Database of Powerplants*, <https://www.wri.org/research/global-database-power-plants>; IEA electricity and heat database (2023^[6]); Dunnett, S., A. Sorichetta and G. Taylor (2020^[7]), "Harmonised global datasets of wind and solar farm locations and power", *Scientific Data*, Vol. 7/1, p. 130.

Figure 3.13. Regional disparities in manufacturing emissions per unit of GVA

Emissions per unit of GVA in manufacturing (tCO₂-eq/USD thousands), 2017, OECD large regions (TL2)



Note: Manufacturing industry emissions include the combustion for manufacturing, oil refineries and transformation industry, chemical processes, non-metallic minerals production, iron and steel production, non-ferrous metals production, non-energy use of fuels and solvents and products use. Only regions where the GVA in manufacturing is higher than USD 1 billion (constant prices, constant purchasing power parity, base year 2015) are represented in the chart. Alaska (United States), not shown in this graph, records 6.8 tCO₂-eq/USD thousands.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; GVA in manufacturing obtained from the OECD regional database (2023^[8]).

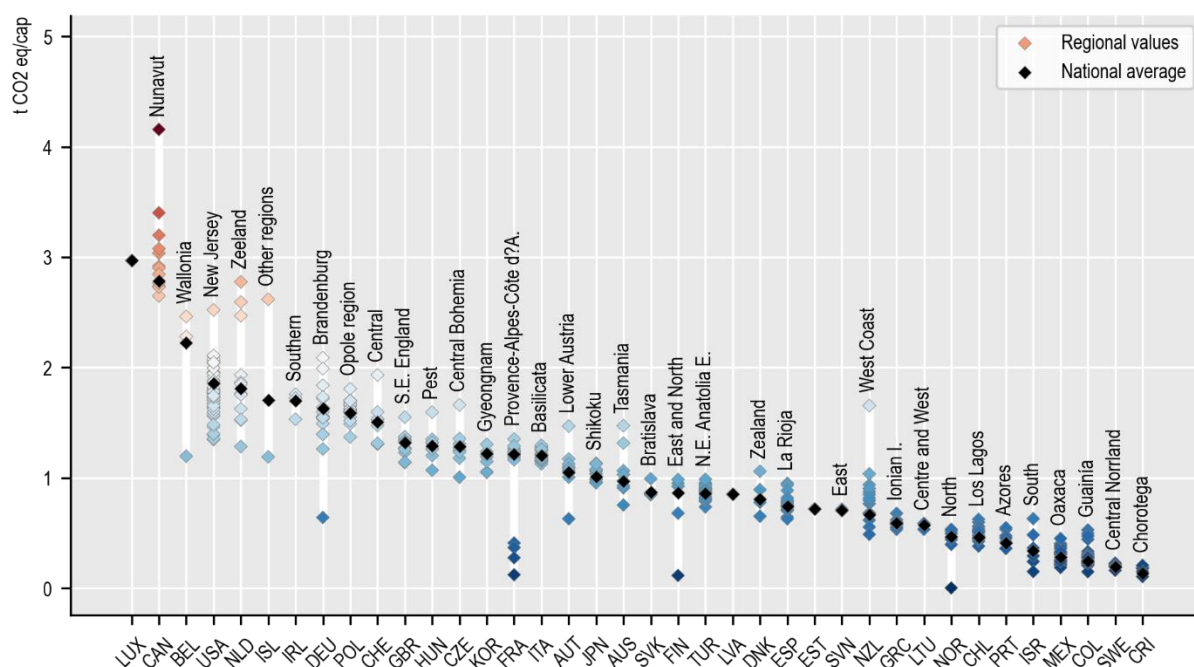
Emissions from the building and transport sectors show large territorial disparities

Building sector

Direct building emissions (excluding the carbon intensity of purchased electricity and of the materials used in building construction) accounted for 11% of total GHG emissions in 2018 (Crippa et al., 2021^[3]). Large disparities in building emissions across and within countries can only be partly explained by climate differences, as they may also originate from differences in energy sources used in the residential sector. In Germany, building emissions per capita in Brandenburg are three times higher than those in Bremen (Figure 3.14). Since 2000, building emissions per capita have decreased in three-quarters of OECD large regions, with Swedish regions experiencing a decrease of more than 75%. However, emissions increased in many regions located in the Baltic states, Colombia and Türkiye.

Figure 3.14. Large disparities in building emissions are only partly explained by local climate

Direct building emissions (tCO₂-eq) per capita, OECD large regions (TL2), 2018



Note: Estimates based on OECD computations.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

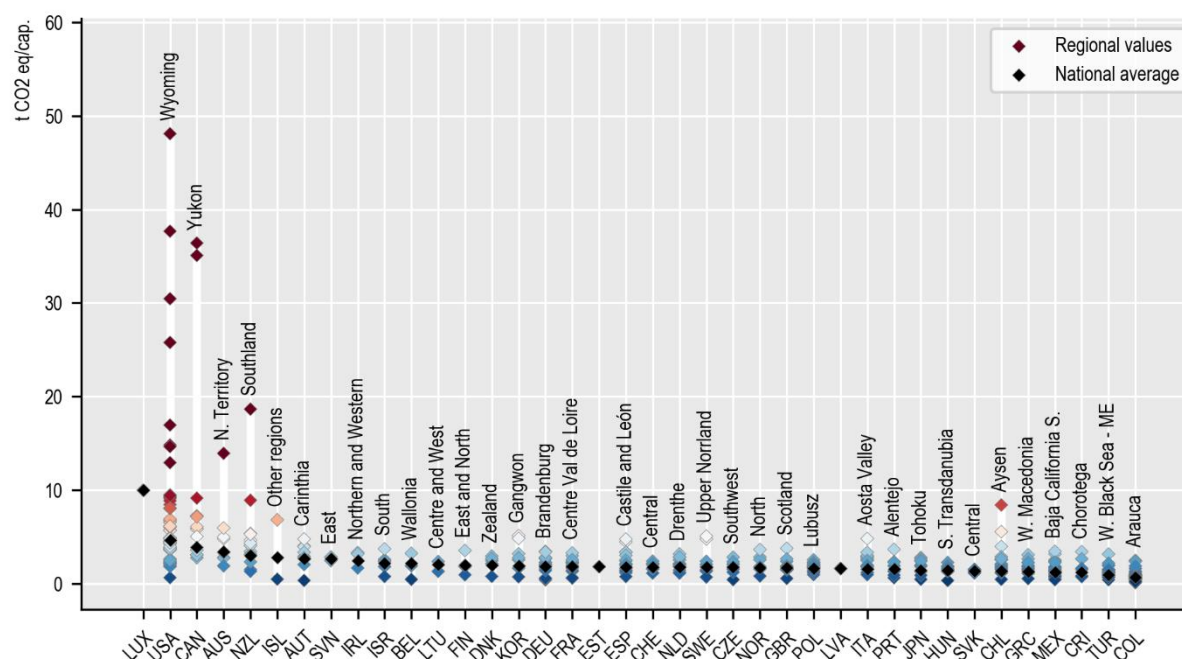
Transport emissions

Road transport accounts for the largest share of transport-related emissions in OECD countries. If we exclude international aviation and international shipping, road transport accounts for 88% of transport emissions, followed by domestic aviation (7%), rail and others (3%) and domestic shipping (2%) (Crippa et al., 2021^[3]).

Disparities in road emissions per capita within countries are particularly large in Oceania and North America (Figure 3.15). Sparsely populated regions in North America record the highest road emissions per capita, including North Dakota, Wyoming and Yukon, which all record more than 30 tCO₂-eq per capita. From 2000 to 2018, road emissions per capita increased, particularly in Eastern Europe, Colombia, Korea and Türkiye.

Figure 3.15. Regions in Oceania and North America are experiencing the largest disparities in road transport emissions per capita

Road transport emissions (tCO₂-eq) per capita in OECD large regions (TL2), 2018



Note: Estimates based on OECD computations.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

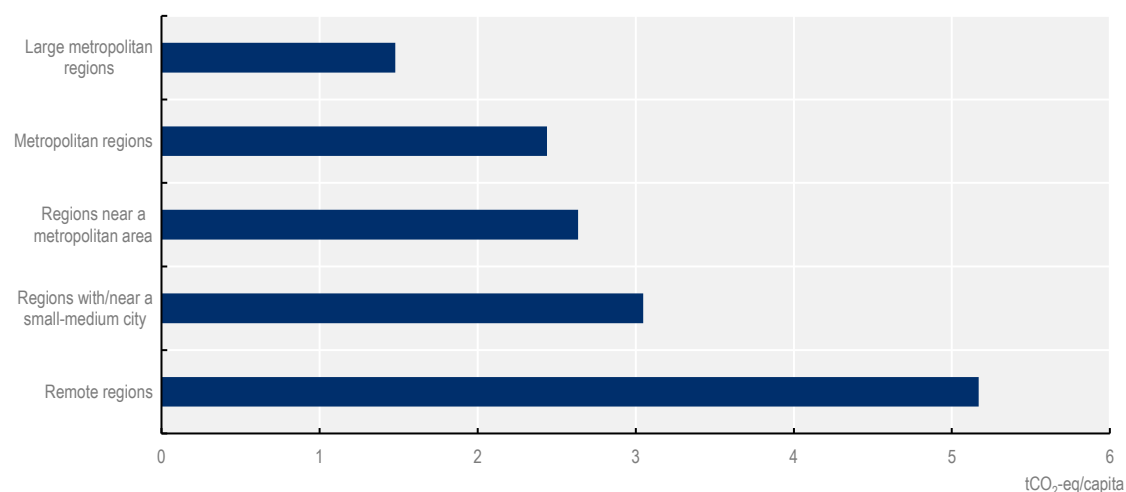
Road emissions per capita in remote regions are, on average, more than three times higher than in large metropolitan regions (Figure 3.16). These differences can be explained by population density, socio-cultural factors, such as the average number of vehicles per household, and the availability of public transport.

Private vehicle ownership

Across OECD countries, private vehicle ownership is concentrated in certain types of regions. In Australia, Mexico, Türkiye and East European countries, metropolitan regions record higher numbers of vehicles per capita than other regions. In contrast, in Asia and most European countries, non-metropolitan regions record more vehicles per capita than metropolitan regions. In Italy and the United States, regional disparities are particularly large. For example, the region of Aosta Valley in Italy records almost 1 800 vehicles per 1 000 inhabitants, the highest number of private vehicles per capita across OECD regions and more than 3 times the number of vehicles per capita observed in Liguria (Figure 3.17).

Figure 3.16. Road transport emissions per capita are three times higher in remote regions than in large metropolitan regions

Road transport emissions per capita by type of small regions (TL3), 2018

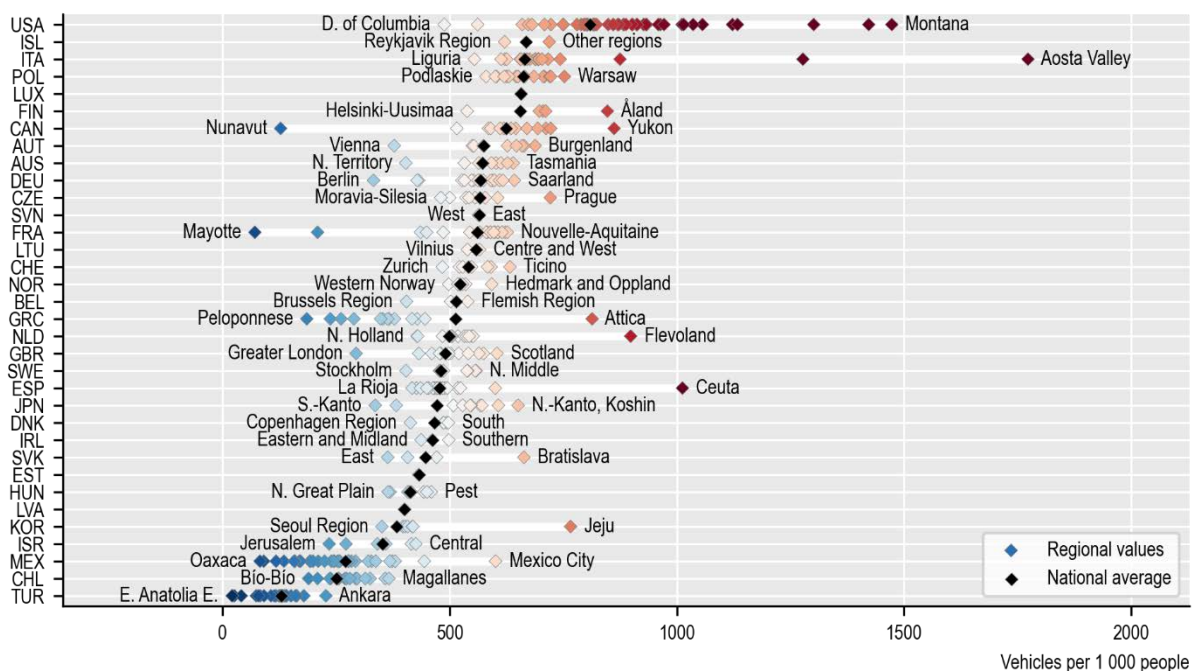


Note: Estimates based on OECD computations.

Source: Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>; Schiavina, M., S. Freire and K. MacManus (2019^[4]), *GHS Population Grid Multitemporal (1975, 1990, 2000, 2015) (dataset)*, Joint Research Centre (JRC), European Commission.

Figure 3.17. Large regional disparities in private vehicle ownership

Private motor vehicles per 1 000 inhabitants in large regions (TL2), 2021



Note: 2009 for CAN; 2010 for ESP; 2011 for EST; 2012 for LUX; 2013 for JPN; 2014 for ISL and TUR; 2019 for ISR and DEU; 2020 for AUS, CHE, CHL, CZE, FIN, GBR, GRC, IRL, ITA, KOR, LTU, MEX, NLD, NOR, POL, SVK, SVN and USA.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>.

In recent decades, the number of private vehicles per capita decreased in most European capital regions. For example, Greater London recorded a decline of 12% in vehicles per capita since 2000. However, in many American regions, especially in Chile, Mexico and the United States, the concentration of private vehicles has increased significantly. In the regions of Morelos and Tlaxcala (Mexico), for example, private vehicles per capita were four times higher in 2020 than in 2001.

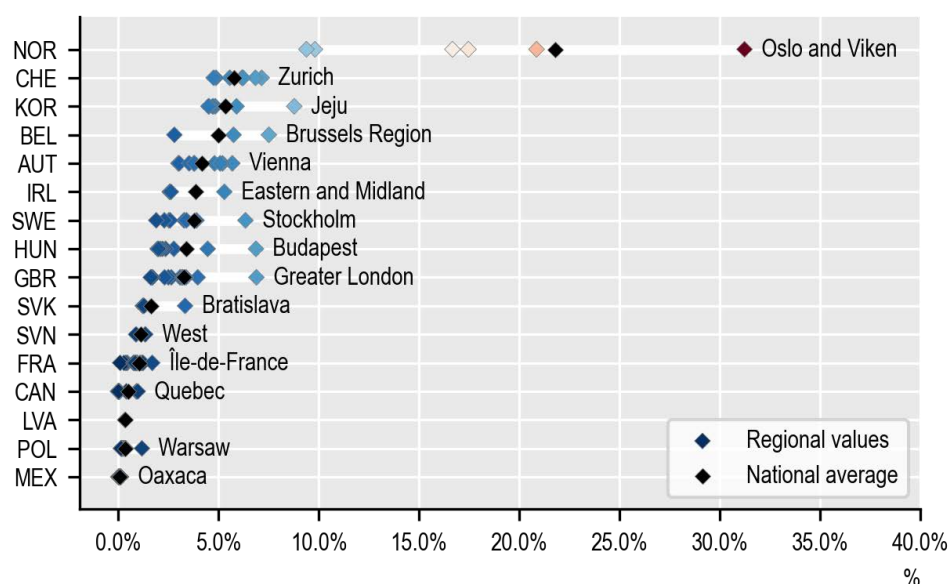
As discussed in Chapter 2, the target corresponds to the “best performers”, i.e. 385 vehicles for 1 000 inhabitants, which corresponds to Eastern Anatolia in Türkiye. However, it is worth noting that this target is not perfect as there is no evidence available regarding the number of vehicles that rely on fossil fuels, which can be a more accurate indication of the progress towards achieving low-emissions transport.

Electric or hybrid vehicle adoption

Norway registers the highest electric mobility adoption rate, as 22% of private vehicles are either electric or hybrid. The carbon intensity of electricity in Norway is also one of the lowest in the OECD, as it is mostly generated from hydropower. Across the OECD, capital regions are leading the adoption of electric or hybrid vehicles. In the Brussels Capital Region (Belgium), Budapest (Hungary), Stockholm (Sweden) and Greater London (United Kingdom), around 7% of private vehicles were either electric or hybrid in 2020. The region of Oslo and Viken (Norway) had a share of 31% of electric or hybrid vehicles in 2020, more than 20 percentage points higher than in 2016 (Figure 3.18).

Figure 3.18. Capital regions are leading the adoption of electric and hybrid vehicles

Share of private electric or hybrid vehicles in large regions (TL2), 2020-21



Note: 2020 for CHE, GBR, IRL, KOR, MEX, NOR, POL, SVN, SWE; 2021 for AUT, BEL, FRA, HUN, LVA, SVK.

Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>.

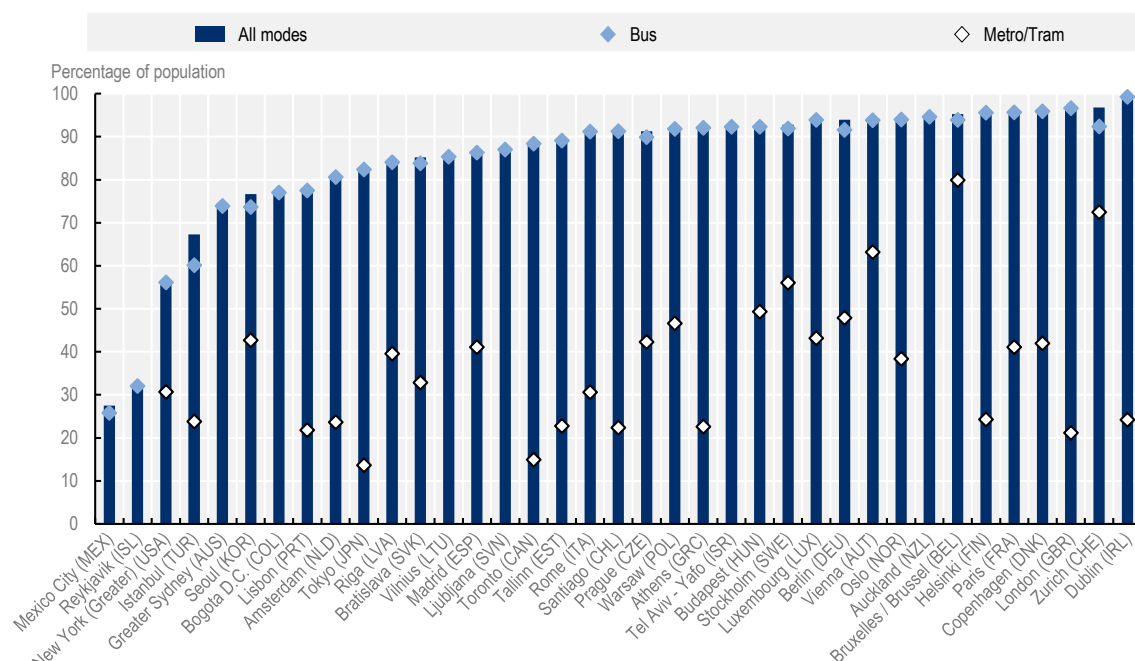
Public transport accessibility in cities

In terms of public transport accessibility, across the largest metropolitan areas per OECD country, on average, 83% of the population has access to a bus stop within a 10-minute walk and 31% to a metro or tram stop. In 31 out of the 35 largest cities in the OECD, more than 70% of the population has access to a

public transport stop within a 10-minute walk. Only Reykjavik (Iceland), Mexico City (Mexico), Istanbul (Türkiye) and New York (United States) register low accessibility rates. Many European cities, as well as Auckland (New Zealand) tend to offer the best accessibility to public transport. However, Southern European cities show relatively low accessibility to metro or tram stops (e.g. Lisbon 21%, Athens 22% and Rome 30%), while Northern and Central European cities record much higher accessibility rates (e.g. Zurich 72%, Vienna 63% and Stockholm 56%) (Figure 3.19).

Figure 3.19. Public transport accessibility is high in Central and Northern European capital cities

Share of population with access to public transport (within 10 min walk from a public transport stop), largest FUA per OECD country



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; based on Open Street Map (2023^[9]), Mapbox Isochrone API (2023^[10]).

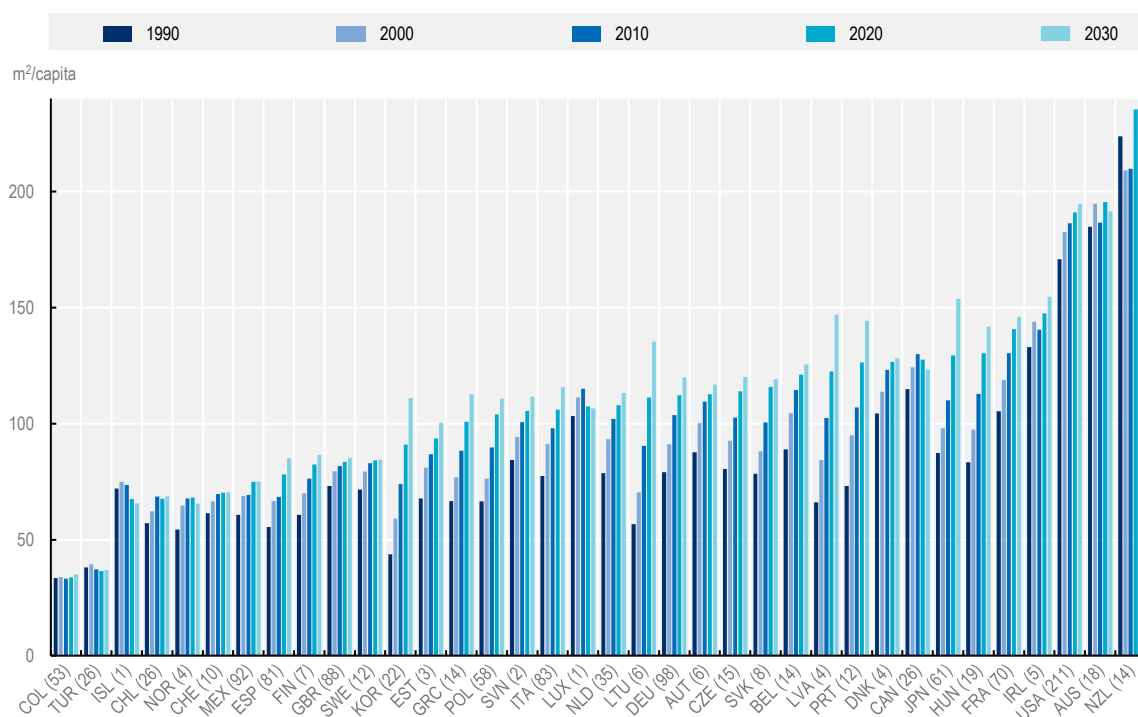
Continued built-up expansion affects emissions from agriculture, forestry and other land use (AFOLU)

Extensive built-up areas are associated with changes in land use through deforestation and soil artificialisation and can thus contribute to shrinking carbon sinks and increasing AFOLU emissions. In addition, low-density housing and urban sprawl can be associated with higher energy demand and transport-related CO₂ emissions (OECD, 2018^[11]). In OECD countries, metropolitan areas recorded an average of 120 square metres (m²) of built-up surface per capita in 2020. However, across OECD countries, built-up area per capita in FUAs varies by a factor of 7, ranging from 34 m² per capita in Colombia to 235 m² in New Zealand (Figure 3.20).

In 80% of OECD FUAs, built-up areas grew faster than population between 2000 and 2020. The difference between built-up area growth and population growth is particularly high in cities located in Japan, Korea and Eastern Europe. In almost 80% of the FUAs with high levels of built-up area per capita in 2000 (above 100 m² per person), land consumption has increased at a higher rate than the population. For example, built-up surface in Polish FUAs increased by 36% in the last 20 years while the population remained

constant. Built-up area per capita has been increasing at different speeds depending on city size, with faster increases in smaller cities. Built-up area per capita in FUAs with less than 100 000 inhabitants has increased by 26%, from 87 m² to 109 m² per person from 2000 to 2020, while it increased by 4% during the same period in large metropolitan areas, i.e. in FUAs with more than 1.5 million inhabitants (Figure 3.21).

Figure 3.20. Built-up area per capita in FUAs have been increasing in most OECD countries



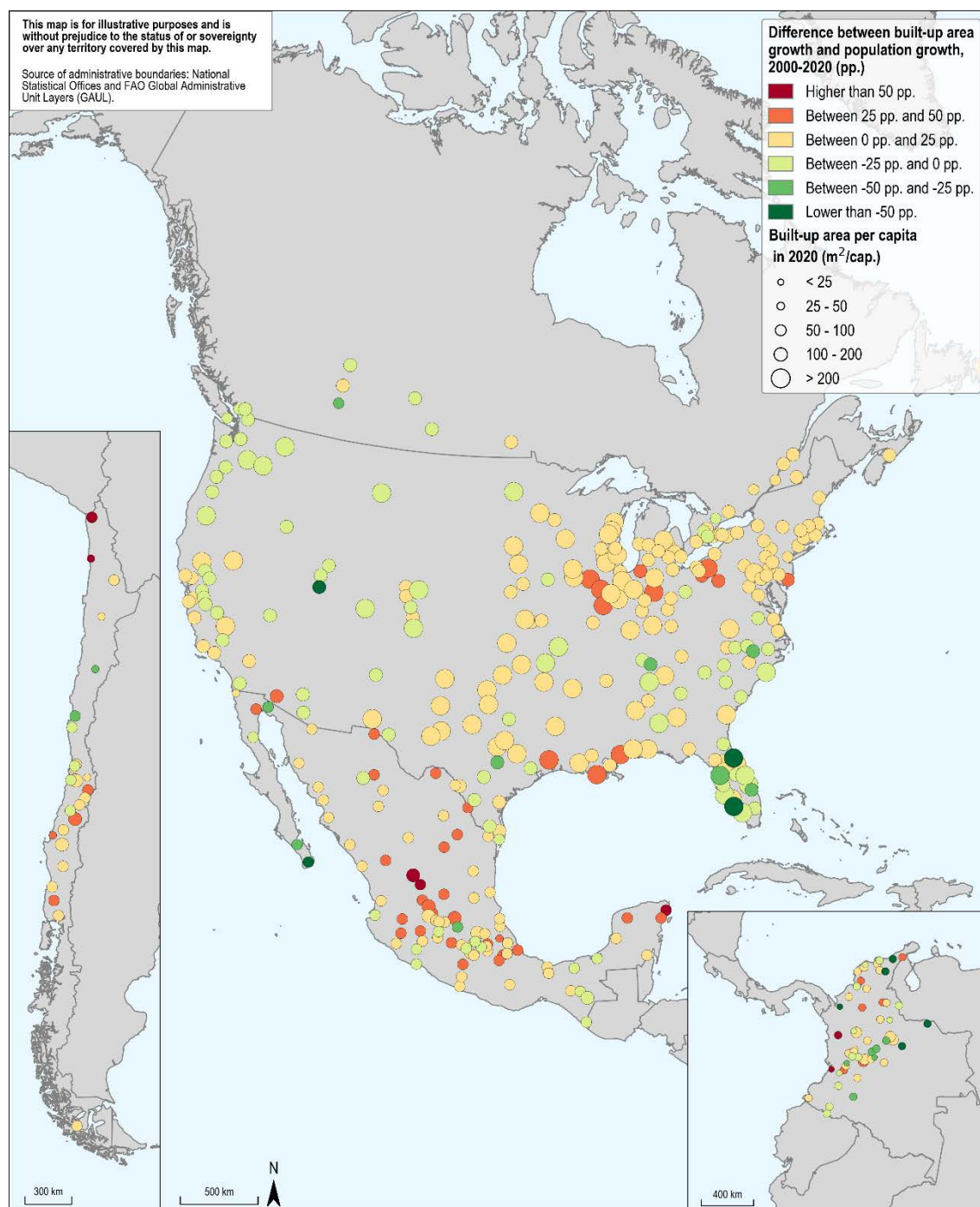
Source: Schiavina, M. et al. (2023^[12]), *GHS-POP R2023A - GHS Population Grid Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE>; Pesaresi, M. and P. Politis (2023^[13]), *GHS-BUILT-S R2023A - GHS Built-up Surface Grid, Derived from Sentinel2 Composite and Landsat, Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA>.

Deforestation and tree cover loss are some of the main drivers of AFOLU emissions. Tree cover area has declined in half of OECD large regions between 2000 and 2020. Particularly large declines in tree cover can be observed in Korea, Northern Chile and the Northeast of the United States. For example, the District of Columbia recorded a decline of almost 40% in tree cover during this period (Figure 3.23).

Agriculture is also a key driver of GHG emissions. These emissions are concentrated in a few regions in OECD countries. According to estimates based on European Commission's Emissions Database for Global Atmospheric Research (EDGAR) data, one-quarter of OECD regions concentrate 70% of agricultural emissions. New South Wales (Australia) and Iowa and Texas (United States) recorded the largest emissions in the sector in 2018. The most emission-intensive regions in terms of emissions per unit of GVA in agriculture are Southern Ireland (Ireland), Canterbury (New Zealand), Wales (United Kingdom) and Montana (United States) (Figure 3.25).

Figure 3.21. In most OECD cities, built-up areas grew faster than populations, Americas

Difference in percentage points between built-up area growth and population growth, 2000-2020

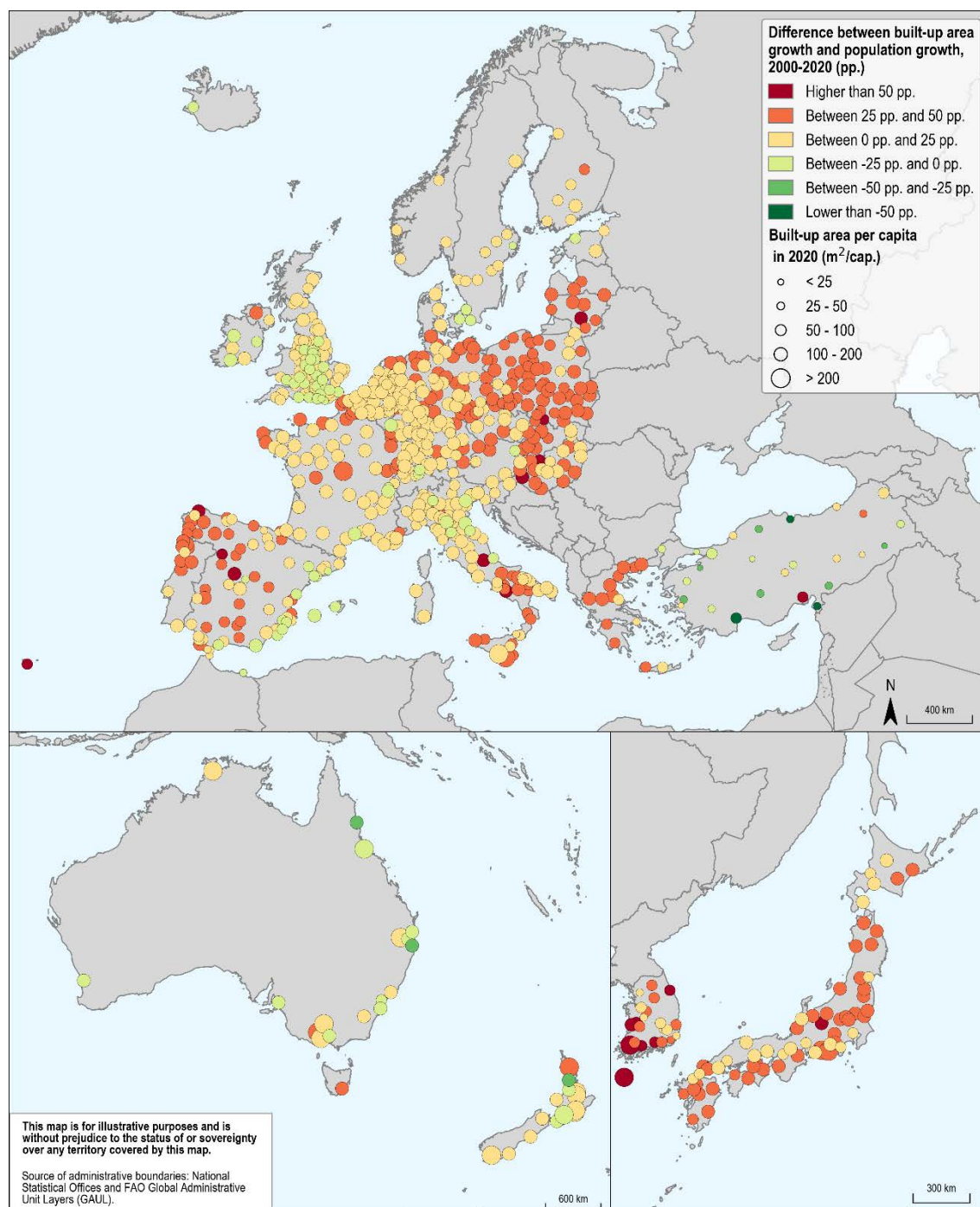


Note: Red dots are associated with a much faster built-up area growth than population growth. On the other hand, green dots correspond to faster population growth than built-up area growth.

Source: Schiavina, M. et al. (2023^[12]), *GHS-POP R2023A - GHS Population Grid Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE>; Pesaresi, M. and P. Politis (2023^[13]), *GHS-BUILT-S R2023A - GHS Built-up Surface Grid, Derived from Sentinel2 Composite and Landsat, Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA>.

Figure 3.22. In most OECD cities, built-up areas grew faster than populations, Europe, Asia, Pacific

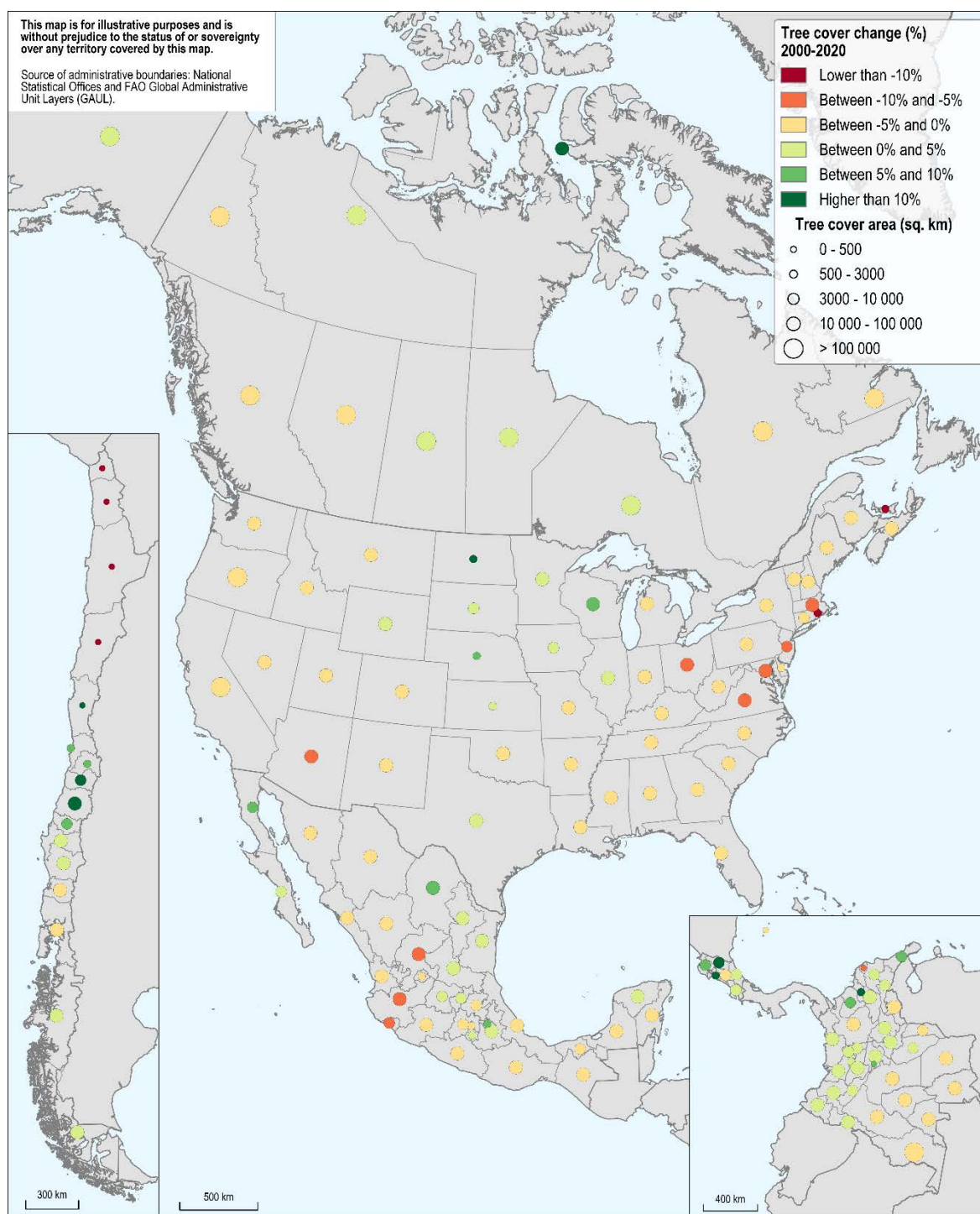
Difference in percentage points between built-up area growth and population growth, 2000-20



Note: Red dots are associated with a much faster built-up area growth than population growth. On the other hand, green dots correspond to faster population growth than built-up area growth.

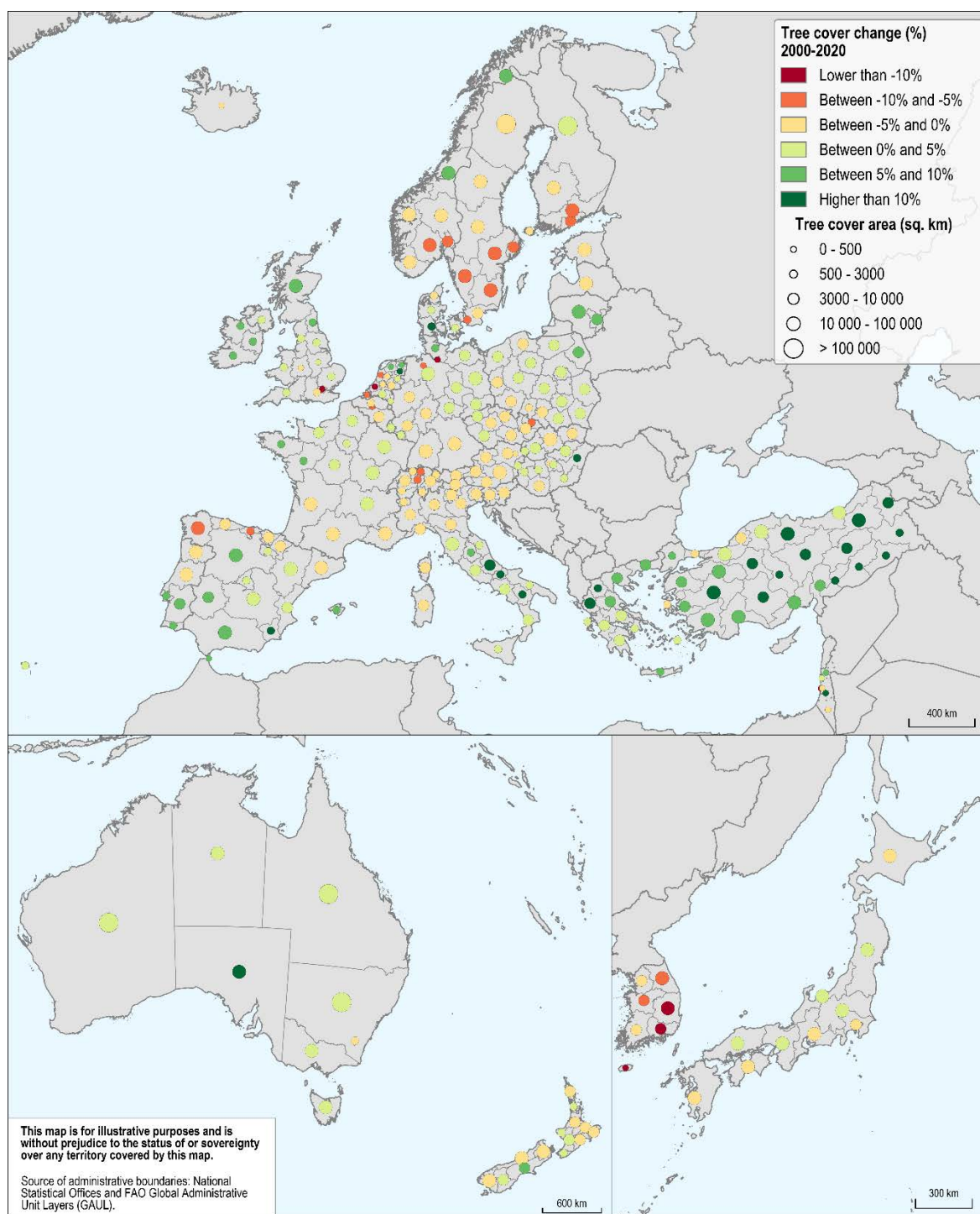
Source: Schiavina, M. et al. (2023^[12]), *GHS-POP R2023A - GHS Population Grid Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE>; Pesaresi, M. and P. Politis (2023^[13]), *GHS-BUILT-S R2023A - GHS Built-up Surface Grid, Derived from Sentinel2 Composite and Landsat, Multitemporal (1975-2030) (dataset)*, <https://doi.org/10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA>.

Figure 3.23. Tree cover area has declined in half of OECD large regions between 2000 and 2020, Americas



Source: EC (2019^[14]), *Land Cover Classification Gridded Maps from 1992 to Present Derived from Satellite Observations*, European Space Agency Climate Change Initiative.

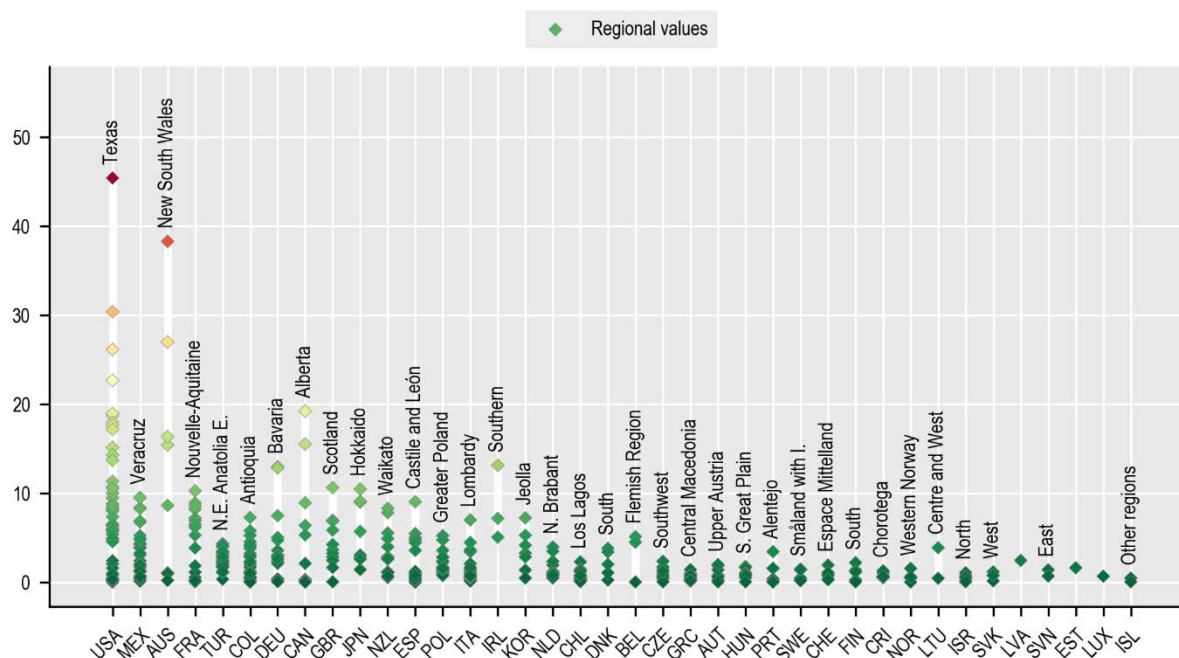
Figure 3.24. Tree cover area has declined in half of OECD large regions between 2000 and 2020, Europe, Asia, Pacific



Source: EC (2019^[14]), *Land Cover Classification Gridded Maps from 1992 to Present Derived from Satellite Observations*, European Space Agency Climate Change Initiative.

Figure 3.25. Emissions in agriculture are concentrated in a few regions

Emissions from agriculture in MtCO₂-eq in OECD large regions (TL2), 2018



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Crippa, M. et al. (2021^[3]), "EDGAR v6.0 Greenhouse Gas Emissions", <http://data.europa.eu/89h/97a67d67-c62e-4826-b873-9d972c4f670b>.

Municipal waste per capita increased in many OECD regions

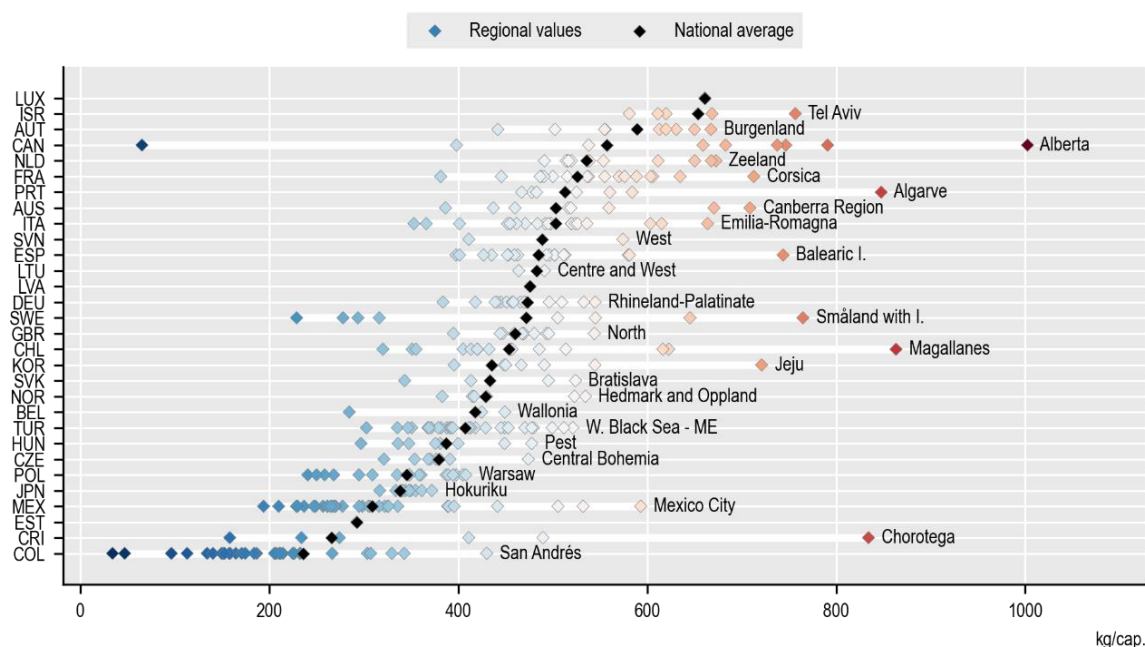
Waste reduction, better waste management and a shift in demand towards sustainable consumption are important mitigation options to reach climate neutrality by 2050 (Shukla et al., 2022^[15]).

Israel and Luxembourg record, on average, almost three times more municipal waste per inhabitant than Canada, Colombia and Sweden, and Latin American countries record large regional disparities. Mexico City, for example, records three times more waste per inhabitant than the state of Oaxaca in Mexico. Over the past decade, municipal waste per capita increased in Colombia, Korea, Mexico and most East European countries. However, many European capital regions register the largest decline in per capita waste in their respective countries (Figure 3.26).

Waste recovery remains limited in Türkiye and Latin America, whereas it is developed in many European countries, particularly in Austria, Belgium, the Netherlands, Norway and Sweden. In the latter countries, recovery rates are close to 100% in most large regions. Capital regions tend to register the highest recovery rates in many OECD countries, such as in Australia, Belgium, France and the Slovak Republic (Figure 3.27).

Figure 3.26. Regional disparities in municipal waste per capita

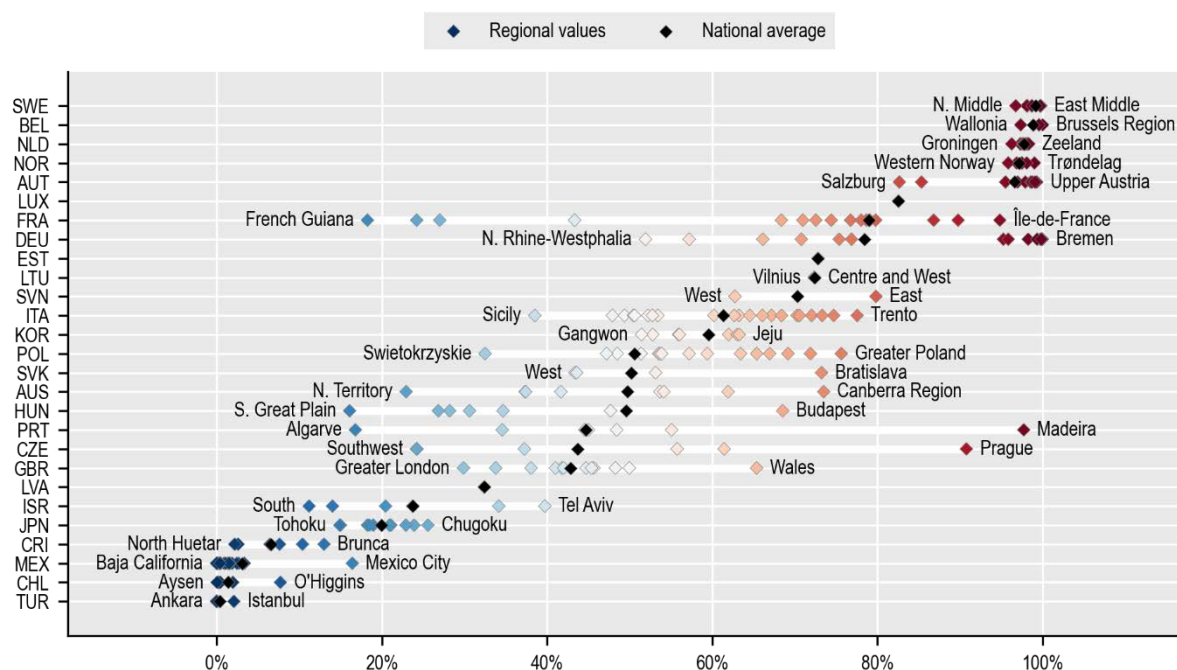
Municipal waste (kg) per capita, OECD large regions (TL2), 2020



Note: 2013 for EST, LUX; 2014 for TUR; 2016 for CAN; 2017 for CHL; 2018 for JPN; 2019 for AUT, COL, ESP, FRA, HUN, ISR and ITA.
 Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>.

Figure 3.27. Waste recovery is very developed in many European regions

Municipal waste recovery rates (%), OECD large regions (TL2), 2020



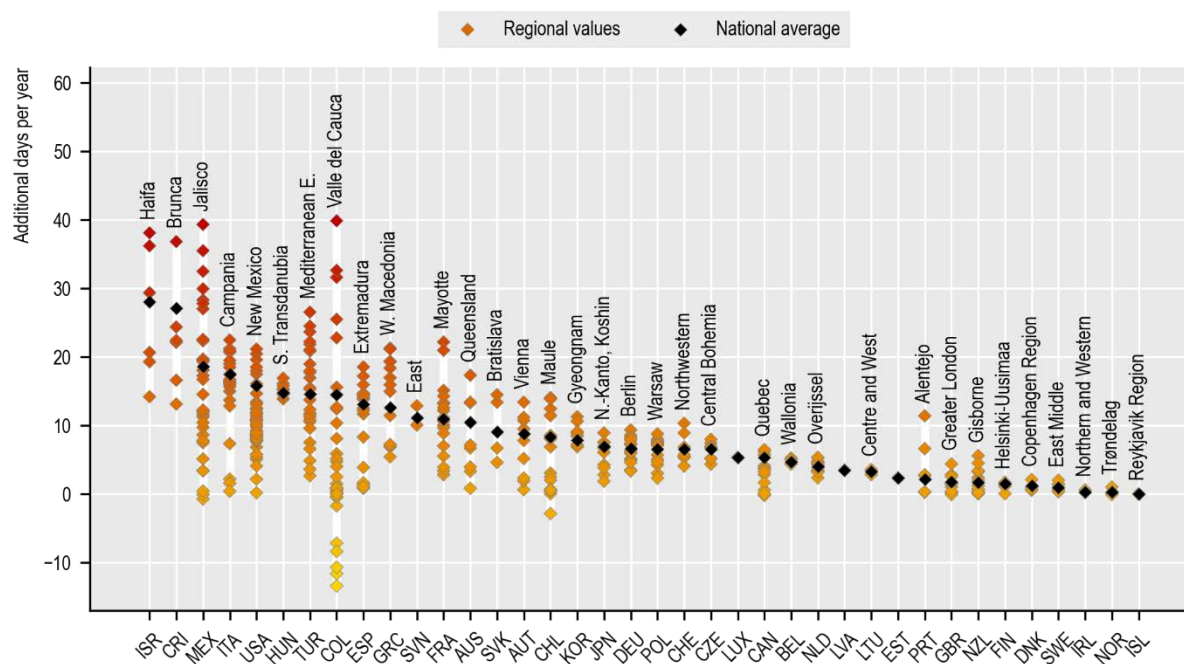
Note: 2013 for CZE, EST, LUX; 2014 for TUR; 2015 for DEU; 2017 for AUS, CHL; 2018 for FRA, JPN; 2019 for AUT, HUN, ISR and ITA.
 Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>.

Climate adaptation

Cities are particularly affected by heat stress

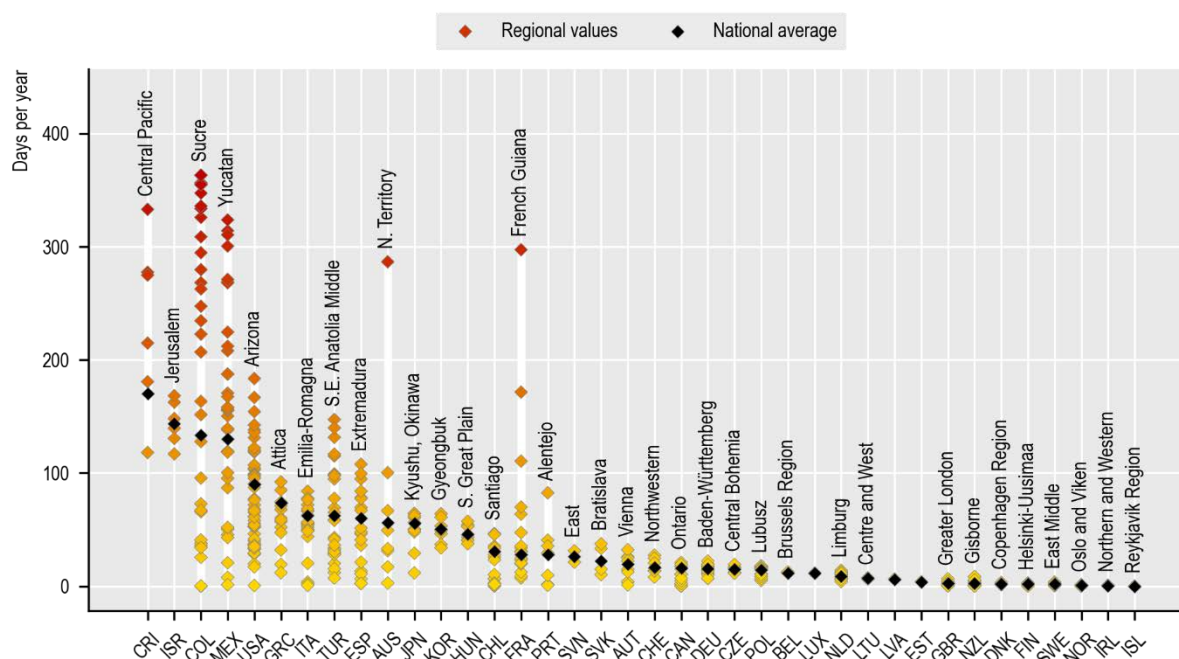
Over the past five years, population exposure to heat stress has been particularly high and has increased faster in Central America and in the Mediterranean Basin. In Costa Rica and Israel, the population experienced, on average, more than 140 days per year of strong heat stress, i.e. over 25 days longer than during the 1981-2010 period (reference period). Nearly all (95%) regions in OECD countries had increased exposure to heat stress over the past five years compared to the reference period (Figures 3.28 and 3.29). For example, over the past 5 years, the region of Córdoba (Colombia) experienced an average of 267 days per year of very strong heat stress as indicated by the Universal Thermal Climate Index (UTCI) surpassing 38°C, i.e. 70 days more than during the 1981-2010 period. Exposure to strong heat stress (UTCI > 32°C) in the districts of Haifa and Tel Aviv in Israel increased by more than a month per year over the past 5 years. The states of Baja California Norte in Mexico and Arizona in the United States were the most impacted by extreme heat stress (UTCI > 46°C) in their respective countries during the past 5 years.

Figure 3.28. Additional days of strong heat stress per year in OECD large regions (TL2), 2017-21 compared to 1981-2010



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Maes, M. et al. (2022^[16]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", <https://doi.org/10.1787/da074cb6-en>; Copernicus thermal comfort indices derived from ERA5 reanalysis, UTCI (2020^[17]).

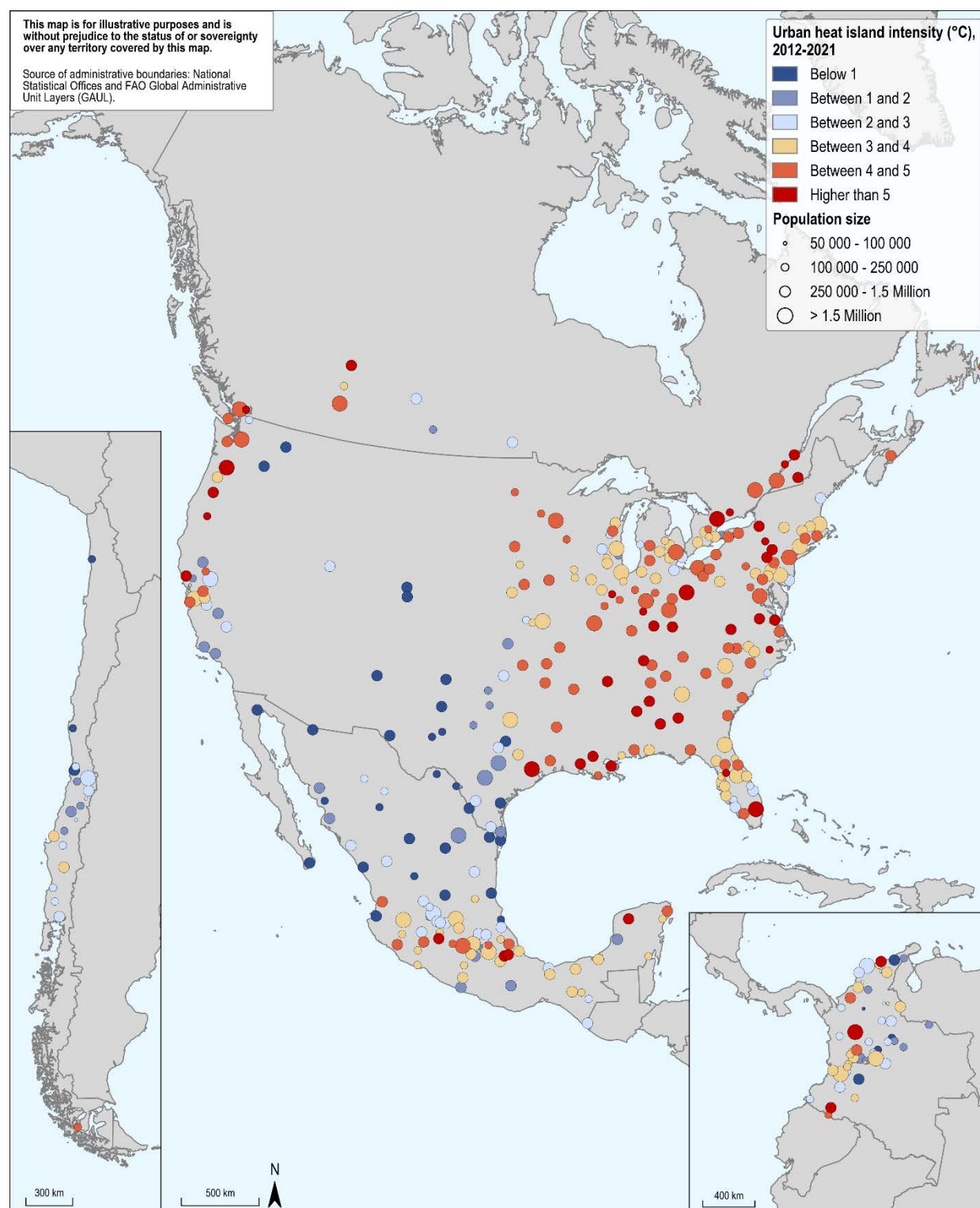
Figure 3.29. Days of strong heat stress per year in OECD large regions (TL2), 2017-21



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Maes, M. et al. (2022^[16]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", <https://doi.org/10.1787/da074cb6-en>; Copernicus thermal comfort indices derived from ERA5 reanalysis, UTCI (2020^[17]).

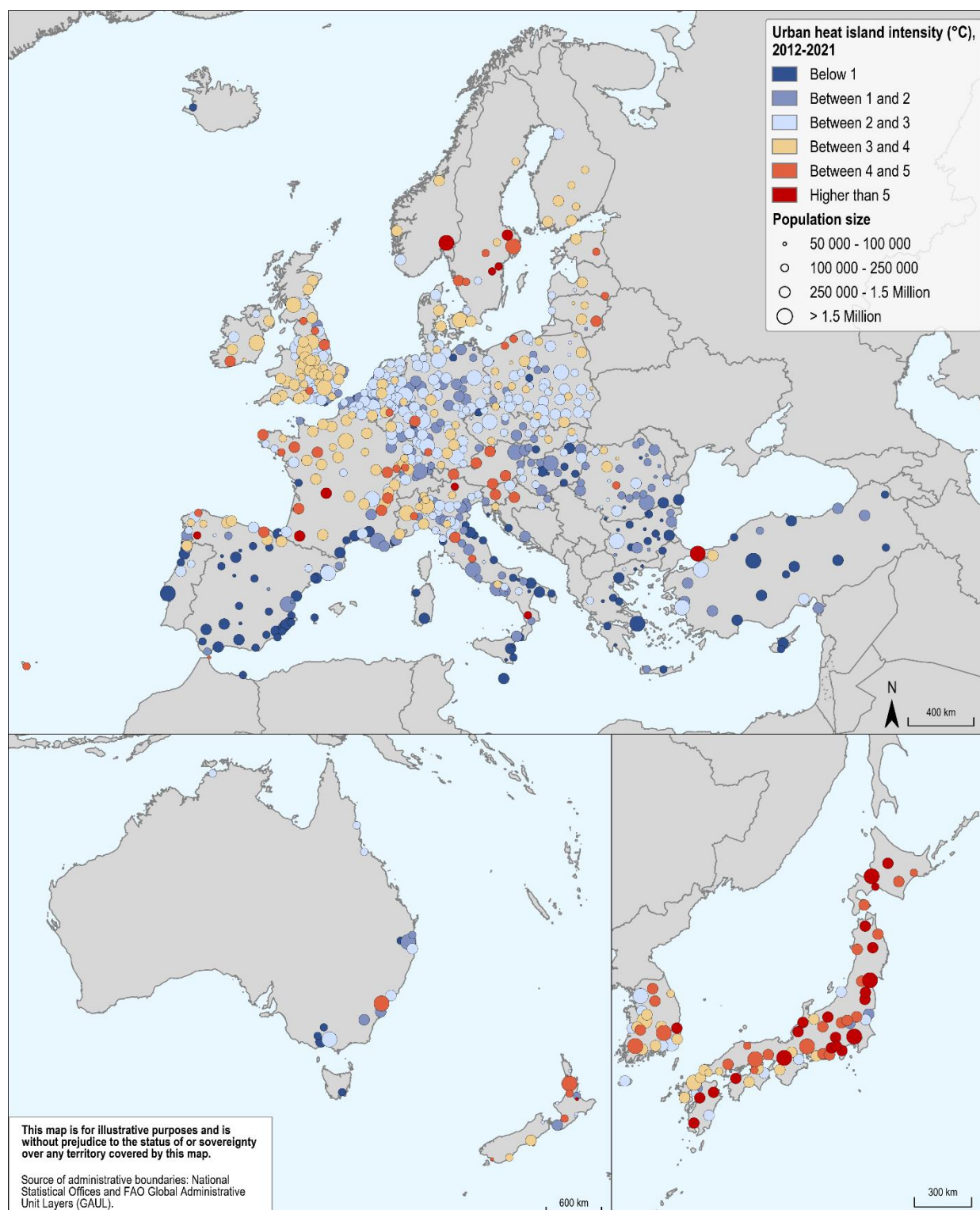
Cities are particularly affected by heat stress due to the urban heat island effect. In 2021, nearly 80% of cities in OECD countries registered a yearly urban heat island intensity higher than 1°C and almost half of OECD cities witnessed a summer daytime heat island effect higher than 3°C. The urban heat island intensity varies across OECD cities, depending on the population size and the climate zone. For example, built-up areas in metropolitan areas, i.e. in cities with more than 250 000 inhabitants, are on average 3°C warmer than their surrounding area, which is almost twice as high as in cities with less than 100 000 inhabitants. Cities located in France, Japan, Korea, the United Kingdom, Scandinavian countries and the East Coast of the United States are more impacted by the urban heat island phenomenon than other OECD cities (Figure 3.30).

Figure 3.30. Urban heat island intensity varies across OECD cities, summer, daytime, 2012-21, Americas



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Wan, Z., S. Hook and G. Hulley (2021^[18]), *MODIS/MYD11A1 Aqua & MOD11A1 Terra Land Surface Temperature/Emissivity Daily L3 Global 1km SIN Grid V061*; Friedl, M. and D. Sulla-Menashe (2019^[19]), *MCD12Q1 MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 500m SIN Grid V006*, NASA EOSDIS Land Processes DAAC.

Figure 3.31. Urban heat island intensity varies across OECD cities, summer, daytime, 2012-21, Europe, Asia, Pacific



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Wan, Z., S. Hook and G. Hulley (2021^[18]), *MODIS/MYD11A1 Aqua & MOD11A1 Terra Land Surface Temperature/Emissivity Daily L3 Global 1km SIN Grid V061*; Friedl, M. and D. Sulla-Menashe (2019^[19]), *MCD12Q1 MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 500m SIN Grid V006*, NASA EOSDIS Land Processes DAAC.

Regions in Australia, Latin America and the Mediterranean Basin are particularly exposed to wildfires

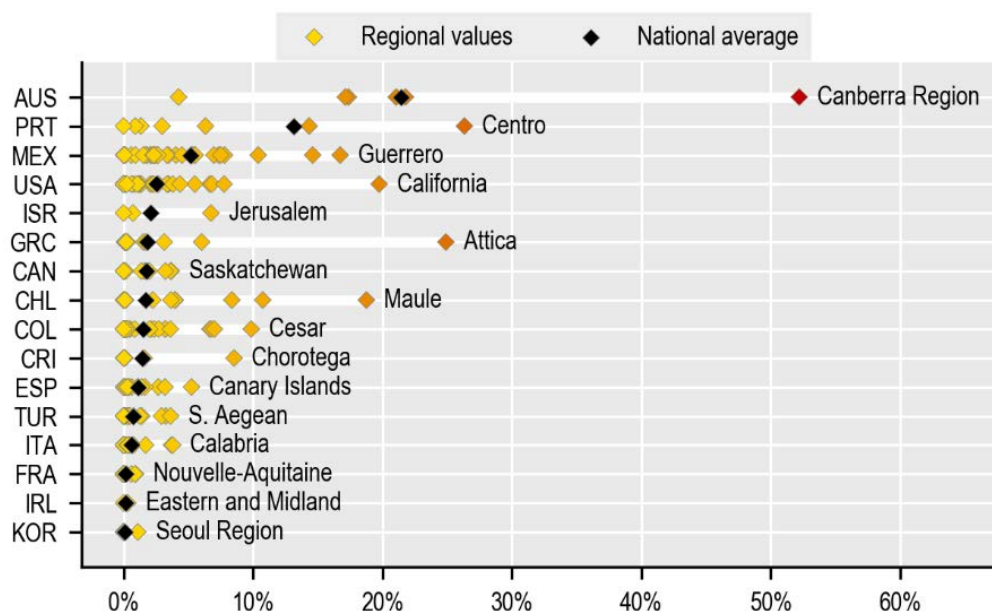
Burned area

Over the past 5 years, in 29 regions located in Australia, Latin America and around the Mediterranean Basin, more than 50% of the population has been exposed to wildfires. Wildfire hazard is usually highest in regions characterised by ignition, fuel and weather conditions conducive to fire (OECD, 2023^[20]). For example, more than 70% of the population in the Australian Northern Territory has been exposed to wildfire compared to only 3% in Tasmania over the last 5 years.

Wildfires have also been affecting forests and agricultural lands. All four OECD regions with the largest burnt forest area during the last five years are located in Australia: Queensland, followed by Western Australia, New South Wales and Northern Territory. Together, these 4 regions registered almost 165 000 km² of total forest area burnt over the past 5 years, equivalent to half the area of Germany. Relative to the total forest area, the most impacted regions are the Canberra region in Australia where 52% of the forest area burnt in the past 5 years, followed by Central Portugal (26%) and Attica in Greece (25%) (Figure 3.32). In terms of cropland exposure, more than 3% of the croplands were burnt in the past 5 years in Australia, Costa Rica, Mexico and Türkiye. In the region of South-eastern Anatolia – Middle, around 20% of the cropland area burnt over the past 5 years, corresponding to a total of 5 500 km².

Figure 3.32. Regions in Australia, Mexico and Portugal were particularly exposed to wildfires

Forest area burned as a percentage of total forest area, OECD large regions (TL2), 2017-21



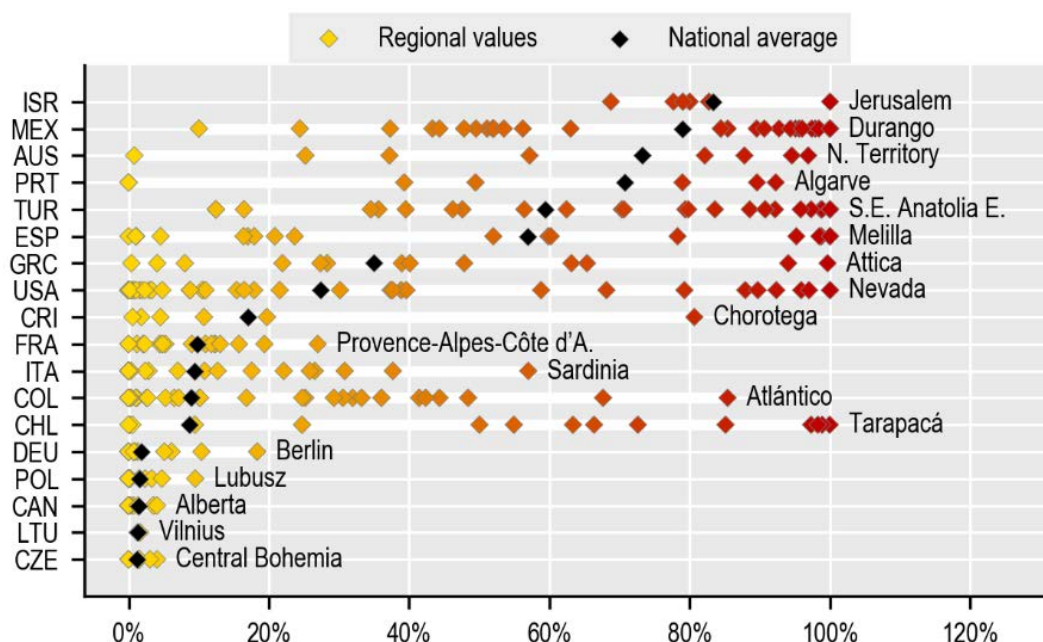
Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Global wildfire dataset (2019^[21]); *Land Cover Classification Gridded Maps from 1992 to Present Derived from Satellite Observations*, European Space Agency Climate Change Initiative (2019^[14]).

Wildfire danger

OECD regions located around the Mediterranean Basin, in Australia, Northern Chile and the Western United States have been particularly exposed to fire danger in recent years. For example, all forest areas in South-eastern Anatolia East, Middle and West (Türkiye) have been exposed to very high or extreme fire danger for at least three consecutive days every year over the past five years (Figure 3.33). Compared to 2001-05, the share of forest exposed to very high or extreme fire danger has increased in 179 OECD regions. Valparaíso in Chile has experienced the largest increase in fire danger exposure, as 66% of its tree cover was exposed to very high or extreme fire danger in the past 5 years, compared to 13% in 2001-05.

Figure 3.33. Regions in Australia, Northern Chile, Mexico, Western United States and around the Mediterranean Basin are at most exposed to fire danger

Share of forest exposed to very high or extreme fire danger over three consecutive days, OECD large regions (TL2), annual average, 2016-20



Source: Maes, M. et al. (2022^[16]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", <https://doi.org/10.1787/da074cb6-en>; EC (2019^[22]), *Fire Danger Indices Historical Data from the Copernicus Emergency Management Service*, <https://doi.org/10.24381/cds.0e89c522>.

Regions in Belgium, Northern Germany and the Netherlands are particularly vulnerable to coastal and river floods

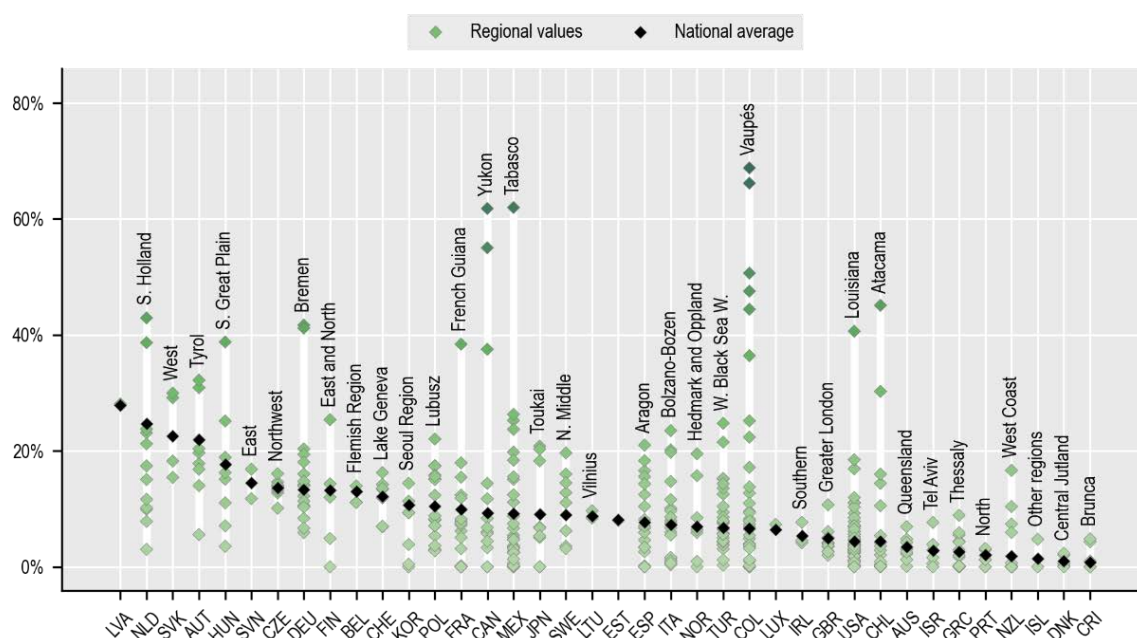
Using a 100-year return period flood extent and population distribution allows for identifying regions where a large share of the population lives within an area at risk of flood. With more than 20% of their population at risk, Austria, Latvia, the Netherlands and the Slovak Republic are, on average, the most exposed OECD countries. In total, 45 OECD regions located in 18 different countries have more than 20% of their population at risk. In some regions, such as Yukon (Canada), Guaviare (Colombia) and Tabasco (Mexico), the share of people living in areas at risk reaches more than 60% (Figure 3.34).

Cities, which often concentrate areas of high population density around rivers, are particularly vulnerable to floods of large magnitude. Rotterdam in the Netherlands is the most exposed OECD metropolitan area of more than 1.5 million inhabitants in terms of river flooding, as more than 60% of its population is at risk, followed by Nagoya in Japan and Hamburg in Germany. Given the long-life cycles of many urban and infrastructure systems, sea level rise will continue to have increasing implications even if warming is stabilised (IPCC, 2022^[23]).

In terms of coastal flood hazard, the most exposed OECD countries are in Northern and Western Europe. The Netherlands is the country most at risk, as 55% of its population is exposed to 100-year coastal floods. Population exposure is higher than 90% in 4 Dutch regions. The other OECD regions particularly exposed are Bremen in Germany, where 55% of the population is exposed, followed by Nunavut in Canada (43%) and Hamburg in Germany (33%) (Figure 3.35).

Figure 3.34. Large subnational disparities in exposure to river flooding

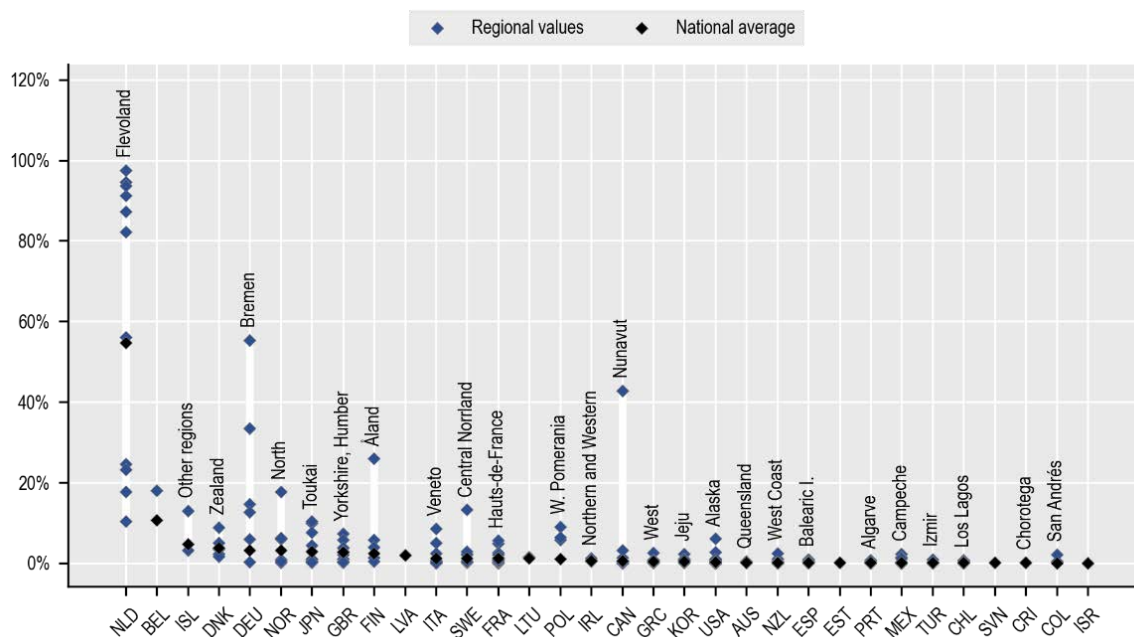
Population exposure to 100-year river flooding in OECD large regions (TL2), 2015



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Maes, M. et al. (2022^[16]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", <https://doi.org/10.1787/da074cb6-en>; Dottori, F. et al. (2021^[24]), *River Flood Hazard Maps for Europe and the Mediterranean Basin Region (dataset)*, <https://doi.org/10.2905/1D128B6C-A4EE-4858-9E34-6210707F3C81>; Florczyk et al. (2019^[25]), *GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes, R2019A (dataset)*, <https://data.jrc.ec.europa.eu/dataset/53473144-b88c-44bc-b4a3-4583ed1f547e>.

Figure 3.35. Large subnational disparities in exposure to coastal flooding

Population exposure to 100-year coastal flooding in OECD coastal regions (TL2), 2015



Source: Muis, S. et al. (2016^[26]), "A global reanalysis of storm surges and extreme sea levels", <https://doi.org/10.1038/ncomms11969>; Florczyk et al. (2019^[25]), *GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes, R2019A (dataset)*, <https://data.jrc.ec.europa.eu/dataset/53473144-b88c-44bc-b4a3-4583ed1f547e>.

Soil moisture has decreased in 70% of OECD regions

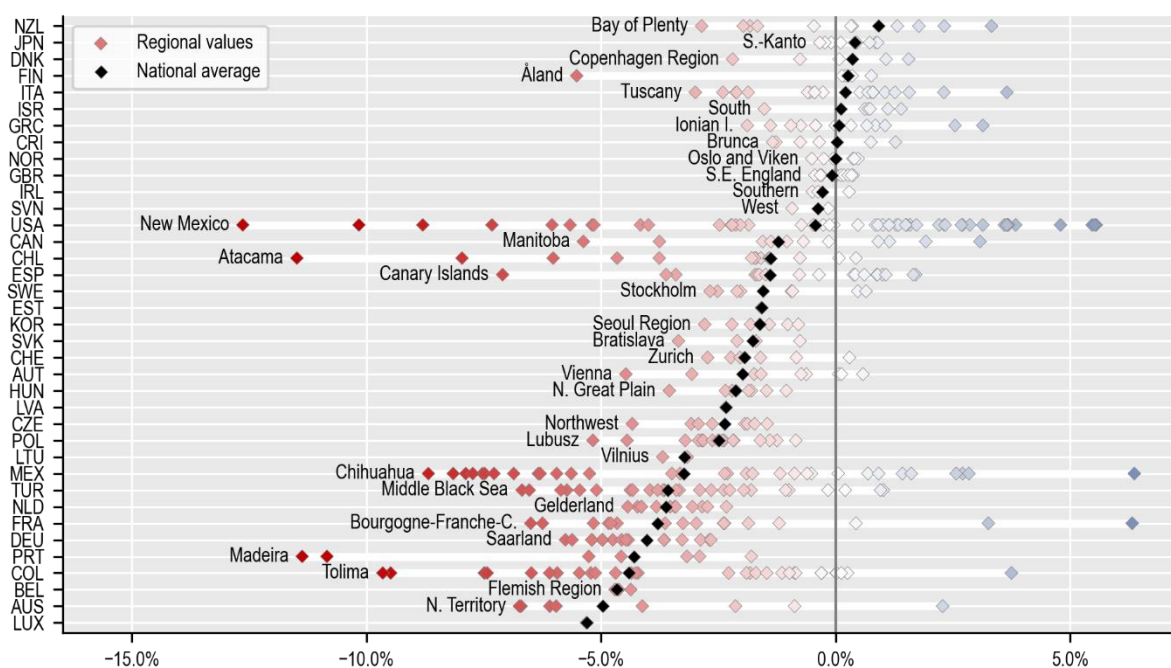
To identify regions where water stress conditions are worsening, the proposed indicator framework uses soil moisture percentage change. Over the past 5 years, the average croplands' soil moisture was lower than during 1981-2010 for 70% of OECD large regions (Figure 3.36). Long-term averages allow for capturing overall trends in soil moisture changes over time but do not reflect shorter drought events.

Soil moisture anomalies at the national level range between -5% and 1% for most countries, when comparing the average soil moisture over the past 5 years to the reference period 1981-2010. However, national averages can hide more severe and localised drops in soil moisture. Seven OECD countries (Australia, Canada, Chile, Colombia, Mexico, Spain and the United-States) recorded soil moisture local drops of more than 30% in the past 5 years compared to 1981-2010 (Figures 3.37 and 3.38).

Combining changes in soil moisture data with an indicator reflecting the importance of the agricultural sector in the regional economy helps identify regions that are particularly vulnerable to changes in drought conditions. For example, cropland soil moisture has decreased by 10% and 9% in Tolima in Colombia and in Chihuahua in Mexico respectively over the past 5 years compared to the reference period. In these 2 regions, GVA in agriculture, forestry and fishing accounts for an important share of total GVA (17% and 7% respectively).

Figure 3.36. Agricultural drought

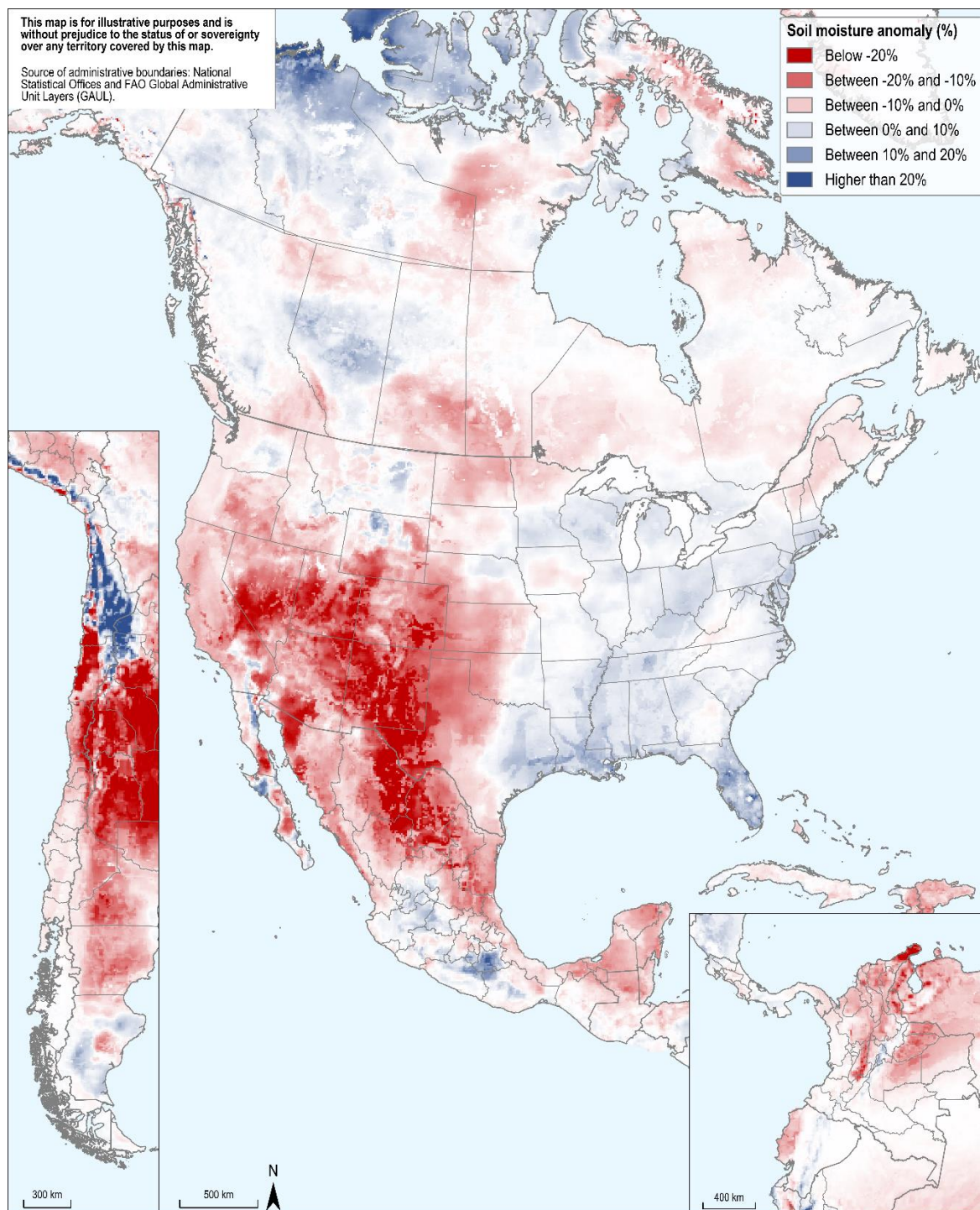
Cropland soil moisture anomaly (%) in 2017-21, compared to 1981-2010 (reference period)



Source: OECD (2022^[2]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; Maes, M. et al. (2022^[16]), "Monitoring exposure to climate-related hazards: Indicator methodology and key results", <https://doi.org/10.1787/da074cb6-en>; EC (2019^[14]), *Land Cover Classification Gridded Maps from 1992 to Present Derived from Satellite Observations*, European Space Agency Climate Change Initiative.

Figure 3.37. The Mediterranean Basin, South America and the United States are particularly impacted by agricultural droughts, Americas

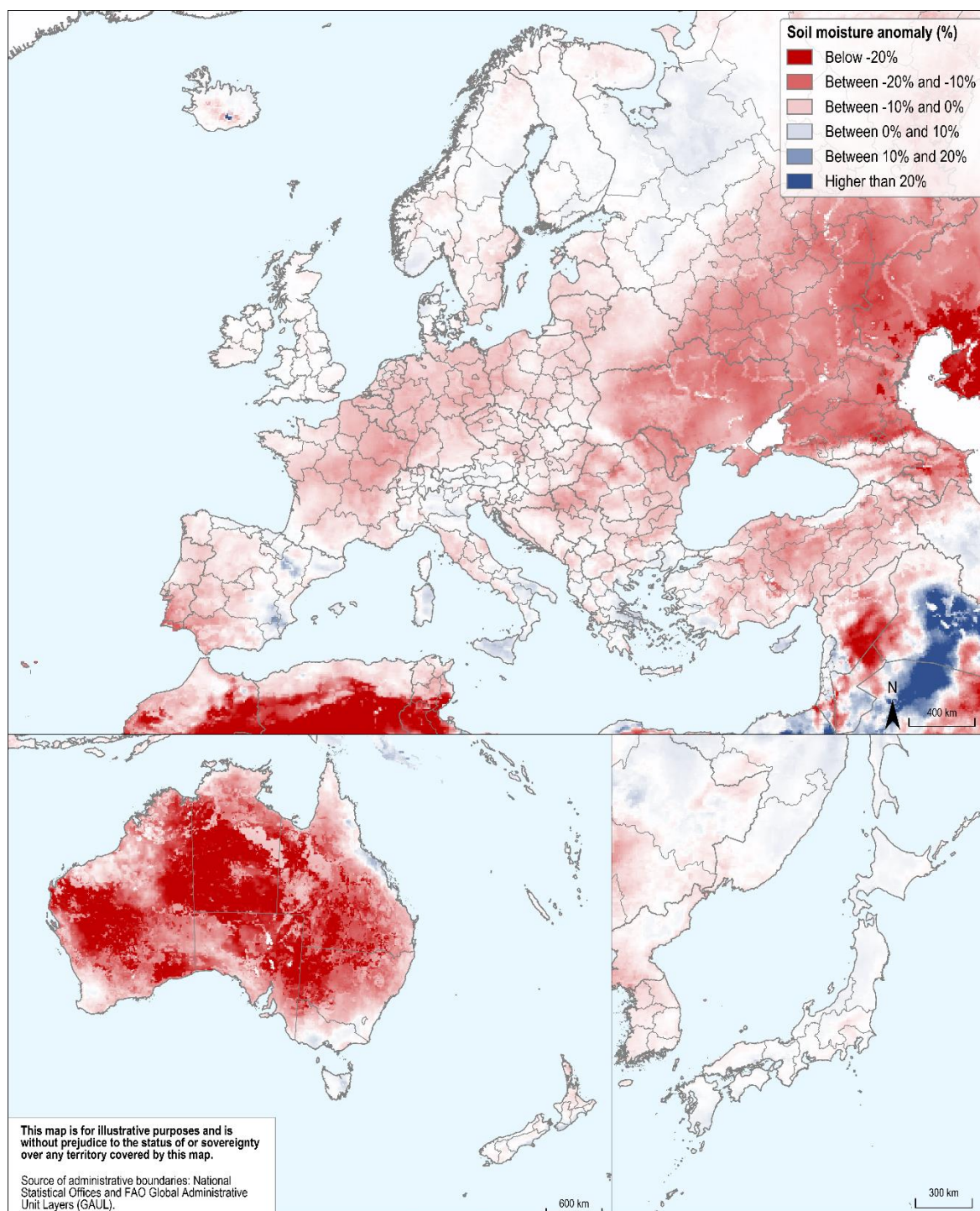
Soil moisture anomaly (%) in 2017-21, compared to 1981-2010



Source: EC (2022^[27]), ERA5-Land Monthly Averaged Data from 1950 to Present, <https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=overview>.

Figure 3.38. Australia is particularly impacted by agricultural droughts, Europe, Asia, Pacific

Soil moisture anomaly (%) in 2017-21, compared to 1981-2010



Source: EC (2022^[27]), ERA5-Land Monthly Averaged Data from 1950 to Present, <https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=overview>.

Conclusions

The analysis in this chapter revealed that most OECD cities and regions are far from reaching climate neutrality. It also found that the volume and source of GHG emission vary significantly across geographical scales within countries, highlighting that the pathways to achieving a net zero transition and enhancing resilience will also differ. Key findings which are worth highlighting include the following:

- In relation to climate mitigation, OECD cities and regions would need to increase their efforts to achieve climate neutrality.
 - Most OECD regions are far from reaching climate neutrality. In 2018, only 61 out of the 432 OECD large regions registered lower production-based emissions per capita than the required global target of 4.7 tCO₂-eq per capita derived from the IEA NZE Scenario. In 40% of the regions, emissions per capita were higher than 10 tCO₂-eq per capita. On average, OECD regions will have to reduce their emissions by a factor of 2.8 by 2030 in order to meet the global target.
 - OECD cities also record high levels of GHG emissions, challenging climate neutrality. In 2018, almost half of OECD metropolitan areas with more than 500 000 inhabitants recorded production-based emissions per capita lower than the target of 4.7 tCO₂-eq per person. To reach this target, the remaining metropolitan areas will have to cut their emissions by an average of 44% by 2030.
 - There are significant territorial disparities in terms of GHG emissions within cities and regions in OECD countries. Regional disparities are particularly important in the United States, where emissions per capita ranged from 3.6 tCO₂-eq in the District of Columbia to 180.7 tCO₂-eq in North Dakota (the latter probably due to its shale oil industry). Large regional disparities in emissions per capita also exist in other OECD countries, such as Canada, the Netherlands and New Zealand. Similarly, road emissions per capita in remote regions are on average more than three times higher than in large metropolitan regions.
 - Many OECD regions are still far from reaching low-carbon electricity generation. More than 50 regions spread across 19 OECD countries still rely heavily on coal for power generation. However, over one-third of regions generate most of their power from low-carbon sources (nuclear or renewables). Quebec (Canada), Auvergne-Rhône-Alpes (France) and Scotland (United Kingdom) are the largest producing regions in their respective countries and rely for more than 90% of their electricity on low-carbon sources. Power generation in these regions emits less than 100 gCO₂-eq/kWh, which is more than 3 times below the OECD average (350 gCO₂-eq/kWh).
- Continued built-up expansion affects emissions from agriculture, forestry and other land use (AFOLU). In 80% of OECD FUAs, built-up areas grew faster than population between 2000 and 2020. The difference between built-up area growth and population growth is particularly high in cities located in Japan, Korea and in Eastern Europe. In almost 80% of the FUAs with high levels of built-up area per capita in 2000 (above 100 m² per person), land consumption has increased at a higher rate than the population. For example, the built-up surface in Polish FUAs increased by 36% in the last 20 years while population remained constant.
- OECD cities and regions also need to accelerate adaptation action if they want to couple with the far-reaching consequences of climate change:
 - Cities are particularly affected by heat stress. In 2021, nearly 80% of cities in OECD countries registered a yearly urban heat island intensity higher than 1°C and almost half of OECD cities witnessed a summer daytime heat island effect higher than 3°C. The urban heat island intensity varies across OECD cities, depending on the population size and the climate zone. For example, built-up areas in metropolitan areas, i.e. in cities with more than 250 000 inhabitants,

are on average 3°C warmer than their surrounding area, which is almost twice as high as in cities with less than 100 000 inhabitants. Cities located in France, Japan, Korea, the United Kingdom, Scandinavian countries and the East Coast of the United States are more impacted by the urban heat island phenomenon than other OECD cities.

- Cities and regions are particularly vulnerable to river and coastal floods. In terms of river flooding, 45 OECD regions located in 18 different countries have more than 20% of their population at risk of river flooding. In some regions such as Yukon (Canada), Guaviare (Colombia) and Tabasco (Mexico), the share of people living in areas at risk reaches more than 60%. Furthermore, cities, which often concentrate areas of high population density around rivers, are particularly vulnerable to floods of large magnitude. Rotterdam (the Netherlands) is the most exposed OECD metropolitan area with more than 1.5 million inhabitants, as more than 60% of its population is at risk, followed by Nagoya (Japan) and Hamburg (Germany). In terms of coastal flood hazard, the most exposed OECD countries are in Northern and Western Europe. The Netherlands is the country most at risk, as 55% of its population is exposed to 100-year coastal floods. Population exposure is higher than 90% in 4 Dutch regions. The other OECD regions particularly exposed are Bremen in Germany, where 55% of the population is exposed, followed by Nunavut (Canada) (43%) and Hamburg (Germany) (33%).

The findings outlined above underscore the critical importance of advancing a territorial approach to tackle climate challenges. The diverse GHG emission profiles and climate risks and impacts of OECD cities and regions suggest that a one-size-fits-all approach would be insufficient. Instead, policies need to be tailored to the specific context and unique needs of each place. To do so, countries, cities and regions need to have a better understanding of GHG emissions trends and climate-related risks at the local and regional scales.

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Notes

¹ OECD subnational regions are classified into two scales: large regions, referred to as Territorial Level 2 (TL2), and small regions, referred to as Territorial Level 3 (TL3). Large regions generally refer to the first government level after the national or federal one. Small regions are contained within large regions and, in the case of European countries, correspond to the NUTS3 nomenclature.

² Developed in collaboration with the European Union and endorsed at the 2020 Statistical Commission of the United Nations, Functional Urban Areas (FUAs) consist of densely populated cities together with their surrounding commuting zones. This definition looks at the full extent of cities' labour markets to capture the economic boundaries of cities. FUAs are generally the aggregation of local units.

4

Assessing the implementation of a territorial approach to climate action and resilience in OECD countries

This chapter assesses how national and subnational governments are implementing a territorial approach to climate action and resilience. The assessment focuses on three dimensions: i) integrating a place-based perspective into climate policy; ii) “climate-proofing” regional development policy at all territorial levels; and iii) enabling and scaling up local climate action. It applies the “actions and opportunities” indicators within the OECD territorial climate indicator framework presented in Chapter 2 and draws on an analysis of 36 leading practices from countries, regions and cities, mainly in the OECD area. The result of the assessment is summarised in a set of nine recommended actions for both national and subnational governments. Detailed and concrete sub-actions have been proposed and summarised in tables for each recommended action, serving as a policy checklist.

Introduction

The assessment conducted in Chapter 3 has shed light on the substantial challenges that OECD cities and regions face while pursuing climate neutrality goals and adapting to climate change. Building on these findings, this chapter will analyse how national and subnational governments are implementing a territorial approach to climate action and resilience. It will specifically focus on three distinct but interrelated dimensions derived from the definition of a territorial approach¹ (Chapter 1):

- **Integrating a place-based perspective into climate policy.** The chapter will assess the extent to which national, regional and local climate policies can integrate a place-based perspective. The assessment focuses on three aspects. First, it looks at how governments can measure and better understand cities' and regions' potential to mitigate greenhouse gas (GHG) emissions as well as local climate risks and impacts. Second, it investigates how national governments are incorporating local climate action into national mitigation and adaptation plans and strategies. Third, it delves into how cities and regions reflect their local needs and interests into their own climate goals and targets while ensuring alignment with the Paris Agreement.
- **"Climate-proofing" regional development policy at all territorial levels.** The chapter will analyse how urban, rural, metropolitan and neighbourhood-level development policies are mainstreaming climate dimensions. The assessment will look at policies according to different territorial characteristics (e.g. city centres, rural areas) and scales (e.g. functional urban areas or FUAS, neighbourhoods). The analysis will focus on how cross-sectoral and integrated development projects can break down sectoral silos, ensure policy alignment and generate multi-faceted benefits to improve overall outcomes and impacts. In addition, the assessment will address how these development policies address inequalities across populations and places and how policy design could better anticipate and manage potential distributional trade-offs and enhance synergies.
- **Enabling and scaling up local climate action.** The chapter will look at how national and subnational governments can facilitate local climate action, notably by removing legal and institutional barriers, enhancing funding and financing mechanisms, engaging multiple stakeholders and sharing local knowledge.

In each dimension, the analysis will cover why it matters (rationale), what action different levels of government are taking (policy practices), what gaps and challenges remain and how to overcome them (policy implications). The assessment draws on a selection of 36 leading practices collected mainly from OECD countries, regions and cities through a literature review, which apply a territorial approach to drive systemic and transformative climate action and resilience (see Annex Table 4.A.1). These leading practices were analysed to identify success factors and lessons from the following perspectives:

- Impacts on GHG emission reduction.
- Preparedness against climate and transition risks, and capacity to reduce and manage potential local impacts.
- Effects on broader co-benefits generated across sectors, including long-term economic benefits (e.g. jobs, incomes), social benefits (e.g. health) and environmental benefits (e.g. avoided loss of biodiversity) while ensuring equal access to the opportunities of the net zero transition.
- Links between mitigation and adaptation measures to generate synergies and manage trade-offs to ensure that the net zero transition is also climate-resilient (and vice versa).
- Ability to identify and address potentially negative or regressive policy impacts on specific geographical locations and population groups.
- Making the most of existing funding mechanisms for climate action and promoting innovative financing mechanisms for climate investment at the subnational level.

- Improved institutional structures and multi-level governance (e.g. horizontal-vertical co-ordination).

This chapter also applies the “actions and opportunities” indicators within the OECD territorial climate indicator framework presented in Chapter 2. The preliminary results of the analyses of four out of six indicators (Existence of subnational climate mitigation and adaptation targets and compliance with national targets, Green areas in cities, Climate-significant expenditure and investments, and Existence of climate-related funds, grants and subsidies for subnational action) were presented and discussed in the assessment.

Table 4.1. The list of indicators analysed in this chapter

Indicator	Unit of analysis	Reference point
Actions and opportunities		
40. Existence of subnational climate mitigation and adaptation targets and compliance with national targets (to be estimated)	National scale	100% of subnational governments (e.g. TL2, TL3 levels) with climate mitigation and adaptation targets complying with national targets
42. Green areas in cities	FUA's urban centres, SAUs	Best performers
43. Climate-significant expenditure and investments	National scale	Best performers
44. Existence of climate-related funds, grants and subsidies for subnational action	National scale	To be defined

Integrating a place-based perspective into climate policy

Measuring and monitoring GHG emissions, climate risks and impacts at different territorial levels

A better understanding of GHG emission reduction potential, climate risks and impacts at different territorial levels is the cornerstone of a territorial approach. For instance, measuring and monitoring national climate goals at the subnational scale in a comparable way will help national governments understand the context-specific conditions of each territory and how far cities and regions are from reaching national goals and targets (e.g. nationally determined contributions [NDCs], Long-Term Low Emission Development Strategies [LT-LEDS], national adaptation plans [NAPs] and national adaptation strategies [NAS]) to achieve the Paris Agreement. It can also help cities and regions understand where they stand with regard to their peers across and within countries. In addition, it allows both national and subnational policy makers to measure the impacts of specific climate policies (e.g. local adaptation actions). Local and regional authorities are at the forefront of collecting local data on climate impacts, while national governments have a key role to play in developing and operating a coherent climate measurement and monitoring framework across levels of government.

This chapter assesses how countries, regions and cities are measuring and monitoring GHG emissions, climate risks and impacts at different territorial levels through a literature review. A mapping of diverse programmes and initiatives across OECD countries, cities and regions has allowed for identifying the following common measuring and monitoring practices taking place, both for climate mitigation and adaptation:

- **National action measuring and monitoring GHG emissions at subnational scales.** The Australian Department of Climate Change, Energy, the Environment and Water estimates GHG emissions by sector for each state and territory in the national inventory submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2021 (DCEEW, 2023^[1]). The United Kingdom Department for Business, Energy and Industrial Strategy produces annual

GHG emission estimates by local authorities and regions. The estimates published each year relate to the calendar year two years earlier (e.g. the publication in 2022 covers emissions up to 2020) (BEIS, 2023^[2]).

- **Development of internationally comparable GHG emission reporting mechanisms for cities and regions.** It has become easier to account for GHG emissions by sector and scope through standardised methods such as the internationally comparable GHG reporting methodologies for companies, organisations and local governments. An increasing number of cities are publicly reporting emissions data by sector and type of emission, with some even reporting emissions based on the consumption of goods and services imported from different jurisdictions (C40 Cities, 2018^[3]; GHG Protocol, 2018^[4]).
- **National action measuring and monitoring climate risks and impacts at local and neighbourhood scales.** Italy has developed a climate model with high spatial resolutions, which can help inform localities on their specific risks as it allows them to downscale the model and run regional climate models with kilometre (km)-scale grids (Raffa et al., 2023^[5]). The Korea Adaptation Centre for Climate Change has developed a climate change vulnerability assessment tool (VESTAP) to help provinces and municipal governments assess their vulnerability. The geographic information system (GIS)-based tool helps municipalities visualise their climate risks by offering data on climate exposure, sensitivity and adaptation capacity. Aside from checking their vulnerability, local governments can also conduct their own assessment by modifying weights and adding new indicators (Case 1 in Annex 4.A) (OECD, forthcoming^[6]).
- **Cities' action measuring and monitoring local climate risks.** A number of cities, such as Barcelona (Spain), Berlin (Germany), Copenhagen (Denmark), Helsinki (Finland), London (United Kingdom), Munich (Germany), New York (United States), Rotterdam (the Netherlands) and Vancouver (Canada), have also developed their own adaptation metrics, which can be either independent or linked to national adaptation indicator frameworks (Leiter et al., 2019^[7]). The city of Boston (United States) has developed the Climate Ready Boston Map Explorer, a tool to identify areas at risk of flooding (due to sea level rise and increased precipitation) and extreme heat (due to rising temperatures and the urban heat island effect). The tool overlays climate data with demographic data to better understand the social factors that intersect with and contribute to vulnerability (City of Boston, 2023^[8]) (Case 2 in Annex 4.A). In Athens, Greece, the Making Athens a Greener and Cooler City strategy has developed 81 adaptation-related indicators, such as the relative decrease in local surface and air temperatures, to measure progress in the implementation of the strategy's actions (e.g. implementation of green roofs, parks and blue corridors) (Goonesekera and Olazabal, 2022^[9]; C40 Cities, 2016^[10]).
- **Real-time monitoring systems,** including early warning systems, to monitor, forecast and inform all levels of government about imminent floods, storms, droughts, extreme heat and other events. For example, as part of its Local Climate Change Strategy and Action Plan, the city of Tatabánya, Hungary, has implemented a local heat and UV alert system to assess heatwaves and forest fires (Climate-ADAPT, 2016^[11]). Similarly, the Emilia-Romagna region, Italy, has developed real-time hydro-meteorological monitoring technologies and a widespread risk communication programme to share information on hydrometeorological risks (Climate-ADAPT, 2018^[12]; OECD, forthcoming^[13]).
- **Open data platforms** to provide local authorities and non-expert stakeholders with access to reliable data on climate impacts, allowing for cross-learning and collaboration among stakeholders and facilitating evidence-based decision making and monitoring of adaptation actions. In the United States, the Climate Mapping for Resilience and Adaptation portal helps subnational stakeholders track real-time climate change impacts and find federal funding opportunities to cover their climate resilience projects (The White House, 2022^[14]; CMRA, 2023^[15]) (Case 3 in Annex 4.A). In France, the DRIAS Futures of Climate portal makes regionalised climate data available for a

variety of uses (French Ministry of Ecological Transition, 2023^[16]). An initial “educational” section of the portal enables users to understand how data are constructed and their potential uses. Two other sections allow for viewing and downloading the data. For each hazard, the portal offers a preselection of indicators and climate scenarios, and a choice between a multimodal simulation or the results of a specific climate model. It can also be used to create maps at both the national and local levels for different time horizons (current, short-term, medium-term, long-term) and different time steps (yearly or monthly average). In Europe, Climate-ADAPT, a partnership between the European Commission and the European Environment Agency, is an online platform to provide cities, regions and other interested parties with information on climate adaptation measures and tools. As a part of the platform, the European Climate Data Explorer provides interactive access to a comprehensive collection of climate data, good adaptation practices and examples, indicators or maps, categorised by themes and sectors (e.g. agriculture, forestry, water and coastal) (Climate-ADAPT, n.d.^[17]; OECD, forthcoming^[13]) (Case 36 in Annex 4.A).

Despite these initiatives, persistent challenges remain to further advance measurement at the local scale in terms of data collection, data integration and comparability:

- Much data on GHG emissions in regions and cities are still lacking or have not yet been reported in a comparable manner due to a range of financial, regulatory and capacity challenges.
- On climate adaptation, the use of adaptation indicators is not yet a common practice at the local level. A study assessing adaptation plans from 136 cities found that only 11 set out indicators and metrics to measure progress on the plan (Goonesekera and Olazabal, 2022^[9]; OECD, forthcoming^[13]).²
- While knowledge of key areas such as sea level rise, flood risk exposure and the adaptive capacity of the built environment has substantially increased, there are still large data gaps at the sectoral and local levels that obscure public and private actors’ awareness of their full risk exposure. Some key features of climate change (e.g. temperature increases, sea level rise) are well captured in climate models but others demonstrate significant uncertainty in model projections, such as rainfall and extreme weather, which have major implications for physical risk assessment, adaptation and insurance, particularly at a regional or local level. Climate models have spatial resolutions of around 100 km, a scope that remains too large for most cities, and while methods have been elaborated to “downscale” climate modelling at lower resolutions, they often magnify uncertainties that may have already been significant at original scales (Shepherd and Sobel, 2020^[18]).
- There is still only a limited understanding of the full impacts of climate change on biodiversity and ecosystem services.

Based on this assessment, three actions can be recommended for national and subnational governments to advance climate measurement and monitoring at different territorial levels. First, national governments can establish standardised and common indicator frameworks for quantifying GHG emissions as well as assessing climate impacts and risks at different territorial scales. This involves conducting a comprehensive review of all existing data and information sources related to local GHG emissions inventories, climate risks, impacts and vulnerabilities, thus assessing their comparability and identifying data gaps. It also means defining a set of indicators that can be consistently applied across different regions and cities within a country. Furthermore, it entails establishing uniform procedures for collecting data on GHG emissions and climate impacts and risks. While the role of national governments is to provide a common language across levels of government, cities and regions play a pivotal role in data collection, as they gather data on a regular basis on various factors driving GHG emissions, including energy consumption, transport and waste, as part of their local GHG emissions inventories. To the extent possible, consumption-based emissions should also be considered. The firsthand knowledge that local governments have gained from experiencing climate change and dealing with the consequences of extreme weather events is invaluable for refining broader climate and hazard models.

Second, by setting common and standardised indicators that ensure comparability between local, regional and national data, countries, cities and regions can obtain accurate information to measure their distance from achieving national and international climate goals and targets. The latter include the goals set in NDCs, LT-LEDS, NAS and NAPs. Chapter 2 offers an OECD methodology to measure the distance of cities and regions to reaching global targets (for climate mitigation) and “climate normal” (for climate adaptation), which can be used to benchmark cities and regions against their peers. Identifying and reporting GHG emissions at the regional and city levels – as well as relevant indicators and benchmarks for the net zero transition (e.g. energy efficiency retrofits in buildings, electric mobility infrastructure) – is crucial to accelerate action and enhance accountability to ensure national governments are on track to reach their climate targets. Setting such common and standardised frameworks can also be developed by using existing or creating new multi-stakeholder platforms that enable dialogue and exchange of good practices on climate data across different stakeholders.

Third, although climate risk and vulnerability assessments are increasingly becoming a common exercise at the local level, such assessments are not always covering different systems (e.g. economic, social) or different geographical scales (e.g. regional, national and international) (Matsumoto and Ledesma Bohorquez, 2023^[19]). Assessing how direct climate impacts and risks are cascading and compounding to other climate and non-climate risks and across different geographical scales offers a great potential to bridge the gap between disaster risk and climate change adaptation (Lawrence, Blackett and Cradock-Henry, 2020^[20]). This is particularly relevant to understand how climate risks make some populations more vulnerable and exposed than others, especially economically and socially marginalised communities.

Table 4.2 outlines a set of recommended actions for both national and subnational governments to address the policy gaps discussed above.

Table 4.2. Recommended actions to measure and monitor GHG emissions, climate risks and impacts at different territorial levels

Category	For whom	Recommended action
Stocktaking and mapping of existing climate measuring and monitoring frameworks	All levels	- Analyse existing data and information sources on GHG inventories, climate risks, impacts and vulnerabilities, etc. and examine whether they are comparable with other levels of government. - Identify data and information gaps for local climate action to achieve the goals and targets set by national and subnational climate policies (e.g. NDC, LT-LEDS, NAP, NAS). - Analyse existing local GHG emission inventories and reporting mechanisms and identify options for developing a compatible measuring and monitoring framework across levels of government.
Creation and use of more granular data and information to measure and monitor local climate action	All levels	- Develop a framework to measure “cascading and compounding” impacts at different territorial scales. - Develop data on consumption-based emissions at different territorial scales. - Downscale GHG emissions inventories at a subnational scale.
Creation of data at different territorial scales	All levels	Develop climate data for FUAs.
	Cities and regions	- Develop city-level climate risk assessments. - Develop climate data at the neighbourhood scale.
Alignment of data across territorial scales	All levels	- Agree upon or develop a common local GHG emissions inventory that is compatible with the national inventory and a monitoring and reporting methodology. - Collect and disclose GHG emission data at different territorial scales.
	National	Collect local GHG emissions inventories and use them for developing national-level GHG emissions trajectories.
Disclosure and dissemination	All levels	- Create multi-stakeholder platforms for dialogues and practice exchange on climate data. - Create open data platforms.

Incorporating local action into national climate plans and strategies

Global recognition of local climate action and resilience is increasing

The adoption of the Paris Agreement, the 2030 Agenda on Sustainable Development (2030 Agenda) and the Sendai Framework for Disaster Risk Reduction 2015-2030 in 2015 has generated strong momentum for all actors across countries, regions and cities to take action to achieve global commitments (Table 4.3). All three global climate-related agendas have clearly recognised the role of subnational action in their formulation processes and have incorporated it into the adopted documents. It is also worth noting that since the adoption of the Paris Agreement, the subsequent United Nations Climate Change Conferences have reinforced the importance of multi-level governance to accelerate the implementation of the Paris Agreement through several initiatives that call for more active participation of cities and regions (Table 4.4).

Within the framework of the UNFCCC, subnational governments (SNGs) are currently unified under the Local Governments and Municipal Authorities (LGMA) Constituency to the United Nations, although they are not “parties”, i.e. they are neither part of formal global climate negotiations nor in the implementation of the agreement (CoR, 2022^[21]). Nevertheless, the assessment of current NDCs, LT-LEDs, NAPs and NAS suggests that, in practice, national governments are increasingly incorporating local climate action into their national pledges and policies, as described below.

Table 4.3. Major global agreements in 2015 that recognise local climate action

Initiative	How local climate action is recognised, supported and facilitated
Paris Agreement	The Paris Agreement acknowledges that climate change is a common concern of humankind and that local communities – among other groups such as Indigenous peoples, migrants and children – must be properly engaged when taking action to address it. The agreement also recognises that all levels of government play a pivotal role in the implementation of climate strategies, with emphasis on climate adaptation, loss and damage and capacity building. Various provisions related to the significance of subnational climate action, such as Article 4, underscore countries' responsibility to outline their climate efforts in NDCs.
2030 Agenda	2030 Agenda outlines collaborations among various entities in the implementation of its endeavours. Article 45 advises public institutions to “work closely on implementation with regional and local authorities, sub-regional institutions, international institutions, academia, philanthropic organizations, volunteer groups”. Although the United Nations Sustainable Development Goals (SDGs) were not explicitly tailored for and by local and regional governments, except SDG 11, they provide a universal ambition and valuable framework that can enable authorities at all levels to align global, national and subnational priorities. Given cities' and regions' proximity to their residents and their assertion of influence on policies and public investments, it is imperative for cities and regions to take actions aligned with the SDGs for the successful implementation of 2030 Agenda.
Sendai Framework for Disaster Risk Reduction 2015-2030	The Sendai Framework underscores the importance of local action in great depth, beginning with emphasis on the fact that “international, regional, sub-regional and transboundary co-operation remains pivotal in supporting the efforts of States, their national and local authorities, as well as communities and businesses, to reduce disaster risk”. The key target to “substantially increase the number of countries with national and local disaster risk reduction strategies by 2020” is rendered more actionable at all levels of government with the recognition that “there is a need for focused action within and across sectors by States at local, national, regional and global levels” to achieve the framework's priorities. The importance of local action is further embedded in three of the framework's guiding principles under Article 19: • “Disaster risk reduction and management depends on coordination mechanisms within and across sectors and with relevant stakeholders at all levels, and it requires the full engagement of all State institutions of an executive and legislative nature at national and local levels and a clear articulation of responsibilities [...]”. • “While the enabling, guiding and coordinating role of national and federal State Governments remains essential, it is necessary to empower local authorities and local communities to reduce disaster risk, including through resources, incentives and decision-making responsibilities, as appropriate”. • “While the drivers of disaster risk may be local, national, regional or global in scope, disaster risks have local and specific characteristics that must be understood for the determination of measures to reduce disaster risk”.

Source: Based on UNFCCC (2015^[22]), *Adoption of the Paris Agreement*, https://unfccc.int/sites/default/files/english_paris_agreement.pdf; UNDRR (2015^[23]), *Sendai Framework for Disaster Risk Reduction 2015-2030*, <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>; UN (2015^[24]), *2030 Agenda for Sustainable Development*, <https://sdgs.un.org/es/2030agenda>.

Table 4.4. Selected global initiatives to enhance local climate action

Initiative (United Nations Climate Change Conference)	Year	Mandate/objective
Marrakech Partnership for Global Climate Action (COP22)	2016	The Marrakech Partnership's mission is to strengthen collaboration between governments and key stakeholders to reduce emissions and increase resilience against climate impacts.
Cities and Regions Talanoa Dialogues (COP23)	2017	At COP23, countries agreed to organise Talanoa Dialogues for cities and regions. These are a series of in-country climate consultations designed to kick off a collaborative process involving all levels of government. They convene national, regional and local governments to shape and strengthen NDCs, to take stock of global efforts to reduce GHG emissions and to increase countries' resilience to the impacts of climate change.
Glasgow Climate Pact (COP26)	2021	Adopted at COP26, the Glasgow Climate Pact, along with other COP26 outcomes, enshrined "multi-level collaboration" as a new normal for the implementation of the Paris Agreement. References to multi-level action appear more than 30 times in the outcome documents.
Sustainable Urban Resilience for the Next Generation – SURGe Initiative (COP27)	2022	Launched at COP27, the SURGe Initiative aims to enhance and accelerate local and urban climate action through multi-level governance, engagement and delivery through five integrated tracks, contributing to achieving the Paris Climate Goals and SDGs. The SURGe Initiative is developed in collaboration with the United Nations Human Settlements Programme (UN-Habitat) and facilitated by non-governmental organisation ICLEI and has been endorsed by more than 70 global partners. The initiative was officially launched at the Urban and Housing Ministerial Session on Cities and Climate Change at COP27.

Source: Based on LGMA (2023^[25]), *About the Local Governments and Municipal Authorities Constituency: The Voice of Cities and Regions in the Climate Negotiation Process*, <https://www.cities-and-regions.org/about-the-lgma/>.

NDCs and LT-LEDS incorporating local action

On climate mitigation, to investigate the extent to which cities and regions are acknowledged in terms of their targets, implementation of local climate action and participation in the planning process, this report has analysed all the latest NDCs (16 from OECD countries and the European Union). The analysis was conducted using the most recent NDCs submitted to the UNFCCC as of September 2023. The analysis focused on the section titled "information to facilitate transparency, clarity, and understanding of nationally determined contributions", as mandated by the Paris Agreement under Article 4 (Table 4.5).

The results revealed that most national governments have incorporated local perspectives on climate action into their NDCs in one way or another, although the extent varies across countries. New Zealand's NDC is the only one that has no reference to local perspectives. Key findings from the analysis of how local perspectives are included in NDCs are the following:

- On "GHG emissions reduction commitment", only a limited number of countries are paying substantial attention to the targets set by their regions or cities. For instance, Canada dedicated a section to discussing the diverse climate commitments and actions undertaken by its provinces and territories. Similarly, the United Kingdom underscored the distinct targets set by its devolved administrations. Moreover, the sector-by-sector assessment conducted in the United States to formulate its national GHG reduction target duly acknowledged the contributions from subnational actions. This underlines the substantial role of states and local governments in achieving national efforts to reduce GHG emissions.
- Regarding "implementation of local climate action", certain NDCs explicitly mention programmes designed to promote local climate action. For instance, Japan's Green Challenge, led by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), places emphasis on cross-sectoral decarbonisation with a special focus on urban development, transport and infrastructure. Likewise, Colombia has formulated a list of sector-specific mitigation measures and adaptation targets in its updated 2022 NDC, highlighting the crucial role of local governments in their implementation. In fact, Law 1931 mandates regional authorities to prepare Territorial Climate Change Management

Plans. To guide the preparation of these plans, the Ministry of Environment and Sustainable Development launched a guidance document in 2022 to support regional authorities in developing plans adapted to the context-specific needs and challenges (Colombian Ministry of Environment and Sustainable Development, 2018^[26]) (Case 4 in Annex 4.A).

- On “engagement in the NDC planning process”, while there are encouraging signs of progress in terms of incorporating local governments into the design of NDCs, there remains room for improvement through the establishment of dedicated co-ordination mechanisms for future NDC developments and updates. For instance, in Canada, the Net-Zero Emissions Accountability Act mandates the Ministry of Environment and Climate Change Canada to facilitate opportunities for provincial governments to submit proposals when governments establish emission reduction targets or reduction plans. The Pan-Canadian Framework on Clean Growth and Climate Change serves as the dialogue platform on climate-related policies between the federal government and the provinces and territories (Case 5 in Annex 4.A). Chile’s NDC acknowledges the importance role of multi-level governance systems through the development of Regional Climate Change Committees (CORECC). These committees are currently developing and implementing regional climate action plans in close collaboration with the central government, municipalities and other non-state and subnational actors to implement the commitment. The CORECC are the main operational structure of regional climate change governance in the country and their mission is to co-ordinate efforts to align climate policies across levels of government and support the integration of long-term objectives related to climate change mitigation and adaptation in the different regional and municipal development plans (MMA, 2022^[27]).

In addition to the NDCs, countries are also formulating LT-LEDS. These policy documents outline pathways for low-emission development, taking into account broader socio-economic objectives. While NDCs are mandatory for all parties of the Paris Agreement, LT-LEDS are voluntary (OECD, 2020^[28]). A recent report analysing 53 LT-LEDS highlighted that cities and regions were engaged in the preparation process (UNFCCC, 2022^[29]). Earlier OECD research on the LT-LEDS of Canada, France, Germany and the state of California (United States) confirms a considerable engagement of cities and regions (Matsumoto et al., 2019^[30]). Several types of co-ordination mechanisms exist in the development and implementation of LT-LEDS and subnational climate plans, from which other countries or states could take inspiration in order to improve the effectiveness of their multi-level co-ordination:

- **Joint development of climate plans.** Germany’s national climate plan took into account the joint proposal of cities and regions. Local, regional and national governments jointly developed French regional climate plans. Similarly, Canada’s Pan-Canadian Framework on Clean Growth and Climate Change (PCF) was adopted by provincial governments and accounts for a range of subnational climate plans and actions.
- **Requirement for policy alignment.** In France, all levels of government are required to take the national climate strategy into account in their planning strategies. Similarly, local governments in France are in charge of setting their own targets to reduce GHG emissions, as is the case in the state of California.
- **Setting up a joint committee.** France created a network of co-ordinated national, regional and local committees to implement local climate plans. In Germany, an alliance of various stakeholders, including regional and local governments, plays a key role in implementing climate policies. Canada’s PCF serves as a strong basis for multi-level co-ordination.
- **Co-financing and financial incentives.** In Canada, the Ministry of Environment and Climate Change Canada has pledged CAN 31.5 million for municipal green grants and loans to 20 cities or towns for projects to improve air, water and soil quality, including reducing carbon emissions. In Germany, the National Climate Initiative (NKI) is one of the most important instruments of the German federal government to promote effective climate protection measures throughout Germany. Over 2008-20, it invested over EUR 820 million in over 18 700 projects domestically,

involving 3 975 local authorities. Funding guidelines for municipalities were updated in 2022 to provide further support for SNG personnel and a broader scope of projects to be supported, including feasibility studies for investment projects. In France, there are more than 28 instruments available to support cities and regions to fund both adaptation and mitigation projects. These instruments are a mix of earmarked grants, loans, funds and contracts. For example, in 2020, the national government launched its national recovery plan, France Relance, endowed with a budget of EUR 100 billion over 2 years, allocating 30% of its resources to the ecological transition and funding 7 instruments benefitting cities and regions (OECD, 2022^[31]).

Table 4.5. The role of cities and regions in the latest NDCs in OECD countries and the European Union

Country	Assessment criteria: Is the role of cities and regions recognised in relation to:		
	GHG emissions reduction commitments	Implementation of local climate action	Engagement in the NDC planning process
	<i>Does the NDC commitment include any explicit references or acknowledgements to the local GHG emissions reduction commitments by its cities and regions?</i>	<i>Does the NDC make any reference to a specific programme/initiative/activity aimed at supporting the implementation of local climate action?</i>	<i>Does the NDC include any explicit mention of the participation of cities and regions in the planning processes?</i>
Federal states (5)			
Australia	"National targets and federal emissions reduction policies are complemented by targets and measures implemented at the State and Territory level".	"As a federation, Australian States, Territories and local government also implement significant policies and programs to reduce greenhouse gas emissions and support clean energy technologies".	No specific programme for local climate action is mentioned.
Canada	"Several provinces and territories have committed to deep GHG emissions reduction targets – for both 2030 and 2050. E.g., British Columbia target to reduce GHG emissions below 2007 levels by 40% by 2030".	E.g. "2.6 CAD billion Canada Greener Homes Grant initiative with grants of up to CAD 5 000 and investing CAD 4.4 billion to help homeowners complete deep home retrofits through interest-free loans worth up to CAD 40 000; Invest CAD 964 million in smart renewable energy and grid modernisation projects, as well as continue to work with provinces and territories to help build key intertie projects".	Under the Canadian Net-Zero Emissions Accountability Act, the Minister of Environment and Climate Change s required to provide opportunities to provincial governments to submit proposals when the government is setting its emissions target or emissions reduction plans.
Mexico	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action is mentioned.	The NDC mentions the participation of states in the process of updating the NDC.
United States	The assessments included consideration of contributions from subnational actions, noting that states and local governments contribute substantially under the United States federal system to national efforts to reduce emissions.	"Local governments are charged with governance responsibilities at the corresponding level of SNG. This shared responsibility for policy in areas such as economic growth, energy development, transport, land use planning and natural resource use creates the opportunity for action at multiple levels".	The NDC was developed based on sector-by-sector assessments of emission reduction potential informed by a whole-of-government process via the National Climate Task Force, led by the White House Office of Domestic Climate Policy.
Switzerland	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action is mentioned.	No reference to the engagement of city/regional government in the planning process of the NDC.
Unitary countries (11)			
Chile	No mention of city/regional GHG emissions reduction commitments.	Regional Climate Action Plans.	"Regional Climate Change Committees (CORECC) plan and implement action to face climate change, in close collaboration with central government, municipalities and other non-state and sub-national actors".

Country	Assessment criteria: Is the role of cities and regions recognised in relation to:		
	GHG emissions reduction commitments	Implementation of local climate action	Engagement in the NDC planning process
	<i>Does the NDC commitment include any explicit references or acknowledgements to the local GHG emissions reduction commitments by its cities and regions?</i>	<i>Does the NDC make any reference to a specific programme/initiative/activity aimed at supporting the implementation of local climate action?</i>	<i>Does the NDC include any explicit mention of the participation of cities and regions in the planning processes?"</i>
Colombia	No mention of city/regional GHG emissions reduction commitments.	The NDC includes a portfolio of sectoral and territorial measures with mitigation and adaptation measures led by regional governments.	
Costa Rica	No mention of city/regional GHG emissions reduction commitments.	The NDC includes several "action areas" with direct implications on local actions (i.e. mobility and transport, territorial management and development).	No reference to the engagement of city/regional government in the planning process of the NDC.
Israel	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action is mentioned.	"The establishment of sectorial working groups consisting of representatives of relevant ministries, local authorities, public representatives, NGOs [non-governmental organisations], academia".
Iceland	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action is mentioned.	"The work on the Climate Action Plan was carried out by an interministerial working group, with the Association of Local Authorities also represented, led by the Ministry for the Environment and Natural Resources".
Japan	No mention of city/regional GHG emissions reduction commitments.	The MLIT's Green Challenge promotes efforts in cross-sectoral decarbonisation in national land, urban and regional spheres.	No reference to the engagement of city/regional government in the planning process.
Korea	No mention of city/regional GHG emissions reduction commitments.	The Korean Green New Deal 2.0 includes green transition in cities/spatial planning as one its four pillars.	No reference to the engagement of city/regional government in the planning process of the NDC.
New Zealand	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action.	No reference to the engagement of city/regional government in the planning process of the NDC.
Norway	No mention of city/regional GHG emissions reduction commitments.	No specific programme for local climate action is mentioned.	"In Norway, two Talanoa Dialogues were held. One between the Minister of Climate and Environment and mayors (municipalities) and one initiated by Norwegian environmental organisations and the Parliament".
Türkiye	No mention of city/regional GHG emissions reduction commitments.	"In the scope of Enhancing Adaptation Action in Türkiye Project, local climate change adaptation action plans are being prepared for 4 pilot cities (Konya, Muğla, Samsun and Sakarya) in Türkiye. Sectoral vulnerability and risk assessments have been completed, and actions are being identified".	No reference to the engagement of city/regional government in the planning process of the NDC.
United Kingdom	"The Devolved Administrations in Scotland, Wales and Northern Ireland have their own statutory emissions reduction targets, i.e. Scotland to reach the net zero GHG emissions by 2030".	"Government works closely with local government and has provided support to help them contribute to delivering net zero including: Local Net Zero Hubs and the Local Net Zero Forum for national and local senior government officials to discuss local net zero policy and delivery issues".	"Prepared in collaboration with government departments and Devolved administrations".
European union			
European Union	No mention of city/regional GHG emissions reduction commitments. However, it mentions the commitments	No specific programme for local climate action is mentioned.	"The enhanced target is based on an extensive impact assessment, as well as stakeholder input, collected via

Country	Assessment criteria: Is the role of cities and regions recognised in relation to:		
	GHG emissions reduction commitments	Implementation of local climate action	Engagement in the NDC planning process
	<i>Does the NDC commitment include any explicit references or acknowledgements to the local GHG emissions reduction commitments by its cities and regions?</i>	<i>Does the NDC make any reference to a specific programme/initiative/activity aimed at supporting the implementation of local climate action?</i>	<i>Does the NDC include any explicit mention of the participation of cities and regions in the planning processes?"</i>
	of its member countries.		public consultation including national, regional and local authorities".

Note: The European Commission's NDC covers all of its member countries and includes the following 22 OECD members: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Portugal, the Slovak Republic, Slovenia, Spain and Sweden.

■ Strong attention; ■ Attention; □ No attention

Source: Based on NDCs.

NAPs and NAS incorporating local action

In terms of adaptation, to assess the role of local governments in relation to climate risk assessment and dissemination of information, adaptation planning, implementation and measurement, this report analysed the national adaptation plans or strategies (NAPs/NAS) of all OECD countries (Table 4.6). In relation to climate risk assessment, several countries such as Belgium, Canada, Sweden and the United Kingdom have dedicated a section in their NAPs/NAS to the role of local governments in risk assessment or in disseminating information on climate risks. Some countries, such as Canada, went beyond and included specific actions in their NAP related to local risk assessment, such as community-based climate monitoring (Government of Canada, 2022^[32]). When it comes to adaptation planning, all OECD countries have recognised the role of local governments. For example, New Zealand emphasises the importance of involving local governments and indigenous communities in adaptation planning, due to their responsibilities (e.g. land use planning, asset management, civil defence) and local knowledge and experience (New Zealand Ministry for the Environment, 2023^[33]). The role of local governments related to the implementation of adaptation measures is also extensively discussed in the NAPs and NAS of most OECD countries. For example, Finland's NAP defined the responsibility of local and regional governments in relation to the measures that have to be implemented based on its objectives (Finnish Ministry of Agriculture and Forestry, 2014^[34]). Regarding measurement, one-third of OECD countries mention the role of local authorities in measuring and evaluating adaptation progress in their NAPs and NAS. For example, the Netherlands set out a number of monitoring activities in its NAP, which mentions the role of municipalities and other subnational entities. The NAP set out an objective to develop a digital platform where municipalities, water authorities and other stakeholders can report their progress and provide guidance for monitoring. Other countries such as Belgium, Colombia, Ireland and New Zealand also highlight the importance of local authorities in measurement, although they do not specify the actions and measures that have to be carried out at the local level (OECD, forthcoming^[13]).³

Table 4.6. The role of local governments in national adaptation plans or strategies in OECD countries

Country	Reference document(s)	Is the role of local government mentioned in relation to:			
		Climate risk assessment or dissemination of information	Adaptation planning	Adaptation implementation	Adaptation measurement
Australia	NAS 2021-2025 (2021)	○	○	○	○
Austria	NAS (2017)	○	○	○	○
Belgium	NAP 2017-2020 (2017)	●	●	●	●
Canada	NAP (2022)	●	●	●	○

Country	Reference document(s)	Is the role of local government mentioned in relation to:			
		Climate risk assessment or dissemination of information	Adaptation planning	Adaptation implementation	Adaptation measurement
Chile	Chile's Long-Term Climate Strategy (2021)	●	●	●	○
Colombia	NAP (2016)	○	○	●	●
Costa Rica	NAP 2022-2026 (2022)		●	●	
Czech Republic	NAS/NAP (2021)	●	●	●	
Denmark	Action plan for a climate-proof Denmark (2012)	●	●	●	
Estonia	Climate Change Adaptation Development Plan until 2030 (2017)		●	●	
Finland	NAP (2014)	○	○	●	●
France	NAP (2018)		○	●	
Germany	Adaptation Action Plan of the German Strategy for Adaptation to Climate Change (2011)	○	●	●	
Greece	NAS (2016)		●	●	
Hungary	National Climate Change Strategy 2018-2030 (2018)		○	○	
Iceland	Climate Change Adaptation Policy (2021)				
Ireland	National Adaptation Framework (2018)		●	●	●
Israel	NAP (2017)	●	●	●	
Italy	NAS (2014)	○	○		
Japan	NAP (2021)	○	●		
Korea	NAP 2021-2025 (2021)	●	●	●	
Latvia	NAP 2019-2030 (2019)			●	
Lithuania	National Energy and Climate Action Plan of the Republic of Lithuania for 2021-2030 (2021)	○	○	○	
Luxembourg	National Adaptation Strategy and Action Plan 2018-2023 (2018)				
Mexico	National Climate Change Strategy (2013)	●	●	●	
Netherlands	NAS 2018-2019 (2018)		●	●	
New Zealand	NAP (2022)	●	●	●	●
Norway	NAS (2021)	○	○		
Poland	NAS 2020 (2013)	○	●	●	
Portugal	Action Program for Adaptation to Climate Change (2019)	○	●	●	
Slovak Republic	NAS (2018)		●	●	
Slovenia	Strategic Framework for Climate Change Adaptation (2016)	○	○	○	
Spain	NAP 2021-2030 (2020)	○	○	●	
Sweden	NAS (2018)	●	●	●	
Switzerland	NAP 2014-2019 (2014)		●		●
Türkiye	National Adaptation Strategy and Action Plan 2011-2023 (2012)		●	●	
United Kingdom	NAP 2023-2028 (2023)	●	●	●	●

Note: The black dot means “mandatory or explicit requirement” and the white dot means “voluntary or encouraged”. The United States does not have a NAP/NAS at the federal level; therefore, it was not included in the list.

When they exist, the reference documents are countries' NAS or NAPs. For other countries, the reviewed documents are official climate-related documents that deal with adaptation.

■ Extensively discussed; □ Slightly discussed; □ Not discussed

Source: Based on OECD (forthcoming^[13]), “Climate adaptation: why can't local governments do it alone?”, OECD Publishing, Paris; Matsumoto and Ledesma Bohorquez (2023^[19]), *Building Systemic Climate Resilience in Cities*, OECD Publishing, Paris.

Policy implications

As demonstrated above, only a limited number of countries are paying substantial attention in their NDCs to the GHG emission reduction targets set by their regions or cities. A possible direction is to set and include climate goals and targets not only for themselves but also for regions and cities, recognising their pledges. By taking stock of existing climate mitigation and adaptation commitments from cities and regions, national governments can identify synergies, gaps and opportunities for aligning policies and resources to implement national policy goals more effectively.

Despite positive signals and examples of cities and regions participating in the process of preparing national climate policies, there is potential to facilitate more proactive engagement. For example, national governments could conduct multi-stakeholder consultations with a particular focus on local authorities. This would help collect local information that is useful for the design of national policies, such as granular information on climate impacts, needs and innovations. They could also set concrete actions, where local governments can be engaged as implementation partners, and allocate resources (e.g. energy efficiency retrofits, expansion of green areas).

Table 4.7 outlines a set of recommended actions for both national and subnational governments to address the policy gaps.

Table 4.7. Recommended actions to incorporate local climate action into national climate plans and strategies

Category	For whom	Recommended action
Goals and targets	National	- Take stock of existing climate mitigation and adaptation commitments from cities and regions, including local and regional climate goals and targets. Set national goals and targets in NDCs, LT-LEDs, NAPs and NAS which consider regional and local climate goals and targets. - Set dedicated and aligned goals and targets for cities and regions in NDCs, LT-LEDs, NAPs and NAS.
	All levels	Develop a multi-level framework/mechanism to align the baseline, data and methodologies to set goals and targets in a coherent manner across levels of government.
Implementation	National	Define the role of cities and regions in implementing NDCs, LT-LEDs, NAPs and NAS and include in these plans and strategies.
	All levels	Develop and include concrete projects/actions implemented by cities and regions in NDCs, LT-LEDs, NAPs and NAS.
Process of developing plans and strategies	National	Engage cities and regions in developing NDCs, LT-LEDs, NAPs and NAS.
	All levels	Create multi-stakeholder platforms and co-ordination mechanisms for developing and implementing NDCs, LT-LEDs, NAPs and NAS.

Developing subnational climate goals and targets reflecting local needs and interests and aligned with the Paris Agreement

This subsection delves into how cities and regions develop and implement their climate goals and targets. Cities and regions are motivated to set their own climate mitigation and adaptation goals and targets, reflecting locally specific needs, interests and priorities for their constituencies, which is a key driver of a territorial approach. Thus, this subsection focuses on grasping the state of play of OECD cities and regions in their goal and target settings and analysing if their actions align with the global goals and targets set by the Paris Agreement. Another focus of the subsection is to understand what national governments are doing to support cities and regions in developing their own goals and targets and to identify policy gaps.

City and regional climate goals and targets and their alignment with those of national governments

This report analyses how OECD cities and regions are setting net zero or carbon neutrality targets and compares them with those of their respective countries. The result demonstrates the existence of leading cities and regions that present more ambitious targets compared with their respective national governments. In 23 out of 38 OECD countries, at least 1 city or region has set a net zero or carbon neutrality target with a target year earlier than the respective national target (Table 4.8). At the city level, Adelaide (Australia), Copenhagen (Denmark), Bremen (Germany), Bari (Italy), Durango (Mexico), Nottingham (United Kingdom) and Akron (United States) are among the cities whose target years are in the 2020s, more ambitious than those of their respective national governments. Similarly, Alberta (Canada), Brittany (France), Bremen (Germany) and Delaware (United States) are among the regions with more ambitious net zero or carbon-neutral target years than their national governments.

These ambitious targets of cities and regions can be useful to raise the ambition of the national goals and targets set by the NDCs or LT-LEDS. However, as discussed in Chapter 1, it is important to be reminded that there are still a number of cities and regions which do not have net zero or carbon neutrality targets. Their plans or strategies may not be necessarily aligned with national goals and targets, and some cities and regions do not even have their own climate plans and strategies, implying the need for enabling and scaling up strategies.

Table 4.8. Net zero or carbon neutrality targets across OECD cities, regions and countries

Country		Region (with the earliest target year)		City (with the earliest target year)	
Name	Target year	Name	Target year	Name	Target year
Australia	2050	Tasmania	2030	Adelaide	2025
Austria	2040	n.a.		Vienna	2040
Belgium	2050	n.a.		Antwerp, Brussels, Liège	2050
Canada	2050	Alberta	2025	Toronto	2040
Chile	2050	n.a.		Santiago	2050
Colombia	2050	n.a.		Valledupar	2030
Costa Rica	2050	n.a.		San José	2050
Czech Republic	2050	n.a.		Praha	2050
Denmark	2050	n.a.		Copenhagen	2025
Estonia	2050	n.a.		n.a.	
Finland	2035	n.a.		Helsinki	2030
France	2050	Brittany	2020	Bordeaux, Grenoble, Lille, Lyon, Marseille-Aix-en-Provence, Nantes, Paris, Toulon, Toulouse	2050
Germany	2045	Bremen	2020	Bremen	2020
Greece	2050	n.a.		Thessaloniki	2030
Hungary	2050	n.a.		Budapest	2050
Iceland	2040	n.a.		n.a.	
Ireland	2050	n.a.		Dublin	2030
Israel	2050	n.a.		Haifa, Tel Aviv	2050
Italy	2050	Abruzzo	2030	Bari, Bergamo, Busto Arsizio	2020
Japan	2050	Fukuoka, Ibaraki	2030	Sendai	2030

Country		Region (with the earliest target year)		City (with the earliest target year)	
Name	Target year	Name	Target year	Name	Target year
Korea	2050	Jeju	2030	Incheon	2045
Latvia	2050	n.a.		Riga	2050
Lithuania	2050	n.a.		Vilnius	2030
Luxembourg	2050	n.a.		n.a.	
Mexico	2050	n.a.		Durango, Toluca	2020
Netherlands	2050	n.a.		The Hague, Utrecht	2030
New Zealand	2050	n.a.		Auckland	2050
Norway	2050	n.a.		Oslo	2030
Poland	2030	Masovia	2030	Łódź	2036
Portugal	2050	n.a.		Porto	2030
Slovak Republic	2050	n.a.		n.a.	
Slovenia	2050	n.a.		n.a.	
Spain	2050	Andalusia, Aragon, Castilla-La Mancha, Community of Madrid, Murcia	2030	Valencia, Zaragoza	2030
Sweden	2045	n.a.		Stockholm	2040
Switzerland	2050	n.a.		Basel	2037
Türkiye	2050	n.a.		Bursa, Denizli	2030
United Kingdom	2050	Scotland	2045	Nottingham	2028
United States	2050	Delaware, North Carolina, Wisconsin	2025	Akron, Sarasota-Bradenton	2025

Note: The analysis is primarily based on the Net Zero Tracker database, which includes regions in the top 25 emitting countries and cities with populations greater than 500 000 inhabitants. The information on Helsinki (Finland) was collected separately. Regions or cities with net zero or carbon neutrality targets but without an explicit target year were not included in the analysis. The blue shading indicates cities and regions which set net zero or carbon neutrality targets with a target year earlier than the respective national target. In the table, n.a. indicates that there no cities or regions with an explicit target year were found in the Net Zero Tracker database.

Source: Based on Net Zero Tracker (2023^[35]), *Methodology*, <https://zerotracker.net/methodology>; City of Helsinki (n.d.^[36]), *Making Helsinki Carbon-neutral*, <https://www.myhelsinki.fi/en/think-sustainably/making-helsinki-carbon-neutral>.

Turning to climate adaptation, comparing goals and targets among countries, regions and cities is not as straightforward as comparing GHG emission reduction targets, indeed, defining adaptation targets is a complex task in itself (see Chapter 2). However, the fact that a growing number of cities and regions are making their own climate adaptation plans and strategies can provide a unique opportunity to develop a methodology to compare their goals and targets and align them with national ones.

National governments' initiatives to promote subnational climate plans and strategies

The report also analysed how countries are guiding and supporting cities and regions developing their goals and targets. Below are the key actions identified:

- **National initiatives combining multi-level dialogues with financial and technical support.** In 2021, Japan launched the Regional Decarbonization Roadmap programme to facilitate the collaboration between national and local governments in the journey to achieve climate neutrality by 2050. The programme came about from discussions at the Council for National and Regional Decarbonisation, led by the Prime Minister, which provided a forum where national and subnational governments can discuss effective collaboration programmes on an equal footing. The programme offers financial and technical support to local governments and private sector companies for decarbonisation projects. The initiative also aims to establish 100 Leading Decarbonisation

Regions, achieving net zero emissions from electricity consumption in households and business sectors by 2030, ahead of the national goal for 2050. This nationally-led initiative with financial support triggered strong motivation from cities and regions to take local decarbonisation actions. The final goal is to encourage neighbouring municipalities and foster a decarbonisation “domino” effect (Case 6 in Annex 4.A).

- **Policy tools translating national mitigation and adaptation goals into action plans or guidelines** are playing a pivotal role in guiding cities and regions to craft local climate plans and strategies that align with the broader national objectives. In Chile, the National Climate Adaptation Strategy for Cities 2018-2022 offered guidelines for cities to develop and implement local adaptation plans and strategies. The strategy is being revised in 2023 to further integrate the targets and goals of the Long-Term Climate Strategy, which sets specific targets for cities, encompassing various aspects such as nature-based solutions, urban mobility, transport and buildings. These targeted policies are instrumental in fostering coherent and co-ordinated efforts both at the national and local levels towards achieving climate goals (Government of Chile, 2019^[37]; 2021^[38]).
- **Guiding local climate adaptation strategies through explicit reference to the roles and responsibilities of local governments in NAPs.** For instance, Ireland’s 2018 National Adaptation Framework (NAF) dedicates a specific section to the role of local and regional governments. The framework establishes that each local authority should develop and adopt local adaptation strategies based on the regional approach to adaptation planning. The development of strategies must be undertaken in accordance with the Local Authority Adaptation Strategy Development Guidelines and the NAF. To support this endeavour, the NAF also delineated the need to develop four Climate Action Regional Offices (CAROs), which work with local authorities and co-ordinate regional and territorial adaptation planning (Case 7 in Annex 4.A). Similarly, other countries such as Belgium and the United Kingdom extensively discuss and set mandatory or explicit requirements for the participation of local governments in the preparation of climate risks assessment, adaptation planning, implementation and measurement.

Some regional governments are also taking strong leadership to support their local governments. The region of Flanders in Belgium has established a Local Energy and Climate Pact (LEKP) to translate the European Union (EU) climate ambition into tangible targets in four different areas including greening, energy, mobility and rainwater. The government of the region of Flanders provides financial support and facilitates knowledge exchange between municipalities to help them implement the commitments. So far, the initiative has attracted interest from more than 200 municipalities (Case 8 in Annex 4.A).

Policy implications

Developing subnational climate goals and targets can be a key driver to raise the ambition of climate commitments and accelerate climate action at all government levels. A territorial approach can help cities and regions better reflect locally specific needs, interests and priorities in setting their climate goals and targets. The result of the assessment implies several policy interventions for national governments. First, they can provide long-term visions and roadmaps to demonstrate how countries, regions and cities can work together to achieve the goal of the Paris Agreement. Second, national governments can support cities’ and regions’ development of their own climate goals and targets through financial and technical support such as guidelines, the creation of regional offices and concrete collaborative projects. Third, countries, regions and cities can develop a pact or agreement that delineates the climate actions to be conducted at each level of government. These national actions can empower cities and regions to take ownership of their contributions to global climate efforts, fostering a sense of responsibility and accountability. Table 4.9 summarises a set of recommendations for both national and subnational governments.

Table 4.9. Recommended actions to promote subnational climate plans and strategies reflecting local needs and interests and aligned with the Paris Agreement

Category	For whom	Recommended action
City and regional climate goals and targets	Cities and regions	• Develop dedicated climate mitigation and adaptation plans and strategies (e.g. locally determined contributions, local adaptation plans), that are aligned with the Paris Agreement as well as respective national goals and targets. • Cooperate with neighbouring municipalities to develop joint climate plans and strategies in a metropolitan area.
National government initiatives to promote subnational climate goals and targets	National	• Set and monitor a national target on the development of climate mitigation and adaptation plans and strategies at the local and regional level. • Create regional offices to support the implementation of local climate action. • Develop strategies/guidelines and support cities and regions in developing and implementing local mitigation, adaptation and resilience plans and strategies.
	All levels	• Identify concrete projects/actions as part of national climate policies that can be implemented in collaboration with cities and regions. • Develop climate and energy agreements/contracts/pacts across levels of government.

“Climate-proofing” regional development policy at all territorial levels

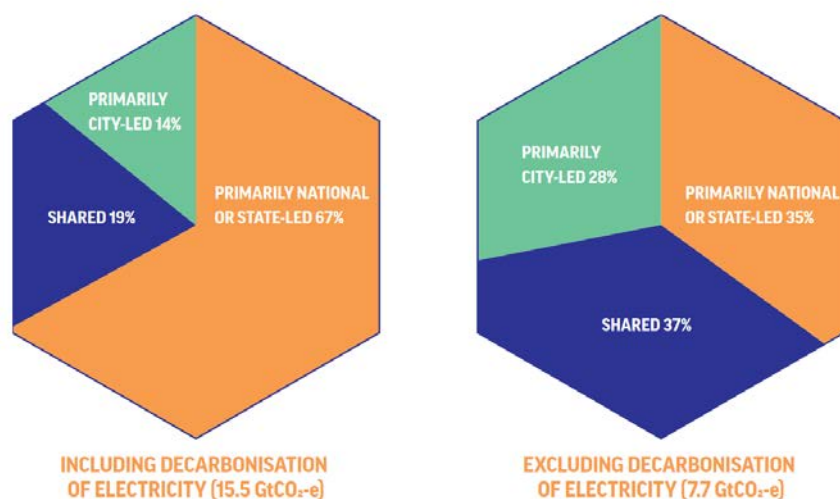
Mainstreaming climate objectives in national urban, rural and regional development policies

The role of national urban policy in climate mitigation and adaptation

Cities are currently home to 3.5 billion people and this number is projected to reach 5 billion by 2050. About 10 000 cities have been identified in the world (OECD/EC, 2020^[39]). Cities are pivotal in global mitigation efforts, as they contribute over 70% of energy-related carbon dioxide (CO₂) emissions and account for two-thirds of global energy demand (IEA, 2021^[40]). If current trends continue, global urban primary energy use will grow by about 70% and global urban CO₂ emissions by about 50% between 2013 and 2050. Yet, cities also have significant potential for implementing impactful solutions. For example, it is estimated that 90% of urban emissions can be cut with existing technologies, at the same time creating 87 million jobs in 2030 and 45 million jobs in 2050 (CUT, 2019^[41]). Other regional and local governments can also replicate climate action, as was the case with the Bus Rapid Transit system in Bogota, Colombia, which has been replicated in other Colombian and Latin American cities. It can even lay the groundwork for national regulations, as was the case with ambitious provisions for solar thermal systems in Barcelona, Spain. The city ordinance requires that all new constructions and significant renovations incorporate solar thermal collectors to provide a minimum of 60% of the energy required for water heating. This led to similar ordinances in over 60 other Spanish municipalities. Six years after its initial adoption in 2000, the national government officially incorporated this requirement into the National Building Code (IRENA, 2021^[42]).

Local governments are estimated to have direct power over a third of urban GHG emissions reduction potential by 2050. However, the remaining two-thirds depend on either national and state governments or on co-ordination across levels of government (CUT, 2019^[41]) (Figure 4.1). Local governments can mainstream climate action into their spatial planning, infrastructure, local economic and fiscal policies through locally tailored climate strategies in line with national objectives (OECD, 2010^[43]; 2019^[44]) but they also rely on multi-level co-ordination for other areas such as decarbonising the energy grid or rural-urban transport.

Figure 4.1. Proportion of urban mitigation potential over which different levels of government have primary authority



Source: CUT (2019^[41]), *Climate Emergency, Urban Opportunity: How National Government Can Secure Economic Prosperity and Avert Climate Catastrophe by Transforming Cities*, <https://urbantransitions.global/en/publication/climate-emergency-urban-opportunity/>.

Smart city solutions, driven by digitalisation and data, can also play a crucial role in advancing the climate transition in cities. For example, they can help reduce energy consumption (e.g. through smart meters, digital twins and carbon emission maps), facilitate a shift to renewable energy (e.g. through flexible and smart power grids), improve resource efficiency (e.g. through Building Energy Management Systems), optimise transport demand and nudge behavioural change (e.g. through ride-sharing applications) (OECD, forthcoming^[45]).

In addition, cities have distinct socio-economic characteristics that affect how climate policies are designed and implemented. For example, urban areas are characterised by a high concentration of buildings with limited space for nature. Therefore, as part of a city's climate strategy, green spaces can provide strong benefits of urban amenities to urban citizens. Similarly, the space constraint in cities poses specific challenges in terms of increasing clean power generation, although solutions such as the installation of photovoltaic panels and micro wind turbines in underutilised built-up areas may bring innovation to renewable energy production. Another important characteristic of cities is the cost of living and the affordability challenge, particularly in terms of housing. Cities also concentrate on low-income households. On climate mitigation, such characteristics may affect policy measures such as those aiming to promote compact urban development and decarbonise buildings, as these measures could face strong opposition if they create negative impacts on housing affordability, for example. Therefore, care must be taken to minimise such negative impacts when designing climate mitigation policies in cities.

On climate adaptation, people living in cities are exposed to climate shocks such as floods, storms and heat waves. As Chapter 3 demonstrates, cities are particularly affected by heat stress due to the urban heat island effect and are vulnerable to floods of large magnitude. Cities are also prone to sea level rise: by 2050, over 570 low-lying coastal cities are projected to face a sea level rise of at least 0.5 metres (C40 Cities, 2018^[46]). These climate shocks present a systemic challenge in cities of all sizes, with far-reaching consequences that span multiple policy sectors (Matsumoto and Ledesma Bohorquez, 2023^[19]). Coping with such challenges requires applying a “systems approach” that can help better identify, analyse and respond to complex challenges while recognising the social, economic and ecological aspects of our societies as part of an interconnected and constantly changing system.

Cities are understood as a “system” in the complex climate landscape. A systems approach thus offers urban policy makers a unique opportunity to understand and address the complexity of the urban climate

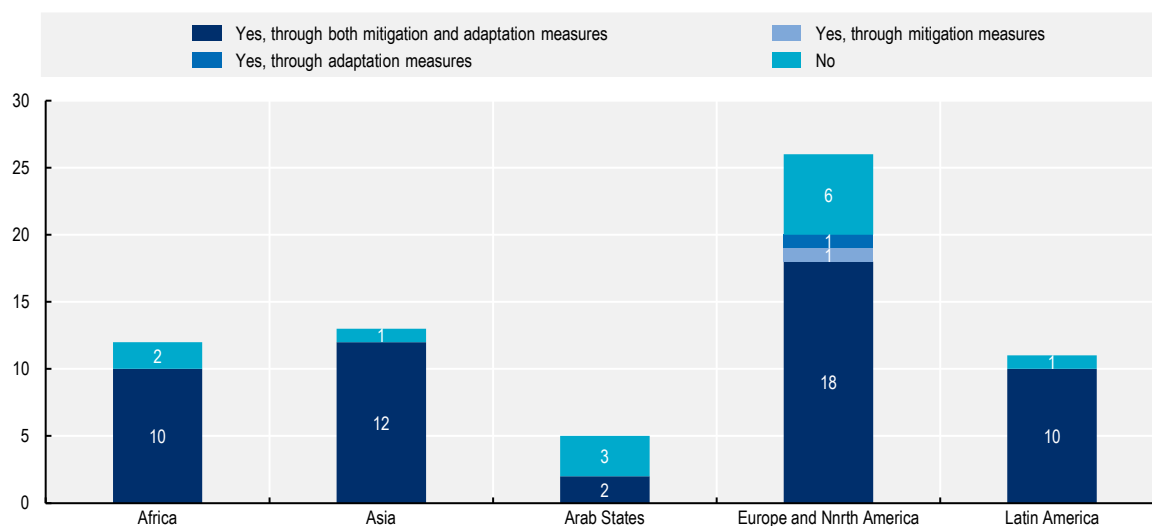
landscape. This approach can be highly effective by identifying untapped opportunities to maximise co-benefits and synergies and manage inevitable trade-offs across economic, social, environmental and other systems interacting in cities. However, national and subnational governments often lack concrete guidance to disentangle the different elements of complex systems in cities and how to approach them (Matsumoto and Ledesma Bohorquez, 2023^[19]).

National urban policy (NUP) plays a critical role in guiding sustainable urban development together with efforts to advance net zero and enhance resilience. While formulating a common vision and strategy for sustainable urban development, NUPs can also encourage and incentivise actions to advance the net zero transition and enhance climate resilience in cities. According to global monitoring of NUPs conducted by the OECD, UN-Habitat and Cities Alliance in 2021, most NUPs address both climate resilience and the low-carbon transition: 54 out of 67 responding countries (81%) report addressing climate change and almost all of them (52) do so via both mitigation and adaptation measures (Figure 4.2). This underscores the growing recognition of the need to apply an urban lens to climate change.

NUPs address climate change in different ways, as illustrated by a selection of country examples below:

- In **the Netherlands**, the 2019 National Strategy on Spatial Planning and the Environment (NOVI) highlights the importance of a climate-resilient, water-robust built environment, accompanied by sufficient, open, green and blue infrastructure to mitigate heat stress and store water. Maintaining such open space demands the densification of housing and employment within existing city boundaries. The Dutch strategy applies a spatial lens to its economic, social and environmental goals. The strategy developed by the Netherlands pays close attention to the different needs and priorities of urban and rural areas, as well as the demands and preferences of different groups within those communities. The strategy further differentiates Dutch regions by their energy intensity, economic structure and connectivity to local and global markets. This analysis underscores different opportunities in a low-carbon transition, particularly the scope to generate renewable power and adopt different transport modes.

Figure 4.2. Number of NUPs addressing climate change, by region, n = 67



Note: Data are drawn from the OECD/UN-Habitat/Cities Alliance National Urban Policy Country Survey 2020. Regional groupings follow the new regional groupings based on United Nations Standard Country and Area Codes (M49) Classifications and UN Habitat regional groupings which are reflected in the UN Habitat World Cities Report.

Source: OECD/UN-Habitat/Cities Alliance (2021^[47]), *Global State of National Urban Policy 2021: Achieving Sustainable Development Goals and Delivering Climate Action*, <https://doi.org/10.1787/96eee083-en>.

- In **Costa Rica**, the National Urban Development Policy 2018-2030 features “effective and efficient urban planning” as the first core pillar, focused on the importance of considering climate change and other environmental factors in a cross-sectoral way, specifically through three strategic areas: i) incorporating a range of environmental considerations in urban and territorial planning instruments; ii) improving the adaptation capacity of urban infrastructure to mitigate natural risks and threats such as those tied to climate change; and iii) promoting the construction and operation of urban buildings and infrastructure with a positive net effect on natural and urban environments (Case 9 in Annex 4.A).
- **Poland’s** National Urban Policy 2030 discusses extensively the challenges related to climate mitigation and adaptation in cities. To do so, it reviews existing climate-related indicators (i.e. accessibility to green areas, spatial distribution of fine particulate matter (PM_{2.5}), average increase in impermeable surfaces in urban areas, change in average annual air temperature) and delineates concrete actions to address climate-related risks. For example, it aims to introduce legislative reforms that raise the profile of blue-green infrastructure for future urban development (Government of the Republic of Poland, 2022^[48]) (Case 10 in Annex 4.A).
- In **Germany**, the Urban Development Support Programme – a historic national programme that provides financial support for investments in urban renewal and regeneration – was updated in 2022 to include climate mitigation and adaptation considerations in the eligibility criteria for the investments, in particular in relation to the improvement of green infrastructure (Case 11 in Annex 4.A).

The global monitoring of NUPs also found that countries are increasingly using NUPs to support the development of climate data and the use of fiscal instruments. Eleven NUPs (20% of responding countries in 2021) are linked to efforts to improve the evidence base for climate action by developing local GHG emission inventories and 10 NUPs (19%) are linked to carbon pricing and fiscal instruments to achieve climate objectives. Although such developments are not present in all NUPs, they indicate how NUPs guide non-traditional climate considerations in urban planning and pave the way for broader change (OECD/UN-Habitat/Cities Alliance, 2021^[47]).

The OECD Rural Agenda for Climate Action

Rural areas are key actors in accelerating the global transition to net zero. They are home to 30% of the OECD population and cover approximately 80% of the land mass of OECD countries. Against this backdrop, rural policies influence many of the activities that are essential in accelerating the transition to net zero, including land use, the deployment of renewable energy projects and circular economy strategies, amongst others. Of particular focus in this subsection is the OECD Rural Agenda for Climate Action (RACA) and its vision for sustainable mobility in rural areas. For instance, challenges for rural areas include addressing high GHG emissions from transport while ensuring that rural communities, markets and services remain accessible across expansive landscapes.

The OECD RACA underlines the pressing need for rural policies to accelerate actions towards net zero emission targets. Beyond the sole aspect of climate adaptation, the RACA envisions a thriving rural landscape that harnesses opportunities that the green transition offers, with an understanding of the unique characteristics, strengths and challenges of each rural region. It strives to chart a course for rural policies that align with overarching global climate objectives by exposing achievements and highlighting opportunities for further growth.

The RACA, which was endorsed by OECD member countries in November 2021 and discussed at the 2021 United Nations Climate Change Conference (COP26), calls for rural policies to play a more active role in achieving net zero GHG emission targets (OECD, 2022^[49]). It aims to take a holistic approach to ensure that rural regions make the most of new opportunities in the transformation towards net zero and environmentally friendly economies. To that end, the RACA highlights six policy areas that can be levers

to reach the twin objectives of rural development and the transition to a net zero carbon economy. It also promotes a long-term dialogue on how rural policies and relevant stakeholders can support the transition to net zero emission economies. Furthermore, it encourages countries, regions, and communities to better integrate rural development opportunities into broader national and subnational climate strategies.

The six policy areas of the RACA are the following:

- **Developing better indicators and information.** Strengthen the evidence base by collecting and consolidating regional and local data, assessing how opportunities and challenges related to climate change will play out in all kinds of rural areas.
- **Increase the capacity of rural places.** Empower rural regions to develop and implement effective transition strategies, ensuring they are involved and have sufficient enabling conditions (i.e. knowledge, institutional capacity, good governance, data, digital infrastructure and funding) to adapt and build resilience to climate change as well as ensure the uptake of climate change mitigation actions that can create win-win situations for rural development.
- **Renewable energy deployment.** Build on the competitive advantage of rural regions in producing renewable energy, establish local innovation ecosystems and link them to new initiatives such as green hydrogen production.
- **Ecosystem services.** Support the sustainable management of natural capital, sustainable land-management practices and value creation from restoring, preserving and enhancing ecosystems for rural development.
- **Circular and bioeconomy deployment.** Support the shift to a circular economy and bioeconomy that minimise environmental pressures and promote resource efficiency to offer opportunities for new rural business models and create new markets.
- **Sustainable mobility.** Contribute to decarbonising transport in rural regions by accelerating the transition to more sustainable and innovative mobility options.

Many OECD countries are making progress in these six policy areas. The RACA also aims to support OECD member countries in implementing and effectively using available funds. Examples of recent commitments that could accelerate the transition to net zero in rural areas include:

- The new EU Common Agricultural Policy (CAP) (2023-27) allocated EUR 387 billion over 7 years to support farmers and rural populations to contribute more decisively to tackling climate change, protecting the environment and moving to more sustainable and resilient food systems (EC, 2021^[50]).
- The United States Department of Agriculture (USDA) allocated over USD 914 million in 2022 to discretionary investments in climate-smart agriculture and forestry activities, as well as USD 564 million for clean energy activities across the United States (USDA, 2022^[51]).
- In 2023, the Australian Government and the Government of South Australia finalised a grant agreement of AUD 100 million to develop the Port Bonython Hydrogen Hub near Whyalla, South Australia, which will create regional jobs and increase Australia's renewable energy capacity (Prime Minister of Australia, 2023^[52]).

Within the scope of the RACA framework, improving sustainable mobility emerges as a pivotal axis for rural regions to reduce GHG emissions stemming from transport, given their higher per capita CO₂ emissions driven by higher usage of private cars and the lack of public transport in low-density areas. This requires policy makers in rural areas to take into account how people and goods move within broad rural landscapes and the potential implications of changes in transport policy on accessibility, community resilience and sustainable development.

Policy implications

Cities, or urban areas, have a substantial potential to drive the net zero transition forward but policy gaps and untapped opportunities remain. National urban policies can enhance their own effectiveness by seamlessly integrating climate action as a fundamental guiding principle in urban development and making sure future urban development is promoting the net zero transition and enhancing climate resilience.

Rural areas, often challenged by limited access to modern infrastructures, are essential in the global climate transition framework, yet face unique difficulties. Notably, rural regions contend with the ‘distance penalty,’ a significant factor that affects service delivery and sustainable development. This penalty manifests in increased pollutant emissions and difficulties in implementing sustainable mobility solutions, due to the longer distances and less advanced infrastructure typical of rural areas. Thus, a major climate-related concern in these regions is transportation, a sector responsible for high levels of greenhouse gas (GHG) emissions. National rural development policies play a key role in tackling the challenges. Rural areas also hold a deep connection with nature and possess untapped resources crucial for combating climate change and promoting sustainable growth. Addressing rural mobility is therefore not just about connecting communities; it's also a strategic approach to reducing overall transport sector emissions, while ensuring equitable access to markets and services. Table 4.10 outlines a set of recommended actions for both national and subnational governments to mainstream climate objectives in national urban, rural and regional development policies.

Table 4.10. Recommended actions to mainstream climate objectives in urban, rural and regional development policies

Category	For whom	Recommended action
National urban policies (NUPs), national rural development policies, national-level regional development policies	National	- Identify place-specific potentials and opportunities to drive the net zero transition forward and build climate resilience at the urban, rural and regional scales. - Delineate clear climate mitigation and adaption objectives and goals in NUPs, national rural development policies and national-level regional development policies which are aligned with the Paris Agreement goals.

Promoting climate action and resilience at the right territorial scale

Planning climate action and resilience at the metropolitan scale

Metropolitan areas concentrate a wide range of networks and services, housing, transport, water and other public services extending to the administrative boundaries of a single city. This offers a distinct opportunity to implement metropolitan strategies that promote an integrated approach across various sectors. By adopting metropolitan governance planning, cities can integrate land use, transport and housing with the objective of reducing urban sprawl, thus reducing GHG emissions and curbing the negative effects of urban sprawl on land use and biodiversity. In addition, metropolitan governance can play a pivotal role in addressing the fragmentation of tasks and responsibilities related to water management.

Despite the growing recognition of metropolitan governance as a tool for climate action, there is limited evidence on designing and implementing metropolitan strategies for climate action and resilience. A few leading practices on climate adaptation can still be highlighted in this field:

- In 2012, the Helsinki Metropolitan Area became one of the first metropolitan areas in the world to put together an adaptation strategy with input from all four cities of the metropolitan area (Helsinki, Espoo, Helsinki, Kauniainen and Vantaa) and with the support of the Helsinki Region Environmental Services Authority (HSY). More recently, the actions set by the strategy were updated as part of the Sustainable Urban Living Programme (prepared between 2019 and 2021) (HSY, 2022^[53]).

- In 2018, the Metropolitan Authority of Barcelona (Spain) adopted the Climate and Energy Plan of the Barcelona Metropolitan Area 2030, which integrates three pre-existing plans: the Carbon Management Strategy, the Roadmap for Energy Transition and the Climate Change Adaptation Plan. The plan proposes 43 adaptation measures, which include adapting buildings to extreme weather conditions, expanding green areas and improving ecosystem services. Its implementation spans the 36 municipalities of the metropolitan area, covering an area of 636 square metres (m²) and a population of around 3.2 million inhabitants (one of the biggest metropolitan areas in Europe) (Matsumoto and Ledesma Bohorquez, 2023^[19]).

Integrating transport and land use through transit-oriented development (TOD) in FUAs

Extensive built-up areas are associated with changes in land use patterns, resulting in challenges to carbon sinks, emissions and energy demand. As discussed in Chapter 3, in OECD metropolitan areas, there are significant variations in built-up area per capita, ranging from an average of 34 m² in Colombia to 484 m² in the United States. Built-up areas have also grown faster than populations in 90% of OECD cities, especially in Europe and the United States Midwest. Moreover, urban heat islands are more pronounced in metropolitan areas with over 250 000 inhabitants, as these areas experience an average temperature difference of 3 degrees Celsius (°C) compared to their surroundings, which is nearly twice that of cities with fewer than 100 000 inhabitants. In addition, the association of urban sprawl with car use has been established with socio-economic modelling and validated empirically in a series of econometric studies. The environmental relevance of the link between urban sprawl and private vehicle use is crucial, as vehicle kilometres translate into air pollution and GHG emissions. Theoretical work highlights two main channels through which urban development may translate to more vehicle kilometres and thus emissions: i) through changes in the spatial dispersion of residences, jobs and other key locations (e.g. shopping centres, schools); and ii) through changes in the modal split, i.e. the share of each transport mode in the total number of kilometres travelled (OECD, 2018^[54]). Indeed, due to high density, integrating low-carbon transport infrastructure investments (public transport, active transport with bike lanes and pedestrian paths) in urban development is a major opportunity for urban built-up areas/urban centres to drive the net zero transition. These challenges related to land use and transport do not stop at the borders of local authorities but extend to an entire metropolitan area, implying that policies at the metropolitan scale would be necessary to tackle them effectively.

Several OECD metropolitan areas have been deploying TOD approaches linked with climate and energy goals. Urban areas developed under TOD often consist of a centre with a public transit station, surrounded by high-density, mixed-use development with lower-density development gradually spreading outward from the centre. Another characteristic of TOD is that it facilitates access to local jobs and services. For that, land use is mixed and most residents have access to services and goods either on foot or by public transport (OECD, 2020^[55]; 2012^[56]). For example, in Canada, “Metro Vancouver 2040: Shaping Our Future” is the Regional Growth Strategy (RGS) that set a goal to reduce GHG emissions by 33% below 2007 levels by 2020 and 80% below 2007 levels by 2050. The strategy aims to stimulate growth in centres and transit corridors, promote working and playing close to home, encourage transit, cycling and walking, adopt green infrastructure; establish mixed-use transit-oriented communities and reduce vehicle kilometres travelled (Melchor and Lembcke, 2020^[57]) (Case 12 in Annex 4.A). Another example is Seoul, Korea, launching the Seoul Transport Vision 2030 in 2013, setting concrete goals to reduce transport CO₂ emissions from 1.2 tonnes in 2010 to 0.9 tonnes a year per capita in 2030, associated with an increase in green transport (public transport, walking, biking and zero tailpipe-emission vehicles) from 70% to 80% by 2030 (CLC, 2003^[58]).

Greening cities: Linking climate mitigation and adaptation in FUAs

Greening cities is one of the most desirable policy interventions as they have proved to be effective in linking mitigation and adaptation efforts. In this context, nature-based solutions (NbS) have emerged as a

key tool to help cities integrate nature into the urban fabric, generating multiple benefits. NbS aim to maintain, enhance and restore ecosystems to address a variety of social, economic and environmental challenges, including climate change and biodiversity loss. These solutions encompass a broad range of interventions, from green roofs and urban parks in cities to the restoration of watersheds, forests and degraded land. Well-planned, implemented and maintained NbS can provide key services to people – such as clean water and protection from flooding – with lower energy consumption and environmental impacts than their grey infrastructure equivalent. NbS can also yield co-benefits for the planet, such as increasing carbon storage, providing habitats for species and contributing to climate adaptation (OECD, forthcoming^[59]).

Cities across OECD countries have been securing and enhancing green areas in different ways related to their specific characteristics. Cities in Ireland, Norway, Switzerland and the United Kingdom include three times more green areas relative to their total land area than cities in Chile, Japan or Mexico. Cities with the highest share of green areas are mostly located in Central and Western Europe, on the American East Coast, Midwest and Northwest. In Chile, Japan, Spain and Türkiye, almost all cities, apart from a few coastal cities, have very scarce vegetation areas (Figure 4.3 and Figure 4.4). In per capita terms, cities located in the United States record the highest green area per capita with 300 m² per person, compared to 26 m² per person in Chile or Türkiye.

However, a large share of green areas does not necessarily ensure an equal distribution of public green spaces within a city and fair access for the urban population. On average, in FUAs' urban centres located in Finland and Luxembourg, around 95% of the population has access to a public green area of more than 1 hectare (ha) within 400 m distance. Among large metropolitan areas (metropolitan areas with more than 1.5 million inhabitants), Calgary (Canada) and Stockholm (Sweden) have the highest accessibility rate, as almost 95% of their population has access to such public green spaces. On the other hand, in Mexico and Türkiye, this rate falls under 40% (Figure 4.5 and Figure 4.6).

Cities have been implementing diverse measures to increase the size of and accessibility to green areas. Some key actions identified include the following:

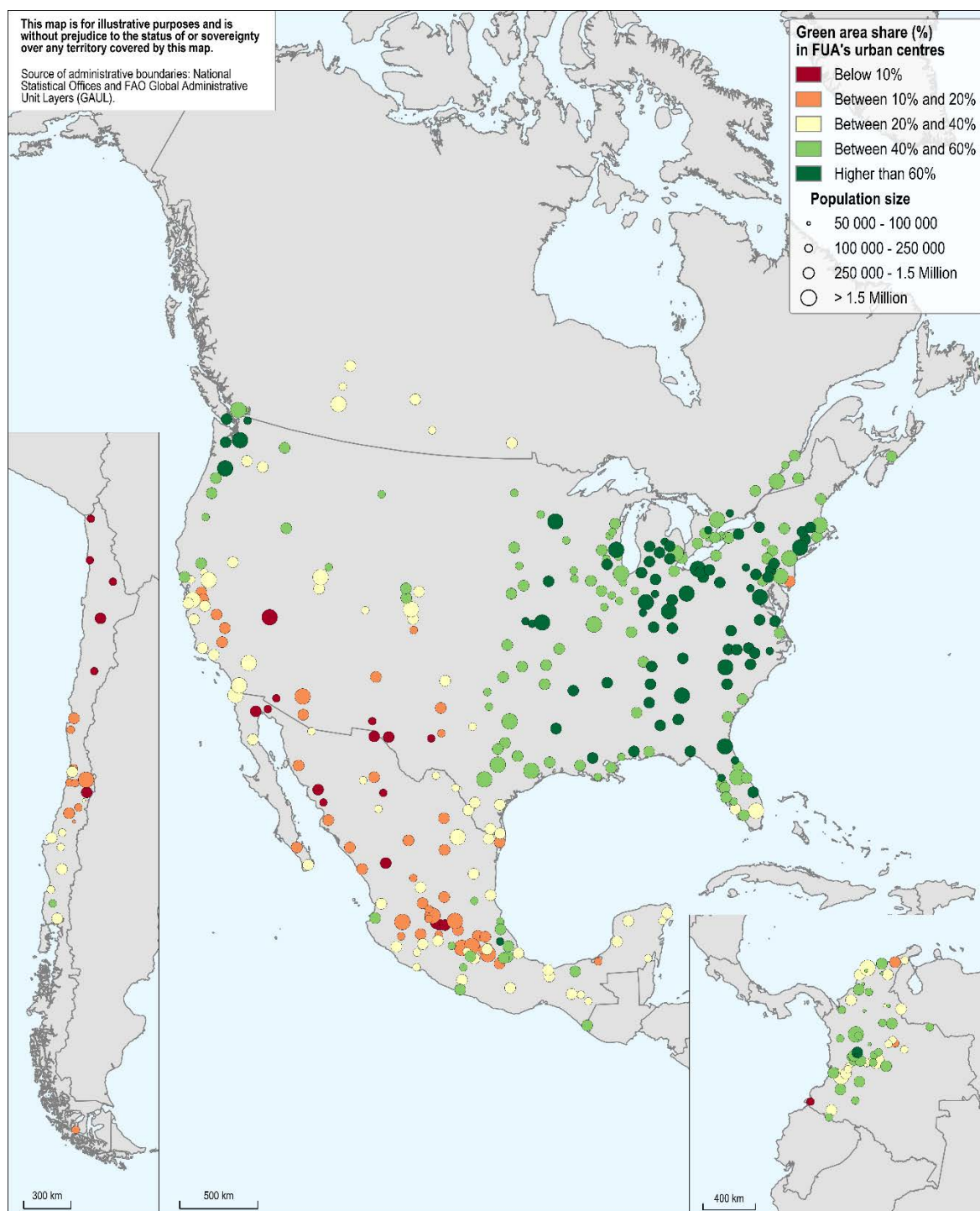
- **Innovative spatial planning tools.** For instance, Berlin (Germany), Malmö (Sweden) and London (United Kingdom) are using the Green Space Factor (GSF) to promote green spaces. The GSF offers a planning tool to ensure a designated amount of vegetation within residential courtyards. GSF schemes work by assigning a factor between 0 and 1 for various surface cover types, with sealed surfaces corresponding to 0 and the most natural cover to 1. To calculate a GSF for a site, the factor for a particular surface cover is multiplied by its area. This is repeated for each surface cover type. The multiplied sums are added and then divided by the overall site area to give an overall GSF score for a site between 0 and 1 (City of Malmö, 2023^[60]; The Ecology Consultancy, 2017^[61]).
- **Regulatory and planning frameworks to expand green areas.** For example, the city of Seoul (Korea) and the city of Toronto (Canada) have mandatory green roof regulations. Toronto requires all new developments that are greater than 2 000 m² in gross floor area to construct green roofs over 20-60% of the available roof space (City of Toronto, n.d.^[62]). Similarly, the Green Roof Campaign in Basel, Switzerland, uses regulation and tax incentives to promote the installation of flora on roofs, which fosters cost-saving and richer biodiversity (Case 13 in Annex 4.A). The city of Copenhagen, Denmark, is increasing green spaces to enhance water retention as part of the Cloudburst Management Plan (Case 14 in Annex 4.A). The city of Lisbon, Portugal, is aiming at creating a water retention and drainage network, linked with the provision of green infrastructure with minimum water needs (Case 15 in Annex 4.A).

National governments often enforce such regulatory frameworks. For instance, the United Kingdom's Environment Act 2021 mandates a "biodiversity net gain" to ensure that each development leaves biodiversity in a measurably better state than before the development took

place. The mandatory biodiversity net gain requires development to deliver more for nature; setting a nation-wide requirement to increase biodiversity by a minimum of 10% compared to the baseline. This means that there will be more and better-quality places for wildlife to live and thrive and for people to enjoy (Case 16 in Annex 4.A).

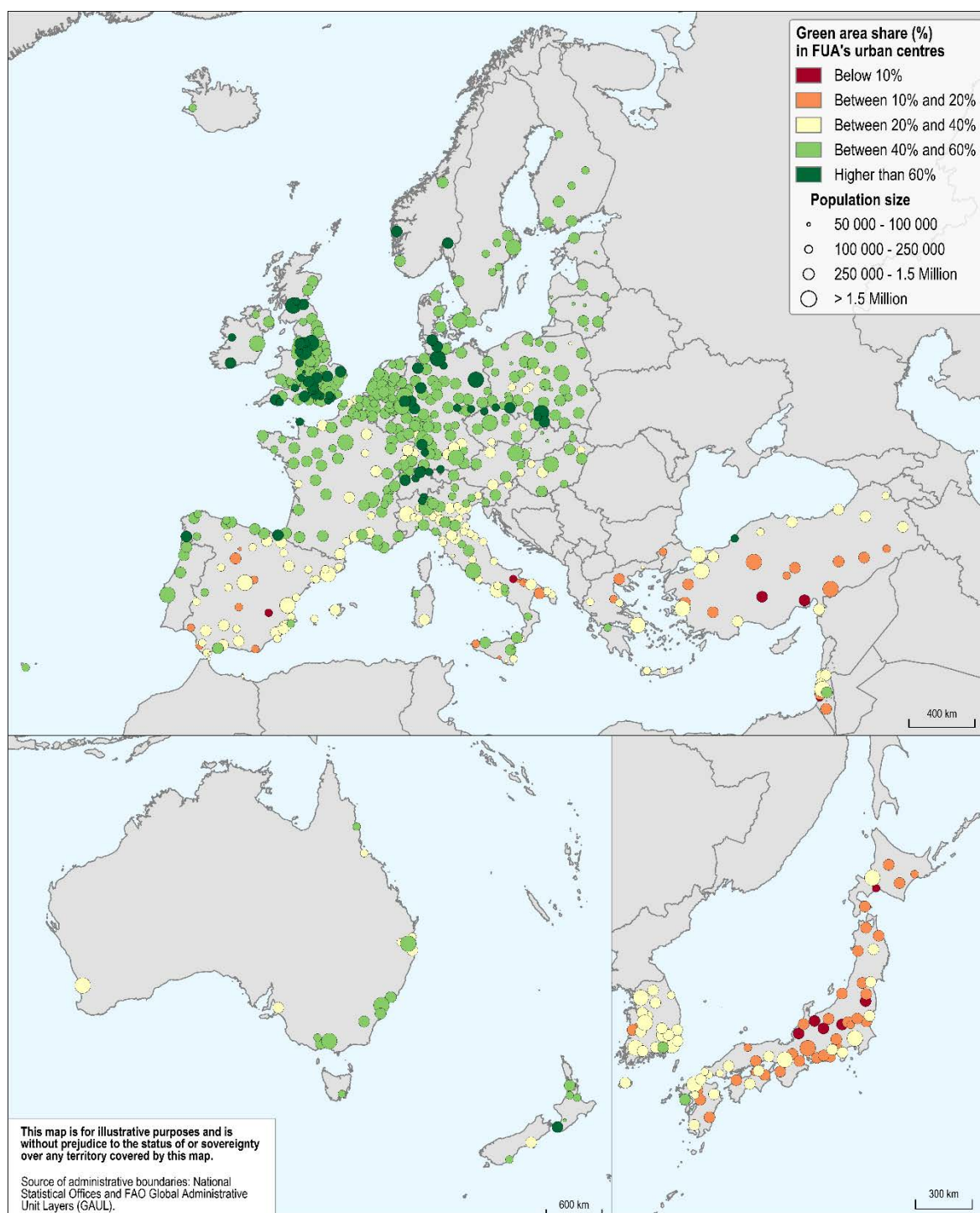
- **Setting targets for the expansion of urban green areas.** For instance, the city of Freetown, Sierra Leone, is implementing the Freetown the Treetown initiative that aims to plan and grow 1 million trees and restore 3 000 ha of land, sequestering approximately 69 000 tonnes of CO₂. The initiative uses innovative, disruptive and low-cost digital technology for tree tracking. It also creates new jobs for women and young people in green sectors, as every tree has been assigned a unique identification code that can be transformed into “impact tokens” and sold as carbon offsets (Case 17 in Annex 4.A). Similarly, the city of Barcelona, Spain, has set a goal to expand its green areas by 1.6 km² by 2030. As of 2019, the city offers an estimated 17.50 m² of green areas per inhabitant. The proposed target seeks to increase this allocation by an additional 1 m² per person. Furthermore, the city has set an objective to enhance tree coverage by 5% by 2037 and establish 10 biodiversity refuges. These goals are incorporated in the city’s Climate Plan 2018-2030 and accompanied by concrete measures to achieve the goal, such as identifying areas that are in greater need of green areas due to their specific climate and spatial factors (e.g. high temperatures, intense use of public spaces) (Case 18 in Annex 4.A).

Figure 4.3. Share of green areas in functional urban areas (FUA's) urban centres, 2020, Americas



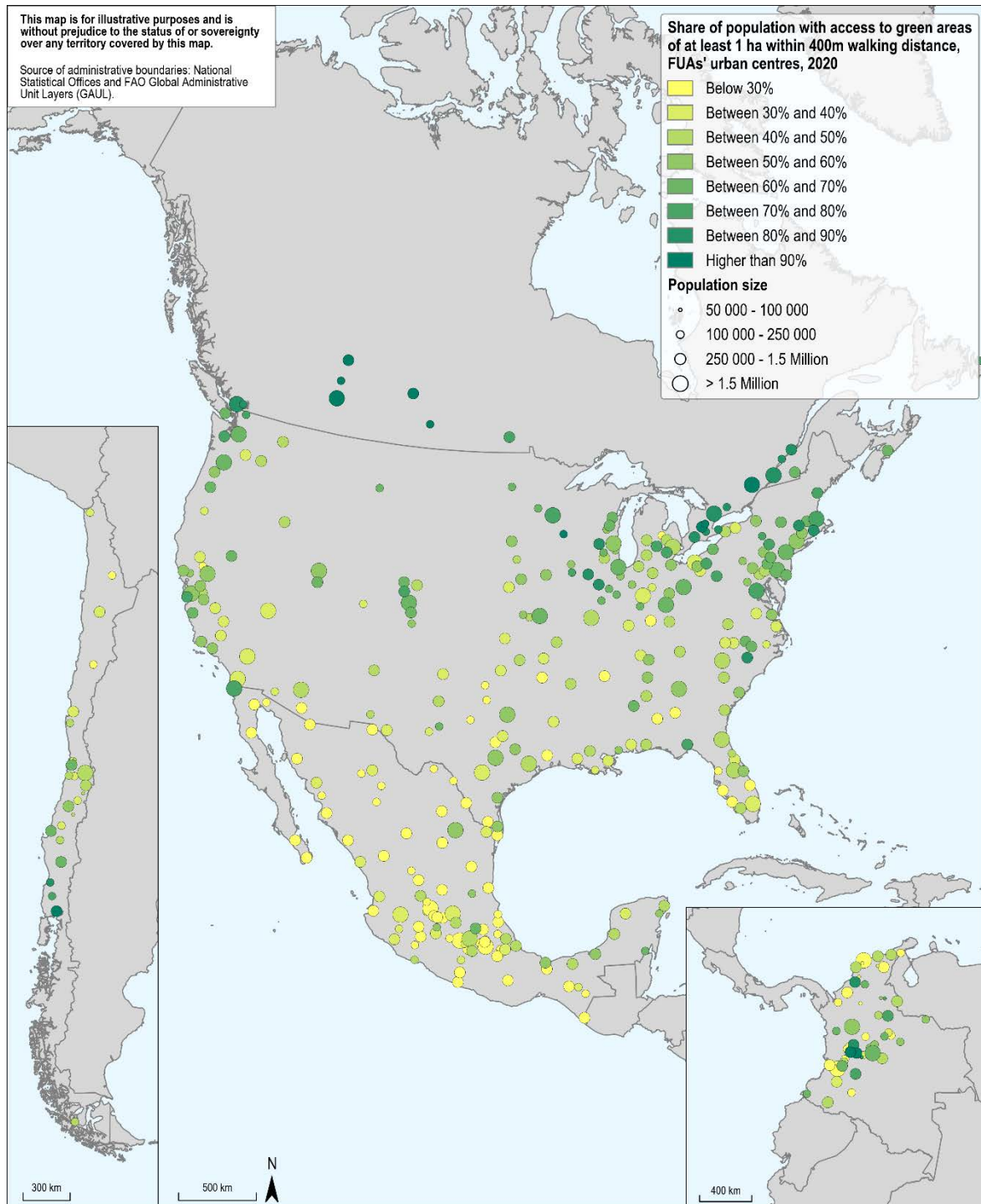
Source: OECD (2022^[63]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; based on Zanaga, D. et al. (2021^[64]), *ESA WorldCover 10 m 2020 v100*; Florczyk, C. et al. (2019^[65]), *GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes, R2019A*, <https://data.jrc.ec.europa.eu/dataset/53473144-b88c-44bc-b4a3-4583ed1f547e>.

Figure 4.4. Share of green areas in functional urban areas (FUA's) urban centres, 2020, Europe, Asia, Pacific



Source: OECD (2022^[63]), *OECD Regions and Cities at a Glance 2022*, <https://doi.org/10.1787/14108660-en>; based on Zanaga, D. et al. (2021^[64]), *ESA WorldCover 10 m 2020 v100*; Florczyk, C. et al. (2019^[65]), *GHS Urban Centre Database 2015, Multitemporal and Multidimensional Attributes*, R2019A, <https://data.jrc.ec.europa.eu/dataset/53473144-b88c-44bc-b4a3-4583ed1f547e>.

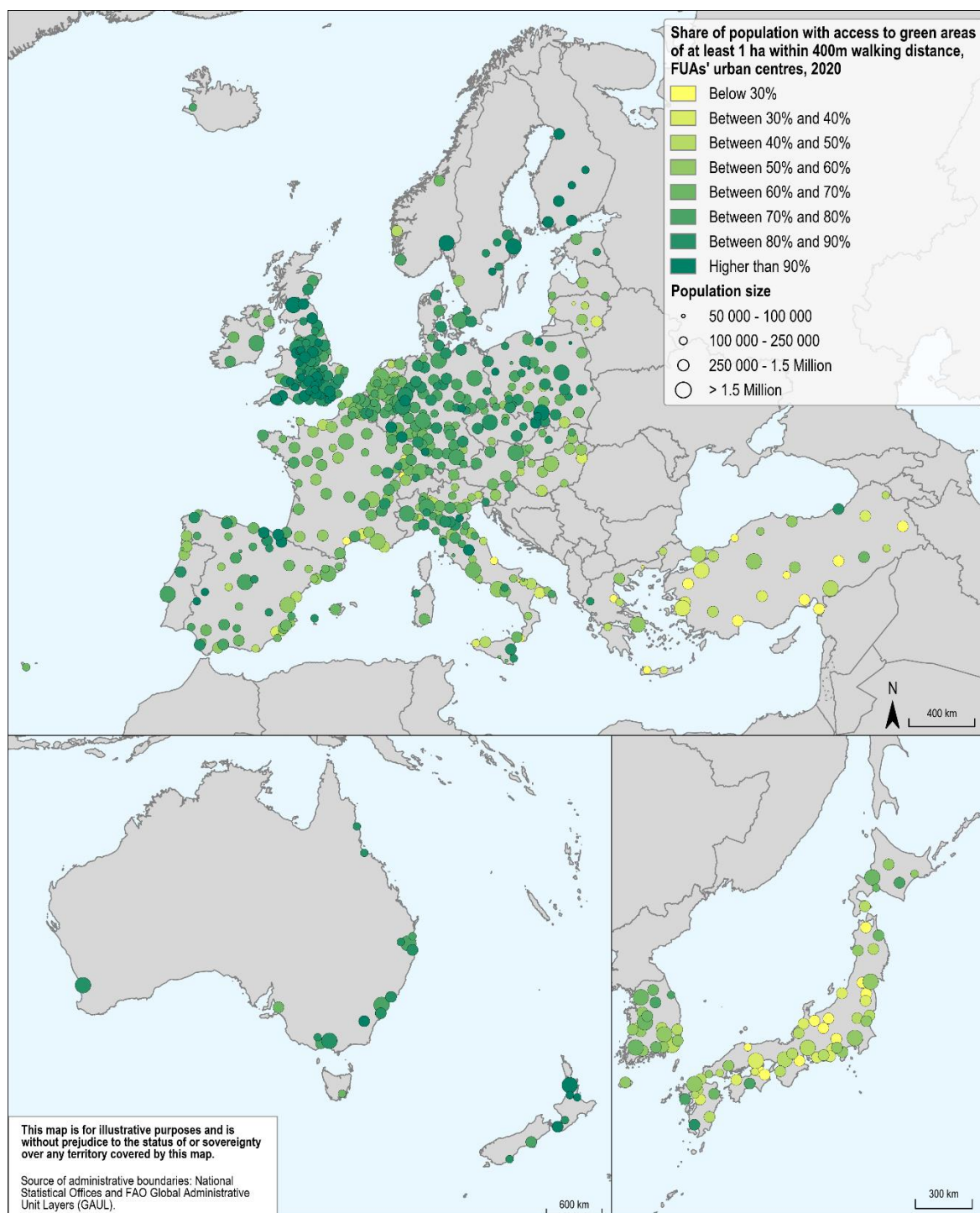
Figure 4.5. Accessibility to green areas, 2020, Americas



Note: Urban green space corresponds to the following tags in OSM: amenity: grave_yard; landuse: cemetery, forest, recreation_ground, village_green; leisure: nature_reserve, park, playground, recreation_ground, garden; tourism: zoo; natural: wood, scrub, heath, grassland, wetland.

Source: Methodology based on Poelman, H. (2018^[66]), "A walk to the park? Assessing access to green areas in Europe's cities", *DG Regional and Urban Policy Working Paper*, using OpenStreetMap (2023^[67]), *Planet Dump*, <https://planet.osm.org> (accessed on 6 July 2023), to get urban green spaces and Schiavina, M., S. Freire and K. MacManus (2022^[68]), *GHS-POP R2022A - GHS Population Grid Multitemporal (1975-2030)*, <http://data.europa.eu/89h/d6d86a90-4351-4508-99c1-cb074b022c4a>.

Figure 4.6. Accessibility to green areas, 2020, Europe, Asia, Pacific



Note: Urban green space corresponds to the following tags in OSM: amenity: grave_yard; landuse: cemetery, forest, recreation_ground, village_green; leisure: nature_reserve, park, playground, recreation_ground, garden; tourism: zoo; natural: wood, scrub, heath, grassland, wetland.

Source: Methodology based on Poelman, H. (2018^[66]), "A walk to the park? Assessing access to green areas in Europe's cities", *DG Regional and Urban Policy Working Paper*, using OpenStreetMap (2023^[67]), *Planet Dump*, <https://planet.osm.org> (accessed on 6 July 2023) to get urban green spaces and Schiavina, M., S. Freire and K. MacManus (2022^[68]), *GHS-POP R2022A - GHS Population Grid Multitemporal (1975-2030)*, <http://data.europa.eu/89h/d6d86a90-4351-4508-99c1-cb074b022c4a>.

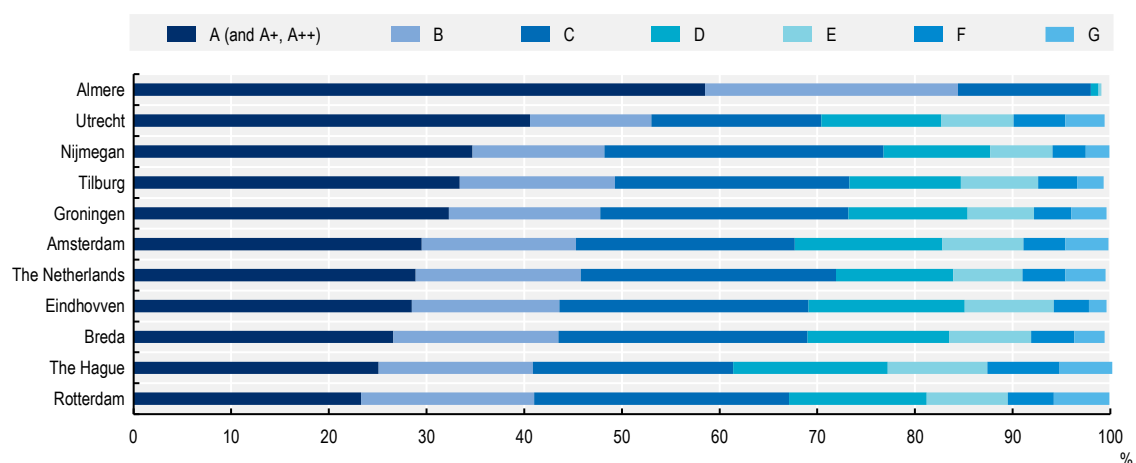
Decarbonising buildings while addressing the affordability challenge in urban areas

Buildings are a major source of final energy consumption in urban areas. In 2021, buildings accounted for 33% of global energy-related and process-related CO₂ emissions (8% from the use of fossil fuels in buildings, 19% from the generation of electricity and heat used in buildings and 6% from the manufacture of materials used in buildings construction) (IEA, 2022^[69]).

In most countries, national governments oversee the process of setting a framework for energy efficiency investments, including building standards. However, local actions are critical for decarbonising buildings due to the heterogeneity in local conditions. Buildings are local infrastructure by definition and reflect different ways in which the population takes shelter from local weather conditions. Houses in colder regions generally have better-insulated walls, while those in hotter areas have features such as long eaves to minimise exposure to heat (OECD, 2022^[70]). Considering the heterogeneity of local climate conditions, local building stock and other factors can lead to a wide range of technically and economically viable pathways to building decarbonisation (OECD, 2023^[71]).

However, the weather difference only partially explains the pressing need for local actions to decarbonise buildings. The energy label of building stock also differs across cities and regions. For instance, among the ten largest municipalities in the Netherlands in 2022, Almere had the highest share of homes within the range of the A to A++ energy performance certificate level (about 60% of the local housing stock), whereas Rotterdam had the lowest share (less than 25%) (Figure 4.7).

Figure 4.7. Breakdown of residential buildings in the ten largest Dutch municipalities, by energy label, 2022

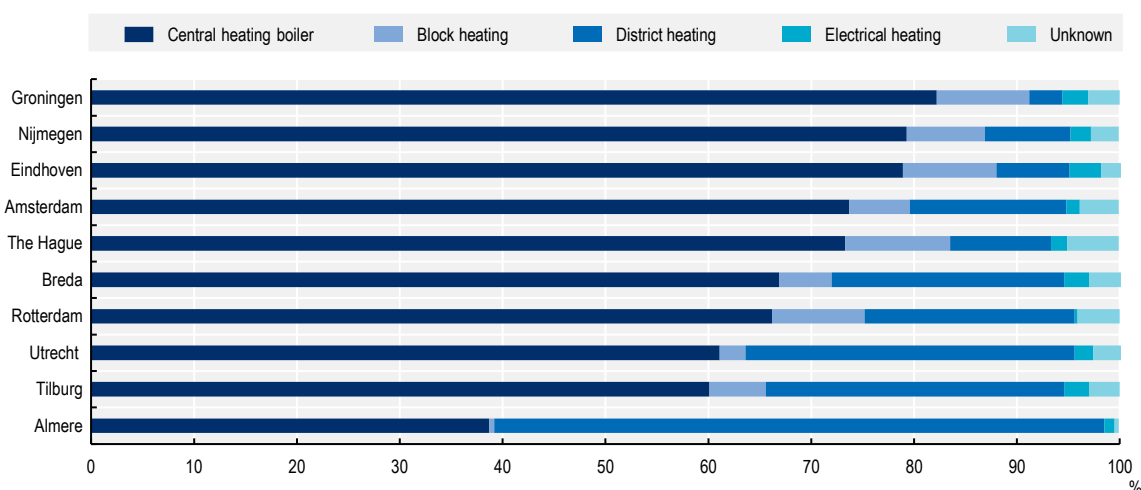


Source: OECD (2023^[71]), "Decarbonising homes in cities in the Netherlands: A neighbourhood approach", <https://doi.org/10.1787/b94727de-en>.

Furthermore, the heating system differs across cities and regions. Figure 4.8 shows the share of heating systems in the top largest municipalities in the Netherlands and reflects the diversity across territories – despite the small sample – in terms of the share of central boilers and district heating. Moreover, the availability of local heating sources plays a vital role in shaping sustainable heating solutions. For instance, concerning district heating, certain municipalities, including Deventer, Rotterdam and Schiedam are close to facilities such as wastewater treatment plants or ports that can supply residual heat. Meanwhile, in other municipalities, such as Leusden, there is no readily accessible local heat source that they can use for district heating. Therefore, the municipalities with no possibility of residual heat need to seek other sustainable heating options such as heat pumps or renewable energy heating (OECD, 2023^[71]).

Figure 4.8. Heating systems used in the ten largest (by population) municipalities in the Netherlands

Breakdown by type of heating system in each municipality



Source: Drawing on data from CBS (n.d.^[72]), *Woningen; hoofdverwarmingsinstallaties, regio* (Homes; Main Heating Installations, Region), <https://opendata.cbs.nl/statline/?dl=2238E#/CBS/nl/dataset/84948NED/table?ts=166299810934>.

Recognising these locally specific conditions, cities are adopting innovative policy instruments to decarbonise buildings, some of which are combined with renewable energy generation. Major policy practices are the following:

- In 2010, Tokyo, Japan, introduced an urban cap-and-trade programme, one of the first of this kind in the world, including mandatory targets for Tokyo's biggest emitters, namely commercial buildings and industrial facilities. All facilities covered by the programme successfully met their targets for the second compliance period (2015-19), achieving a 15-17% reduction below 2000-level emissions. By 2020, emissions had dropped by 33% below base-year levels, propelling the city towards its goal of climate neutrality by 2050 (OECD, 2020^[73]; ICAP, 2020^[74]).
- As of 2022, more than 1 300 cities had adopted renewable energy targets and/or policies, with nearly half of them setting the target year as 2030. These cities are actively undertaking measures to fulfil their commitments. For example, in 2019, the city of Valencia, Spain, inaugurated its first energy office. The energy office engages in various activities aimed at raising awareness of renewable energy among citizens. It offers information and training on topics such as energy bills, energy efficiency, home renovation and the right to energy and renewable energy generation. Thanks to these services, it is estimated that citizens have managed to save an average of EUR 226 per year (Covenant of Mayors - Europe, 2022^[75]).
- In New York City, United States, under Local Law 97, buildings over 25 000 m² will be required to meet new energy efficiency and GHG reduction standards by 2024, with stricter limits coming into effect in 2030. The goal is to reduce the emissions from the city's largest buildings by 40% by 2030 and 80% by 2050. The law also established the Local Law 97 Advisory Board and Climate Working Groups to advise the city on how best to meet these aggressive sustainability goals (City of New York, n.d.^[76]).

A major challenge of decarbonising buildings, in particular decarbonising homes, is associated with the upfront cost of energy efficiency investment, particularly for low-income households. Different local conditions encompass different levels of energy poverty and human resources dedicated to sustainable building measures. In particular, energy poverty is a pressing concern in many regions. According to the OECD Survey on Decarbonising in Cities and Regions, 89% of cities and regions recognise the significance of lowering energy costs for low-income families through building energy efficiency (OECD, 2022^[70]). However, the initial investment required for energy-efficient upgrades may increase housing expenses for these vulnerable households. To overcome this challenge, British Columbia, Canada, offers a free energy assessment, installation of energy-saving equipment and personalised energy efficiency advice for low-income households (EERE, n.d.^[77]). Such an incentive programme allows cities to pursue sustainability goals while ensuring housing affordability, as energy-efficient improvements not only reduce carbon emissions but also enhance living conditions and residents' overall well-being. Effective measures to decarbonise measures thus require: i) better understanding of local building stocks; ii) identifying solutions that address the local specificities; and iii) mobilising local actors (including local constructors, communities etc.) to implement the solutions. Many cities and regions are equipped to factor in such local elements and leverage their policy authority over buildings.

Managing water through metropolitan arrangements

As discussed in Chapter 3, metropolitan areas with high population density around rivers and coastal zones are also particularly susceptible to significant floods. For example, Rotterdam in the Netherlands is the most exposed OECD metropolitan area with more than 1.5 million inhabitants in terms of river flooding, as more than 60% of its population is at risk, followed by Nagoya in Japan and Hamburg in Germany.

In most cases, hydrological boundaries cut across city administrative perimeters, calling for a functional approach to water management. Further efforts are needed to foster greater co-operation between cities and their hinterlands, and among cities of a given metropolitan area. The scale at which water is managed depends on the function: it can be at the local or metropolitan level for drinking water and sanitation; at the sub-basin or basin level for water resources management or at higher levels for flood protection. As functional geographies depend on the function in question, in the case of water resources management, appraising the metropolitan and hydrological logics is the key to addressing linkages between urban areas (where most people live) and the surrounding environments (rural and watersheds) that sustain them (OECD, 2016^[78]).

Metropolitan governance can pool resources and capacity at a critical scale for effective water management. Several cities have developed metropolitan governance arrangements for water management. For instance, Glasgow, United Kingdom, has implemented the Metropolitan Glasgow Strategic Drainage Partnership to gather local authorities and national agencies to address the risks of flooding and improve water quality. Similarly, the Metropolitan Authority of Barcelona, Spain, has fostered an integrated perspective across local governments as well as shared infrastructure and expenses, while Nantes Métropole, France, has been engaging stakeholders to improve local services (OECD, 2016^[78]). More recently, the state of Jalisco, Mexico, launched the Agenda for Water Resilience for the Metropolitan Area of Guadalajara. The strategy was designed collectively by the 9 municipalities that compose the metropolitan area, covering an area of 742 km², the country's second-biggest metropolitan area. The strategy combines actions at the drainage basin and urban area scale and identifies a set of projects to increase water resilience. It aims to strengthen water management so that it can face the effects of climate change and the socio-economic challenges that put at risk the sustainable access of the population, the agricultural sector and industry to water resources (Matsumoto and Ledesma Bohorquez, 2023^[19]).

Tackling sustainable mobility in rural areas

Addressing sustainable mobility is an important focus for rural areas in reducing GHG emissions to meet net zero targets and ensuring equitable access to markets and services across vast landscapes. On a per capita basis, transport is a primary source of emissions in rural regions (Figure 4.9). While the vast amount of land and other characteristics of rural places are important drivers of biodiversity and carbon sequestration, they can also present bottlenecks to sustainable mobility. Rural regions, by definition, lack population density. They are often defined by their degree of accessibility to metropolitan regions or remoteness and peripherality. In sum, they share three distinct features:

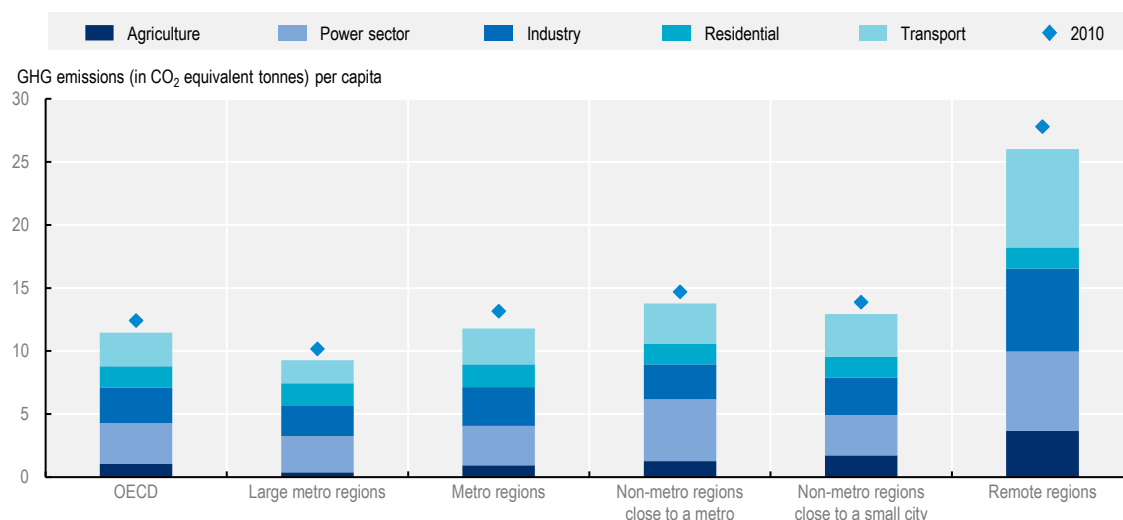
- **Physical distance to major markets.** Distance increases travel times and shipping costs, which must be borne by the buyer (in the form of higher prices) or seller (in the form of lower margins).
- **Economic connectedness.** A lack of economic integration not only reduces current trade opportunities but also the ability of agents in a place to identify new opportunities. Thus, there are both static and dynamic associated costs.
- **Degree of specialisation or lack of critical mass.** Production is concentrated in relatively few sectors since achieving “critical mass” in more than a few activities is impossible. A narrower economic base implies greater vulnerability to sector-specific shocks, whether positive or negative.

In this context, rural places have “low-density economies”, which tend to specialise in niche markets (e.g. tourism) or those linked to natural resources (e.g. agriculture, mining, forestry, etc.) with often capital-intensive forms of production. Geographical features and settlement patterns set rural areas apart from urban areas, as they differ in terms of local workforce size, sensitivity to transport costs, level of competition with similar regions, and reliance on innovations developed elsewhere. Although these characteristics pre-condition feasible forms of mobility, there is an urgent need to transform emission-intensive activities in rural regions into environmentally friendly and net zero alternatives. Indeed, available data confirms that emissions per capita are, on average, higher in rural regions, with the remote rural regions’ contribution to total emissions being the largest in transport and industry (Figure 4.9):

- Average emissions per capita in OECD countries in 2018 were 3 times higher in remote rural regions (26.3 tonnes of CO₂ per capita) compared to large metropolitan regions (9.3 tonnes of CO₂ per capita).
- Remote regions, home to about 8% of the OECD population, contributed 17% of total GHG in the OECD in 2018. In the same year, non-metropolitan regions, which are home to 28% of the population and include regions close to large metropolitan regions, small and medium-sized cities and remote regions, contributed 40% of total GHG in the OECD.
- In many OECD countries, including Chile, Finland, Germany, the United Kingdom and the United States, rural regions have the highest emissions per capita, often driven by the lack of sustainable alternatives and the demand of metropolitan areas for power generation, mineral extraction and agricultural production.

This illustrates the extent of economic activity transformations required in rural regions, especially in transport, mobility and industry, where emissions are highest. Rural regions have some commonalities, including smaller administrations, lower capacity to manage transitional processes, attract funding and develop effective strategies to mitigate and adapt to climate change. Nevertheless, not all rural regions are alike, with different sub-types of rural regions necessitating different policy responses. In broad terms, the Rural Well-being Policy Framework (OECD, 2019^[79]) identifies three types of rural regions, each with stark structural differences and distinct challenges and opportunities: i) rural inside FUAs; ii) rural close to cities; and iii) remote rural.

Figure 4.9. GHG emissions per capita by type of region, 2018



Note: OECD countries, Bulgaria and Romania. GHG emissions, excluding emissions from land use and land use change.

Source: Calculations based on EC (2020^[80]), *EDGAR - Emissions Database for Global Atmospheric Research*, Joint Research Centre, European Commission.

Taking into account this diversity can help shape policy responses for the transition to a net zero emission economy that ensure the accessibility of transport in all rural areas. For example, rural regions inside FUAs and rural places close to cities have much stronger linkages between transport networks, commuting flows, spatial planning and the provision of goods and services. These rural places can also benefit from good access to markets, services and agglomeration of talent present in urban areas. Multimodal transport can help integrate rural regions into the local labour market of cities and enable residents to move around by using a combination of walking, cycling and public transport. Multimodal transport infrastructure can also support a greater variety of job opportunities. Multimodal transport can increase affordability and add options for people who are unable to drive (i.e. elderly, people with disabilities and youth) (OECD, 2021^[81]). Well-designed multimodal transport requires integrating different modes of transport and facilitating the switch between transport modes. Unique ticketing systems and other accommodations for travellers, such as public transport vehicles with space for bikes or scooters, can favour these systems.

In contrast, remote rural regions are much more dependent on private car use. This is also partly driven by the low-density and dispersed settlement patterns that lack the critical mass needed to deploy cost-effective public transport networks. Long distances and low ridership make it difficult to offer public transport options that are quick, reliable, affordable and efficient enough to attract rural consumers without requiring large-scale public subsidies.

Rural remote regions are also disproportionately vulnerable to national policies such as increasing taxes on fuel to disincentive car use. Thus, differential taxation of car usage, depending on whether it takes place in rural or urban areas, can help mitigate this asymmetric impact. Solutions will also need to focus on net zero engines and technological innovations to reduce emissions and on-demand transport and pooling solutions.

In some cases, classic modes of public transport become uneconomical as regions undergo demographic change (De Jong et al., 2011^[82]). On-demand pooling can help address this challenge while securing an important public service for the local population. Open data and mobile information platforms are rapidly changing the options available when it comes to public transport provision in rural areas; this holds particularly true for the rise of big data (Box 4.1). Big data can indeed help deliver demand-responsive transport (DRT) to meet public transport needs in rural areas. There are essentially two models of DRT:

door-to-door or predefined pick-up and drop-off points, with service provided only if there is demand. Several examples of deploying DRT include:

- In Spain, on-demand pooling transport services have been introduced in the municipalities of Sant Cugat del Vallès and Vallirana (Case 19 in Annex 4.A). The services replace former regular services by introducing a technological pooling platform, with positive results in terms of occupancy and cost. In Sant Cugat, the average occupancy of vehicles increased from 6 passengers per trip to 16 with the new service and the flexible service's operational costs are 15% lower than the former conventional line (OECD, 2021^[81]).
- In the Czech Republic, Radiobus operates like a conventional bus in that it has a regular timetable but it runs only when users confirm demand (by phone or Internet) and only on the part of the route required (OECD, 2016^[78]) (Case 20 in Annex 4.A).

Information and communications technologies are used to adapt collective transport routes, stops and timing to the actual needs of customers. In addition to working well in sparsely populated areas or at periods of low demand, such schemes can operate effectively in denser areas to meet the needs of specific groups that are dispersed among the general population, such as the elderly or people with disabilities. Local transit authorities may fully or partially fund DRT schemes, as they are often providers of socially necessary transport and may be selected by public tender. However, these schemes can also be funded privately, operate with a profit motive or through community-operated non-profit enterprises.

Box 4.1. Big data and public transport provision

Big data hold much promise for improving the planning and management of transport activity by radically increasing the amount or near-real-time availability of mobility-related data. Transport authorities will need to ensure an adequate level of data literacy for handling new streams of data and novel data types. Traffic operations, transport planning and safety are areas where authorities must critically evaluate where and how new or newly available data and data-related insights can improve policy.

Big data can help governments, businesses and individuals make more informed decisions. Better data can help transport authorities understand commuters' behaviour, provide targeted information and identify policy interventions. In fact, the biggest gains from using big data may come from changing user behaviour. From the government's perspective, there is a need for better data to support decision making, at least for the following purposes:

- Better understanding the demand (needs by different user groups).
- Better planning services to match user needs.
- Making the market case for privately operated services (profitability).

Source: OECD/ITF (2015^[83]), *International Experiences on Public Transport Provision in Rural Areas*, https://www.itf-oecd.org/sites/default/files/docs/15cspa_ruralareas.pdf.

Municipalities in Japan are also active in this sphere. Indeed, on-demand buses have operated in Japan since the 1970s (Takeuchi et al., 2003^[84]). What has changed in recent years is technology and uptake. Computer-assisted scheduling, routing, and dispatching have made operations much more efficient, while mobile applications have made such services far easier for users. In response to these changes and in an effort to deal with pressure on public transport services, Japanese municipalities have increased their DRT provision. Between fiscal years 2006 and 2013, the number of DRT schemes nearly doubled (OECD, 2016^[78]), with more than 200 municipalities offering on-demand bus services of three types:

- The first are essentially bus services with fixed routes that operate only based on customer demand.
- The second involves some flexibility along a fixed route in response to customer demand.
- The third involves a much freer route, based on customers' demand for pick-up and drop-off; since the area of operation is defined and the number of customers is small, the operator selects the route that minimises inconvenience to passengers.

In addition, ride-sharing services allow door-to-door service with no fixed routes or stops in certain areas. For example, the Migon shared taxi service around the Tohkadai Newtown in Komaki (Aichi Prefecture) is based on flat rate fares, shared rides, limited area of operation and door-to-door service.

A number of Japanese locales have shown how identifying service levels based on customer needs can help plan the supply so as to meet actual demand. Such customer-based planning has resulted in the revitalisation of several public transport services in Japan, resulting in increased numbers of users. In some places, the local private sector has also been involved in designing routes and financing initiatives in co-operation with local authorities. For example, Hidakagawa-cho (Wakayama Prefecture) has integrated its bus routes with shared taxis, allowing variation in vehicle size depending on demand at different times, as well as enhanced feeder services and greater frequency. Niseko-cho in Hokkaido has integrated the routes of private buses, municipal welfare buses and school buses (OECD, 2016^[78]). The buses stop on demand and there is some variation of routes at times of peak demand (e.g. early morning school runs). The resulting increase in frequency and reliability then led to an upward trend in use by the general public. In a number of places, community bus services now operate on a not-for-profit basis, sustained partly by fares but with support from municipal budgets and, most importantly, local businesses along the routes.

Car- and ride-sharing programmes are also widespread and growing fast. While this is often seen chiefly as an urban phenomenon (and matching is certainly easier where passenger and vehicle densities are higher), it can also work very well in rural areas, particularly for key routes to and from centres of employment or essential services. By the beginning of 2014, it was estimated that almost 500 000 Japanese had registered for car-sharing services and the numbers were rising fast, with private companies entering the market alongside municipalities, which in some cases have launched services of their own or in collaboration with private firms, in an effort to make better use of their official vehicle fleets.

Deploying electric vehicles (EVs) can also help deliver sustainable forms of mobility and will require investments in charging infrastructure, especially in rural regions. While new electric cars typically offer ranges of 800 km or higher, the lack of charging stations can pose barriers to rapid EV adoption. Most governments continue to provide financial incentives to increase demand rather than invest in charging infrastructure (ITF, 2019^[85]). In rural regions, the dispersed nature of residences and infrastructure requires recharge points to be placed strategically, for instance, at supermarkets and schools. Governments also need to consider increasing demand for total electricity with increasing market penetration of EVs, which calls for more co-ordinated charging and local reinforcements of grids. A leading example of investments in EV infrastructure can be found in Southern Alberta, Canada. In the province, civil society groups, local businesses and local and regional governments collectively invest in EV charging infrastructure to facilitate emission reductions, economic development and tourism. The project has installed 22 charging stations powered using renewable energy sourced from the region (Peaks to Prairies, 2019^[86]).

Green hydrogen production can offer rural regions specialised in renewable energy an opportunity for economic development. Many rural economies require heavy-duty transport, including trucks, maritime and aviation, to export their tradeable goods. At the same time, projections see road freight activity at least doubling by 2050, offsetting efficiency gains and increasing road freight CO₂ emissions (ITF, 2018^[87]). Green hydrogen can be used to produce alternative fuels for heavy-duty transport and decarbonise industrial processes at the same time. The first hydrogen-fuelled trucks have recently been put onto the road and governments have started to invest strategically in this technology. In March 2023, the Marubeni Corporation launched the first green hydrogen injection demonstration project in the natural gas distribution

network of Portugal, distributing hydrogen by electrolysis to a customer base of 80 residential, commercial and industrial locations (Marubeni Corporation, 2023^[88]). The Netherlands unveiled a hydrogen strategy in late March, outlining plans for 500 megawatts (MW) of green electrolyser capacity by 2025 (EBRD, 2020^[89]). While prices are not yet competitive, increased demand could reduce the cost.

Finally, remote working can also reduce the frequency and intensity of mobility in rural regions. Although the uptake in remote working was lower in rural regions than in cities during the COVID-19 pandemic, it doubled in towns and semi-dense areas; in rural areas, it increased by 70% between 2019 and 2020. Improving digital skills and quality broadband in rural places can help increase remote working in rural places. Although the gaps between urban and rural areas in access to broadband have substantially declined in recent years, the gaps in download speeds remain significant. Download speeds over fixed networks in rural areas in Group of Twenty (G20) countries are, on average, 31 percentage points below the national average, against 21 percentage above the national average in cities.

Accelerating the deployment of renewable energy sources in remote rural areas

Rural regions, particularly remote areas, are at the forefront of renewable electricity production. The decreasing cost associated with renewables has made the latter more accessible, allowing a larger group of individuals to become owners of renewable energy production facilities and potentially increase profit margins. Utility-scale solar photovoltaics and onshore wind are the cheapest options for new electricity generation in a significant majority of countries worldwide (IEA, 2022^[90]). This presents an opportunity for the establishment of more decentralised and community-owned energy co-operatives, as well as the potential for integration with net zero innovations. These include the production of green hydrogen, the implementation of circular economy and bioeconomy practices, and the adoption of electric vehicles that rely on renewable energy. However, promoting local ownership and ensuring local benefits will also be needed to address the current resistance to renewable energy developments in rural areas. The lack of consultations and engagement with local communities has often been identified as a bottleneck to ensure greater acceptance of renewable energy deployments.

Policy implications

In terms of climate mitigation, the FUA approach is particularly important to promote low-emission spatial development structure by integrating land use and transport planning. In terms of climate adaptation, metropolitan adaptation and resilience strategies can leverage the spatial continuity and functional relationships between urban and rural areas to better identify and address climate shocks as their impacts may span administrative boundaries and geographic realities.

However, the analysis revealed that there are very few climate plans and strategies at this territorial scale. National governments have a key role to play in promoting the FUA approach for the development of metropolitan climate plans and strategies.

Climate mitigation and adaptation actions require a localised perspective that takes into account the unique characteristics and needs of individual cities and regions so that they can be tailored to be most effective at different geographical locations. For instance, as demonstrated above, sustainable mobility presents distinct challenges across urban and rural areas. Similarly, cities can benefit most by combining mitigation efforts with adaptation strategies, particularly through the development of nature-based solutions, to deliver more integrated and comprehensive climate action. The building sector plays a pivotal role in the pursuit of GHG emissions reduction and presents one of the most significant opportunities to achieve net zero in cities, while remote rural areas have unique opportunities to boost renewable electricity production.

Enhancing rural mobility through greener transport options can help accelerate the adoption of sustainable practices and bridge the urban-rural divide. Rural development policies, therefore, do not merely serve an economic goal but can also offer an essential piece in achieving overarching environmental and climate

ambitions. This entails a comprehensive strategy that considers the specificities of rural contexts, ensuring their socio-economic advancement while bolstering their pivotal role in global sustainability.

Table 4.11 outlines a set of recommended actions for both national and subnational governments to address the policy gaps discussed above.

Table 4.11. Recommended actions to promote climate action and resilience at the right territorial scale

Category	For whom	Recommended action
Metropolitan strategies for climate action and resilience	All levels	- Collect and analyse climate data at the metropolitan scale to identify opportunities for GHG emission reduction, climate change risks and impacts, etc. - Develop a mechanism for co-ordination among local municipalities within a metropolitan area. - Use the OECD-EU methodology to define FUA approaches for the development of climate action and resilience strategies.
Integrate transport and land use	All levels	Adopt transit-oriented development (TOD) approaches at the metropolitan scale.
Urban planning and design	Cities and regions	Delineate clear climate mitigation and adaption objectives and goals in urban masterplans.
Greening urban areas	Cities and regions	- Use innovative planning tools to expand urban green spaces such as the Urban Green Factor. - Create mandatory regulatory frameworks for green roofs. - Set concrete targets for the expansion of green areas and reflect them in existing plans and strategies.
	All levels	Design labelling and certification schemes for urban development/neighbourhood improvement.
Decarbonising buildings in cities	Cities and regions	- Understand the different types of local building stock. - Examine locally available heating sources in shaping decarbonisation policies and initiatives. - Provide incentives for energy assessment, installation of energy-saving equipment and personalised energy efficiency advice for low-income households.
Water management at the water basin scale	All levels	- Assess climate impacts and risks at the water basin scale and identify projects to increase water resilience. - Co-ordinate across municipalities within the same water basin to develop a common strategy for water resilience.
Sustainable mobility in rural areas	All levels	On-demand services: use big data to enhance DRT and integrate shared taxis with bus routes to optimise transport at varied times and frequencies.
	Regions	- Integrate different modes of transport and switch between them seamlessly. Develop unique ticketing systems to accommodate varied travellers' needs. - Implement differential taxation based on car usage in rural vs. urban areas to mitigate policy impacts. - Offer incentives for investing in EV charging infrastructure and strategise locations like schools for charging points.
	Cities	- Advocate for public transport vehicles that can carry bikes or scooters, boosting green travel options. - Collaborate with private entities to amplify car- and ride-sharing service offerings. - Foster co-ordination between government levels to co-invest in EV infrastructure.
Renewable energy deployment in rural areas	All levels	- Support establishing more decentralised and community-owned energy co-operatives. - Promote consultations and engagement with local communities. - Form public-private partnerships (PPPs) to boost production and promote a shift towards green hydrogen.

Supporting neighbourhood projects generating co-benefits and synergies beyond climate

Prioritising investment in integrated development at the neighbourhood scale that can generate co-benefits and synergies

Neighbourhoods exhibit unique territorial characteristics that influence the potential of a given city for achieving net zero emissions and enhancing resilience to climate impacts. One of the advantages of neighbourhood-scale climate projects is that they can combine multiple sectoral measures to create integrated development. Integrated development implies a comprehensive and co-ordinated approach combining social, economic, environmental and spatial considerations (Matsumoto and Ledesma Bohorquez, 2023^[19]). Integrated policy can better address multiple policy objectives, generate co-benefits and manage complex trade-offs. It can often identify hidden complementarities across sectoral interventions. For example, addressing both climate mitigation and adaptation measures through integrated urban development is likely to receive more political support and cost less money than implementing separate mitigation and adaptation measures (Matsumoto and Ledesma Bohorquez, 2023^[19]).

In France, the ÉcoQuartier National Programme supports the implementation of net zero and resilience solutions at the neighbourhood scale by using a labelling system (Case 21 in Annex 4.A). As an example, in Rouen, France, the former industrial area Luciline along the River Seine has been fully redesigned into an eco-district (*écoquartier*) covering 125 000 m², where a mix of green and blue infrastructures are improving drainage from the built environment and generating groundwater geothermal energy to heat and cool homes in summer and winter respectively, thus reducing energy demand from residential buildings.

Using neighbourhood-scale projects for innovative solutions

Neighbourhood-scale climate projects can be particularly useful in experimenting with decarbonisation solutions. In the Netherlands, for instance, a national project called the Natural Gas-free Neighbourhood Programme (*Programma Aardgasvrije Wijke*, PAW) provided up to EUR 5 million to each of 66 selected neighbourhoods in 59 municipalities from 2018 to 2022 to help them experiment with and scale up natural gas-free measures. The success of PAW can be attributed to three key factors: multi-stakeholder partnerships with co-ordinated government staff, a flexible funding approach and a commitment to long-term support, as evidenced by the evolution of the programme into the National Programme for Local Heat Transition (NPLW) in January 2023. Overall, the PAW provides an example of the national government supporting local governments in adopting the neighbourhood approach and gathering valuable insights for the transition process (OECD, 2023^[71]) (Case 22 in Annex 4.A).

Supporting vulnerable residents and communities with a participatory approach

Another potential advantage is that neighbourhood-scale climate projects can better target the most vulnerable communities, which tend to be concentrated in specific neighbourhoods in cities and meet specific needs for climate action. Importantly, such projects are also well suited to engage communities and reflect their voices into projects. An illustrative example can be found in the United States, where the Department of Housing and Urban Development (HUD) is handling the United States Community Development Block Grant Disaster Recovery (Case 23 in Annex 4.A). Through these funds, various states, cities and counties receive flexible grants that they tailor to aid their recovery efforts following disasters, including climate-related disasters. The allocated funds empower the recipients to take charge of designing and executing recovery initiatives that effectively address the unmet needs arising from the disasters. A key aspect of this approach is ensuring the inclusion of low-income residents throughout the process. To do so, HUD developed two toolkits to enhance citizen participation processes (HUD, 2023^[91]; n.d.^[92]; n.d.^[93]). The city of Ahmedabad, India, has been tackling against extreme heat through its Heat Action

Plan, in partnership with Mahila Housing Trust (MHT), a women-focused non-profit organisation. MHT helped the city better understand the challenges that informal communities face and co-create viable solutions. For example, MHT pioneered cool roofing solutions, which were adopted into the city's 2017 Heat Action Plan (Case 24 in Annex 4.A).

Policy implications

As demonstrated by several examples above, neighbourhood-scale projects offer a distinctive opportunity to craft tailored climate solutions that directly address specific territorial characteristics through a participatory approach. This leads to increased efficiency and more inclusive solutions for all. It is, however, important to note that the process of tailoring solutions at the neighbourhood scale is inherently complex, requiring careful consideration of local specificities, available resources and community engagement.

Table 4.12 outlines a set of recommended actions for both national and subnational governments to design and implement climate action at the neighbourhood scale, generating co-benefits and synergies beyond climate and making sure the transition is just.

Table 4.12. Recommended actions to support neighbourhood projects generating co-benefits and synergies beyond climate

Category	For whom	Recommended action
Prioritising investment in integrated development at the neighbourhood scale	All levels	• Mainstream climate change considerations into wide neighbourhood development projects. • Use a labelling system to evaluate and promote innovative net zero and resilient solutions.
Spurring innovation by neighbourhood-scale decarbonising measures	All levels	• Pilot and experiment with new clean energy solutions at the neighbourhood scale.
Supporting vulnerable residents and communities with a participatory approach	Cities and regions	• Develop and use data and statistics on the risk of extreme heat and flooding at the neighbourhood level. • Engage the most vulnerable communities and population groups (e.g. low-income residents) throughout the neighbourhood project process. • Partner with local NPOs to better understand the challenges local communities face and co-create viable solutions.

Enabling and scaling up local climate action and resilience

Creating a legal and institutional environment for local climate action and resilience

Reviewing national regulatory frameworks

Cities and regions often encounter obstacles within broader national frameworks as they advance their climate action. First, national standards and regulations are not always designed to accommodate new local solutions. For example, in Hungary, the implementation of nature-based solutions (NbS) in urban infrastructure is hindered by national regulatory frameworks, as the latter require technical specifications that do not fit with small-scale adaptation measures such as NbS. According to current regulatory practices in the Hungarian water sector, a water authority can have only one function in its operating license, which limits the recognition of the multifunctionality of blue infrastructures and other similar adaptation measures (OECD, forthcoming^[59]). Such regulatory barriers can limit the implementation of blue infrastructure, which local authorities typically plan and implement. Second, national governments are responsible for many critical policy areas for achieving climate goals and there can be misalignments between national and

subnational actions in a given place. For example, national laws often do not give authority to subnational governments to oblige retail electricity operators to supply certain amounts of renewable energy in their jurisdictions, which makes it uncertain to meet the net zero targets (OECD, 2019^[94]). Regulations that are designed for a centralised energy system can limit cities' ability to fully harness their renewable energy potential. Such regulatory frameworks can be reviewed from the point of view of climate action while making sure they serve their own purpose. In some other cases, complex administrative procedures introduced by national legal and institutional frameworks may slow down cities' and regions' efforts.

Clarifying roles and responsibilities for climate action across levels of government

Unclear allocation of responsibilities across levels of government may also undermine subnational climate action. For example, while local authorities could invest in adaptation measures to limit damages from climate events, post-disaster damage is often covered by national entities, which does not encourage local authorities to bear the cost of adaptation. Such disaster recovery funds at the national level are available in Australia, Germany, Japan, the United States and many other countries (Australian Government, 2023^[95]; Carrel, 2021^[96]; DOI, n.d.^[97]; OECD/World Bank, 2019^[98]). Political instability at the national level may also create frequent changes in the responsibility of cities and regions in climate action, which in turn affects cities' and regions' willingness and capacity to take own climate action. These challenges highlight that a clear legal, institutional and administrative environment at the national level can help cities and regions tap into their potential for local climate action.

Many OECD countries have been advancing multiple measures to overcome these barriers. Below are some key actions identified:

- **GHG emission reduction targets adopted by law.** Countries and cities are enshrining local emission reduction targets by local decrees and ordinances, thereby ensuring that they are legislative decisions and securing policy continuity across administrations. In Mexico, the national government adopted the General Law on Climate Change in 2012 to legalise its commitment to climate action. The law was updated in 2018 to integrate the NDC's commitment to emission reduction (Case 25 in Annex 4.A).
- **Clear responsibilities for local governments to be accountable for climate adaptation.** In Norway, municipalities are responsible for conducting climate risk assessments before authorising new building developments and are legally committed to prohibiting new buildings in areas at risk (Climate-ADAPT, n.d.^[99]). Many countries, such as Denmark, France, Ireland, Korea and the United Kingdom, also have national legislations that make it mandatory for municipalities to develop their local adaptation plans or policies (Reckien et al., 2023^[100]; Tuhkanen, Piirsalu and Lahtee, 2019^[101]; Government of Denmark, 2012^[102]; Lee, Paavola and Dessai, 2023^[103]; Ministry of Environment of Korea, 2021^[104]). In the state of Victoria, Australia, the responsibilities of local governments are defined under the Local Government Act 2020, which states that councils are required to promote the economic, social and environmental sustainability of the municipal district, including mitigation and planning for climate change risks (O'Donnell et al., 2020^[105]; OECD, forthcoming^[13]). In France, the national government adopted the MAPTAM "Modernisation Law", which facilitates interventions at the local scale and ensures that defined institutions oversee specified tasks (Case 26 in Annex 4.A).

Aligning and co-ordinating climate action across levels of government

Some national governments are actively creating mechanisms to align and co-ordinate climate action across levels of government, which is crucial for all actors to effectively work together towards the same goal of the Paris Agreement. A common mechanism is setting co-ordination bodies across levels of government. Countries such as Canada, France and Germany have established strong co-ordination mechanisms across levels of government in developing and implementing long-term low-emission

development strategies and subnational climate plans (OECD, 2019^[94]). Similarly, in Denmark, municipalities are actively encouraged to draft local adaptation plans as a complement to the national-level strategy and action plan. They have been supported in this process by a specially created “climate change adaptation squad” and a mobile task force, as well as through a legislative change allowing municipalities to cite adaptation as a basis for local plans (OECD, 2015^[106]).

Building local technical and human capacity

National governments play a key role in addressing the capacity gap in terms of technical and human resources, in particular at the local scale. Developing and implementing climate policies tailored to local-specific conditions require strong knowledge and expertise in climate policies (both in mitigation and adaptation) and in urban, rural and regional development policies. With regard to adaptation, the lack of expertise, technical skills and available staff time is considered to potentially prevent the implementation of adaptation policies at the local level (Covenant of Mayors - Europe, 2023^[107]). With the increasing frequency and intensity of extreme climate events, new and innovative technical knowledge and capacity may be needed, which goes well beyond resources available at the local level (Corfee-Morlot et al., 2011^[108]). Some adaptation options, especially those related to the upgrade or construction of resilient infrastructure, often need a wide set of specific competencies and external expertise that are not always easily accessible at the local level (Tuhkanen, Vilbiks and Piirsalu, 2020^[109]). Many adaptation competencies, particularly those relating to the installation or construction of adaptation solutions (e.g. building a dyke, insulating buildings, etc.), are one-off actions that may not justify the development of skills at the local level, particularly in small municipalities. Local authorities will, therefore, not invest in training their staff and developing these technical skills, otherwise available at the national or state level (OECD, forthcoming^[13]).

National governments can use pilot projects to help build local technical capacities. In Switzerland, the National Centre for Climate Services has been implementing a Pilot Programme on Adaptation to Climate Change. As of October 2023, the programme has benefitted more than 80 local adaptation projects that aim to adapt to more frequent and intense extreme weather events (i.e. heat stress, droughts) but also to raise awareness among citizens about the consequences of climate change (NCCS, 2023^[110]). Similarly, the Natural Gas-Free Neighbourhood Programme in the Netherlands has provided support to more than 60 projects to phase out natural gas from heating. The lessons learned from this programme have inspired the National Programme for Local Heat Transition, launched in 2022 (Case 22 in Annex 4.A) (OECD, forthcoming^[13]).

Table 4.13. Recommended actions to create a legal and institutional environment for local climate action

Category	For whom	Recommended action
Delineation of roles and responsibilities of cities and regions	National	Use a clear legal framework to set clear roles and responsibilities for cities and regions in national climate policies, building on their competencies/mandates over key sectors and policy areas for climate action.
Goals and targets by law	All levels	Adopt GHG emissions reduction goals and targets by law.
Technical assistance for building capacity	National	Create regional offices for co-ordinating climate action across different levels of government.
Sectoral/multi-level co-ordination for policy coherence	National	- Set inter-ministerial co-ordination bodies addressing subnational climate action. - Establish requirements for policy alignment encouraging cities and regions to take national strategies into account.
Experiment/pilot programmes to boost innovation	All levels	Design piloting programmes for testing innovative net zero and resilience solutions at different territorial scales.

Enhancing funding and financing mechanisms for local climate action and resilience

Cities and regions play a pivotal role in many policy areas that are crucial to economic growth, social inclusion and well-being, as reflected by the level of public expenditure and investment carried out by local and regional governments (37.1% and 54.5% respectively, in the OECD on average in 2021) (OECD, 2023^[111]). In particular, regional and local governments are responsible for policy domains that are critical for the net zero transition, such as environmental protection, land use planning, waste and water management, housing, transport or energy and can design and implement ambitious policies and infrastructures to mitigate and adapt to climate change. This makes them key players in the green and climate transition, in collaboration and co-ordination with the central government and other stakeholders.

The capacity of cities and regions to assume these roles is largely contingent on the financial resources at their disposal and their room to manoeuvre with these resources. In addition to traditional sources of subnational finance (funding), access to external resources (financing) for climate change adaptation and mitigation initiatives is, therefore, a key lever for accelerating territorial climate action. Subnational climate finance provides cities and regions with resources to develop and implement the policies and infrastructures laid out in their climate and environment action plans. Mobilising further funding and financing resources at the subnational level can ensure the fiscal feasibility of net zero strategies at that level, making them resilient over the long term (OECD, 2023^[112]).

The state of SNG climate finance

There is an increasing recognition of the critical role of cities and regions in climate-related spending and investment to make territories more resilient and sustainable. However, despite the importance of subnational expenditure and investment to drive the net zero transition, their magnitude remains relatively unknown and difficult to compare in OECD countries. This is due mainly to a lack of data at the national and subnational levels on climate finance, both at a macro level (national accounts) and micro level (subnational budgets). There are significant methodological challenges in assessing climate-related expenditure and investment using the international Classification of the Functions of Government (COFOG) and assessing the alignment of expenditure budget lines with green and climate objectives, due notably to fragmented definitions of what is climate-related. There is also a data gap on the revenue side. There are no fiscal data on climate-related revenue sources. For example, the extent to which tax revenues or intergovernmental transfers are earmarked for climate objectives or, on the contrary, can harm them remains largely unknown.

These knowledge gaps are problematic as they hinder efforts to track and measure the progress that cities and regions are making towards their climate adaptation and mitigation objectives, both at the aggregated level and individual government level. This is why COP28 aims, among other priority objectives, to set a new collective quantified goal (NCQG) on climate finance (UNFCCC, 2023^[113]). While several public climate finance tracking exercises currently exist at the international and national levels, there is a notable lack of work to track and compare climate finance at the SNG levels (OECD, 2022^[114]). In order to develop a common terminology and understanding of subnational climate finance, the OECD developed a pilot methodology in 2022 to track SNG climate expenditure and investment in the framework of a project in collaboration with the European Commission DG REGIO Directorate-General for Regional and Urban Policy (DG REGIO),⁴ which resulted in the creation of the Subnational Government Climate Finance Database (OECD.Stat, n.d.^[115]).

According to this database, in 2019, cities and regions accounted for 63% of climate-significant public expenditure and 69% of climate-significant public investment, which corresponds to respectively 1.1% and 0.4% of gross domestic product (GDP) across the 30 OECD and EU countries covered in the sample. These ratios have been increasing on average since 2009, by 2.5% annually for expenditure and by 1.4% for investment, with stark disparities between countries (OECD, 2022^[114]).

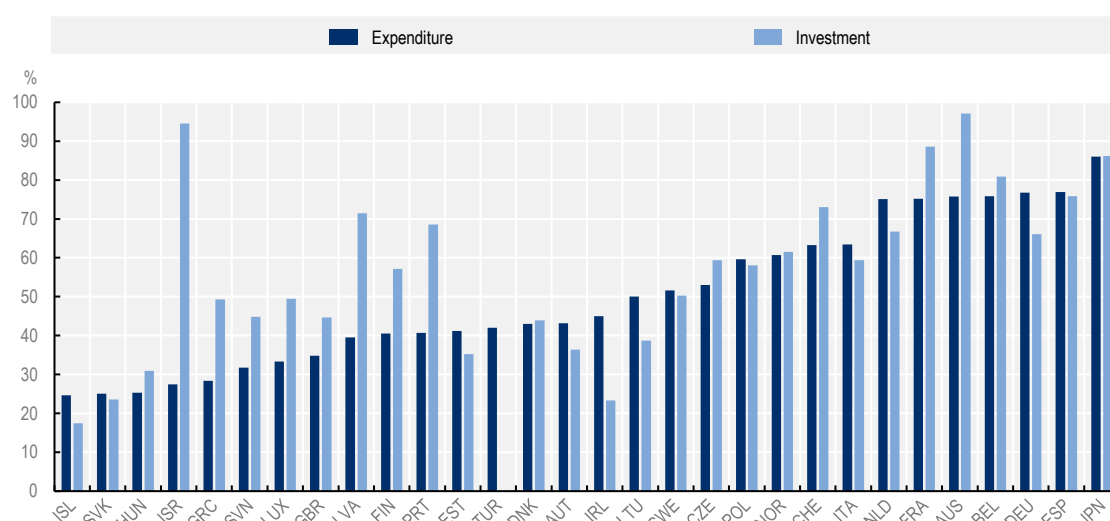
Such disparities in SNG climate-significant expenditure and investment across OECD countries reflect different levels of spending decentralisation as well as the involvement of cities and regions in key areas relevant to the carbon-neutral transition (Figure 4.10). Subnational climate-significant expenditure ranges from 24% of general government climate-significant expenditure in Iceland to more than 80% in Japan, and investment from 17% in Iceland to 97% in Australia. In countries such as Greece, Hungary, Iceland, Israel or the Slovak Republic, the central government covers more than 70% of climate-significant expenditures. Most of the countries with the highest ratios of both subnational climate-significant climate expenditure and investment are federal countries, although some unitary countries such as France or Japan also record high levels of climate-significant spending.

In the past decade (2009-19), SNG climate expenditure and investment have increased overall, with a great majority of the countries sampled recording a positive annual average rate of change. However, strong variations exist between countries. Regarding climate expenditure, some countries have an annual average increase of over 6% (France, Hungary, Norway, the Slovak Republic and Türkiye), while there was a decline in Greece, Ireland, Latvia and Spain (Ireland and Latvia seeing annual declines of 4% and -6% respectively). Disparities are even greater when it comes to climate investment over the same 2009-19 period, with some countries registering an annual average increase between 7% and 10% (Denmark, Hungary, Norway), whereas other countries saw a significant annual decline: -15% in Ireland, -10% in Lithuania and -8% in Spain.

On the one hand, downward trends can be explained by austerity measures that were put in place in response to the 2008 financial crisis but also by the recentralisation of some responsibilities (e.g. functions related to water services and waste management in Ireland). On the other, upward trends can refer to the devolution of additional responsibilities to cities and regions (e.g. granting environmental responsibilities related to soil pollution and the mapping and planning of raw materials extraction to regions in Denmark) and access to new sources of funding (green funds) or financing (green bonds and loans).

Figure 4.10. SNG climate expenditure and investment compared to general government

SNG expenditure and investment as a share of general government climate-significant expenditure and investment, 2019



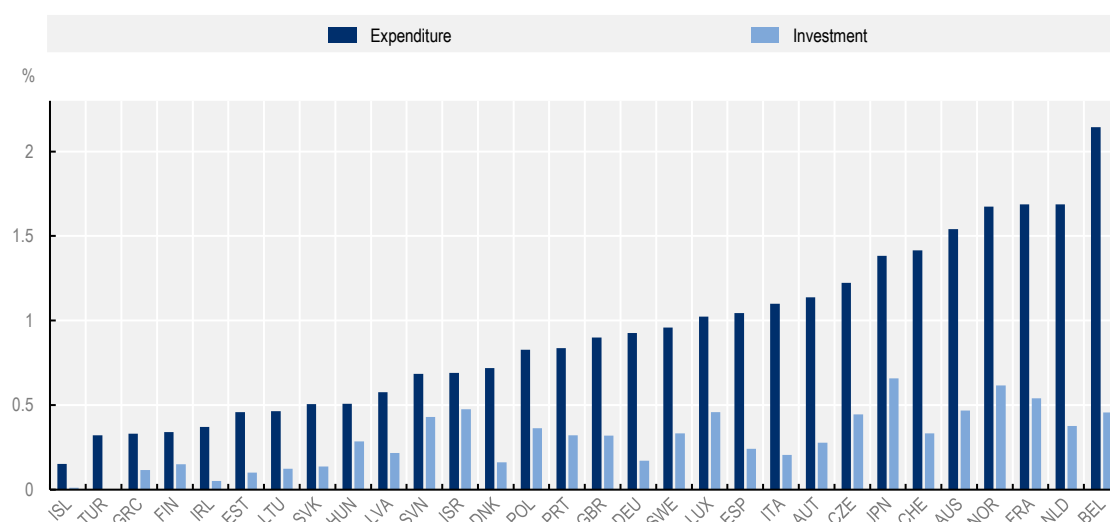
Note: For Austria, Germany and Japan, the methodology was adapted as these countries do not provide second-level COFOG data.

Source: OECD.Stat (n.d.^[115]), *OECD Subnational Government Climate Finance Database*, https://stats.oecd.org/index.aspx?DataSetCode=S_GCFD.

However, in terms of GDP share, SNG climate expenditure and investment remain relatively low, accounting for 1.1% and 0.4% of GDP respectively in 2019. Belgium recorded the highest subnational climate-significant expenditure (2.2% of GDP) and Japan the highest investment (0.7% of GDP). Iceland recorded both the lowest ratio of subnational climate-significant expenditure (0.1%) and investment (0.01%) (Figure 4.11).

Figure 4.11. SNG climate expenditure and investment as a share of GDP

SNG climate-significant expenditure and investment as a share of GDP (%), 2019



Note: For Austria, Germany and Japan, the methodology was adapted as these countries do not provide second-level COFOG data.

Source: OECD.Stat (n.d.^[115]), *OECD Subnational Government Climate Finance Database*, <https://stats.oecd.org/Index.aspx?DataSetCode=SGCFD>.

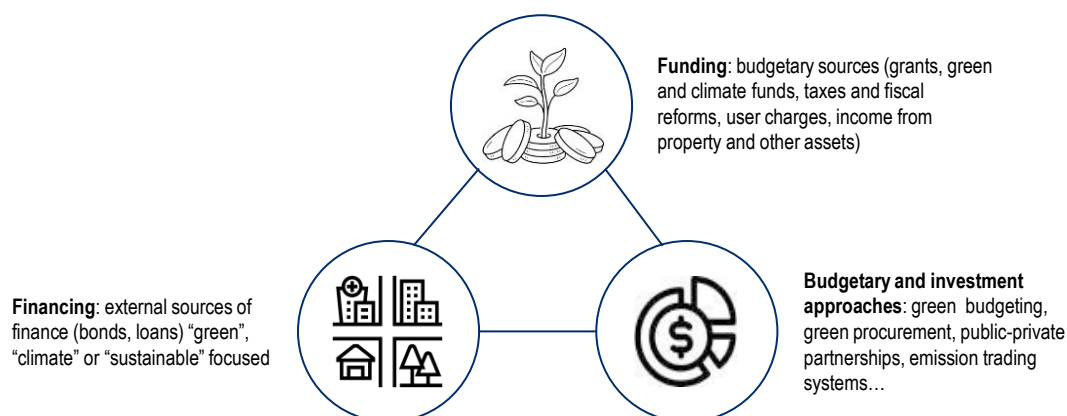
These amounts have only slightly fluctuated over the past decades, with an annual average rate of change of +1.4% for climate investment between 2009 and 2019, with significant variations among countries. These figures are confirmed by the 2022-23 European Investment Bank Municipalities Survey (EIB, 2023^[116]). According to this survey, most municipalities (60%) view their infrastructure investments in climate mitigation and adaptation infrastructure between 2020 and 2023 as insufficient and plan to increase them in the upcoming 3 years. This is, however, mostly the case for municipalities from more economically developed regions, whereas municipalities from less developed regions are less inclined to increase their climate investment. This reflects the fact that there is a lack of funding and financing for subnational climate action in general. Going forward, there is a critical need to scale up climate spending and investment if governments are to attain the targets they set at the subnational, national and global levels.

Diversifying sources of funding for climate actions at the subnational level

Implementing climate action at the territorial level requires increasing both current and capital SNG expenditure by adopting a comprehensive approach to climate finance. This requires mobilising a broad basket of revenue streams for cities and regions, both from budgetary sources (e.g. grants and own-source revenues, such as taxes, user charges, etc.) and from external sources of finance (e.g. bonds, loans, loan guarantees, etc.). Funding (grants and own revenue) and financing (external resources) are closely related when it comes to implementing territorial climate action, as sufficient, balanced and sustainable funding is crucial to enhance subnational creditworthiness and unlock access to finance, in particular climate finance (Figure 4.12). Similarly, traditional finance and specific so-called “climate” finance are mutually dependent.

For instance, grants, loans and bonds can have a “green”, “climate” or “sustainable” focus, but even those without an explicit “climate” focus can be used for climate adaptation or mitigation projects.

Figure 4.12. Basket of resources to finance subnational climate action



Not all OECD countries are equal when it comes to access to revenue, hence the different strategies and leeway for mobilising resources for climate action across countries. The OECD Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries (OECD, 2022^[31]) shows that more decentralised and populous countries provide a greater diversity of public funding instruments to cities and regions for climate action. Federal countries tend to have an average of 13.5 climate-related instruments available for cities and regions per country versus 5.5 instruments in unitary countries. The degree of decentralisation, in particular the degree of devolution of environment and climate competencies to cities and regions, are key factors contributing to the number and diversity of funding instruments available to cities and regions in a given country (e.g. 11 instruments were found in Italy, against 1 in Türkiye) (OECD, 2022^[31]).

Own-source revenue to fund climate action

Increasing own-resources can enable cities and regions to finance their climate actions in two ways: by raising additional subnational revenue and by improving their creditworthiness and their access to external financing. Subnational own-source revenues come from three main streams: i) tax revenue; ii) user charges and fees; and iii) land and assets.

Tax revenues (including shared and own-source taxes) are the main source of SNG revenue in the OECD. In 2021, they accounted for the bulk of SNG revenues on average in OECD countries (42.2%). However, this share varies greatly from one country to another – from around 2-3% in Estonia and Lithuania to 79% in Iceland – leading to various degrees of fiscal leeway and opportunities for reforms (OECD, 2023^[111]).

There are different ways for “green” subnational tax systems to foster environmental and climate priorities. All categories of taxes can potentially be used to finance climate objectives, using them to advance green practices or by eliminating their “anti-green” bias. A classic example is the property tax on land and buildings, which is the “local tax” by excellence and the main source of tax revenue for cities and regions in many countries, accounting for 1.0% of GDP in OECD countries (OECD/UCLG, 2022^[117]). Depending on how they are designed, property taxes can favour more sustainable urban development patterns while raising additional revenue for cities and regions.

Governments can also design taxes that specifically target environmental protection, foster green practices and change behaviours. So-called “environmental taxes”, earmarked for financing environmental protection, can be classified into four broad sectors: energy (carbon taxes, taxes on energy products, tax on electricity, etc.), transport (car sales/registration taxes, annual vehicle circulation taxes), pollution taxes

(including waste taxes and taxes on the use of pesticides and/or fertilisers) and taxes on water abstraction and resources extraction (OECD, 2019^[44]). At the same time, such environmental taxes can aim to foster green practices and change behaviours, thereby contributing to GHG emission reduction or climate adaptation, and thus have the paradoxical effect of reducing revenues. For example, taxes and excise duties on fossil fuels aim to reduce fossil fuel energy consumption. In Mexico, five states have introduced a carbon tax as part of a green fiscal reform. Measures adopted include new taxes that provide incentives to invest in green, low-carbon technologies and infrastructure as well as to finance government-sponsored climate change adaptation measures while reducing inefficient subsidies and distortionary taxation (World Bank, 2023^[118]). As another example, waste taxes can encourage emission reduction by encouraging circular economy practices, helping reduce demand-based emissions in high-income cities for instance. In Spain, autonomous communities have quite extensive responsibilities in taxation and environment policy and, therefore, have used their taxing powers to mitigate negative environmental outcomes while maintaining (or raising) tax revenues. Andalusia, for example, is using its tax competencies to pursue environmental goals in key environmental areas, namely GHG emissions and air pollution, water usage and pollution, as well as waste and circular economy (OECD, 2023^[119]). However, the capacity of cities and regions to use fiscal resources to pursue environmental and climate priorities depends on their taxation powers (ability to modify tax rates and bases), which are often limited, except in federal and quasi-federal countries. Reforming tax systems at a subnational level mostly depends on the decision of central or federal governments (OECD, 2021^[81]). National governments could allocate the full benefit (or a share) of certain national environmental taxes to cities and regions, providing them with more flexibility on rates and bases and tax creation power to implement a regional or local climate-friendly tax policy.

Revenue from user charges and fees, which accounted for 13% of SNG revenue in 2021 (OECD, 2023^[111]), are a source of own revenue that is complementary to tax revenue to support the net zero transition. User charges and fees may include congestion charges, parking fees, high occupancy toll lanes, water and wastewater user fees, urban tolls or utility fees (water, waste and energy) (Merk et al., 2012^[120]; OECD, 2019^[44]; 2021^[81]). Cost-reflective water charges will be important in the context of climate adaptation, as many regions will face rising drought risk as well as increasing water demand in agriculture. Road user charges will need to replace fossil fuel taxes when fossil fuel vehicles are phased out, both to replace revenue streams from fossil fuel taxes and to price negative externalities related to vehicle use, such as congestion, accidents and noise. Road use charges that are time- and place-contingent can price externalities more efficiently, especially in urban areas, where external costs are much higher than typical fuel tax rates. In the waste sector, a pay-as-you-throw system has been in place in Seoul, Korea, since the 1990s. It enables charging households, businesses and office buildings for general waste on a volume-based fee system. There are, however, several limitations attached to the development of user charges and fees, including the legal ability of cities and regions to create and determine the level of such fees, in particular in sectors considered as essential (e.g. energy), the capacity and willingness of users to pay and capacity management (OECD, 2021^[81]).

Other sources of funding can include the use of “land value capture” instruments and harnessing the revenues from existing infrastructure assets. Although revenue from land and other assets accounts for a relatively small share of SNG revenue (2% in 2021), it can represent a significant source of own revenue for cities and regions to close some of the funding gaps of the net zero transition (OECD, 2023^[111]). Cities and regions can reclaim gains from investments or changes in land regulations through land value capture instruments and use them to fund infrastructure investment (OECD/Lincoln Institute of Land Policy, PKU-Lincoln Institute Center, 2022^[121]). Provisions can be made upfront so that funding is put aside for future maintenance interventions. Cities and regions can also use their power over urban development strategies, local land use decisions and development control to plan the effective use of local and regional assets and thus minimise investment costs (OECD, 2023^[122]).

Grants and subsidies as a major funding instrument for subnational climate action

Grants and subsidies are the second source of SNG revenue in the OECD in 2021 (41.9%) and the main source of revenue for cities and regions worldwide (51.5% in 2019) (OECD, 2023^[111]; OECD/UCLG, 2022^[117]). Grants and subsidies offer key instruments for cities and regions to finance their climate action and a major vehicle for supra-national, national and state governments to influence subnational spending and investment towards climate priorities. The OECD Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries (OECD, 2022^[31]) has identified earmarked grants and funds as the most common type of climate-related funding instruments available to cities and regions in the OECD and the European Union, with large variations in how constrained the use of the funds is. Several European countries rely heavily on EU funds (in particular, the EU Cohesion Fund and Modernisation Fund) to encourage climate action at the subnational level.

Making the most of grants and subsidies to deliver on the objectives of the net zero transition can occur by introducing conditionalities in the general system of intergovernmental transfers. In such cases, national or state governments (in federal countries) integrate environmental and climate objectives as indicators in the design of the transfer system (including general and/or earmarked grants) to provide incentives for local governments to contribute to the net zero emissions target. Using conditionalities in the national transfer system contributes to ensuring policy coherence across levels of government and sectors (e.g. energy, agriculture, transport and land use planning) to pursue country-specific climate objectives (e.g. afforestation, transition to renewable energy, etc.). Grant conditionalities can also enable tackling social, economic and territorial inequalities related to climate change (e.g. EU Just Transition Mechanism). This has been the case in particular in the context of green recovery plans that were developed in the aftermath of the COVID-19 pandemic (e.g. France Relance). Conditionalities can also be used to address fiduciary and accountability concerns and to promote minimum public service standards. Some countries have also introduced environmental conditionalities in the allocation of grants and subsidies for infrastructure projects (e.g. Canada's Climate Lens programme).

Conditionalities must, however, be used with caution in order to be efficient in a decentralised context. It is important to keep a certain degree of flexibility in how grant funds can be used to allow cities and regions to implement projects relevant to their local climate adaptation and mitigation needs. Overly restricting the use of grant funding can lead to inefficient use of funds and hinder the low-carbon investments needed to ensure a carbon-neutral transition (OECD, 2022^[114]).

Central, federal or state governments can also support local climate action by establishing climate or green funds. Green or climate funds that cities and regions can access exist at the national level in Canada, France, Germany and at the state level in Jalisco, Mexico, or California, United States. The international community and national/state governments could further develop specific or matching grants to support climate-related projects developed by regions and municipalities, focusing on targeted policy areas or infrastructure that align with the net zero policy target. Currently, most of the funds established by multilateral or bilateral banks and other international donors are not directly targeted at cities and regions. Most resources are channelled through international implementing entities and the national governments of recipient countries, which may cause delays and extra administrative costs.

Accelerating local climate action through better access to external financing

External sources of financing are crucial for cities and regions to mobilise enough resources to finance climate and green infrastructure and investment projects. Globally, infrastructure investment needs between 2016 and 2040 are forecasted at USD 94 trillion and, looking specifically at cities in emerging markets; the cumulative climate investment needs to mitigate and adapt to climate change are estimated at USD 29.4 trillion between 2018 and 2030 (OECD, 2023^[122]).

Financing is essential for cities and regions to complement self-financing and capital transfers, to help spread the high upfront capital expenditure of infrastructure over time and to bridge the gap between the timing of payments for construction and future revenues. A variety of instruments are available to match the different types of subnational governments and projects to be financed, such as loans earmarked for green, social and sustainable investments, loan guarantees but also several types of subnational bonds, and the recent emergence of tools that are specific to climate action and resilience such as catastrophe bonds (Table 4.14).

However, access to climate or green external resources remains relatively limited at the subnational level. As shown by the OECD Compendium of Financial Instruments that Support Subnational Climate Action in OECD and EU Countries, climate-related loans and contracts are the two less common climate-related instruments available to cities and regions (OECD, 2022^[31]). Overall, access to external financing is conditioned by two main prerequisites, to various extents depending on each instrument:

- First, an enabling environment that encompasses fiscal and regulatory frameworks, institutional capacity, co-ordination and co-operation mechanisms and developed financial institutions and capital markets.
- Second, sufficient and predictable sources of funding to help cover operational expenses, including maintenance and to repay financing.

Table 4.14. Selection of sustainable financing instruments for cities and regions, potential uses and barriers

Instrument	Green, social and sustainable (GSS) loans	Subnational bonds (general obligation bonds)	GSS bonds	Sustainability-linked bonds (SLB)	Catastrophe bonds
Description	GSS loans are granted via financial institutions, earmarked to finance specific projects (eligibility criteria determined by the Green Loan Principles).	Subnational bonds (or sub-sovereign bonds, local authority bonds, etc.) are general obligation bonds emitted on the capital market.	GSS bonds are subnational bonds whose proceeds are earmarked for defined green, social and sustainable projects (eligibility criteria determined by the Green Bond Principles).	SLB are subnational bonds whose proceeds are linked to the achievement of specific, predefined objectives (sustainability performance targets or key performance indicators).	Catastrophe bonds are insurance-linked securities that allow the issuer to get proceeds from the capital market only if a catastrophic condition occurs.
Uses and benefits	Can be used to finance small-size investments and to support SNGs who cannot access capital markets. They can be matched to a GSS bond issuance or grants through blended finance mechanisms.	Better financing rates on the capital market from both domestic and international investors over a longer time. Respond to financing needs of larger SNGs (e.g. state, provincial, regional and large local governments). Provide the basis for accessing other types of bonds.	Similar to “subnational bonds”. Enhanced transparency on investment project evaluation, selection and reporting.	Proceeds are available for general purposes, which provides SNGs with more budget flexibility. Potential to align financing with long-term policy objectives while providing budget flexibility and reducing compliance costs for SNGs.	Can transfer defined risks from catastrophic events off their balance sheet to manage exposure. Provide an alternative form of insurance against future risks, such as hurricanes, floods, bushfires or earthquakes.

Instrument	Green, social and sustainable (GSS) loans	Subnational bonds (general obligation bonds)	GSS bonds	Sustainability-linked bonds (SLB)	Catastrophe bonds
Barriers to use	Higher financing rates than through bond issuances. Requires good SNG creditworthiness and enabling framework at the national level.	Require regulatory frameworks in place, local financial market and good SNG creditworthiness and fiscal discipline. High transaction costs (e.g. credit ratings, auditing, etc).	Similar to “subnational bonds”. More limited budget flexibility. Require additional expertise for reporting and auditing and co-ordination for identifying suitable projects.	Lower transparency of the use of the proceeds. Require specific expertise for monitoring the key performance indicators.	High transaction costs, “niche” investor base. As a result, catastrophe bonds have most commonly been issued by national or state governments.

Source: Based on OECD (2023^[122]), *Financing Cities of Tomorrow: G20/OECD Report for the G20 Infrastructure Working Group under the Indian Presidency*, <https://doi.org/10.1787/51bd124a-en>; Ando, S. et al. (2022^[123]), *Sovereign Climate Debt Instruments: An Overview of the Green and Catastrophe Bond Markets*, International Monetary Fund.

Despite rapid growth, green bonds still account for a small share of the global bond market. Cities and regions are increasingly active in the green bond market (Case 27 in Annex 4.A) but there is significant room for scaling up (they accounted for only 4.4% of total green bond issuance in 2019). In many countries, SNGs, or certain categories of SNGs, are not allowed to issue bonds on capital markets. This said, even in countries where SNGs are allowed to issue bonds, the practice is not widespread. In some countries (e.g. France, Japan, Sweden and the United States), cities and regions are becoming significant issuers of green bonds or climate bonds, yet there is still significant scope for improved use of these instruments (OECD, 2023^[122]).

To scale up the use of green bonds, borrowing frameworks could be adapted to allow borrowing for SNG investments, especially if investments support the net zero transition. Central governments could also develop guidelines, standards, reporting and certification practices to create the foundations for a green bond market. They could also provide technical assistance to develop bankable green projects and support for capacity building at the local level (Case 28 in Annex 4.A). Another way to support the development of a local green bond market is credit enhancement from governments and multilateral institutions, possible provision of tax incentives for an initial period to foster market development and the development of green banks and green funds (Climate Bonds Initiative, 2015^[124]).

Supporting new budgetary and investment approaches for subnational climate action

In addition to mobilising public and private resources, cities and regions of all kinds and sizes can also finance their climate actions through other instruments, whether budgetary via green budgeting or based on partnerships with the private sector through climate-oriented PPPs and green public procurement (GPP) or by setting up regulatory frameworks for companies, through emission trading systems.

Contract agreements between national and subnational governments are, for example, interesting multi-level governance instruments to foster place-based, long-term action for reaching climate objectives. Based on data from the OECD compendium (OECD, 2022^[31]), contracts with green and climate lenses exist primarily in Canada and European countries (Belgium, Denmark, France, Sweden and Switzerland). In particular, France has a longstanding practice of contractual arrangements, which in recent years have incorporated environmental and climate priorities with the launch of Recovery and Ecological Transition Contracts (*contrats de relance et de transition écologique*) for inter-municipal co-operation bodies in 2020 (OECD, 2022^[31]).

Another example of an innovative approach is green budgeting. Subnational practices have emerged in recent decades at the national, regional and local levels, taking into account country specificities and environmental objectives and commitments. Behind the broad definition of “green budgeting” as “using the

tools of budgetary policymaking to help achieve environmental and climate objectives” (OECD, 2020^[125]), green budgeting encompasses a variety of environmentally-related budgeting practices, including carbon budgets, eco-budgets, climate budgets, environmental and climate impact analysis, green budget tagging and more.

Green budgeting is a relatively new practice in many OECD countries, both at the national and subnational levels, and the number of experimentations has been growing steadily across the world. According to a stocktake of existing subnational green budgeting practices in OECD and EU countries, these were identified at the regional level in France (Bretagne, Grand-Est, Occitanie), Italy (Sardinia), Spain (Andalusia and Catalonia) and the United Kingdom (Scotland) but also at the municipal level in Austria (Vienna), Norway (Bergen, Oslo), Sweden (Stockholm) and in several municipalities and associations of municipalities in France. These countries are pioneers in the use of subnational green budgeting (OECD, 2022^[126]).

Fully incorporating environmental and climate concerns into the budgetary process can play a pivotal role in complementing the mobilisation of funding and financing by cities and regions for concrete climate action (Case 29 in Annex 4.A) yet it is not easy to put into practice. Green budgeting presents several opportunities and challenges (Table 4.15).

Table 4.15. Opportunities and challenges of subnational green budgeting

Opportunities	Challenges
• Aligning their expenditure, investment and revenue-raising decisions with environmental and climate objectives. • Fostering a whole-of-government approach for policy making. • Instilling a science-based understanding of climate and environmental issues across the administration. • Improving the evaluation of public policies. • Enhancing transparency and accountability of government climate action. • Prioritising low-carbon and resilient investment and spending. • Identifying funding and financing gaps for their green objectives. • Mobilising additional sources of public and private finance to bridge financial gaps.	• Methodological challenges: defining and measuring the needs for reaching their green objectives; adapting accounting and reporting tools to the specific budgeting contexts of SNGs and ensure that the methodology can adapt to changing scientific evidence and climate challenges. • Resource challenges: training of SNG staff to carry out the exercise in a timely manner; allocating sufficient resources to upgrade existing information management systems in line with green budgeting needs. • Operational challenges: establishing a dedicated organisational structure based on horizontal co-ordination amongst departments; involving stakeholders and communicating widely; implementing internal and external auditing processes. • Political challenges: ensuring sustained, high-level political support for from both administrative and elected officials; reconciling green and social objectives; ensuring follow-up to identify trends and implement medium- and long-term strategies.

Source: OECD (2022^[126]), “Aligning Regional and Local Budgets with Green Objectives: Subnational Green Budgeting Practices and Guidelines”, <https://doi.org/10.1787/93b4036f-en>.

Green budgeting is most effective when combined with other means of government action (e.g. regulation, public procurement, environmental planning) and aligned with a regional/local climate strategy. To support the implementation of green budgeting practices by cities and regions, the OECD has developed six guidelines, accompanied by a self-assessment tool:⁵

- **Guideline 1:** Conduct a diagnostic of local environmental and climate challenges as a prerequisite to launching a green budgeting practice.
- **Guideline 2:** Ensure strong, high-level involvement and support from both the administrative and elected sides of government.
- **Guideline 3:** Ensure the practice has a robust, shared scientific basis to facilitate public trust and ensure the practice can adapt to changing scientific evidence.

- **Guideline 4:** Adopt a step-wise approach to implementing green budgeting in order to learn from previous steps and reinforce the alignment of the practice with local strategic priorities.
- **Guideline 5:** Integrate the green budgeting practice into existing public financial management procedures and tools to help ensure the practice endures.
- **Guideline 6:** Include revenues within the scope of the green budgeting practice to ensure the entire budget aligns with green objectives.

Mobilising the private sector through climate-related public-private partnerships and green public procurement

The challenges of attracting private sector financing are important both at the national and subnational levels but even more so at the latter level, given the capacity constraints and lack of creditworthiness. Potential instruments for tapping private finance for the net zero transition include practices such as PPPs and green public procurement.

PPPs are a long-term contract between a private party and a government entity for providing a public asset or service, with part of the risk and management responsibility shifted to the private party. Climate-related PPPs may offer added value. For example, in Slovenia, the city of Ljubljana developed two PPPs through energy performance contracting (PPP EPC). These are recognised as successful PPP EPC across the European Union and have been replicated by other Slovenian cities. These projects are based on the principle of retrofitting and introducing renewable energy sources in the majority of building stock owned by the SNG (e.g. schools, cultural centres, sports and healthcare facilities, etc.). Consequently, their GHG emissions are being reduced. For the first project batch, 25 deeply retrofitted buildings have received 51% of their funding from private partners, 40% from EU Cohesion Policy funds and 9% from the city (OECD, 2021^[81]).

Subnational PPPs, however, are not without risks. Challenges emerge in areas such as financing and funding. Private borrowing costs might be higher than public ones for example, raising the costs of the PPP project overall. PPPs require intergovernmental regulatory coherence, cross-jurisdictional co-ordination, economies of scale and asymmetric information between the contracting parties, which may put local governments at a disadvantage. It also requires management capacity in cities and regions. Challenges associated with climate-related PPPs may incur even lower returns on green investments. In addition, the economic benefits that green investments generate may be difficult for investors to grasp. Climate-resilient investments face an additional hurdle in that it is difficult to monetise the avoided costs associated with climate-related damages (OECD, 2019^[44]).

GPP is another manner for cities and regions to support environment-friendly policies and investment strategies by integrating environmental and social considerations into the procurement process. On average, in the OECD, cities and regions are responsible for half of total public spending on public procurement (OECD, 2023^[111]). In addition to greening public consumption and investment policies, GPP can provide the industry with incentives for developing environmentally friendly products and services, particularly in markets where public purchasers represent a large share, such as construction or public transport. GPP is most effective when integrated into broad subnational emission reduction strategies with concrete net zero benchmarks. These benchmarks should apply throughout the whole procurement cycle (including the pre-procurement phase, procurement process and continuous monitoring and evaluation) and be integrated into policy and regulation (EC, 2014^[127]).

Finally, emissions trading systems (ETS) are part of “carbon pricing”, together with carbon taxes. ETS, also referred to as cap-and-trade systems, can be used to help cover climate investment needs by generating revenues while reducing emissions. ETS are a policy mechanism based on which high-polluting industries are required to pay when they exceed predetermined emission amounts. In order to emit over the prescribed amount, companies are forced to purchase emission allowances. As of 2023, there are

73 carbon pricing initiatives in place across the world. While many systems operate at the national level, some ETS are operated by cities and regions, for example in Canada, the United States and more recently in eight pilot provinces in China. Most recent initiatives include the newly started ETS in the state of Washington (United States).

In the United States, ETS are almost entirely implemented at the subnational level. The Regional Greenhouse Gas Initiative (RGGI), launched in 2012 as a co-operative effort among several US states (as of 2023, 12 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and Virginia), was the first mandatory market-based programme to reduce GHG emissions from the power sector. Another example is the California Cap-and-Trade Program, which is the main source of funding for the state of California's climate investments. At the city level, as part of a local law that sets emission intensity limits for most large buildings starting in 2024, the New York City government released findings from a study on the feasibility of a citywide ETS for the building sector in 2021 and started developing regulations in 2023 (World Bank, 2023^[118]).

Despite the increase in carbon prices in many jurisdictions, they remain substantially low and come with social limitations that need to be addressed. For instance, some jurisdictions have delayed measures to strengthen their carbon pricing instruments and have extended compliance deadlines. To ensure the efficiency of the system, carbon pricing should be as uniform as possible at an international or at least national level. In this regard, the Canadian federal government sets minimum national stringency standards (federal “benchmark”) that all subnational systems must meet if they choose to have their own pricing system. If the system set up by a province or a territory does not meet these standards, the federal system is put in place (World Bank, 2023^[118]).

Policy implications

Despite the significant role that cities and regions play in expenditure areas that are key to the net zero transition, such as environmental protection but also transport or housing policies, their role remains poorly understood due to a lack of comparable data and analysis. By building on the pilot methodologies developed by the OECD, it is crucial to enhance the tracking and measuring of climate finance flows at the national and subnational levels. In addition, the action of cities and regions to contribute to the net zero transition remains limited by a lack of access to reliable and diversified funding, including grants, tax revenues and user charges, undermining their creditworthiness and access to external financing options. Central governments can reform subnational fiscal frameworks to promote more diversified funding and facilitate access to external resources for cities and regions, including through innovative climate finance mechanisms. By implementing initiatives such as green budgeting and GPP, cities and regions can also better align their expenditure and revenues with climate and green objectives as well as mobilise further resources to accelerate local climate action.

Table 4.16 outlines a set of recommended actions for both national and subnational governments to address the policy gaps discussed above.

Table 4.16. Recommended actions to accelerate local climate action through innovative finance

Category	For whom	Recommended actions
Tracking of subnational climate finance	National	Enhance the tracking and measurement of subnational climate finance, both for climate-related expenditure and revenue, to better understand cities' and regions' needs for climate action.
Green budgeting and GPP	National	Support the emergence of green budgeting practices and green procurement systems at the subnational government level.
	All levels	Adopt climate/environmental considerations for locally procured public goods and services.
Taxation and user fees	All levels	Develop and optimise taxation and user fees and charges and make the most of grants and subsidies to support climate objectives.
Land value capture	All level	Adopt land value capture mechanisms to finance sustainable urban infrastructure.
Financing instruments	All levels	Improve the ability of cities and regions to access financing for climate and green investments, e.g. through GSS municipal bonds and loans, etc.
Carbon pricing	National	Facilitate the adoption of carbon pricing instruments ("cap-and-trade") at the subnational level.

Engaging local actors, building partnerships and sharing knowledge

Citizen's engagement and awareness raising

A co-production approach allows sharing and recognising varied interests, living experiences and knowledge among different stakeholders such as the public and private sectors, citizens and academia, making climate action more inclusive. The Strategic Plan 2016-2028 in Umeå, Sweden, was built on multi-stakeholder partnerships and policy alignment between different levels of government. It involved the private sector, public companies, academia and the municipality to build and share knowledge and promote innovation and experimentation to advance the circular economy (Case 30 in Annex 4.A). Engaging the private actors. Similarly, Barcelona, Spain, has adopted a co-production approach to delineate its Climate Plan 2018-2030, working with hundreds of city organisations and citizens. It enabled the city to acknowledge the local impacts of climate change, especially how it affects different groups in the city (Case 18 in Annex 4.A). Engaging building owners and developers is a key strategy to accelerate decarbonisation of buildings. For example, In New York, the NYC Retrofit Accelerator, a citywide programme launched in 2015, provides free, personalised advisory services, one-on-one expert advice on building upgrades, local law compliance, incentives and financing to building owners to decarbonise the city's building stocks. The programme uses extensive datasets created by the city's energy benchmarking and audit laws to identify and prioritise updates in privately-owned buildings (Case 31 in Annex 4.A).

Indigenous communities are a key actor. In New Zealand, the Climate Change Commission (He Pou a Rangi in Māori) provides the central government with independent, evidence-based advice to help transition to a low-emissions and climate-resilient economy, based on extensive stakeholder consultation including indigenous communities. In 2021, the commission provided a report to the Minister of Climate Change with 33 recommendations, collaboratively developed through engagement and quantitative analysis, including 4 246 responses from a range of stakeholders, including individuals, businesses, the public sector, Iwi/Māori, NGOs and youth (Case 32 in Annex 4.A).

Cities are also using communication strategies such as awareness-raising campaigns to communicate the policy impacts and trade-offs in a transparent manner, thereby building trust and confidence with citizens. The Day Zero campaign in Cape Town, South Africa, was implemented in 2018 to reduce citywide water usage. The campaign deployed an extensive communication strategy to raise awareness. It combined different tactics, including: i) sending simple messages; ii) offering concrete examples; and iii) making the water reduction activities somehow enjoyable (Case 33 in Annex 4.A).

Facilitating knowledge sharing through city networks and programmes

Many cities have formed international city and regional networks to join forces to achieve their net zero targets (Table 4.17). These networks have served as powerful platforms for collaboration and knowledge sharing. The Global Covenant of Mayors for Climate and Energy is the largest global alliance for city climate leadership, built upon the commitment of over 10 000 cities and local governments from 6 continents, 140 countries and representing more than 900 million people. Another example is the Race to Zero Campaign, which has engaged 1 136 cities and 52 regions (as of September 2022) (Race to Zero, 2023^[128]). Through these collaborative efforts, cities and regions are demonstrating their commitment to being at the forefront of the global fight against climate change.

Table 4.17. Major city and regional networks for climate action and resilience

Name of the network	Year established	Mandates/ objectives	Members	Reference
C40	2005	C40 is a global network of nearly 100 mayors of the world's leading cities that are united in action to confront the climate crisis. The cities that join the initiative are committed to using an inclusive, science-based and collaborative approach to cut their fair share of emissions in half by 2030, help the world limit global heating to 1.5°C and build healthy, equitable and resilient communities.	96 cities/ municipal actors	(C40 Cities, 2023 ^[129])
Global Covenant of Mayors for Climate and Energy (GcoM)	2008	Engage and support cities and towns to commit to reaching the EU climate mitigation and adaptation targets, bridging the gap from climate ambition to action delivery. The three key areas of the GcoM involve supporting local governments and the participation of cities and local governments in city networks, reducing emissions and fostering local climate resilience.	12 825 cities and local governments, 14 countries and representing more than 900 million people	(GcoM, 2023 ^[130])
Under2 Coalition	2015	This initiative brings together ambitious states and regions willing to make key commitments to accelerate climate action, with the commitment to reduce their GHG emissions by 80% to 95% or limit them to 2 metric tons of CO ₂ -equivalent per capita by 2050.	167 states, regions, provinces and cities, alongside several other national and subnational entities	(The Climate Group, 2023 ^[131])
Climate Ambition Alliance	2020	The objective of this initiative is to build momentum and advocate for governments to engineer their commitments to the Paris Agreement with the goal of reaching (net) zero in the 2040s or sooner, or by mid-century at the latest, in line with global efforts to limit warming to 1.5°C and fostering a more inclusive and resilient economy.	1 136 cities/ municipal actors	(Climate Ambition Alliance, 2023 ^[132])
Race to Zero Campaign	2020	The Race to Zero Campaign rallies non-state actors – including companies, cities, regions, financial, educational and healthcare institutions – to take rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero-carbon world. The cities and regions that are signatories of the Race to Zero Campaign commit to pledging to reach net zero GHG emissions as soon as possible (2050 at the latest), phasing out fossil fuels and setting interim targets to achieve in the next decade. Within 12 months of joining the campaign, the signatories need to publicly disclose a transition plan that outlines how the Race to Zero criteria will be met, including specific actions and timelines. The signatories are also required to take immediate action through all available pathways towards the net zero goal, publish their progress against both interim and long-term targets and align their external policy and engagement to the Race to Zero goals.	1 147 cities	(Race to Zero, 2023 ^[128])

Source: Based on the references listed in the right-hand column.

City-to-city collaboration is a powerful tool that can help cities implement innovative solutions to climate challenges. Several international and national programmes have been at the forefront of this endeavour. In 2022, the European Commission launched the EU NetZeroCities programme as part of the implementation of the EU Green Deal. The programme includes a twinning programme that offers support to participating cities in replicating net zero solutions from other cities (Case 34 in Annex 4.A). Similarly, the EU Climate-ADAPT provides a database of case studies on climate adaptation from which cities and regions can learn to tailor and adapt their own policies (Case 35 in Annex 4.A).

Some national governments are also fostering city-to-city partnership programmes to facilitate experience exchange. In the Netherlands, the former Ministry of Infrastructure and the Environment (currently the Ministry of Infrastructure and Water Management) hosted the Climate Adaptation City Deal between 2016 and 2021. The initiative facilitated collaboration between different stakeholders, including civil society organisations, universities, private companies and local governments, to design innovative solutions to climate adaptation in cities. The initiative benefitted several cities, including Amersfoort, Amsterdam, Breda, Deventer, Dordrecht, Eindhoven, Groningen, Rotterdam, The Hague and Zwolle, where different technological solutions and capacity-building activities were tested, including permeable pavements to avoid the risk of flooding and “water coaches” to inform house owners about water conservation methods (Case 36 in Annex 4.A).

Policy implications

When acting alone, cities and regions may not be able to leverage their full potential to make a significant difference in transitioning to net zero and enhancing climate resilience. Engagement with different stakeholders at the local level is critical to build on their wealth of “bottom-up” knowledge and experiences. Such engagement can be facilitated at various levels and in different forms, including citizens and other cities (nationally and internationally). Table 4.18 outlines a set of recommended actions for both national and subnational governments to address the policy gaps discussed above.

Table 4.18. Recommended actions to engage local actors, build partnerships and share knowledge

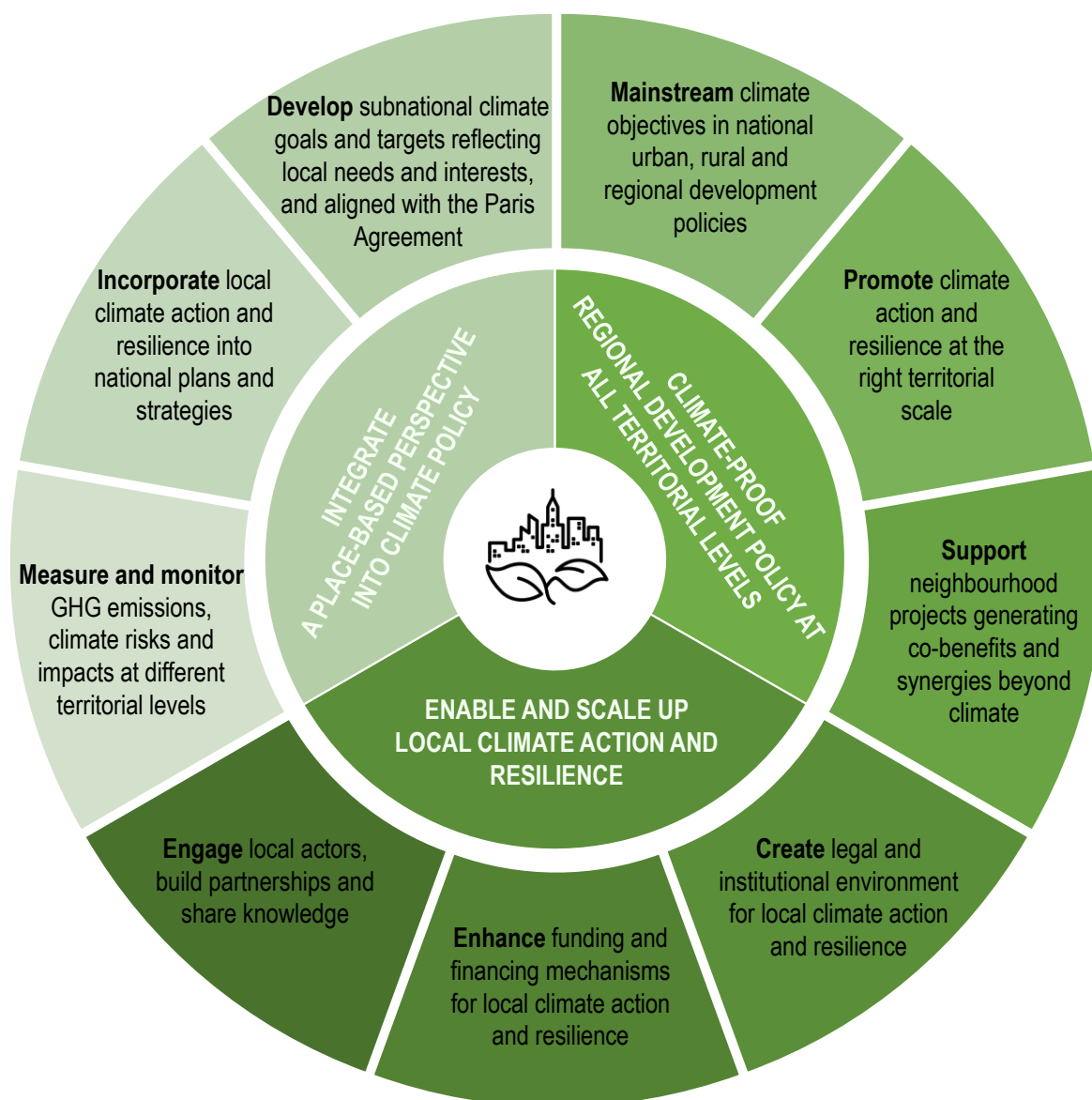
Category	For whom	Recommended action
Engaging local actors	All levels	• Enable citizens' participation in the design of national and subnational climate policies. • Create “experts commissions” to inform national and subnational climate action planning.
	Cities and regions	• Engage with universities and research institutions to build knowledge on local climate action. • Adopt local green and energy deals or pacts among local governments, local businesses and industries and other stakeholders.
Vertical partnerships	All levels	• Co-develop climate action plans between local, regional and national governments. • Create co-ordinated national, regional and local committees. • Develop co-financing agreements for the implementation of climate action between national, regional and local governments.
Horizontal partnerships	Cities and regions	• Adopt city-to-city collaboration agreements.
Knowledge sharing across governments and stakeholders	Cities and regions	• Create knowledge centres with relevant information on climate mitigation and adaptation at the regional/city scale. • Develop communication campaigns to raise awareness of residents about the importance of the net zero and resilient transition.

Conclusions

This chapter has assessed how cities, regions and countries in OECD countries are implementing a territorial approach to climate action and resilience. Drawing on a selection of 36 leading examples (presented in further detail in Annex 4.A), this assessment can be translated into the following 3 pillars subdivided into 9 recommended actions (Figure 4.13). Detailed and concrete sub-actions have been proposed and summarised in tables for each recommended action, serving as a policy checklist.

- **Pillar I: Integrate a place-based perspective into climate policy**
 - Measure and monitor GHG emissions, climate risks and impacts at different territorial levels.
 - Incorporate local action into national climate plans and strategies.
 - Develop subnational climate goals and targets reflecting local needs and interests and aligned with the Paris Agreement.
- **Pillar II: “Climate-proof” regional development policy at all territorial levels**
 - Mainstream climate objectives in national urban, rural and regional development policies.
 - Promote climate action and resilience at the right territorial scale.
 - Support neighbourhood projects generating co-benefits and synergies beyond climate.
- **Pillar III: Enable and scale up local climate action and resilience**
 - Create a legal and institutional environment for local climate action and resilience.
 - Enhance funding and financing mechanisms for local climate action and resilience.
 - Engage local actors, build partnerships and share knowledge.

Figure 4.13. Nine recommended actions to apply a territorial approach to climate action and resilience



Annex 4.A. Leading practices advancing a territorial approach to climate action and resilience

Annex Table 4.A.1. List of leading practices of a territorial approach in OECD countries, regions and cities, by type of action

Case no.	Location	Name of practice	Scope	Recommended actions								
				1	2	3	4	5	6	7	8	9
1	Korea	Helping cities and regions develop adaptation measures: Vulnerability Assessment Tool to Build Climate Change Adaptation Plan (VESTAP)	Adaptation									
2	Boston, United States	Identifying local climate risk together with social factors contributing to vulnerability: Climate Ready Map Explorer	Adaptation									
3	United States	Tracking real-time climate change impacts: Climate Mapping for Resilience and Adaption (CMRA)	Adaptation									
4	Colombia	Integrating cities' needs and interests into national climate policies: Roundtable of Cities and Climate Change	Mitigation, adaptation									
5	Canada	Developing climate strategies in close collaboration with provinces: Pan-Canadian Framework on Clean Growth and Climate Change	Mitigation, adaptation									
6	Japan	Collaborative climate action across levels of government: Council for National and Regional Decarbonization, Regional Decarbonization Roadmap and 100 Decarbonization Leading Areas	Mitigation, adaptation									
7	Ireland	Delineating a whole-of-government and society approach: National Adaptation Framework	Adaptation									
8	Flanders Region, Belgium	Translating EU climate targets into local action plans: Local Energy and Climate Pact	Mitigation, adaptation									
9	Costa Rica	Incorporating climate objectives into national urban policies: National Urban Development Policy 2018-2030	Mitigation, adaptation									
10	Poland	Understanding local climate challenges to delineate action of national urban policy: Polish National Urban Policy 2030	Mitigation, adaptation									
11	Germany	Integrating climate considerations for urban development investments: Urban Development Support Programme	Mitigation, adaptation									
12	Vancouver, Canada	Incentivising non-motorised transport at the metropolitan scale: Transit-Oriented Communities in Metro Vancouver	Mitigation									
13	Basel, Switzerland	A city-wide regulation on greening all flat roofs: Green Roofs Planning	Mitigation, adaptation									
14	Copenhagen, Denmark	Enhancing water retention with green infrastructure in cities: Cloudburst Management Plan	Adaptation									
15	Lisbon, Portugal	Expanding green urban areas without increasing water needs: Strategic Plan for Water Reuse	Adaptation									
16	United Kingdom	Strengthening nation-wide planning requirements for enhanced biodiversity: Biodiversity Net Gain Planning	Mitigation, adaptation									

Case no.	Location	Name of practice	Scope	Recommended actions								
				1	2	3	4	5	6	7	8	9
17	Freetown, Sierra Leone	Setting targets for the expansion of urban green areas: The Freetown the Treetown initiative	Mitigation, adaptation									
18	Barcelona, Spain	Setting a local goal on green areas with a co-production approach: Climate Plan 2018-2030	Mitigation, adaptation									
19	Spain	Promoting on-demand pooling transport in low-demand rural areas: Sant Cugat del Vallès and Vallirana	Mitigation									
20	Czech Republic	Bridging the gap in public transport in rural regions: Radiobus	Mitigation									
21	France	Promoting sustainable neighbourhood development: ÉcoQuartier label	Mitigation, adaptation									
22	Netherlands	Enabling municipalities to innovate and develop energy transition measures: Natural Gas-Free Neighbourhood Programme	Mitigation									
23	United States	Funding unmet needs post major disasters: Community Development Block Grant Disaster Recovery (CDBG-DR) funds	Adaptation									
24	Ahmedabad, India	Tackling against extreme heat in informal communities in partnership with a women-focused non-profit organisation: Heat Action Plan	Adaptation									
25	Mexico	Safeguarding climate commitments with legislation: General Law on Climate Change	Mitigation, adaptation									
26	France	Empowering municipalities to manage water: Loi de Modernisation de l'action publique territoriale et d'affirmation des métropoles (MAPTAM)	Adaptation									
27	Mexico City, Mexico	Funding urban infrastructure with municipal green bonds: Green Bond Issuance in Mexico City	Mitigation, adaptation									
28	Region of Andalusia, Spain	Providing the basics for the issuance of green bonds: Sustainable Finance Framework for Issuing Sustainable Bonds	Mitigation, adaptation									
29	Region of Brittany, France	Classifying climate expenditures: Climate Budget Tagging	Mitigation, adaptation									
30	Umeå, Sweden	Multi-stakeholder partnerships and collaboration for the circular economy: Strategic Plan 2016-2028	Mitigation, adaptation									
31	New York, United States	Engaging building owners to boost the energy performance of buildings: NYC Retrofit Accelerator	Mitigation									
32	New Zealand	Providing independent and evidence-based advice for climate policies: Climate Change Commission/He Pou a Rangi	Mitigation, adaptation									
33	Cape Town, South Africa	Raising awareness on water conservation: Day Zero Campaign	Adaptation									
34	European Union	Experimentation and innovation hubs for European cities: EU Mission for 100 Climate-neutral and Smart Cities by 2030 and NetZeroCities	Mitigation									
35	European Union	Facilitating knowledge sharing for climate adaptation: Climate-ADAPT	Adaptation									
36	Netherlands	Facilitating knowledge sharing among different actors: Climate Adaptation City Deal	Adaptation									

Note: Dark blue corresponds to the most relevant action related to the case, whereas light blue signifies indirectly related actions.

Action 1. Measure and monitor GHG emissions, climate risks and impacts at different territorial levels

Case 1. Helping cities and regions develop adaptation measures: Vulnerability Assessment Tool to Build Climate Change Adaptation Plan (VESTAP) (Korea)

Scope	Climate adaptation
Most relevant action	Action 1
Other relevant actions	Action 7
Location	Korea
How a territorial approach is implemented	In 2014, the Korea Adaptation Center for Climate Change (KACCC) developed the Vulnerability Assessment Tool to Build Climate Change Adaptation Plan (VESTAP) to help provinces and municipal governments assess vulnerability and update their adaptation measures. It can be used as science-based evidence to analyse climate change status and vulnerabilities. This GIS-based tool helps provinces and municipalities visualise their local vulnerability and risk, offering data on climate exposure, sensitivity and adaptation capacity. It includes 2 725 vulnerability indexes covering 7 assessment categories: health, disaster, agriculture, forest, ocean, water management and ecosystem. Equipped with raw data for 17 provincial and 252 municipal governments, VESTAP allows users to assess the vulnerability of different spatial ranges from provinces to municipalities. After selecting climate change scenarios (RCP 4.5/8.5) and time range (10-year intervals from 2010-40), VESTAP displays a visualised vulnerability map and a list of indicators. Aside from checking the pre-assessed vulnerability, cities and regions can also conduct their own assessment by modifying weights and adding new indicators.
Impacts/ success factors/ lessons learned	The customised assessment result will help cities and regions determine place-based adaptation priorities and budget allocations. This is a successful case where the national government provides the tool and information that help local governments (provinces and municipalities) understand their vulnerabilities, recognise their climate change adaptation priorities and develop contextualised measures to mitigate vulnerability by sector.
Sources	(KEI, 2018 ^[133])

Case 2. Identifying local climate risk together with social factors contributing to vulnerability: Climate Ready Map Explorer (Boston, United States)

Scope	Climate adaptation
Most relevant action	Action 1
Other relevant actions	Action 3
Location	Boston, United States
How a territorial approach is implemented	Boston copes with rising sea levels, increased temperatures and intensified storms, which present challenges to the city's local communities, infrastructure and open spaces. As a result, the city initiated the implementation of Climate Ready Boston, starting with the publication of a report in 2016. This initiative endeavours to cultivate resilience strategies, encompassing comprehensive coastal resilience plans and strategies to mitigate the increasing temperatures. The Climate Ready Boston Map Explorer, an integral component, provides regularly updated spatial data, in turn enabling stakeholders at various levels to comprehend and effectively address climate risks in the city of Boston. The Climate Ready Boston Map Explorer is a tool that grants users access to comprehensive spatial data pertaining to the risks of flooding and extreme heat in the city of Boston, fostering a better understanding of vulnerability factors and acquiring access to information concerning climate resilience projects within the city. The initiative is aligned with the city's commitment to inclusive adaptation to ensure that all city dwellers can actively participate in building a more climate-resilient Boston.
Impacts/ success factors/ lessons learned	The Climate Ready Boston Map Explorer has made substantial contributions to Boston's climate resilience endeavours. By providing accessible and consistently updated spatial data, it has bestowed upon stakeholders the capacity to identify vulnerabilities and give priority to resilience projects. It has played a pivotal role in enhancing readiness and engagement at multiple tiers, reflecting the importance of place-based climate action.
Sources	(City of Boston, 2023 ^[8])

Case 3. Tracking real-time climate change impacts: Climate Mapping for Resilience and Adaptation (United States)

Scope	Climate adaptation
Main action	Action 1
Other relevant actions	Action 7
Location	United States
How a territorial approach is implemented	In response to the ever-changing climate challenges in the United States, the Climate Mapping for Resilience and Adaptation (CMRA) initiative has emerged as a vital instrument. It endeavours to evaluate place-based exposure to climate-related hazards, recognising the significance of preventative climate mitigation measures and is the result of collaborations under the U.S. Global Change Research Program (USGCRP), showcasing an intergovernmental effort to advance climate resilience in the United States. The CMRA is an online platform that aims to address climate-related hazards effectively throughout the United States. It supports city dwellers and other stakeholders at multiple levels in comprehending and assessing communities' vulnerability to these risks. The portal serves as an extensive source of data pertaining to governmental policies concerning climate adaptation. Additionally, it provides valuable insights regarding federal funding prospects that can be utilised to strengthen projects aimed at enhancing climate resilience.
Impacts/success factors/lessons learned	Positioned as an accessible source of information, the CMRA demonstrates notable benefits to individuals who are seeking federal funding opportunities. It has been found that proactive investments in climate mitigation have the potential to yield substantial cost reductions in post-major disasters and have played a pivotal role in augmenting climate resilience throughout the United States, highlighting the value of multi-tiered stakeholder partnerships. By fostering co-operation among essential federal entities, the CMRA facilitates the advancement of climate resilience at multiple levels.
Sources	(The White House, 2022 ^[14] ; CMRA, 2023 ^[15])

Action 2: Incorporate local action into national climate plans and strategies

Case 4. Integrating cities' needs and interests into national climate policies: Roundtable of Cities and Climate Change (Colombia)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 2
Other relevant actions	Action 3, Action 7
Location	Colombia
How a territorial approach is implemented	In 2018, the government of Colombia enforced Law 1931, which mandates districts and municipalities to prepare Territorial Climate Change Plans and implement and monitor them. Territorial entities must also incorporate climate change management into their development plans and other planning instruments. The law also delineates eight areas of action: i) provide urban infrastructure resilient to floods and rising sea levels; ii) reduce climate risk due to urban water shortages; iii) provide efficient public transport systems; iv) encourage constant reductions in the generation of solid and liquid waste; v) encourage residential and non-residential energy efficiency; vi) reduce flood exposure and transport emissions through controlled urban expansion; vii) promote conservation of local ecological systems; and viii) generate scientific knowledge to quantify CO₂ capture. A roundtable of cities and climate change enabled the national government to integrate cities' needs and interests into national climate policies by selecting indicators and identifying financial instruments to forward cities' low-emission initiatives and integrate them into national climate policies.
Impacts/success factors/lessons learned	The law of 1931 and the roundtable helped align national and local climate policies. The stipulation of national commitment and legal action led Colombia to announce a more ambitious climate objective. In 2020, it announced the renewed NDC with a 51% reduction of GHG by 2030, compared to 20% below the business-as-usual scenario announced in 2017. The new NDC includes many city-level climate actions.
Sources	(Colombian Ministry of Environment and Sustainable Development, 2018 ^[26]) (MinAmbiente, 2022 ^[134])

Case 5. Developing climate strategies in close collaboration with provinces: The Pan-Canadian Framework on Clean Growth and Climate Change (Canada)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 2
Other relevant actions	Action 7
Location	Canada
How a territorial approach is implemented	Canada launched the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) in 2016, the first national climate plan developed with the provinces and territories and in consultation with indigenous communities to meet emission reduction targets, grow the economy and build resilience to a changing climate. It aims to drive innovation and growth by promoting technological development and adoption to ensure the country remains competitive in the global low-carbon economy, simultaneously advancing climate change adaptation and building resilience to climate impacts. The PCF is built on four main pillars: i) carbon pricing; ii) complementary measures to further reduce emissions; iii) measures to adapt to the climate change impact and build resilience; and iv) actions to accelerate innovation, support clean technology and create jobs. The PCF guarantees flexibility for provinces and territories to design their own policies and programmes to meet local emission reduction targets, supported by federal infrastructure investments, specific emission reduction opportunities and clean technologies. For instance, while the PCF requires provinces and territories to introduce a carbon pricing scheme, it can range from a carbon tax, a cap-and-trade system, credit trading programmes or a hybrid approach, depending on the local administrative capacity and emissions. The PCF supports locally tailored policy and action-making while setting out the wider agenda and strategies.
Impacts/ success factors/ lessons learned	The PCF has served as the dialogue platform on climate-related policies between the federal government and the provinces and territories. Driven by measures in the PCF alone, Canada is expected to see a 19% reduction in emissions below 2005 levels by 2030 (227 millions of tonnes decrease).
Sources	(Government of Canada, 2023 ^[135]) (Government of Canada, 2021 ^[136])

Action 3: Develop subnational climate goals and targets reflecting local needs and interests and aligned with the Paris Agreement

Case 6. Collaborative climate action across levels of government: Council for National and Regional Decarbonisation, Regional Decarbonisation Roadmap and 100 Decarbonisation Leading Areas (Japan)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 3
Other relevant actions	Action 7, Action 8, Action 9
Location	Japan
How a territorial approach is implemented	In 2021, the Ministry of Environment of Japan launched the Regional Decarbonisation Roadmap programme to facilitate the collaboration between national and local governments in the journey to achieve climate neutrality by 2050. The programme came from Council for National and Regional Decarbonisation discussions, where the prime minister of Japan, other relevant ministers and selected mayors consulted on how to accelerate national decarbonisation. The Japanese government provides grants and technical support to help local governments and private sector companies implement decarbonisation projects. These are regions that achieve net zero emissions from electricity consumption in households and the business sectors by 2030 – earlier than the national goal of 2050. This initiative applies a territorial approach by supporting locally tailored solutions based on the collective action of national, regional and local governments. At the end of 2022, 46 plans have been selected as “decarbonisation leading areas” after the first and second rounds of applications and the aim is to select at least 100 of them by 2030. For example, the city of Nagoya was selected to build a wide-area renewable energy grid that connects distributed renewable energy resources within and around the city. The programme aims to create a “decarbonisation domino effect” whereby local initiatives catalyse similar efforts in neighbouring municipalities, leading to a nationwide movement towards carbon neutrality.
Impacts/ success factors/ lessons learned	The Council for National and Regional Decarbonisation provided a forum where national and subnational governments can discuss effective collaboration programmes on an equal footing. The 100 Decarbonisation Leading Areas national pilot programme, a nationally-led initiative with financial support, triggered strong motivation for cities and regions to take local decarbonisation actions.
Sources	(Japanese Ministry of the Environment, 2023 ^[137])

Case 7. Delineating a whole-of-government and society approach: National Adaptation Framework (Ireland)

Scope	Climate adaptation
Most relevant action	Action 3
Other relevant action	Action 2, Action 7, Action 9
How a territorial approach is implemented	Ireland published its first statutory National Adaptation Framework (NAF) in 2018, which lays out the national strategy to reduce the vulnerability of the country to negative climate change impacts and amplify positive impacts. The NAF delineates a whole-of-government and society approach to climate action by improving the enabling environment for adaptation through ongoing engagement with civil society, the private sector and the research community. The NAF explicitly delineated the role of key sectors, including local governments, and recognised the need to ensure co-ordination of adaptation actions across sectors and government departments and agencies. The local adaptation plans and initiatives are built on multi-stakeholder partnerships. First, the NAF is subject to regular review, at least every five years. The latest review process in 2022 included a public consultation, in addition to feedback from key sectoral, department and agency stakeholders. The framework establishes that each local authority should make and adopt local adaptation strategies based on the regional governance approach to adaptation planning. The development of strategies must be undertaken in accordance with the Local Authority Adaptation Strategy Development Guidelines and the NAF. To support this endeavour, the NAF also delineated the need to develop four Climate Action Regional Offices (CAROs), which work with local authorities and co-ordinate regional and territorial adaptation planning. CAROs provide technical capacity training and financing to local authorities so they can develop and implement territorial climate plans. The NAF and accompanying initiatives, such as CAROs, align climate policies between local and national governments, but also across sectors.
Impacts/success factors/lessons learned	Under the NAF, in 2019, all 31 local authorities prepared Local Adaptation Strategies. In 2021, over 13 000 local authority staff received training provided by the Local Authority Climate Action Training Plan.
Sources	(Government of Ireland, 2018 ^[138]) (Government of Ireland, 2023 ^[139])

Case 8. Translating EU climate targets into local action plans: Local Energy and Climate Pact (Flanders, Belgium)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 3
Other relevant actions	Action 7, Action 9
Location	Region of Flanders, Belgium
How a territorial approach is implemented	The region of Flanders launched a Local Energy and Climate Pact (LEKP) to set out concrete objectives for its signatories to tackle the global climate challenge at the local level. It refers to the European Climate Act, an initiative of the European Commission to invite "people, communities and organisations to participate in climate action and build a greener Europe". The LEKP specifies four key areas: greening, energy, mobility and rainwater. By 2030, the pact aims to have 1 tree per person, 50 collective renovations per 1 000 residential units, 1 charging point per 100 inhabitants and 1 cubic metre of extra rainwater collection per inhabitant. The LEKP holds a stakeholders' climate dialogue every two years, including cities, local governments and citizens' organisations, to co-design climate objectives and actions, facilitating broad inclusivity at a grassroots level. Based on this, the Flemish regional government biannually engages with the Belgian national government to assess, evaluate and integrate local and regional plans into the national policy and NDC development. The Flemish government also promised subsidies for municipalities.
Impacts/success factors/lessons learned	The LEKP aligns local climate objectives and action plans with the wider climate agenda of Belgium and the European Union. So far, 293 out of 300 municipalities have committed to the initial pact (LEKP 1.0) and 210 cities and municipalities have signed up for the renewed LEKP 2.0 so far. Signing the LEKP encompasses signing the Covenant of Mayors 2030; in this way, the Flemish government aligns local initiatives with European climate policies and strategies.
Sources	(Flemish Government, 2023 ^[140])

Action 4: Mainstream climate objectives in national urban, rural and regional development policies

Case 9. Incorporating climate objectives into national urban policies: National Urban Development Policy 2018-2030 (Costa Rica)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 4
Other relevant actions	Action 2, Action 5, Action 9
Location	Costa Rica
How a territorial approach is implemented	Costa Rica announced the National Urban Development Policy 2018-2030 and Action Plan 2018-2022, which recognise the importance of climate change and other environmental factors in a cross-sectoral manner. The policy and action plan set out three strategic areas: i) incorporate a range of environmental considerations in urban and territorial planning instruments; ii) improve the adaptation capacity of urban infrastructure to mitigate natural risks and threats such as those tied to climate change; and iii) promote the construction and operation of urban buildings and infrastructure with a positive net effect on natural and urban environments. The national urban policy prioritises implementing low-emission public transport, enhancing the treatment of organic solid waste and promoting sustainable and bioclimatic construction that makes use of natural lighting and ventilation. However, there is still an opportunity for improvement; the National Urban Development Policy does not include a specific evaluation and follow-up model, leaving a need for indicators to monitor and report on the progress of the 2030 Agenda.
Impacts/success factors/lessons learned	The policy and plan institutionalise political will to integrate climate consideration into urban and territorial planning. The national urban policy covers human rights and social inclusion, requiring local governments to meet the needs of all citizens equally. Costa Rica also provides the entire population with free access to geospatial information, promoting greater engagement of citizens in urban policy.
Sources	(MIVAH, 2018 ^[141]) (OECD/UN-Habitat/Cities Alliance, 2021 ^[47])

Case 10. Understanding local climate challenges to delineate action of national urban policy: Polish National Urban Policy 2030 (Poland)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 4
Other relevant actions	Action 1, Action 5, Action 7
Location	Poland
How a territorial approach is implemented	National urban policy is one of the three pillars of Polish local policy, alongside the Strategy for Responsible Growth and the Strategy for Regional Development. In Poland, challenges pertaining to mitigating the negative effects of climate changes in cities, improving the quality of natural environment in cities and sustaining sustainable and integrated urban mobility systems are prevalent in urban areas across the country. Launched in 2023, the Polish National Urban Policy 2030 seeks to tackle these challenges effectively by placing climate at the forefront of urban development. At its core is the vision to strengthen the capacity of cities and urban areas, improve the quality of life for city dwellers and build resilience to climate change. The Polish National Urban Policy 2030 discusses extensively the challenges related to climate mitigation and adaptation in cities. To do so, it reviews existing climate-related indicators (i.e. accessibility to green areas, spatial distribution of PM _{2.5} , average increase in impermeable surfaces in urban areas, change in average annual air temperature) and delineates concrete actions to address climate-related risks. For example, it aims to introduce legislative reforms that raise the profile of blue-green infrastructure for future urban development, by proposing legal empowerment of blue-green infrastructure as 'critical infrastructure' according to the 2007 Act on crisis management and by introducing a blue-green infrastructure plan as a tool to monitor and coordinate its development.
Impacts/success factors/lessons learned	The national government's clear vision through the National Urban Policy 2030 can guide cities and regions, putting climate at the forefront of urban development. The use of local climate data provided an evidence-based understanding of local challenges.
Sources	(Government of the Republic of Poland, 2022 ^[48])

Case 11. Integrating climate considerations for urban development investments: Urban Development Support Programme (Germany)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 4
Other relevant actions	Action 7, Action 8, Action 9
Location	Germany
How a territorial approach is implemented	In 1971, in West Germany, the Urban Development Support Programme was launched under the Urban Planning Funding Act to provide financial support for investments in the reformation and development of cities and communities. Since 2007, it has been one of the key instruments for delivering on the Leipzig Charter on Sustainable European Cities. The latest restructure was made in 2020, updating the eligibility to include measures for climate protection and climate change adaptation, including the improvement of green infrastructure. The programme is built on multi-level co-ordination, integrated planning, flexible needs-oriented measures, community participation and feedback. In terms of multi-level co-ordination, federal states are responsible for actual distribution of funding to towns, cities and communities based on their state-specific urban development policy, strategic support and local requirements. The ultimate authority for planning and implementation remains solely in towns, cities and communities. Local stakeholder engagement is another key to the programme, inviting various stakeholders from businesses to educational sectors to participate in development processes and individual projects. This contributes to creating an identity for the local community. This nationwide funding programme acknowledges the importance of a place-based planning approach grounded in local needs and voices.
Impacts/success factors/lessons learned	Since its inception, the programme has given a total of EUR 18 billion in funding to support municipalities in urban development adaptation processes. As of 2020, 9 314 joint projects received the funding. Every euro of the funding generates an average of EUR 7 of private or public construction investment, bringing monetary returns to the regional economies, in addition to positive social and climate impacts.
Sources	(Federal Ministry for Housing, Urban Development and Building, 2023 ^[142])

Action 5: Promote climate action and resilience at the right territorial scale

Case 12. Incentivising non-motorised transport at the metropolitan scale: Transit-Oriented Communities in Metro Vancouver (Vancouver, Canada)

Scope	Climate mitigation
Most relevant action	Action 5
Other relevant actions	Action 6
Location	Vancouver, Canada
How a territorial approach is implemented	The Metro Vancouver Region (MVR) in British Columbia, Canada, is the third-largest metropolitan region in the country. It produces over 60% of the province's real GDP. Between 2013 and 2017, the MVR had an average annual real GDP growth of 3.9%, while the national average was 2.1%. However, despite having high levels of well-being, the region faces important challenges: underinvestment in public transit and road infrastructure, poor housing affordability, land scarcity for port expansion, low labour productivity levels and stalled educational attainment rates. Transport-related issues have been a priority for policy makers in the region for the last two decades as the conditions of streets and roads, traffic congestion, long commute times, the quality and level of public transit, road safety and parking deteriorate. The lack of affordable housing is a growing concern for citizens. To rise to the mobility and accessibility challenges, the MVR has had a consistent long-term development vision supported by transport investments. The Regional Growth Strategy (RGS) and the Regional Transport Strategy (RTS), the two main strategic planning documents, underpin the ten-year investment plans, as well as the municipal transport and economic development plans. The development of "transit-oriented development communities" is one of the strategic goals of both the RGS and RTS. This aims to incentivise people to drive less and walk, cycle and take transit more.
Impacts/success factors/lessons learned	A solid culture of community engagement, the existence of a co-ordinating body for transport planning and the links between transport and land use policy are the main assets MVR has to enhance accessibility. However, tackling the affordable housing deficit around transport hubs remains a challenge for local authorities.
Sources	(Huerta Melchor and Lembcke, 2020 ^[143])

Case 13. A city-wide regulation on greening all flat roofs: Green Roofs Campaign (Basel, Switzerland)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 5
Other relevant actions	Action 3, Action 8, Action 9
Location	Basel, Switzerland
How a territorial approach is implemented	The Green Roof Campaign is a local initiative in Basel, launched in 1996. The campaign initially aimed at energy saving but, over time, the objective shifted to biodiversity conservation while addressing climate change impacts, including high temperatures, exacerbating urban heat island effects, habitat loss and increasing GHG emissions. The campaign uses a combination of financial incentives and regulations. In the first instance, Basel's energy-saving law collected 5% of all customers' energy bills in an Energy-Saving Fund, which was then used to fund energy-saving campaigns and measures. In 2002, Basel passed a new building and construction law requiring all new and renovated flat roofs to be green and stipulating their design to maximise biodiversity. Since the beginning, stakeholder engagement with local businesses, environmental organisations and citizens played a key role in embedding the green roof concept and educating on the co-benefits of green roofing. The campaign has evolved over time, accommodating the changing place-based climate risks and challenges.
Impacts/success factors/lessons learned	Blended incentives and statutory regulation mechanisms have helped embed the green roof concept in the city. In 2019, the city of Basel had the largest area of green roofs per capita in the world, at 5.71 m ² /inhabitant. According to the Basel municipality, approximately 40% of the city's roof surface is covered by green roofs as of 2022.
Sources	(Climate-ADAPT, 2020 ^[144])

Case 14. Enhancing water retention with green infrastructure in cities: Cloudburst Management Plan (Copenhagen, Denmark)

Scope	Climate adaptation
Most relevant action	Action 5
Other relevant actions	Action 3, Action 6
Location	Copenhagen, Denmark
How a territorial approach is implemented	The Cloudburst Management Plan was developed by Copenhagen in 2012, as part of its Climate Adaptation Plan to reduce the impacts of pluvial flooding, whose frequency and intensity are expected to worsen because of climate change. The plan was built on a detailed socio-economic assessment to ascertain whether cloudburst and stormwater management can pay off for society. Appropriate prioritisations and co-benefits analysis are the keys to the plan. Due to its administrative and financial capacity constraints, Copenhagen needed to prioritise in line with the Copenhagen Climate Adaptation Plan. Among the planned 300 projects, the city makes annual prioritisation decisions, considering: i) high-risk areas; ii) areas where measures are easy to implement; iii) areas with ongoing urban development projects; and iv) areas where synergistic effects can be gained. Around 15 projects will be carried out annually for the next 20-30 years accordingly. Adaptation measures are integrated with the existing and planned urban development, considering recreational value, biodiversity and social and health benefits. For instance, water reservoirs function as parks and recreational places when it is not raining. The estimated cost of full implementation over the 20 years is DKK 3.8 billion, which is still cheaper than the cost of the 2011 flooding alone (DKK 5 billion). However, several challenges remain. For example, some projects are planned in private roads, where road owners can decide whether or not to implement the project. Co-ordination with private landowners and developers is key to implementing projects.
Impacts/success factors/lessons learned	The deployed functional approach has enabled Copenhagen to generate co-benefits by aligning climate objectives with other economic, social and environmental considerations.
Sources	(OECD, 2018 ^[145]) (Climate-ADAPT, 2020 ^[144])

Case 15. Expanding green urban areas without increasing water needs: Strategic Plan for Water Reuse (Lisbon, Portugal)

Scope	Climate adaptation
Most relevant action	Action 5
Other relevant actions	Action 3
Location	Lisbon, Portugal
How a territorial approach is implemented	The Strategic Plan for Water Reuse is Lisbon's strategy to create a citywide recycled water distribution network and a working group for water quality assurance. Non-potable use, such as street washing and irrigation, has been consuming 75% of the city's drinking water. The plan is aligned with a wider city vision, manifesting a strong commitment to managing water as a part of a wider Water Efficiency Strategy. The city invested EUR 20 billion to create a 55-km reclaimed water distribution network. It also introduced lower tariffs for recycled water, which would save EUR 26.8 billion by 2030. The Wastewater Reuse Plan, a part of the strategic plan, aims to reuse more than 1 million m³ to irrigate many urban parks. Lisbon also constructed nine rainwater retentions as nature-based solutions (NbS) to store rainwater and reduce the impacts of floods, including small basins and changes to plant life. The plan is based on a territorial approach, considering synergies with other climate policies and addressing localised water challenges with NbS most appropriate to the local environment.
Impacts/success factors/lessons learned	As of 2020, the city positions as one of the lowest water leakage rates in the world, at 11%. Lisbon is greening the city without increasing its overall water use, making it more resilient to heatwaves and flooding and reducing the urban heat island effect. The estimated saving of drinking water by 2025 could reach 6 million m ³ . The urban recycled water system is also expected to reach 25% of the green structure in 4 years.
Sources	(Lisboa E-Nova, n.d. ^[146]) (C40 Cities, 2019 ^[147]) (Copenhagen Centre, n.d. ^[148])

Case 16. Strengthening planning requirements for enhanced biodiversity: Biodiversity Net Gain Approach (United Kingdom)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 5
Other relevant actions	Action 7
Location	United Kingdom
How a territorial approach is implemented	The United Kingdom passed the Environment Act 2021 to improve and protect the natural environment. It provides the government with powers to set new binding targets, including for air quality, water, biodiversity, conservation covenants and updates to laws on chemicals. The act is pertinent for the Department for Environment, Food and Rural Affairs' various environmental policies and lays out the legal framework for significant reforms to local authority waste and recycling services, as well as creating new statutory duties for local authorities on nature conservation. The act makes it mandatory for local plans to incorporate biodiversity consideration; from November 2023, all planning permissions in England (United Kingdom) will have to deliver at least 10% biodiversity net gain.⁶ Local governments, local planning authorities and developers need to work with local communities, landowners and farmers to deliver benefits to biodiversity. The act also established a new environmental watchdog, the Office for Environmental Protection, which will hold the government and other public bodies accountable for nature and environment conservation. The act streamlines nature conservation and biodiversity into both national and local planning processes, reinforcing local climate resilience. Viewing protection of natural environment and climate change as twin challenges, the act intends to improve air quality, biodiversity, water quality and resource efficiency and reduce waste. Setting a minimum biodiversity net gain, the act strives to halt the decline of nature by 2030.
Impacts/success factors/lessons learned	A legal framework provided ambitious targets cutting across different policy areas (e.g. water, agriculture) and a clear mandate to all actors engaged, including local authorities, local communities and landowners.
Sources	(Natural England, 2022 ^[149])

Case 17. Setting targets for the expansion of urban green areas: The Freetown the Treetown initiative (Freetown, Sierra Leone)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 5
Other relevant actions	Action 8, Action 9
Location	Freetown, Sierra Leone
How a territorial approach is implemented	The initiative aims to plan and grow 1 million trees and restore 3 000 hectares of land, sequestering approximately 69 000 tonnes of CO ₂ . The initiative uses innovative, disruptive, low-cost digital technology for tree tracking. It also creates new jobs for women and young people in green sectors as every tree has been assigned a unique identification code that can be transformed into "impact tokens" and sold as carbon offsets. The campaign brought out multiple benefits, collaborating with a technology firm and a neighbouring municipality. The city partnered with a technology company to develop a localised system that creates a unique geotagged record for each tree planted so tree growers can document their plants' survival and growth. Upon verification of their growth, plant growers are entitled to receive supplementary money. Analysing the water pathways, the campaign worked with a neighbouring authority, the Western Area Rural District Council, which is home to a watershed that supplies Freetown's water and is also where the flooding begins. The campaign took a territorial approach to address disaster risk reduction by: i) analysing and creating local co-benefits beyond environmental impacts; and ii) applying a functional approach by working with an adjacent authority.
Impacts/ success factors/ lessons learned	Within 2 years after the campaign's launching, 560 000 trees have been planted, digitally tracked and tokenised, with 578 ha of urban land restored. It also helped the city create 1 000 green jobs, 80% of which for youth and 47% women, who started making money as community-based tree growers. The use of digital technology allowed the city to: i) build long-term climate resilience by tracking and monitoring tree growth; as well as ii) create accessible job opportunities for local youth and women.
Sources	(OECD, 2023 ^[150]) (Freetown City Council, 2023 ^[151])

Case 18. Setting a local goal on green areas with a co-production approach: Climate Plan 2018-2030 (Barcelona, Spain)

Scope	Mitigation, adaptation
Most relevant action	Action 5
Other relevant actions	Action 3, Action 9
Location	Spain
How a territorial approach is implemented	Barcelona announced its Climate Plan 2018-2030 to set out the city's strategy to reduce emissions by 45% by 2030, to achieve 2050 carbon neutrality and alleviate climate change impacts such as extreme heat, reduced water availability and flooding. It proposes 242 actions grounded on 4 strategic goals: mitigation, adaptation, climate justice and promoting citizen action, with the most vulnerable people at the centre of its plan. Notably, the plan set a goal to expand its green areas by 1.6 km ² by 2030, corresponding to an extra 1 m ² per person. As of 2019, the city offers an estimated 17.50 m ² of green areas per inhabitant. Hundreds of city organisations and lay citizens highly contextualised and co-produced the climate plan. Barcelona acknowledged that the local population will be affected by climate change unevenly. The city adopted a "co-production" approach where the city council and social actors jointly work for a specific action or policy of public interest to create a more just and inclusive climate plan for the local context.
Impacts/ success factors/ lessons learned	A range of several long-term and medium-term measures accompany the goals. These measures include identifying areas within the city that are in greater need of green spaces due to factors such as climate conditions and spatial considerations, such as high temperatures and intensive use of public spaces. Barcelona used two unique channels to ensure a co-production approach. First, it relied on the Barcelona and Sostenible network, a network of approximately 1 000 organisations (NGOs, private companies, schools and trade unions) to incorporate voices from civil societies. Second, the city launched Decidim Barcelona, a digital platform, in February 2016 to collect citizens' voices through proposal collections and share updates such as evaluation of a proposal's acceptance and rejection. It enhanced citizen participation and promoted democratic governance.
Sources	(City of Barcelona, 2018 ^[152]) (Ajuntament de Barcelona, n.d. ^[153])

Case 19. Promoting on-demand pooling transport in low-demand rural areas: Sant Cugat del Vallès and Vallirana (Spain)

Scope	Climate mitigation
Most relevant action	Action 5
Other relevant actions	Action 6, Action 7, Action 8
Location	Spain
How a territorial approach is implemented	In Spain, on-demand pooling transport services were introduced in the low-demand areas of Sant Cugat del Vallès and Vallirana, situated near the Barcelona conurbation, between 2017 and 2018. These services were specifically designed to replace previous regular bus lines deemed ineffective. For instance, conventional bus lines previously served the residential area of Can Barata in Sant Cugat and certain peripheral parts of Vallirana. Earlier, these areas faced transportation challenges. For example, Can Barata was connected through a conventional bus line in Sant Cugat, which is characterised by lengthy travel times and limited coverage outside peak hours. On average, the vehicles operated with an occupancy of around six passengers per trip. Similarly, Vallirana experienced issues with infrequent bus services, leading to less-than-optimal user satisfaction due to long wait times and accessibility concerns. The shift to on-demand pooling transport services, facilitated through a technological platform provided by the information technology company Shotl, led to changes in service dynamics. In Sant Cugat, there was an observed increase in the average vehicle occupancy from 6 to 16 passengers per trip with the introduction of the new service. Moreover, the operational costs of the flexible service were found to be 15% lower than the previous regular line. An essential feature of this transformation is the ability for users to book trips remotely through an application or, in the case of Sant Cugat, over the phone. The system's algorithms adjust the routes in real-time based on the prevailing demand and traffic conditions. The platform offers distinct interfaces for passengers, drivers and operators.
Impacts/ success factors/ lessons learned	It is crucial to highlight the legal and organisational framework backing these services. Both Sant Cugat and Vallirana operations fall within the public transport concessions granted by their respective municipalities, adhering to the Spanish public transport regulations. While there are costs associated with the services, they are subsidised by the regional administration.
Sources	(OECD, 2021 ^[81]).

Case 20. Bridging the gap in public transport in rural regions: Radiobus (Czech Republic)

Scope	Climate mitigation
Most relevant action	Action 5
Other relevant actions	Action 6
Location	Czech Republic
How a territorial approach is implemented	In the Czech Republic, the Radiobus transportation service has been bridging the gap in public transportation since 2004. Unlike regular buses that run based on fixed timetables regardless of demand, Radiobus operates on a unique principle: it only takes the road when called upon by a passenger. By 2011, its efficiency and adaptability were recognised and it became an integral part of the general public transport system, specifically designed to supplement areas or times of low demand. To utilise the Radiobus, passengers simply place a request either via phone or the Internet. Once a demand is confirmed, the Radiobus will operate but only along the necessary route based on user requirement.
Impacts/ success factors/ lessons learned	A demand-driven approach ensures minimal waste of resources, providing a cost-effective and environmentally friendly transportation alternative. In essence, the Radiobus stands as a testament to innovative solutions that cater to real-world transportation challenges, ensuring everyone has access to public transport, no matter the time or place.
Sources	(OECD, 2016 ^[78])

Action 6: Support neighbourhood projects generating co-benefits and synergies beyond climate

Case 21. Promoting Sustainable Neighbourhood Development: *ÉcoQuartier Label* (France)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 6
Other relevant actions	Action 2, Action 9
Location	France
How a territorial approach is implemented	In 2012, the French Ministry of Ecological Transition launched the <i>ÉcoQuartier</i> as a national labelling system aiming to create more environmentally friendly, socially inclusive and economically vibrant neighbourhoods to provide residents with a high quality of life while reducing the adverse ecological impact of urban development. To be considered as an <i>ÉcoQuartier</i>, a neighbourhood must meet certain criteria such as “zero net artificialisation of soils” and “RE 2020 regulations”. The <i>ÉcoQuartier</i> programme advocates 20 commitments covering the 3 pillars of sustainable development (social, economic and environment), governance and evaluation. The labelling consists of four stages: signing of the charter (<i>ÉcoProject</i>), <i>ÉcoProject</i> review, project delivery and experienced districts reviewed a few years after project delivery. The project leaders and developers have the sole liberty to choose the appropriate solution to satisfy the commitment to meet the major challenges of place-based climate risk, biodiversity and social inclusion. Awarded districts consist of <i>the ÉcoQuartier Club</i>, which works in the form of thematic working groups, offers training to the regions and districts, and organises conferences and site visits. To date, more than 1 000 development actors (local authorities, public and private developers, researchers, to name a few) are members. The club intends to: i) share their experiences; ii) discuss the difficulties encountered and reflect on the opportunities; and iii) support each project.
Impacts/success factors/lessons learned	At the end of March 2023, 322 districts held <i>ÉcoQuartier</i> labelling; this means 277 330 dwellings had been built or renovated in <i>ÉcoQuartier</i> districts.
Sources	(French Ministry of Ecological Transition and Territorial Cohesion, 2023 ^[154])

Case 22. Enabling municipalities to innovate and develop energy transition measures: *Natural Gas-Free Neighbourhood Programme* (Netherlands)

Scope	Climate mitigation
Most relevant action	Action 6
Other relevant actions	Action 4, Action 9
Location	Netherlands
How a territorial approach is implemented	The Dutch government mandated that all municipalities in the Netherlands submit Heat Transition Visions encompassing plans for home insulation and sustainable, natural gas-free heating and cooking at the municipal and neighbourhood levels by the end of 2021. However, transitioning from traditional heating methods to sustainable alternatives presents complex challenges in technical, social, regulatory and financial aspects. To address these challenges effectively, practical implementation is crucial, starting at the neighbourhood level. In this context, the Natural Gas-free Neighbourhood Programme (PAW) was established as a national pilot project in 2018 to help neighbourhoods transition away from natural gas and upscale natural gas-free initiatives across the country. As of 2019, natural gas accounts for approximately 85% of the total energy use in residential buildings in the Netherlands. The PAW provides financial resources and technical assistance for neighbourhoods to experiment with natural gas-free measures. Each selected neighbourhood can receive up to EUR 5 million in funding, with full autonomy to allocate the funds as needed. Additionally, national and local governments second experts to the PAW organisation for management, addressing local needs and challenges. The PAW website provides a range of thematic information to the districts, including guidance, research reports, podcasts, case studies, interviews and webinars. Multi-stakeholder partnerships and long-term policy continuity help national and subnational governments to align their visions and objectives while allowing flexibility for neighbourhoods to select and carry out locally tailored strategies and solutions. As of 2022, 66 neighbourhoods have been selected as pilots. To scale up the lessons learned at the national level, a new inter-administrative organisation called the National Programme for Local Heat Transition (NPLW) was introduced in January 2023 to support all municipalities in the Netherlands, especially those not involved in a pilot project. The NPLW intends to accelerate the national heat transition to help 1.5 million homes phase out natural gas by 2030.

Impacts/ success factors/ lessons learned	The success of the PAW can be attributed to three key factors: multi-stakeholder partnerships with co-ordinated government staff, a flexible funding approach and a commitment to long-term support, as evidenced by the evolution of the programme into the NPLW in January 2023. Overall, the PAW provides an example of the national government supporting local governments in adopting the neighbourhood approach and gathering valuable insights for the transition process.
Sources	(PAW, 2023 ^[155]) (OECD, 2023 ^[71])

Case 23. Funding unmet needs post major disasters: Community Development Block Grant Disaster Recovery (CDBG-DR) Funds (United States)

Scope	Climate adaptation
Most relevant action	Action 6
Other relevant actions	Action 8, Action 9
Location	United States
How a territorial approach is implemented	The Community Development Block Grant Disaster Recovery (CDBG-DR) is a United States Ministry of Housing and Urban Development (HUD) fund to rebuild disaster-impacted areas and provide seed money for long-term recovery. Upon the presidential declaration of a major disaster, Congress may appropriate certain funding to the CDBG-DR. Subsequently, the HUD formally announces the CDBG-DR awards and publishes specific rules in a Federal Register notice. The programme focuses on ameliorating equity in disaster recovery processes by actively involving people who have been historically underserved, marginalised and adversely affected by persistent poverty and inequality, and prioritising their needs throughout planning and implementation. Appropriations limit the use of the funds to the "most impacted and distressed" areas resulting from a major disaster. Focus is placed on low-income areas, subject to the availability of supplemental appropriations. The programme advocates equitable local community engagement to address the hurdles and experiences of the vulnerable.
Impacts/ success factors/ lessons learned	At the end of January 2023, Congress allocated USD 99.2 billion to the CDBG-DR, USD 92.4 billion of which is active in grants. After Hurricane Katrina, the costliest natural disaster in United States history, HUD appropriated USD 13.4 billion of the CDBG-DR to the state of Louisiana for recovery from hurricanes Katrina and Rita. Part of the fund was allocated to the Building Code Enforcement programme to alleviate a major impediment to housing development: the lack of building, electrical and plumbing inspectors and permit processing staff. The programme aimed to strengthen buildings' resilience against future disasters.
Sources	(EERE, n.d. ^[77])

Case 24. Tackling against extreme heat in informal communities in partnership with a women-focused non-profit organisation: Heat Action Plan (Ahmedabad, India)

Scope	Climate adaptation
Most relevant action	Action 6
Other relevant actions	Action 3
Location	Ahmedabad, India
How a territorial approach is implemented	Ahmedabad is the most populous city in the State of Gujarat, with more than 8.5 million people. With summer daytime temperatures expected to be in the high 40 °C, and after a heatwave in May 2010 when 1,344 people lost their lives on one week, the city has been tackling against extreme heat through its Heat Action Plan (HAP). In 2013, Ahmedabad became the first city in India, and in South Asia, to have such a plan which then became the template for other cities in developing countries. The HAP includes four strategy areas: building public awareness and community outreach, initiating an early warning system and inter-agency coordination, capacity building of healthcare professionals, and promoting adaptive measures. For example, a color-coded alert system (yellow means it's going to be a hot day, between 41.1 °C and 43 °C, while red is the highest level, reserved for days above 45 °C) is linked a number of actions such as extreme heat campaigns and a shift of working hours for outside workers. In designing and implementing the HAP, the city has partnered with Mahila Housing Trust (MHT), a women-focused non-profit organisation to better understand the challenges that informal communities face and co-created viable solutions. Actionable solutions range from household-level interventions such as painting rooftops white (replacing metal roofs) and sprinkler taps to community-level interventions such as water meter installations. MHT also pioneered cool roofing solutions, which was adopted into the city's 2017 Heat Action Plan.
Impacts/ success factors/ lessons learned	While India doesn't have comprehensive cause-of-death data, Ahmedabad has reported fewer than 100 deaths every summer even during the worst daytime highest temperatures. This has been often attributed to the implementation of the HAP. Grounded in the knowledge of local women in informal communities, MHT helped the city develop viable and effective measures for women and the poorer communities who suffer most from extreme heat. MHT also provides trainings on

	concepts like heat waves, indoor temperatures and ventilation, which has effectively raise awareness of extreme heat and its effect.
Sources	(Bloomberg, 2023 ^[156]) (Desai, 2023 ^[157]) (Mahila Housing Trust, 2023 ^[158])

Action 7: Create a legal and institutional environment for local climate action and resilience

Case 25. Safeguarding climate commitments with legislation: General Law on Climate Change (Mexico)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 7
Other relevant actions	Action 3
Location	Mexico
How a territorial approach is implemented	In 2012, Mexico passed the General Law on Climate Change to institutionalise political commitment to climate action, becoming the first large oil-producing economy to adopt climate legislation. It promoted policy alignment across the different levels of government and established climate funding and regulations. Co-ordination across levels of government is managed through the National System on Climate Change (SINACC). It consists of different levels of government aligning policies: two entities from the federal level, the Inter-Ministerial Commission on Climate Change and the National Institute of Ecology and Climate Change; three entities from the regional and local level – the Federal Congress, state and municipal authorities; and the Climate Change Council as an adviser. The law was amended in 2018 to make it compatible with the Paris Agreement and aligned with the NDCs. The law established a climate change fund to channel public, private, national and international financial resources to finance climate change actions and the National Emissions Registry, mandating industries to report emissions and quantify mitigation actions annually. It helped stakeholders address local and sector-specific challenges by directing available funding and making emission information accessible.
Impacts/success factors/lessons learned	The law has made a visible impact in facilitating the low-carbon transition, assumably allowing Mexico to start generating half of its power from clean energy by 2034, 16 years earlier than the original target. It also promoted energy efficiency, reduced energy consumption and the development of energy policy instruments.
Sources	(Cámara de Diputados de México, 2022 ^[159]) (LSE, 2018 ^[160])

Case 26. Empowering municipalities to manage water: Loi de Modernisation de l'action publique territoriale et d'affirmation des métropoles (MAPTAM) (France)

Scope	Climate adaptation
Most relevant action	Action 7
Other relevant actions	Action 6
Location	France
How a territorial approach is implemented	The 2018 MAPTAM Law, a French modernisation law, transferred the authority to manage aquatic environments and flood risk (GEMAPI) to municipalities and intercommunal services. This devolution intends to facilitate interventions at the local scale and ensures that defined institutions oversee specified tasks. Under GEMAPI, local governments are responsible for: i) hydrographic basin planning; ii) installation and maintenance of water streams, canals and lakes, including access to them; iii) flood and sea defence measures; and iv) the protection and restoration of water ecosystems. Municipalities or inter-municipal services can raise a maximum tax of EUR 40 per citizen annually, attached to the local property tax, to finance new responsibilities. This tax facilitates the necessary release of resources capable of financing the monitoring and maintenance of the dykes or even their complete rehabilitation responding to local needs to increase the level of protection. Under the law, the central government must submit a report to the parliament evaluating the outcome and effectiveness of GEMAPI. It promotes a place-based approach to managing the aquatic environment and flood prevention.
Impacts/success factors/lessons learned	In 2021, 664 municipalities implemented the GEMAPI tax paid by property owners. The collected tax amounts to EUR 204 million as of 2020.
Sources	(French Ministry of Ecological Transition and Territorial Cohesion/Ministry of Energy Transition, 2020 ^[161]) (OECD, 2017 ^[162])

Action 8: Enhance funding and financing mechanisms for local climate action and resilience

Case 27. Funding urban infrastructure with municipal green bonds (Mexico City, Mexico)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 8
Other relevant actions	Action 4, Action 5
Location	Mexico City, Mexico
How a territorial approach is implemented	Mexico City is one of the largest cities in the world, with a population of approximately 21 million people across its FUA. Given its large and growing population, the city has had a substantial need for sustainable infrastructure investments to support population growth and improve quality of life. In recognition of the need for sustainable development, the city adopted a Climate Action Program in 2014 as a planning tool to help guide its climate change response. The programme accounted for the environmental, social and economic risks posed by climate change and related impacts on people. In line with the programme, a series of sustainable investments for the city were identified. These included a Green Corridor project along one of Mexico City's largest arterial roads, which included 100 electric buses, dedicated bus lanes, cycle paths and pavements for pedestrians to reduce carbon emissions and improve air quality. To help finance the green projects related to the Climate Action Program, Mexico City decided to issue its first municipal green bond in 2016. The USD 50 million bond issuance, with a 5-year maturity, was the first green bond issued by a city government in Latin America. Proceeds would help finance the Green Corridor project, an LED street lighting conversion and a water supply plant project. The city had previously issued around USD 200 million of municipal bonds each year and had a strong credit rating (AAA from Fitch Ratings). The decision to issue a green bond was made instead of municipal bond issuance to help guarantee that proceeds are used for the defined green projects, increase certainty and transparency to investors (due to certification and reporting requirements) and respond to investor demand. To support the issuance of the green bond, the city had to increase co-operation between its environmental and finance departments and achieve external certification of the green projects. Despite being issued in difficult market conditions, the bond was oversubscribed by 2.5 times and had a coupon of 6.02% (December 2016 issuance). Mexico City was awarded the Municipal Bond of the Year award by Environmental Finance and the Green Bond Pioneer Award by the Climate Bond Initiative in 2017.
Impacts/ success factors/ lessons learned	Key success factors included: • Sustainable finance institutions: In the years before the issuance, there were important efforts to grow the market for sustainable finance in Mexico by a variety of actors, including the Mexican Climate Finance Advisory Group, the Mexican Stock Exchange (including MexiCO2), the Climate Bonds Initiative and C40, among others. These organisations supported knowledge sharing, the development of local standards and the creation of local organisations for certification. • Technical assistance: Mexico City worked with the C40 Cities Finance Facility (CFF) to help develop bankable projects. The CFF works with cities to prepare urban climate change projects and to access financing instruments to help pay for the projects. Capacity building as part of the programme also aimed to put the city in a stronger position to finance future low-carbon projects. • Creditworthiness: Mexico City had substantial experience in issuing bonds to finance investments and had a good credit rating (AAA from Fitch Ratings), which can result in a lower cost of borrowing. Proceeds from the issuance of a green bond by Mexico City helped to support the Green Corridor project and other investments. By issuing a green bond instead of a municipal bond, Mexico City supported the achievement of other benefits, including increasing green finance knowledge and capacity, aligning internal processes with green investment objectives and strengthening internal and external co-ordination for sustainable investments. The issuance also linked the city to global climate agendas.
Sources	(C40 Cities, 2017 ^[163]) (Environmental Finance, 2017 ^[164]) (OECD, 2023 ^[122]) (University of Zurich, 2020 ^[165]) (Reuters, 2017 ^[166])

Case 28. Providing the basics for the issuance of green bonds: Sustainable Finance Framework for Issuing Sustainable Bonds (Andalusia, Spain)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 8
Other relevant actions	Action 3
Location	Andalusia (Spain)
How a territorial approach is implemented	The Autonomous Community of Andalusia has developed a Sustainable Finance Framework to serve as the basis for issuing sustainable bonds to fund green and social projects. Part of developing this framework included implementing green budget tagging within the regional budget in order to identify projects to be funded using the proceeds of sustainable (green and social) bond issuances. Andalusia's Sustainable Finance Framework follows existing GSS bond labels and includes rules on the use of proceeds, on evaluating and selection projects, and on the management of proceeds and reporting. It is subject to external review. In parallel, the autonomous community has developed a green budget tagging methodology to identify budget programmes to be funded by the proceeds of its sustainable bond issuances. Each budget programme was analysed in four ways: • Whether the programme has a social, climate or environmental impact. • Whether the programme can be linked to Green Bond Principles or Social Bond Principles. • Whether the programme meets the EU Taxonomy's technical screening criteria to be considered as significantly contributing to climate adaptation and mitigation. • Whether the programme's budget indicators are adequate to meet post-issuance reporting requirements and to follow-up on programme execution. The methodology allows the region to measure the amount of expenditure within each budget programme with a positive climate, environment or social impact and therefore the expenditure items that can be funded using sustainable bonds. More recently, the region has sought to align its regional tax framework with its environmental and climate strategies, in the areas of GHG emissions and air pollution, water usage and pollution, and circular economy and waste management.
Sources	(OECD, 2022 ^[126]) (OECD, 2023 ^[119])

Case 29. Classifying climate expenditures: Climate Budget Tagging (Brittany, France)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 8
Other relevant actions	Action 3, Action 9
Location	France
How a territorial approach is implemented	The French region of Brittany began working on developing its own green budgeting practice at the end of 2020, inspired by the success of a few experiments conducted in France and other European countries. These efforts led to the development of a climate budget tagging methodology focused on climate adaptation and mitigation, which was piloted on the region's 2020 closed accounts and is now being consolidated in order to be applied to the 2023 draft budget. In total, more than 27 000 budget lines amounting to almost EUR 1.6 billion of actual operating and investment expenditure have been analysed according to their climate mitigation impact. The first phase (April to July 2021) focused on developing the reference framework for the green budget (scope, general methodology) and carrying out an initial analysis of the region's 2020 closed accounts. The second step consisted in finalising the exercise and gathering feedback on the methodology, in order to apply it to the 2022 provisional budget and define an operational process which would include integrating the results in the budgetary decision-making process, involving external partners (for example, by setting obligations to provide additional information to subsidised entities or include green conditionalities in third-party contracts). To facilitate the implementation of the exercise, the region relied on methodological support from the Institute for Climate Economics (I4CE) and took part in a working group co-ordinated by Régions de France and I4CE, composed of the French regions of Brittany, Grand-Est and Occitanie.
Impacts/ success factors/ lessons learned	Brittany's first climate tagging exercise has produced encouraging results. Current and capital expenditure were totally classified under the mitigation axis, enriching the I4CE methodology in order to adapt to regional specificities, and about a third of the analysed expenditure was classified as "potentially structuring" under the "adaptation" axis. The resulting pilot methodology is now being consolidated by the region in order to be replicated in the 2023 draft budget. Key success factors identified included strong political support and the capacity to mobilise personnel from various levels of the regional administration. Extensive communication and thorough training of all participants (both internal and external) were crucial to ensure, after a gradual roll-out, the total mobilisation of the region and its partners and an in-depth understanding of the local environmental and climate issues and objectives.
Sources	(OECD, 2022 ^[126])

Action 9: Engage local actors, build partnerships and share knowledge

Case 30. Multi-stakeholder partnerships and collaboration for a circular economy: Strategic Plan 2016-2028 (Umeå, Sweden)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 9
Other relevant actions	Action 8
Location	Sweden
How a territorial approach is implemented	The Strategic Plan 2016-2028 is a municipal strategy to a more circular approach in response to the expected population growth, which will pressure housing, natural resources and waste production in Umeå. It aims to strengthen climate resilience through green transition, sustainable mobility and sharing economy. The strategy is built on multi-stakeholder partnerships and policy alignment between different levels of government. It involves the private sector, public companies, academia and the municipality to build and share knowledge and promote innovation and experimentation. The Faculty of Science and Technology of Umeå University has carried out several research and development projects focusing on future sustainable solutions, exchanging knowledge and creating interfaces between students, researchers, citizens and the private sector. Moreover, the city of Umeå created Circular Economy Business Accelerator North Sweden with a consultancy firm to accelerate business model innovation for circular economy. The plan co-ordinates policies towards circular economy across different levels of government and disseminates knowledge and technologies across stakeholders to plan, design and implement place-based solutions.
Impacts/success factors/lessons learned	The national government played a key role in creating an enabling environment with a reformed tax favouring repairs on used items and a roadmap to highlight the importance of co-operation across industries and urban areas. While Umeå has seen the flourishing new business models, some challenges remain. Considering the adequate scale is one of them. A circular economy requires rethinking processes along value chains, including production, distribution and consumption. City boundaries can be too limited to advocate and drive the circular economy, suggesting the need for a functional approach engaging with the national and adjacent cities and regions.
Sources	(OECD, 2020 ^[167])

Case 31. Engaging building owners to boost energy performance of buildings: NYC Retrofit Accelerator (New York, United States)

Scope	Climate mitigation
Most relevant action	Action 9
Other relevant actions	Action 1, Action 4
Location	New York City, United States
How a territorial approach is implemented	The NYC Retrofit Accelerator is a citywide service provider programme launched in 2015 to decarbonise the city's building stocks by boosting energy performance and savings, improving air quality and comfort for occupants, and helping building owners comply with local laws. It is sponsored by the city of New York and administered through the New York City Mayor's Office of Sustainability. The programme offers building owners and managers free, personalised advisory services, one-on-one expert advice on building upgrades, local law compliance, incentives and financing. The programme uses extensive datasets created by the city's energy benchmarking and audit laws to identify and prioritise updates in privately-owned buildings. The service is tailored to the specific conditions and needs of each building.
Impacts/success factors/lessons learned	Underlying data are key to the success of adequate assessment and prioritising across the buildings. New York City has building performance benchmarking policies requiring building owners to report their buildings' energy and water use, compiling the city's building portfolio datasets. The success also sits on the partnership with the city government, which funds and administers the project. NYC Accelerator also partners with local utility companies, which will act as service providers, offering energy upgrades to the city's buildings. Since 2015, the team has assisted over 9 000 buildings in the city; it is expected to cut 1 million tonnes of CO₂ and reduce utility bills by USD 360 million annually by 2025.
Sources	(C40 Cities, 2018 ^[168]) (MOCEJ, 2023 ^[169])

Case 32. Engaging indigenous communities to develop advice for national climate policy: Climate Change Commission/He Pou a Rangi (New Zealand)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 9
Other relevant actions	Action 1, Action 7
Location	New Zealand
How a territorial approach is implemented	The Climate Change Commission (He Pou a Rangi in Māori) was founded in 2019 to set the country's climate targets alongside the National Climate Change Response (Zero Carbon) Amendment Act. It is responsible for providing the central government with independent, evidence-based advice to help transition to a low-emissions and climate-resilient economy. It delivers the next National Climate Change Risk Assessment and monitors the progress of the government's National Adaptation Plan. It explores the emissions reduction options and associated impacts from Iwi/Māori perspectives. The commission partners with Iwi/Māori in developing advice and incorporates their perspectives. This partnership allows the commission to understand their expectations, rights and interests and creates opportunities for their participation. It uses an online platform for consultation and engagement on the question of nationwide climate action. The learnings from stakeholder engagement with Iwi/Māori and others within and beyond the national boundary are integrated into the research and data, using economic modelling and quantitative and qualitative methods. It encourages a partnership between central and local government along with Iwi/Māori to develop and implement the measures to meet local climate goals.
Impacts/ success factors/ lessons learned	In 2021, the commission provided a report to the Minister of Climate Change with 33 recommendations, collaboratively developed through engagement and quantitative analysis, including 4 246 responses from a range of stakeholders, including individuals, businesses, the public sector, Iwi/Māori, NGOs and youth.
Sources	(New Zealand Government, 2023 ^[170]) (New Zealand Infrastructure Commission, 2021 ^[171])

Case 33. Raising awareness on water conservation: Day Zero Campaign (Cape Town, South Africa)

Scope	Climate adaptation
Most relevant action	Action 9
Other relevant actions	Action 4, Action 7
Location	Cape Town, South Africa
How a territorial approach is implemented	The City of Cape Town initiated the Day Zero Campaign in 2018 to reduce citywide water usage. Following three consecutive years of meagre rainfall, the city was on the edge of running out of water supply. The campaign deployed an extensive communication strategy to raise awareness. It combined different tactics, including: i) sending simple messages; ii) offering concrete examples; and iii) making the water reduction activities somehow enjoyable. First, Cape Town delivered a clear message that the catastrophic crisis was approaching; it developed a water map to visualise the water usage per household. Second, the city created 2 two-minute shower songs to help citizens quantify their water consumption during showers and provide a clear guide on how much water they can use per daily activity. Lastly, Cape Town partnered with the water supplier and schools to advocate school competition on water consumption. The campaign kept evolving over time, changing its strategies from punitive measures (fining households with large water usage) to rewarding strategies (celebrating the residents with decent water reduction), raising citizens' awareness and enabling the city to avoid the potential crisis. It epitomises a territorial awareness-raising campaign, catering to local interests and living styles through tailored communication strategies.
Impacts/ success factors/ lessons learned	The beginning of the campaign witnessed the non-compliance of Capetonians with water restrictions due to the lack of clarity on what would happen should they not reduce their water consumption. The research has shown that the campaign contributed to the 80% reduction in average water use among high-income residents. The crisis also encouraged the city to develop a water strategy in 2019 based on the enhanced understanding of the water system and the need for better water governance.
Sources	(Behavioral Scientist, 2020 ^[172]) (City Of Cape Town, 2023 ^[173]) (City Of Cape Town, 2023 ^[173])

Case 34. Experimentation and innovation hubs for European cities: EU Mission for 100 climate-neutral and smart cities by 2030 and NetZeroCities (European Union)

Scope	Climate mitigation
Most relevant action	Action 9
Other relevant actions	Action 2, Action 3, Action 8
Location	European Union
How a territorial approach is implemented	EU Missions are a novelty of the Horizon Europe research and innovation programme for the years 2021-27. They will deliver impact by putting research and innovation into a new role, combined with new forms of governance and collaboration, as well as by engaging citizens. In this context, the European Commission launched in 2021 the Mission for 100 Climate-Neutral and Smart Cities by 2030. The mission aims to deliver 100 climate-neutral and smart cities by 2030 and to ensure that these cities act as experimentation and innovation hubs to enable all European cities to follow suit by 2050. The mission will provide financial support for pilot cities under a wide range of subjects such as zero-emission mobility, positive clean energy districts, urban greening and re-naturing, as well as associating Ukrainian cities to the climate-neutral and smart cities mission. In April 2022, the European Commission announced the 100 EU cities that were selected to participate in the EU mission. The 100 cities come from all 27 member states, with 12 additional cities coming from countries associated or potentially associated with Horizon Europe, the European Union's research and innovation programme (2021-27). The 100 selected cities are developing Climate City Contracts, which will include an overall plan for climate neutrality across all sectors, such as energy, buildings, waste management and transport, together with related investment plans. This process involves citizens, research organisations and the private sector. The cities will also benefit from tailor-made assistance from a dedicated mission platform run by NetZeroCities. The platform will provide the necessary technical, regulatory and financial assistance to cities, including those that the EU mission did not select. The platform offers a one-stop platform accessible to all cities with new and existing tools and resources. It also offers pilot projects to help drive rapid learning about how to achieve climate neutrality at the city scale, as well as a "twinning programme" to enable peer-learning.
Impacts/ success factors/ lessons learned	A clear mission (i.e. delivering 100 climate-neutral and smart cities by 2030, ensuring that these cities act as experimentation and innovation hubs to enable all European cities to follow suit by 2050) with strong financial support has raised the ambition of many European cities and regions.
Sources	(EC, 2022 ^[174]) (Net Zero Cities, 2023 ^[175])

Case 35. Facilitating knowledge sharing for climate adaptation: Climate-ADAPT (European Union)

Scope	Climate adaptation
Most relevant action	Action 9
Other relevant actions	Action 1
Location	European Union
How a territorial approach is implemented	In 2012, the European Commission and the European Environment Agency (EEA) collaboratively launched Climate-ADAPT, a platform to build and update the knowledge base to support the European region in adapting to climate change. It consists of two components: the first provides information on vulnerability assessments, adaptation policies and strategies and funding opportunities, while the latter half is a database of case studies of regions, cities and towns implementing adaptation plans and solutions to address the adverse effects of climate change. Climate-ADAPT provides comprehensive guidance on adaptation policy by offering sector-specific information from EU sectoral policies and available investment and funds, including agriculture, biodiversity, buildings, coastal, disaster risk reduction, ecosystem-based approaches, energy, financial, forestry, health, marine and fisheries, transport, urban, water management as well as migration and social issues. Interested actors can customise the information based on their geographical scale – countries, transnational regions and cities. With the accumulated information from EU-wide cities and regions, Climate-ADAPT helps interested parties understand local contexts and address local-specific climate challenges.
Impacts/ success factors/ lessons learned	As of March 2023, Climate-ADAPT shares 56 tools online that help cities, regions and countries assess climate risk, impacts and resilience. Users can obtain information on the policy framework (strategies, programmes and initiatives) and leading examples that were awarded EU funding; they can also customise appropriate scales from transnational, national and local (cities and towns).
Sources	(Climate-ADAPT, 2023 ^[176]) (EEA, 2018 ^[177])

Case 36. Facilitating knowledge sharing among different actors: City Deal Climate Adaptation (Netherlands)

Scope	Climate mitigation, climate adaptation
Most relevant action	Action 9
Other relevant actions	Action 4, Action 8
Location	Netherlands
How a territorial approach is implemented	The City Deal Climate Adaptation was a co-operation agreement launched in the Netherlands in 2016 between 37 parties, including 10 cities (Amersfoort, Amsterdam, Breda, Deventer, Dordrecht, Eindhoven, Groningen, Rotterdam, The Hague and Zwolle), other authorities, citizens, the private sector and the national government. It aimed to exchange good examples and encourage innovative solutions between and across the participating partners. The collaboration took place in a collection of pilot projects, where experts and administrators worked together on activities to develop, build and be climate-proof by 2050. In addition to the network of Dutch cities, the initiative worked with a range of stakeholders, from governmental organisations to engineering enterprises and universities. Through partnership and knowledge sharing, the agreement helped Dutch cities to understand and address place-based climate challenges and implement locally tailored measures. It identified seven themes that should be scaled up and pursued, based on the experiences from the pilot projects: i) integrated approach to public space; ii) climate-proof social housing; iii) role of the financial sector; iv) vital and vulnerable functions and networks; v) climate-proof and nature-inclusive construction; vi) green living environment; and vii) urban adaptation strategy and policy mix.
Impacts/ success factors/ lessons learned	The City Deal's ambitions led the parliament to adopt a new Climate Act in 2019, which sets legally binding GHG emissions reduction targets. The Netherlands is now committed to a 49% reduction of GHG emissions by 2030, compared to 1990 levels, and a 95% reduction by 2050, outlining a clear goal for individuals and companies.
Sources	(Klimaatadaptatie, n.d. ^[178])

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Notes

¹ A territorial approach to climate action and resilience is defined as a comprehensive policy framework that integrates a place-based perspective into national and subnational climate policies and mainstreams climate objectives into urban, rural and regional development policies, to effectively drive the net zero and resilient transition at all territorial scales (see Chapter 1).

² Athens (Greece), Auckland (New Zealand), Barcelona (Spain), Glasgow (United Kingdom), Lima (Peru), Montreal (Canada), Nagoya (Japan), New York (United States), Portland (United States), Tokyo (Japan) and Vancouver (Canada).

³ Another OECD survey also finds that 83% (25 countries) of the responding countries report that SNGs or authorities contribute to adaptation measurement.

⁴ The joint OECD/EC project Measuring and Enhancing Subnational Government Finance for Environment and Climate Action in OECD and EU Countries.

⁵ The OECD Guidelines and Self-Assessment Tool (in Excel format) are available on the Subnational Government Climate Finance Hub: <https://www.oecd.org/regional/sngclimatefinancehub.htm>.

⁶ Biodiversity value attributable to the development needs to exceed the pre-development biodiversity value of the onsite habitat by at least 10%, which need to be secured for a minimum duration of 30 years.

A Territorial Approach to Climate Action and Resilience

Global warming is likely to reach 1.5°C as early as in 2030, with current climate action falling short of meeting the Paris Agreement goals and a mounting risk of tipping beyond the ability of human societies to adapt. Building on broader OECD work on climate, this report proposes a new OECD territorial climate indicator framework and demonstrates that the potential to mitigate greenhouse gas emissions, adapt to climate impacts and address vulnerabilities varies across different territories. The report also presents a policy framework of 9 recommended actions to help decision makers unleash more effective climate action and resilience, both by integrating a territorial approach into national and subnational climate policies and by mainstreaming climate objectives into urban, rural and regional policies. The report summarises the analysis into a checklist for national and local governments to implement a territorial approach to climate and resilience policies, as well as a compendium of 36 best practices from cities, regions and countries from all around the world.



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