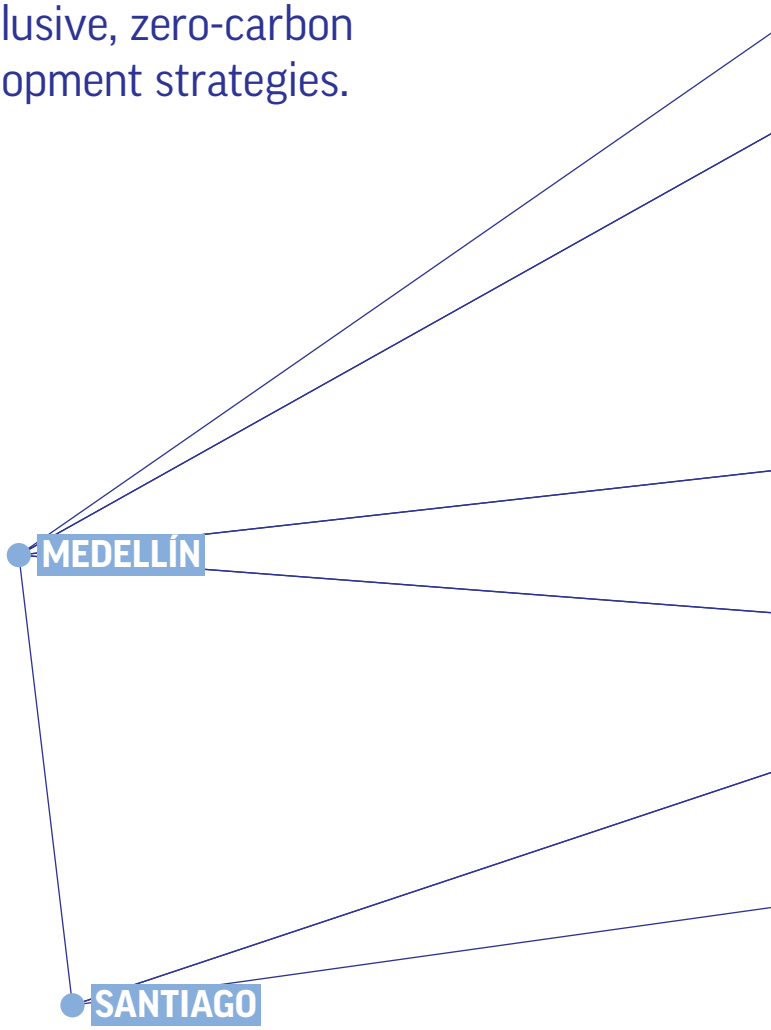
COALITION FOR URBAN TRANSITIONS

CLIMATE EMERGENCY | URBAN OPPORTUNITY

HOW NATIONAL GOVERNMENTS CAN SECURE ECONOMIC PROSPERITY AND AVERT CLIMATE CATASTROPHE BY TRANSFORMING CITIES

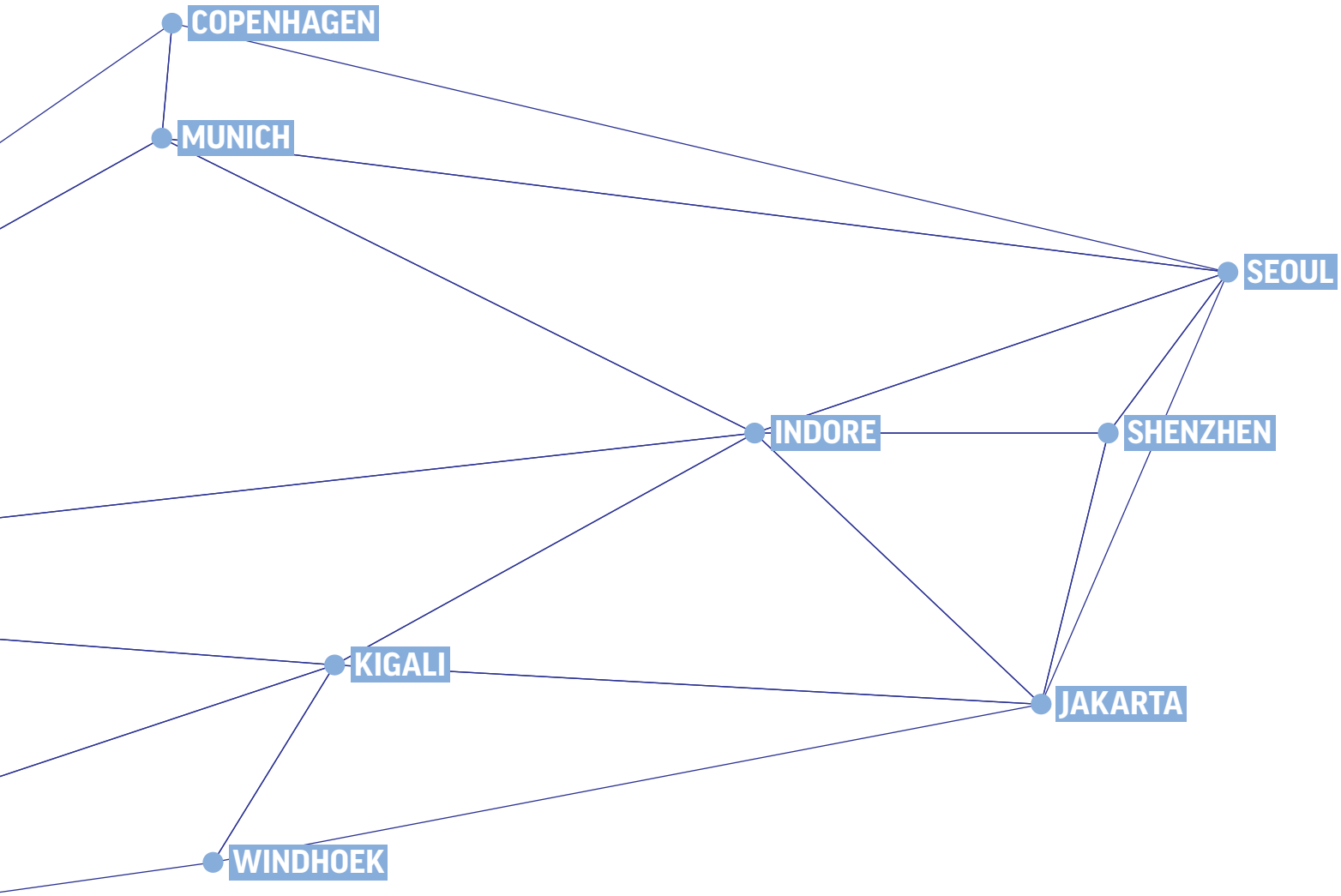
This report, a collaborative effort of more than 50 organisations brought together by the Coalition for Urban Transitions, is being launched in September 2019 in advance of the Climate Action Summit and Sustainable Development Goals Summit in New York. The aim of the Summits, hosted by UN Secretary-General António Guterres, is to accelerate action to implement the 2030 Agenda for Sustainable Development and the Paris Agreement.

The Coalition for Urban Transitions is a global initiative to support national governments in transforming cities to accelerate economic development and tackle dangerous climate change. Collectively, the contributors hope this report will provide the evidence and confidence that governments need to submit more ambitious Nationally Determined Contributions in 2020, and to propel inclusive, zero-carbon cities to the heart of their national development strategies.



The graphic map shown here represents the key cities discussed in case studies throughout this report.

The analysis, arguments and conclusions presented here are a synthesis of the diverse views of the authors, contributors and reviewers. The Coalition for Urban Transitions takes responsibility for selecting the areas of research. It guarantees its authors and researchers freedom of inquiry, while soliciting and responding to the guidance of advisory panels and expert reviewers. Coalition partners, some as organisations and others as individuals, endorse the general thrust of the arguments, findings and recommendations made in this report, but the text does not necessarily reflect the personal views or official policies of any of the contributors or their members.



Forewords

"With the Paris Agreement, 195 countries unanimously decided to change the course of the global economy to protect future generations. Cities are the most powerful lever we have to achieve this tectonic shift. We have the technology, we have the finance and we have the ingenuity to create cities approaching net-zero emissions. Moreover, this report outlines the clear advantages to such cities: cleaner air, better health, more energy security and higher productivity. In the lead-up to COP26, countries can harness the dynamism and creativity of cities to increase the ambition of their Nationally Determined Contributions."

Christiana Figueres
Vice-Chair, Global Covenant of Mayors; Former Executive Secretary, UN Framework Convention on Climate Change (2010-2016)

"We are at a unique moment in human history. The policies and investments made in the next two decades will determine the quality of life on this planet for generations to come. We need cities with net-zero emissions by mid-century to have a reasonable chance of staying close to 1.5°C. Such a transition will need big investments, and quickly, but they are very productive, attractive investments. This report shows that low-carbon investments in cities could yield returns worth US$24 trillion over the next thirty years – equivalent to the GDP of the United States and Japan combined. Visionary leadership in the next decade will be vital to seize this opportunity."

Lord Nicholas Stern of Brentford, CH, Kt, FBA, FRS
IG Patel Professor of Economics and Government at the London School of Economics and Political Science; Co-Chair of the Global Commission on the Economy and Climate

"We urgently need a 'new normal' to address both the old challenge of inequality and the emerging challenge of climate change. We cannot do one thing at a time. If we do not prevent climate change, we will not eradicate poverty: floods, heatwaves, food shortages and water scarcity will devastate the lives and livelihoods of millions of people. And if we do not eradicate poverty, we cannot prevent climate change: an informed, engaged, empowered citizenry will be key to achieving net-zero emissions. We need bottom-up action to meet with top-down possibilities. National governments must work with urban dwellers, including those who are poor and vulnerable, if they are to achieve the Sustainable Development Goals and Paris Agreement."

Sheela Patel
Chair, Slum Dwellers International (SDI); Founder and Director, Society for the Promotion of Area Resource Centres (SPARC)

"1.5 million people are added to the urban population every week. This demographic transition offers a unique chance for rapidly urbanising countries to position themselves at the next investment frontier: the green economy. They can take advantage of low-carbon innovations in energy, mobility and building design to nurture thriving cities with affordable services and clean environments. City governments have a critical role to play – but they cannot realise this opportunity alone. National leaders will need to purposefully and strategically shape urban development if they are to bring hundreds of millions of people into a modern, climate-safe economy."

Professor Carlos Lopes
High Representative, African Union Commission; Former Executive Secretary, UN Economic Commission for Africa (2012-2016)

"There are no jobs on a dead planet. Working people want their governments to deal with the pollution that causes climate change, which is why trade unions across the world are joining global protest actions. The transition to a low-carbon economy could create massive employment opportunities: this report finds that creating cities with net-zero emissions would support 87 million additional jobs in 2030. To create an economy that works for people and the planet, national governments need long-term strategies to ensure a just transition, so that decarbonising our cities delivers decent jobs for all."

Sharan Burrow
General Secretary, International Trade Union Confederation

"The leading countries of tomorrow will be those whose cities successfully make an equitable transition to a climate-safe economy. As the OECD Principles on Urban Policy recognise, far-sighted, consistent national urban policies will be crucial. However, this report highlights that fewer than two in five national governments have an explicit strategy for cities, and only a handful of these speak meaningfully to both climate action and human development. At the UN Climate Summit and Sustainable Development Summit, national governments should pledge to prioritise equitable, zero-carbon cities so that they can deliver shared prosperity in the context of climate crisis."

Ángel Gurría
Secretary-General, Organisation for Economic Co-operation and Development

"Cities offer a solution to the climate crisis because they offer an opportunity for citizens to enjoy a high quality of life in ways that use less land, energy and materials. We therefore need to create inclusive, green cities – and create them within a single generation – to keep the planet safe and secure an economy that works for everyone. This report demonstrates that we can cut 90% of emissions from cities using proven low-carbon measures. These measures will simultaneously stimulate productivity and innovation, so that economic development and climate action go hand-in-hand. In these urgent times, this is an opportunity not to be missed."

Naoko Ishii
Chief Executive Officer and Chairperson, Global Environment Facility

Managing partners

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GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY

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Executive summary

The world faces a climate emergency – but cities offer national governments a solution. Rising temperatures are already causing serious loss of life and threatening vital ecosystems. Further increases pose an existential threat to entire cities and countries. The battle for the planet will be won or lost in cities. Over half the world's population lives in urban areas, which produce 80% of gross domestic product and three quarters of carbon emissions from final energy use.[1] And the share of people, economic activity and emissions in cities is growing rapidly, especially in Africa and Asia.

Deploying low-carbon measures in cities could reduce greenhouse gas emissions from urban buildings, materials, transport and waste by nearly 90% by 2050. These measures would have a net present value of US$23.9 trillion – greater than the biggest economy in the world, the US.

This report shows that a carefully managed transition to zero-carbon, climate-resilient cities could help secure national economic prosperity and improve quality of life while tackling the climate crisis. Science tells us that to keep global temperatures from rising by more than 1.5°C, cities have to achieve net-zero emissions by mid-century.[2] New analysis conducted for this report shows that greenhouse gas emissions from cities can be reduced by almost 90% by 2050 using technically feasible, widely available mitigation measures. If designed and delivered with care, these measures could also address urgent political priorities, including choking air pollution, chronic traffic congestion, poor services and lost productivity. The bundle of investments would collectively generate an economic return worth US$23.9 trillion in today's terms. The leading countries of tomorrow will be those whose cities can successfully make an equitable and sustainable transition to a new urban economy.

Action by city governments is critical, but on its own, it cannot achieve this goal. There has been a groundswell of local-level climate action in recent decades. City governments have shown particular leadership: nearly 10,000 cities and local governments worldwide have committed to set emission reduction targets and prepare strategic plans to deliver on them.[3] However, even the largest and most empowered city governments can deliver only a fraction of their mitigation potential unilaterally.[4]

Fewer than two in five countries have an explicit national strategy for cities, and only a handful of these speak meaningfully to both climate action and human development

National governments have unique and crucial roles to play in nurturing zero-carbon, climate-resilient cities. Many national and state policies are explicitly urban-focused, such as the design of spatial planning guidelines and the drawing of municipal boundaries. Many more, though not urban-specific, hugely influence the performance of cities, such as national energy, tax and transport policies. In addition, funding and financing mobilised by national and state governments is crucial for cities, particularly for large infrastructure projects. The future of cities therefore depends substantially on decisions made or support provided by higher levels of government. National governments formally recognised the importance of cities when they adopted the 11th Sustainable Development Goal (SDG11), which commits countries to "make cities and human settlements inclusive, safe, resilient and sustainable". Yet today, fewer than two in five countries have an explicit national strategy for cities,[5] and only a handful of these speak meaningfully to both climate action and human development. Worldwide, only seven countries have both a National Urban Policy and a Nationally Determined Contribution that specifically address climate mitigation in cities (although many more make sectoral-based commitments to decarbonise buildings, energy, transport and waste).

In Africa and Asia, the urban population is expected to grow by 2.5 billion people over the next 30 years

Cities will change dramatically in the coming decades. Technological innovation is enabling new forms of service delivery and transforming the nature of work, but also displacing many jobs. Demographic changes, from falling fertility to ageing populations, are driving demand for new forms of housing and services. Economic turbulence and structural economic change are redirecting global trade and investment. And in Africa and Asia, the urban population is expected to grow by 2.5 billion over the next 30 years.[6] Business-as-usual modes of development are not delivering a decent standard of living for most people. Nearly a billion urban residents live in slums without access to decent housing, clean drinking water or safe sanitation.[7] Too many workers toil in unsafe conditions for less than a living wage.

At the same time, immediate action is necessary to tackle the climate crisis. The world is on track for average temperatures to increase to at least 3°C above pre-industrial levels by the end of the century.[8] That would lead to more frequent and catastrophic weather events, ecosystem collapse and possibly several metres of sea-level rise.[9] These impacts will fall disproportionately on the poor and disenfranchised, eroding the development gains of recent decades and making it impossible to eradicate poverty. To hold global warming to 1.5°C above pre-industrial levels, carbon dioxide (CO_2) emissions need to nearly halve by 2030 from 2010 levels and reach net-zero around 2050.[10] As the major centres of production and consumption, what happens in cities in the next decade will be critically important to countries everywhere. National decision-makers can help put cities on a path to prosperity and resilience, or to decline and vulnerability.

This report shows that greenhouse gas emissions in cities can be brought close to net-zero using proven technologies and practices. It identifies a bundle of technically feasible low-carbon measures that could cut emissions from key urban sectors by almost 90% by 2050 (see *Figure ES.1*). In absolute terms, these savings are greater than the combined 2014 energy-related emissions of the two largest emitters, China and the US.[11] 58% of these carbon savings come from the buildings sector, 21% from the transport sector, 16% from materials efficiency and 5% from the waste sector. The investments required to reduce urban emissions would be US$1.83 trillion (about 2% of global GDP) per year,[12] but they would generate annual savings worth US$2.80 trillion in 2030 and US$6.98 trillion in 2050. This yields a net present value of US$23.9 trillion.[13] This estimate is conservative. With higher energy prices and faster technological learning rates, the net present value of these investments rises to US$38.19 trillion. These figures do not include wider benefits, such as long-run productivity gains or improved public health.

TECHNICALLY FEASIBLE LOW-CARBON MEASURES COULD CUT EMISSIONS FROM URBAN AREAS BY ALMOST 90% BY 2050

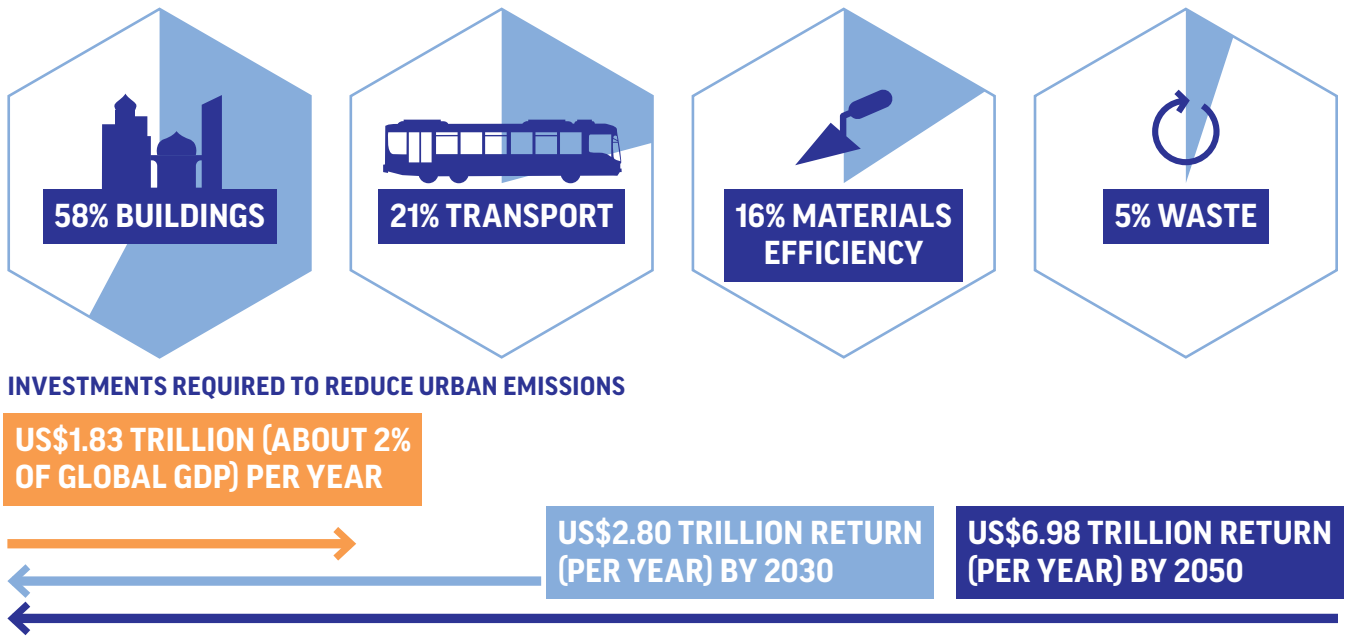
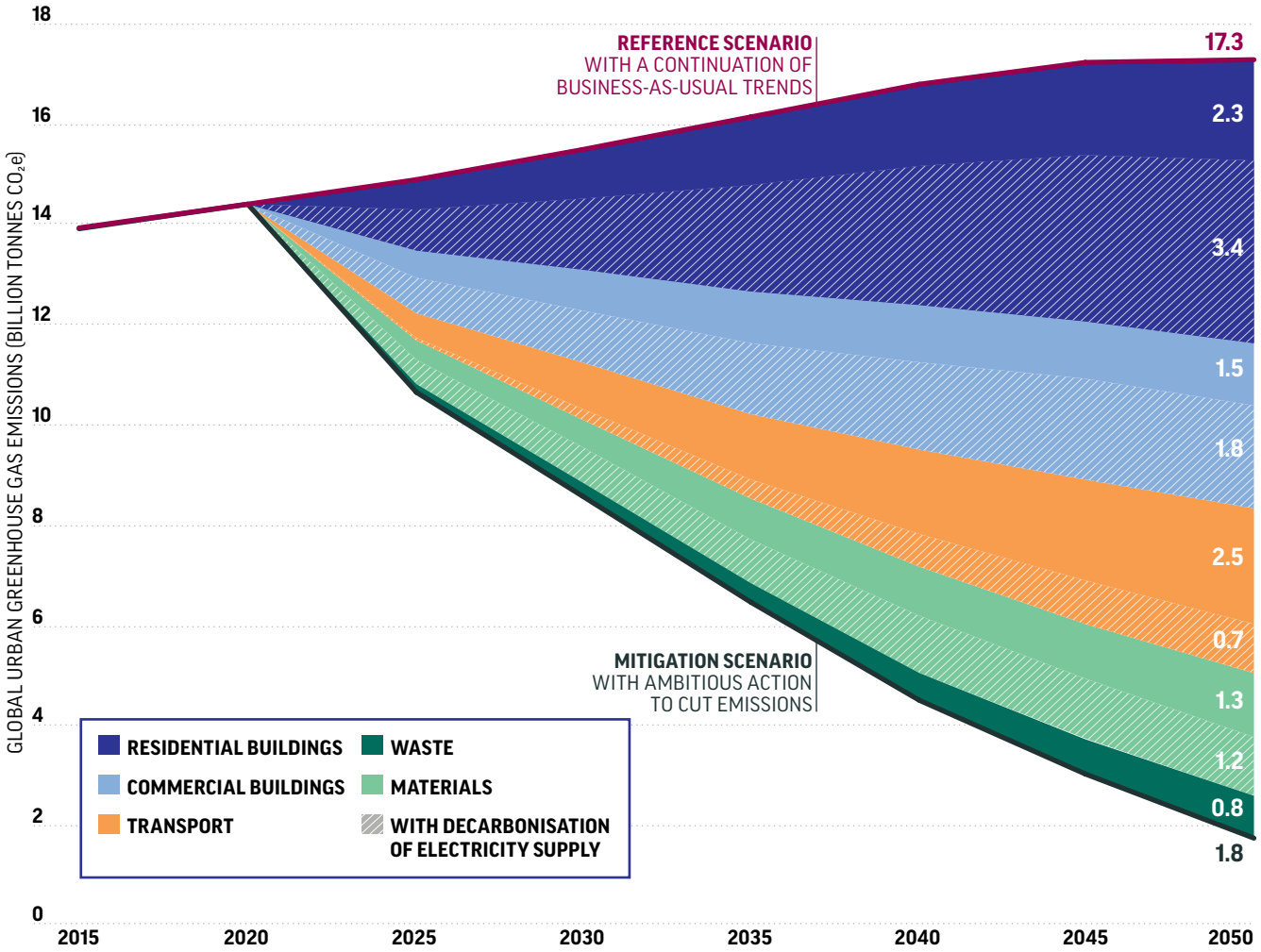


FIGURE ES.1. TECHNICALLY FEASIBLE POTENTIAL TO REDUCE GREENHOUSE GAS EMISSIONS FROM CITIES BY 2050, BY SECTOR.

Note: The reference scenario line reflects projected greenhouse gas emissions from urban buildings, materials, transport and waste without further action. The mitigation scenario line reflects projected greenhouse gas emissions from these sectors with ambitious deployment of selected low-carbon measures. The striped wedges reflect the mitigation potential achievable through decarbonisation of electricity. More aggressive deployment of low-carbon measures, behavioural changes and innovation will be required to mitigate the remaining emissions from urban buildings, transport, materials and solid waste.



Proactive leadership from national governments and meaningful partnerships with other tiers of government are needed to seize this opportunity. Enabling policies and investments can stimulate climate action by the private and civic sectors. Over half of the abatement potential identified in this report comes from decarbonising electricity grids, which are typically overseen by national and provincial governments. Notably, over half of the total abatement potential is in urban areas with populations under 750,000, which often lack the financial and technical resources of larger cities. Indeed, new analysis for this report finds that, worldwide, national and state governments have primary authority over 35% of urban mitigation potential (excluding decarbonisation of electricity), including from improved cement production processes and more stringent efficiency standards for appliances, lighting and vehicles. Local governments have primary authority or influence over 28%, including compact urban form, travel demand management and waste disposal. 37% of the identified mitigation potential depends on collaborative climate action among national, regional and local governments, including building codes, decentralised renewables and mass transit infrastructure. Bold national leadership is therefore needed to deliver these emission reductions and provide an enabling environment for local action.

Zero-carbon cities will be places where people are healthier and more productive. The bundle of low-carbon measures identified in this report would make cities more compact, connected and clean (see *Figure ES.2*). It also offers an opportunity to eradicate poverty and improve living standards for all. In the future, people around the world could live in neighbourhoods where they can walk quickly and safely to work, school and parks, along quiet streets with plenty of places to meet and rest. Pedestrians and cyclists could enjoy protected sidewalks and paths lined with trees, shops and restaurants. Speed limits on the streets could be low enough that everyone feels safe crossing – even if they are elderly, disabled or pushing a pram. With steady foot traffic, local retailers and eateries would thrive. Well-maintained public transit could offer convenient and comfortable commutes, connecting every district so that people do not have to drive. The few vehicles on the streets could all be electric, quiet and pollution-free. With much cleaner air in cities, asthma, allergies and other respiratory diseases would be far less common. It would be more pleasant inside homes and commercial buildings, with increased natural lighting, good ventilation, and material and design choices that limit the need for temperature control. Combined with rooftop solar panels and highly efficient heating and cooling systems, compact, connected and clean cities would sharply reduce costs for households and businesses.

Case studies from around the world demonstrate that a rapid urban transition is possible. The vision presented here may seem far-fetched when millions of urban residents today live in deep poverty and degraded environments. Yet this report offers case studies from around the world – Medellín in Colombia, Copenhagen in Denmark, Indore in India, Seoul in Korea and Windhoek in Namibia – where national and local governments have worked together to profoundly improve the quality of life in cities within two or three decades. These examples show that the scale and pace of change required to achieve SDG11 and reach zero-carbon cities are both technically and politically feasible.

FIGURE ES.2. KEY ABATEMENT OPTIONS TO ACHIEVE ZERO-CARBON CITIES.

National and state governments have primary authority over 35% of urban abatement potential,* while local governments have primary authority over 28%. Collaborative climate action across tiers of government is necessary to deliver fully 37% of the urban abatement potential identified in this report.

** excluding electricity decarbonisation*

Pursuing compact, connected and clean cities also offers a huge opportunity for national governments to achieve faster, fairer economic development. This report finds that governments in the Organisation for Economic Co-operation and Development (OECD) and BRIICS (Brazil, Russia, India, Indonesia, China and South Africa) countries collectively spend US$41.6 billion a year subsidising fossil fuel consumption in urban areas. These subsidies effectively incentivise costly urban sprawl, toxic air pollution, traffic injuries and dangerous climate change. New approaches are needed to foster thriving cities. Policies and markets are already changing to support a new, low-carbon economy. Countries that do not proactively manage this transition will face stranded assets and stranded workers as high-carbon systems become unaffordable or no longer comply with evolving regulations.

National governments that anticipate these structural trends and place zero-carbon cities at the heart of their long-term national development and climate strategies will secure four economic advantages:

It is cheaper to provide infrastructure and services in more compact, connected and clean cities. Less land, materials and energy are required to physically connect households and firms when they are closer together, and higher densities make infrastructure investments more economically feasible, from metro systems to district heating and cooling. Moreover, many low-carbon measures are now more economically attractive than their high-carbon counterparts. The bundle of low-carbon measures identified in this report represents a US$23.9 trillion opportunity; adopting all these low-carbon measures would also support the equivalent of 87 million jobs in 2030 (mostly from deep building efficiency improvements) and 45 million jobs in 2050 (mostly in the transport sector).

The productivity of workers and businesses is higher in larger, more densely populated cities, particularly those with good public transport networks. A recent review of over 300 studies on compactness finds that a 10% difference in the number of people living and working in an area is worth about US$182 per person a year from higher productivity and better access to jobs and services.[14]

The transition to compact, connected and clean cities can build national capacity to both create and absorb innovations that will be critical for economic competitiveness in the future. This report finds that a 10% higher population density (measured by number of inhabitants per square kilometre) is associated with an additional 1.1% patents per 1000 people in Europe and an additional 1.9% in the US. Innovation in all its forms can have huge real-world impact. China, for instance, has supported its city governments to experiment with electric vehicles and charging infrastructure with impressive results: as of 2017, China was home to 40% of the world's electric passenger cars and over 99% of the world's electric buses.[15]

A 10% higher urban population density is associated with an additional 1.1% patents in Europe and 1.9% in the US

LOW-CARBON MEASURES IN CITIES COULD SUPPORT THE EQUIVALENT OF:

87 MILLION JOBS

IN 2030 (MOSTLY IN THE BUILDINGS SECTOR)

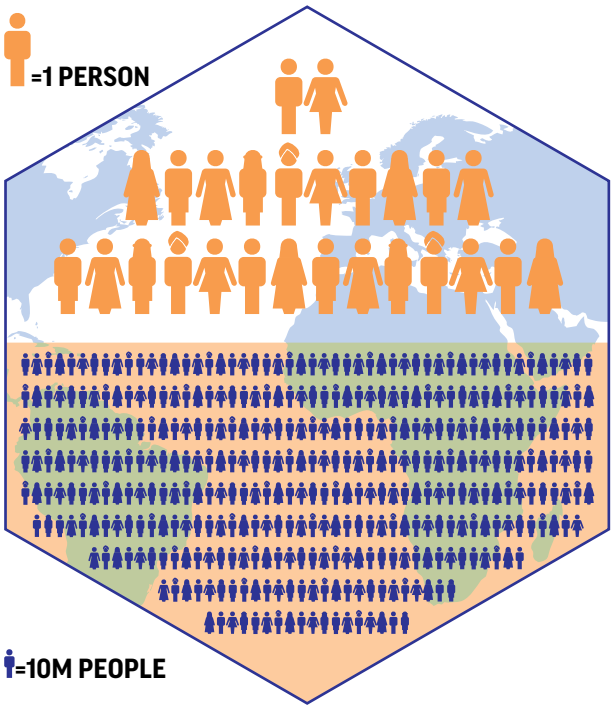
45 MILLION JOBS

IN 2050 (MOSTLY IN THE TRANSPORT SECTOR)

10% MORE PEOPLE LIVING AND WORKING IN AN AREA

=US$182 PER PERSON/YEAR

When these benefits are taken together, compact, connected and clean cities would offer countries a distinct competitive advantage as they seek to secure global talent and investment. Most countries seek to attract firms that produce tradeable goods and services. Because these firms can sell their products to a global market, they are not constrained by the size of local or regional markets. Firms and workers in these sectors are highly mobile, and are likely to be attracted to the direct cost savings, higher productivity and better quality of life associated with zero-carbon cities.



However, the full promise of zero-carbon cities cannot be achieved without meaningful progress to eradicate poverty and reduce inequality. Every transition has some trade-offs, and reaching net-zero emissions will require profound social and cultural changes. Citizens need to be confident that they will be protected from any negative impacts and that they will truly benefit from new ways of living, consuming, travelling and producing. Building public support for such a transformation will be difficult if profound deprivation and inequality persist. Today, the world's 26 wealthiest people own as many assets as the 3.8 billion people in the poorer half of the population.[16] This means that a few (powerful) people have a vested interest in the status quo, while many (voting) people feel vulnerable and are thus apprehensive about radical change – even if everyone benefits from ambitious climate action in the not-too-distant future. To make the most of this opportunity, national governments need to put equity and inclusion at the top of their agendas.

The world's 26 wealthiest people own as many assets as the 3.8 billion people in the poorer half of the population

Ambitious climate mitigation is no longer enough to secure national prosperity; investments in urban resilience will be essential to cope with inevitable climate change. Global temperatures are already 1°C above pre-industrial levels,[17] and the impacts are clear. In the last few years, cities from Ahmedabad in India, to Melbourne in Australia, to Rome in Italy suffered heatwaves in which temperatures exceeded 40°C.[18] Cities from Cape Town in South Africa, to Chennai in India, to São Paulo in Brazil have all but run out of water.[19] Much higher temperature increases are likely,[20] and consequently much more severe climate hazards. With their concentration of people, assets and economic activity, cities are hotspots of vulnerability. New analysis for this report finds that 710 million people live in coastal urban and quasi-urban areas less than 10 metres above sea level; more than three quarters of them live in Asia. In low-lying countries such as the Netherlands, Thailand and Viet Nam, over half the urban population lives in coastal settlements less than 10 metres above sea level. Nearly 10% of the world's land within 10 metres above sea level is already urban or quasi-urban, compared with 2% elsewhere. This means that storm surges and sea-level rise are now overwhelmingly urban threats. Urban adaptation will be critical to minimise the devastation that climate change will wreak upon national economies and societies.

National governments have many opportunities to simultaneously support climate mitigation, adaptation and sustainable development in cities. For example, more compact cities can safeguard cultivated land and natural habitats around the urban periphery, protecting carbon stocks stored in biomass and soils. Avoiding land use change can also protect biodiversity and crucial ecosystem services such as pollination, soil formation and nutrient recycling. Sustaining oceanic and agricultural productivity is particularly important in the context of the climate crisis, which threatens to reduce yields from fish stocks and staple crops such as wheat, maize and rice.[21] Despite the importance of managing urban expansion, sprawl is happening apace. New analysis for this report finds that, between 2000 and 2014, urban areas expanded by an amount roughly equivalent to two Sri Lankas. Two thirds of this urban expansion was in Asia, and one fifth was in Africa, where millions of people depend on fishing, forestry and farming for their livelihoods. More sustainable urban development can therefore support and stimulate rural development as well.

This report presents six key priorities for actions that national governments should take to seize this opportunity. These priorities for national action (summarised in *Figure ES.3*) are grounded in three years of research and an extensive consultation process involving over 50 institutions: research institutes, networks of national and city governments, investors, infrastructure providers, strategic advisory companies, non-governmental organisations and social movements. The priorities for national action were tested with representatives of national and city governments to confirm their feasibility and relevance. The breadth of these recommendations reflects the interconnectedness and centrality of cities to wider national development, and the myriad ways in which they are influenced by national policies.

Within each priority for national action, this report offers an array of measures to suit different contexts and recommendations for how to sequence them. National governments can realise the economic, social and environmental advantages of zero-carbon cities in multiple ways. Some measures focus narrowly on urban and climate outcomes; others would create economy-wide conditions for a zero-carbon urban transition. Policy-makers can select specific instruments according to their national circumstances and development objectives. While not all options identified will be appropriate for every country, the toolbox as a whole has relevance to countries at all levels of development.

STORM SURGE AND SEA LEVEL RISE ARE NOW OVERWHELMINGLY URBAN THREATS

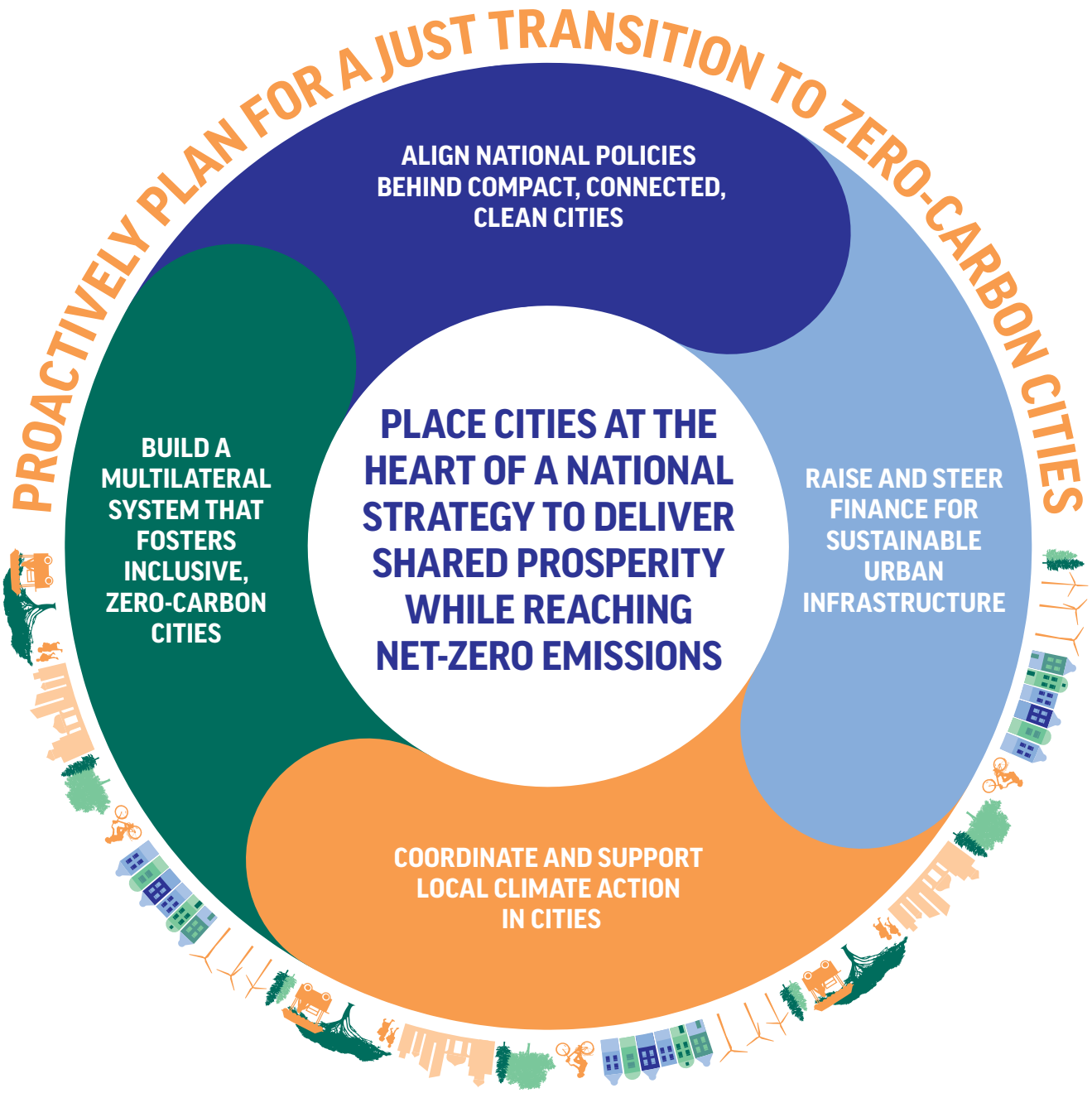
IN 2015, OVER 710 MILLION PEOPLE LIVED IN COASTAL URBAN CENTRES AND QUASI-URBAN CLUSTERS LESS THAN 10 METRES ABOVE SEA LEVEL

=10M PEOPLE

IN LOW-LYING COUNTRIES SUCH AS THE NETHERLANDS, THAILAND AND VIET NAM, OVER HALF THE URBAN POPULATION LIVES IN COASTAL SETTLEMENTS LESS THAN 10 METRES ABOVE SEA LEVEL

10% OF THE LAND WITHIN 10 METRES ABOVE SEA LEVEL IS ALREADY URBAN OR QUASI-URBAN, COMPARED WITH 2% ELSEWHERE

FIGURE ES.3. SIX PRIORITIES FOR NATIONAL ACTION TO ACHIEVE INCLUSIVE, ZERO-CARBON, RESILIENT CITIES.

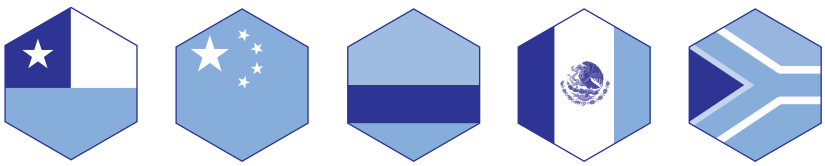


The six priorities for national action are:

Develop an overarching strategy to deliver shared prosperity while reaching net-zero emissions – and place cities at its heart. Few national governments have robust plans to deliver economic and social development in the context of a climate emergency. Given the growing share of people, economic activity and emissions concentrated in cities, any such plan needs to have a meaningful urban dimension. A comprehensive national strategy, focused on compact, connected, clean cities and underpinned by a genuine partnership between national and local governments, could eradicate poverty, reduce inequality and avoid climate catastrophe. Such a strategy should be grounded in a shared vision for the future of cities, and their links to country-wide development. It can inspire every line ministry to approach urban development in a considered and purposeful way, de-risk low-carbon investment by providing clear signals to private actors, and empower local governments to go farther and faster on low-carbon, climate-resilient development.

Align national policies behind compact, connected, clean cities. Key measures include removing land use and building regulations that limit higher density; reforming energy markets to decarbonise the electricity grid; reaching net-zero operating emissions in all buildings with minimal use of carbon offsets; decarbonising the electricity grid; banning the sale of fossil fuel-powered vehicles; adopting green alternatives to steel and cement; and shifting away from building detached housing in established cities. Senior decision-makers in India, for example, are suggesting that the sale of fossil fuel-powered passenger cars and two-wheelers will be prohibited from 2030.[22]

Fund and finance sustainable urban infrastructure. Key measures include eliminating subsidies for fossil fuels; establishing a carbon price of US$40–80 per tonne, which should then increase over time; working with local governments to establish a pipeline of climate-safe, bankable projects to anchor compact, connected, clean urban development; scaling land-based financing instruments to fund sustainable urban infrastructure and limit sprawl; and shifting national transport budgets from road-building to public and active transport. As of 2018, 45 countries have put a price on carbon, including emerging economies such as Chile, China, Colombia, Mexico and South Africa.[23]



As of 2018, 45 countries have put a price on carbon, including emerging economies such as Chile, China, Colombia, Mexico and South Africa

Coordinate and support local climate action in cities. Key measures include passing legislation explicitly clarifying the roles and powers of different tiers of government, including measures to enhance own-source revenue options; creating integrated land use and transport authorities for cities; strengthening local capacities to act on climate change; authorising local governments to introduce climate policies and plans that are more ambitious than national policies; establishing "regulatory sandboxes" for low-carbon innovations in cities; and allocating at least a third of national research and development (R&D) budgets to support cities' climate priorities. Between 2000 and 2018, Germany expanded the share of renewable electricity from 6% to over 38%, largely through the Renewable Energy Sources Act, which empowered municipal authorities and citizen cooperatives.

Build a multilateral system that fosters inclusive, zero-carbon cities. Key measures include scaling up collaborative climate action in cities in the Nationally Determined Contributions; requiring all international financial institutions to end all fossil fuel financing; ensuring that all international development assistance is aligned with national urban strategies that are compatible with the Paris Agreement and the 2030 Agenda for Sustainable Development; establishing an international carbon price floor; and helping city governments to access international public finance for low-carbon, climate-resilient development (with adequate sovereign oversight). Mexico, for example, has been systematically recording climate policies and projects by states and municipalities, and will use them to enhance national ambition in the next round of the climate negotiations.

Proactively plan for a just urban transition. Key measures include strengthening tenure security for the urban poor; enhancing climate resilience and gender equality by educating all young people; using revenues from fossil fuel subsidy reform or carbon taxes to compensate people who bear the costs of climate action; supporting local governments to make well-located, serviced land available for growing urban populations; supporting community-led upgrading of informal settlements; and anticipating, protecting and supporting the workforce of the future, including by developing transition plans for fossil fuel-based workers and industries. Namibia, for instance, has accommodated most of the rapid increase in its urban population by making small plots of serviced, competitively priced land available in cities, reducing the heavy health and economic burden associated with informal settlement.

Pursuing zero-carbon, resilient cities in an inclusive way will simultaneously raise countries' living standards, tackle inequality and address the climate crisis. For national leaders, creating such cities would yield short-term political dividends and secure long-term national prosperity. It is an opportunity not to be missed.

1. Purpose of this report

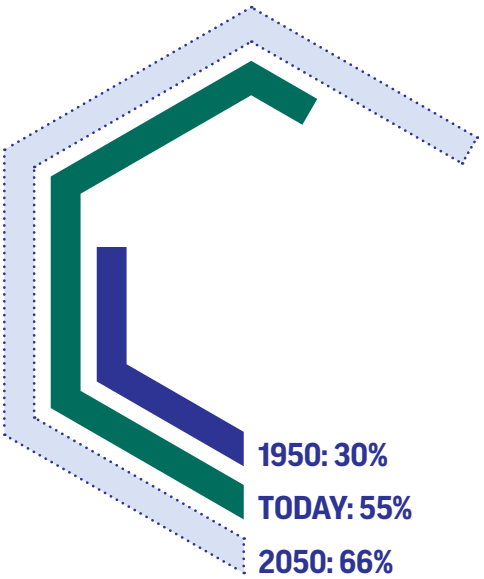
A transition to zero-carbon cities offers an immense opportunity to secure national economic prosperity and improve quality of life while tackling the existential threat posed by climate change. Realising the potential of cities demands bold action by national governments, working in close collaboration with city governments, businesses, civil society, research institutes and other partners.

National governments face three urgent challenges: a slowing global economy that is not meeting the needs of many people, especially the hundreds of millions still living in poverty; widening inequality and a resulting loss of faith in political institutions; and climate change that is happening faster and causing more damage than most scientists predicted even a decade ago. These challenges are closely interconnected. It is difficult to sustain ambitious action on poverty or climate change when wealth is concentrated in the hands of a powerful few who benefit from the status quo. Economies will slow and jobs will disappear if countries do not harness the low-carbon innovations emerging from every corner of the world. And ever-worse climate change impacts will make it even harder to eradicate poverty or reduce inequalities.[24]

Sustainable cities offer a powerful lever to respond to these national challenges. Cities can be deeply unequal, with extraordinary wealth coexisting with dire poverty. Accounting for over 80% of global gross domestic product (GDP),[25] they are also beacons of opportunity, offering scope for people to earn a higher income and improve their quality of life. This helps to explain why the number of people living in cities is growing so rapidly, from 30% of the world's population in 1950 to 55% of the world's population today, to a projected 66% by 2050.[26]

At the same time, unsustainable consumption – concentrated among high- and middle-income urban residents – is a major driver of global climate change, biodiversity loss and land use change.[27] Up to three quarters of carbon emissions from final energy use can be attributed to urban areas.[28] Changing the ways that people live, play, work and move within cities is therefore an important part of tackling global environmental crises. Cities also offer large opportunities to provide a high quality of life while using land, materials and energy more efficiently. Long-term national prosperity within planetary boundaries thus increasingly depends on thriving cities.[29] National governments formally recognised the importance of cities when they adopted the 11th Sustainable Development Goal (SDG11), which commits countries to "make cities and human settlements inclusive, safe, resilient and sustainable".

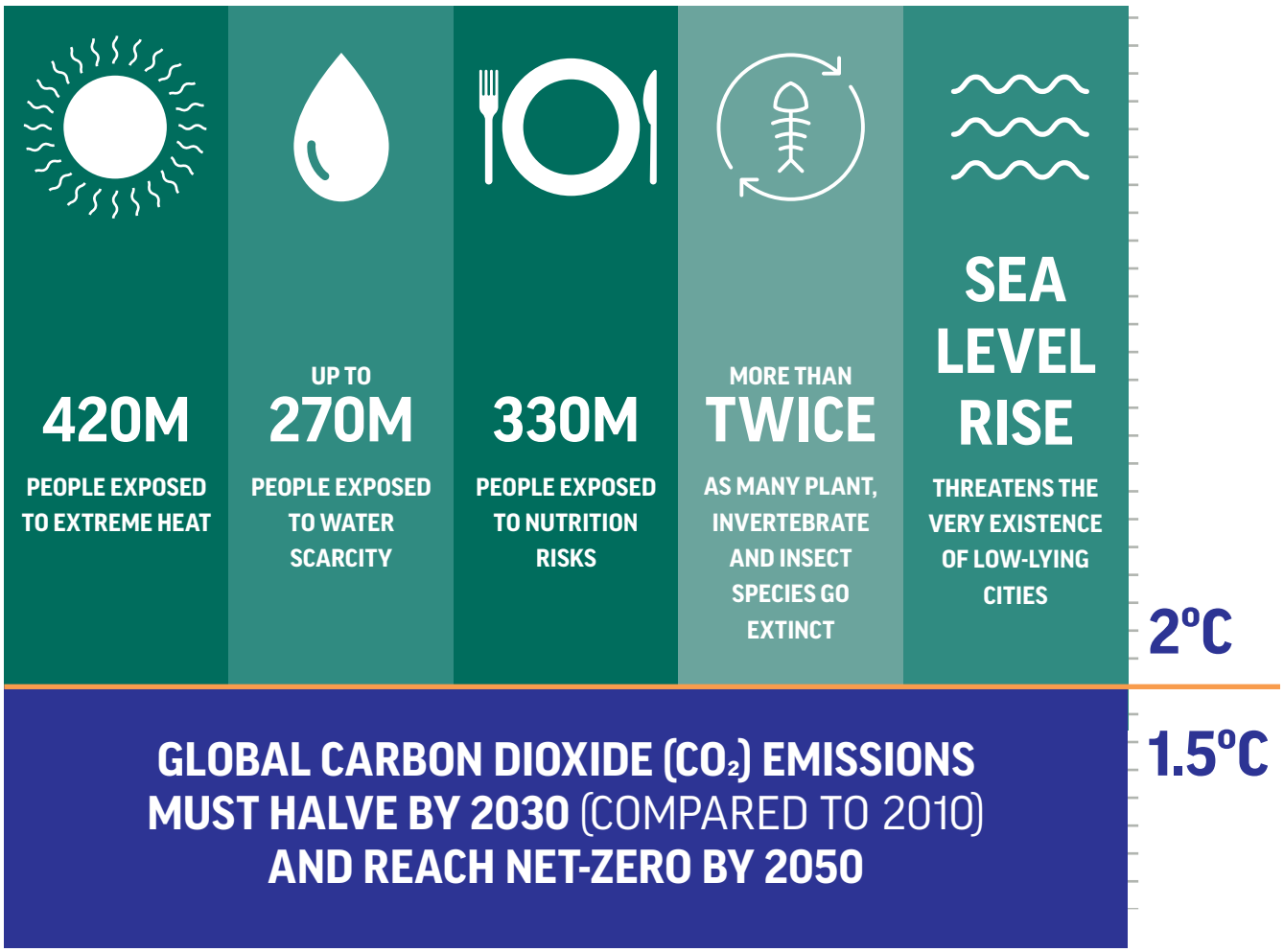
The share of people living in cities is growing rapidly



Local action is critical, but – on its own – insufficient to achieve this goal. Recent decades have seen a groundswell of climate action at the local level. City governments have shown particular leadership: nearly 10,000 city and local governments worldwide have committed to setting emission reduction targets and preparing strategic plans to deliver on that commitment.[30] However, even the largest and most empowered city governments can deliver only a small share of mitigation potential on their own.[31] Governments of small- and medium-sized cities, which are home to over half the global urban population and half the urban mitigation potential,[32] have even less power and fewer resources to reduce emissions or enhance resilience. For them, the support provided and standards established by national and state governments are particularly important.

This report focuses on the unique and crucial role of national governments in creating successful cities that secure shared prosperity and climate safety. International attention so far has focused mainly on local governments' commitments and actions, which are certainly worth celebrating and learning from. Yet this narrative overlooks the critical importance of collaborative climate action with national and provincial governments to deliver sustainable urban development that leaves no one behind. This is not an argument for recentralisation, but a recognition that the scale and urgency of these global challenges demands collaborative, ambitious action across all tiers of government. Today, fewer than two in five countries have an explicit national strategy for cities,[33] and only a few of those strategies speak to human development and climate action. This report seeks to rebalance the global conversation, underscoring the crucial roles of national and state governments, in partnership with local governments, in shaping cities.

This report responds to four recent developments that have heightened both the urgency of ambitious climate action in cities, and the immense benefits that might flow to countries that show early leadership.



Growing scientific evidence on the climate emergency:
The special report Global Warming of 1.5°C[34] by the Intergovernmental Panel on Climate Change (IPCC) shows that 420 million additional people will be exposed to extreme heat and 184–270 million additional people to water scarcity if global temperatures rise by 2°C, compared with a 1.5°C scenario.[35] Crop yields and fishery stocks will decline much faster, exposing an additional 330 million people to nutrition risks.[36] More than twice as many plant, vertebrate and insect species will go extinct, leading to the collapse of entire ecosystems. Feedback loops and threshold effects could mean that sea levels rise by several metres,[37] threatening the very existence of low-lying cities such as Alexandria, Dhaka, Guangzhou, Miami, Osaka, Rio de Janeiro and Venice. It is difficult to meaningfully quantify the human impacts of such catastrophic ecological changes. But staying below 1.5°C will require rapid system change at an unprecedented pace and scale. Global carbon dioxide (CO_2) emissions must nearly halve by 2030 (from 2010 levels) and reach net-zero by around 2050.[38] The IPCC special report identifies urban and infrastructure as one of four key systems that urgently need to be decarbonised.[39] In other words, cities need to reach net-zero CO_2 emissions by mid-century to avoid climate catastrophe.

Rising popular demand for ambitious action on climate change:
A 2018 Pew poll of voters in 26 countries found that in 13 of those countries, climate change was seen as the top threat. In another seven, it was rated as second most urgent.[40] Concern about the climate crisis has spilled out into the streets, with students around the world striking for climate action. On 15 March 2019, an estimated 1.6 million protesters across 133 countries turned out to demand a more ambitious response to the crisis.[41] These calls are echoed in universities, boardrooms and town halls. A survey of nearly 1,000 leaders from the public, private, and civic sectors identified extreme weather events as the most severe global risk today.[42] There is clearly public appetite for leadership on climate change, both to reduce greenhouse gas emissions and adapt to the impacts of rising temperatures.

A stronger economic case for low-carbon policies and investments:
The economic and financial case for low-carbon measures, many of which can be deployed in cities, is increasingly compelling. Renewable electricity is now competitive with fossil fuel generation in most contexts,[43] and electric vehicles are selling in record numbers.[44] Energy efficiency in cities – achieved through building codes, energy management systems and efficiency standards for appliance, lighting and vehicles – can be very economically attractive, lowering total costs for users and the need for new power generation capacity.[45] The Global Commission for the Economy and Climate estimates that transitioning to a low-carbon, sustainable development path could deliver a direct economic gain of US$26 trillion through 2030.[46] It could also create millions of additional jobs in sectors as diverse as renewable energy installation, materials efficiency and waste management.[47]

A window of opportunity to transform cities – for better or worse: Cities everywhere will change dramatically in the next few decades. Technological innovation is changing the nature of work and enabling new forms of service delivery. Demographic changes, from falling fertility to ageing populations to rising incomes, are driving demand for new forms of housing and services. Economic turbulence and structural economic change are redirecting global trade, driving massive investment in urban infrastructure. In Africa and Asia, the urban population is expected to grow by 2.5 billion people over the next 30 years.[48] Much of this urbanisation is happening at unusually low levels of income, creating significant resource challenges for governments trying to provide housing and services. Profound economic and social changes around the world in the coming years will be concentrated in cities. The decisions made today could lock countries in to prosperity and resilience – or vulnerability and decline.[49]

At this critical moment, this report aims to support national governments in three ways. First, it lays out the case for pursuing inclusive, zero-carbon cities.* It identifies a bundle of widely available, commercially feasible low-carbon measures that would make cities more compact, connected and clean – and reduce their emissions by nearly 90% by 2050. It then explores what life would be like in such cities, and the many associated social and economic benefits.

Second, this report examines the key roles that national governments need to play in realising this vision, working with local governments, businesses and civil society to craft and achieve a shared vision for cities.

Third, drawing on three years of research and extensive consultation with government networks, businesses, civil society and research institutes, this report identifies six priorities for national action. It lays out ambitious, evidence-based, specific policies, showing how national governments in all parts of the world can lay a strong foundation for climate action, seize opportunities to deliver inclusive economic development while reducing emissions, and keep raising their ambition. The result is a robust and practical agenda for national governments to deliver inclusive economic development and reduce the risks of climate change by transforming their cities.

* *"Zero-carbon cities" is used as shorthand in this report to describe urban areas with net-zero greenhouse gas emissions. Analyses in this report focus particularly on emissions from urban buildings, materials, transport and solid waste.*

Box 1. Defining the city

Urban areas are defined in different ways around the world. A place may be called a "city" because it has a particular type of local government, or because of its population density, its built-up area, its area within commuting range of urban labour markets or other measures. Each of these metrics will generate a different estimate of the share of land, people and economic activity that is deemed urban. Different definitions are appropriate for different geographies and questions. For instance, a suburban area in the US might be regarded as peri-urban in sub-Saharan Africa due to the lack of connecting infrastructure. A political analysis might use urban boundaries as defined by a national government, whereas a spatial analysis might focus on built-up area or population densities. For simplicity, this report uses the term "city" to encompass urban areas of all sizes. The analyses commissioned for this report use specific definitions of "cities" and "urban", which are spelled out in their corresponding annexes.

2. A pathway to inclusive, zero-carbon cities

To avoid a global temperature increase of more than 1.5°C with limited or no overshoot, science shows cities worldwide must reach net-zero CO_2 emissions by mid-century.[50] This chapter shows how to achieve that and explores how this urban transition could raise living standards for all.

Though no zero-carbon cities exist yet, most necessary elements are already available, and there are many success stories that can inspire decision-makers as they craft their own climate action plans. *Section 2.1* demonstrates how a wide array of proven abatement options, implemented together, could move cities towards net-zero emissions.

A rapid transition to zero-carbon cities is challenging, but it is both feasible and attractive. In all countries, deep decarbonisation will require overcoming vested interests and managing difficult trade-offs. It is thus crucial for decision-makers to understand and be able to communicate the many benefits of climate mitigation. *Section 2.2* explores how the bundle of abatement options required to reach net-zero emissions can help create cities with a high quality of life, particularly if the measures are implemented in ways that reduce inequality and vulnerability. These gains could in turn help build and sustain public appetite for further climate action.[51] Copenhagen, Indore, Medellín, Seoul and Windhoek offer potent examples of how quickly cities can be transformed for the better when different tiers and sectors of government work together towards a shared vision.

Without a zero-carbon urban transition, countries risk being left behind economically as global policies and markets evolve. This would leave workers and assets stranded. Moreover, as global climate change accelerates, cities will be hotspots of vulnerability, with dire repercussions for the whole country. Even with immediate action to reduce emissions, cities will need to adapt to significantly greater climate risk. *Section 2.3* examines the consequences for cities and countries if there is no swift action to limit warming to 1.5°C, and underscores the importance of enhancing climate resilience.

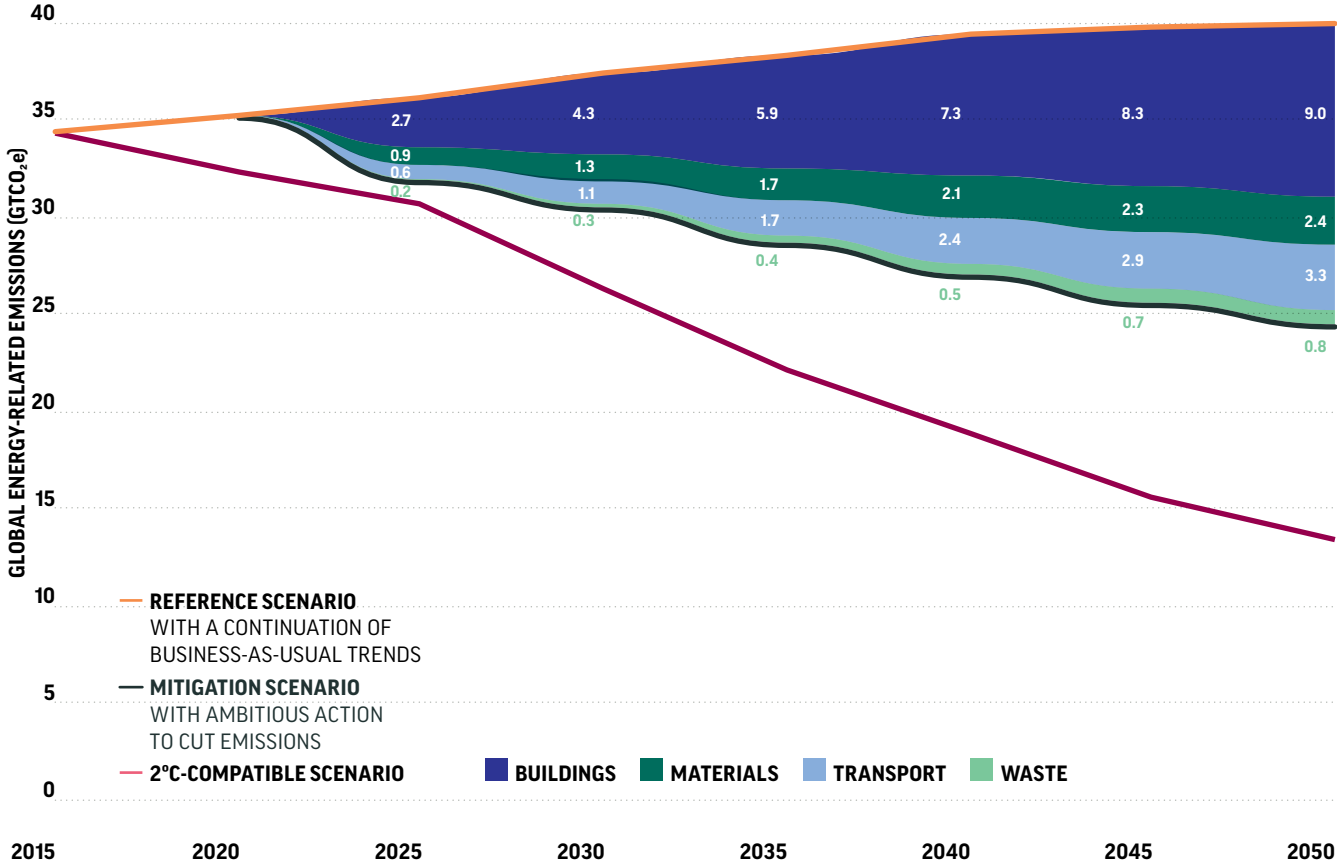
Currently available, technically feasible measures can reduce greenhouse gas emissions from urban buildings, transport, materials and waste by almost 90% in 2050. This would contribute over half of the global energy-related emission reductions needed to keep global warming below 2°C.

2.1 What is the pathway to zero-carbon cities?

The IPCC special report makes it clear that cities need to reach net-zero emissions by mid-century.[52] An analysis by the Stockholm Environment Institute for this report finds that, without further action to tackle climate change, greenhouse gas emissions attributable to urban buildings, transport and waste could reach 17.3 billion tonnes of carbon dioxide equivalent (tCO_2-e) in 2050 – 24% higher than in 2015, when the Paris Agreement was signed. Urban emissions would be even higher if industry and other sectors were included. This projection assumes that current trends in economic activity and energy use will continue, but takes into account recently adopted national policies and commitments, including Nationally Determined Contributions (NDCs) under the Paris Agreement.

The new analysis identifies a range of abatement options that are already widely deployed in cities, and evaluates their mitigation potential if deployed at scale. It finds that it is possible to reduce emissions from urban buildings, materials, transport and waste from the projected level of 17.3 billion tCO_2-e to 1.8 billion in 2050, using technically feasible measures that, for the most part, are already commercially available. This is a reduction of almost 90% relative to business-as-usual levels. In absolute terms, it is more than the 2014 energy-related emissions of the China and the US combined.[53] Altogether, this analysis suggests that these abatement measures in cities could avoid the equivalent of 39% of projected energy-related emissions in 2050. This amounts to 58% of the global energy-related emission reductions needed to be on the International Energy Agency's 2°C pathway (see *Figure 1*).[54]

FIGURE 1. POTENTIAL CONTRIBUTION OF CITIES TO GLOBAL ENERGY-RELATED GREENHOUSE GAS EMISSION REDUCTIONS USING TECHNICALLY FEASIBLE, COMMERCIALLY AVAILABLE ABATEMENT OPTIONS.



Source: Stockholm Environment Institute for the Coalition for Urban Transitions. For the full methodology, see Annex 1.

The emission reductions available in cities are distributed across different sectors: 58% would come from commercial and residential buildings, 21% from transport, 16% from materials and 5% from solid waste management (see *Figure 2*). Fully half of the abatement potential identified in this analysis comes from decarbonising urban electricity, primarily by generating electricity from non-emitting technologies such as solar, wind, hydro, nuclear, biomass and geothermal power – as well as carbon capture and storage technologies.[55] Other significant sources of abatement in cities include:

- Improved cement production processes;
- A shift from using private cars to public transport, cycling and walking;
- More efficient cooking and water heating in residential buildings;
- More efficient space heating and cooling in all buildings;
- More efficient and electric vehicles;
- Reduced use of materials in building construction; and
- Waste prevention.

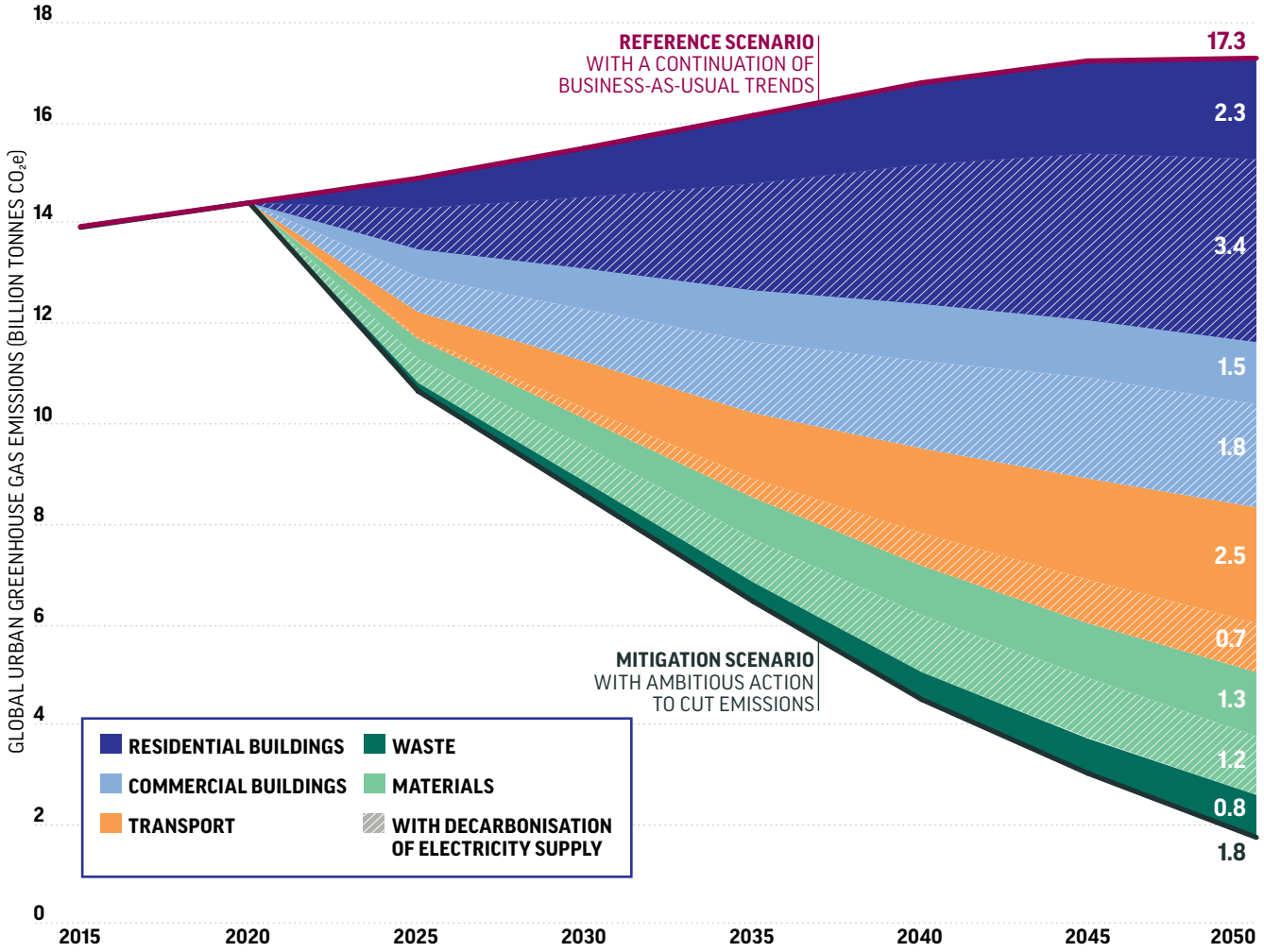
The decarbonisation of energy must go hand-in-hand with a massive expansion in the supply of energy, since successful urbanisation in developing countries – linked as it is to structural economic change and rising per capita incomes – will drive an enormous increase in energy demand. In sub-Saharan Africa, a staggering tenfold expansion of generation capacity is required by 2040 to provide universal access to energy and support economic activity.[56] In all countries, electrification of cooking, heating, transport and other end uses will shift demand from fossil fuels towards electricity, demanding further investment in generation infrastructure. Crucially, this bundle of abatement measures will deliver very substantial energy savings, reducing total energy use in cities by around 1,075 megatonnes of oil equivalent (Mtoe) in 2030 and 2,134 Mtoe in 2050 (see *Table 1*). The savings would significantly offset the total investments needed to expand the electricity supply.

Still, moving towards zero-carbon cities while supporting human development and industrial activity will require massive new investments in electricity generation infrastructure, while simultaneously directing that investment towards renewable options. Many renewable technologies offer significant advantages over fossil fuel options: for instance, they produce little or no air pollution, and some can be deployed quickly and even off-grid. Renewable technologies are also increasingly economically attractive: the levelised cost of electricity generated from solar photovoltaics and offshore wind, for example, is now often competitive with fossil power, and capital costs are projected to fall by a further 25–40% between 2018 and 2023.[57] These factors help to explain why new renewable generation capacity has grown so rapidly, with annual new capacity expanding eightfold between 2001 and 2014, from 20GW to over 160GW.[58] Renewables now account for 33% of global generation capacity, up from 22% in 2001.[59]

Renewable technologies do also pose challenges. Their capital costs are higher, even if the levelised cost of electricity is competitive over the lifespan of the investment. Geothermal and hydropower are only available at scale in a limited number of countries. The intermittent nature of solar and wind energy requires upgrades to grid infrastructure and management. Still, while a zero-carbon energy transition is complex, it is certainly possible,[60] and this analysis makes it clear that it is an essential precondition for a zero-carbon urban transition.

Moving towards zero-carbon cities while supporting human development and industrial activity will require massive new investments in electricity generation infrastructure, while simultaneously directing that investment towards renewable options.

FIGURE 2. TECHNICALLY FEASIBLE POTENTIAL TO REDUCE GREENHOUSE GAS EMISSIONS FROM CITIES BY 2050, BY SECTOR.



Note: The striped wedges reflect the mitigation potential through decarbonisation of energy.
Source: Stockholm Environment Institute for the Coalition for Urban Transitions. For the full methodology, see Annex 1.

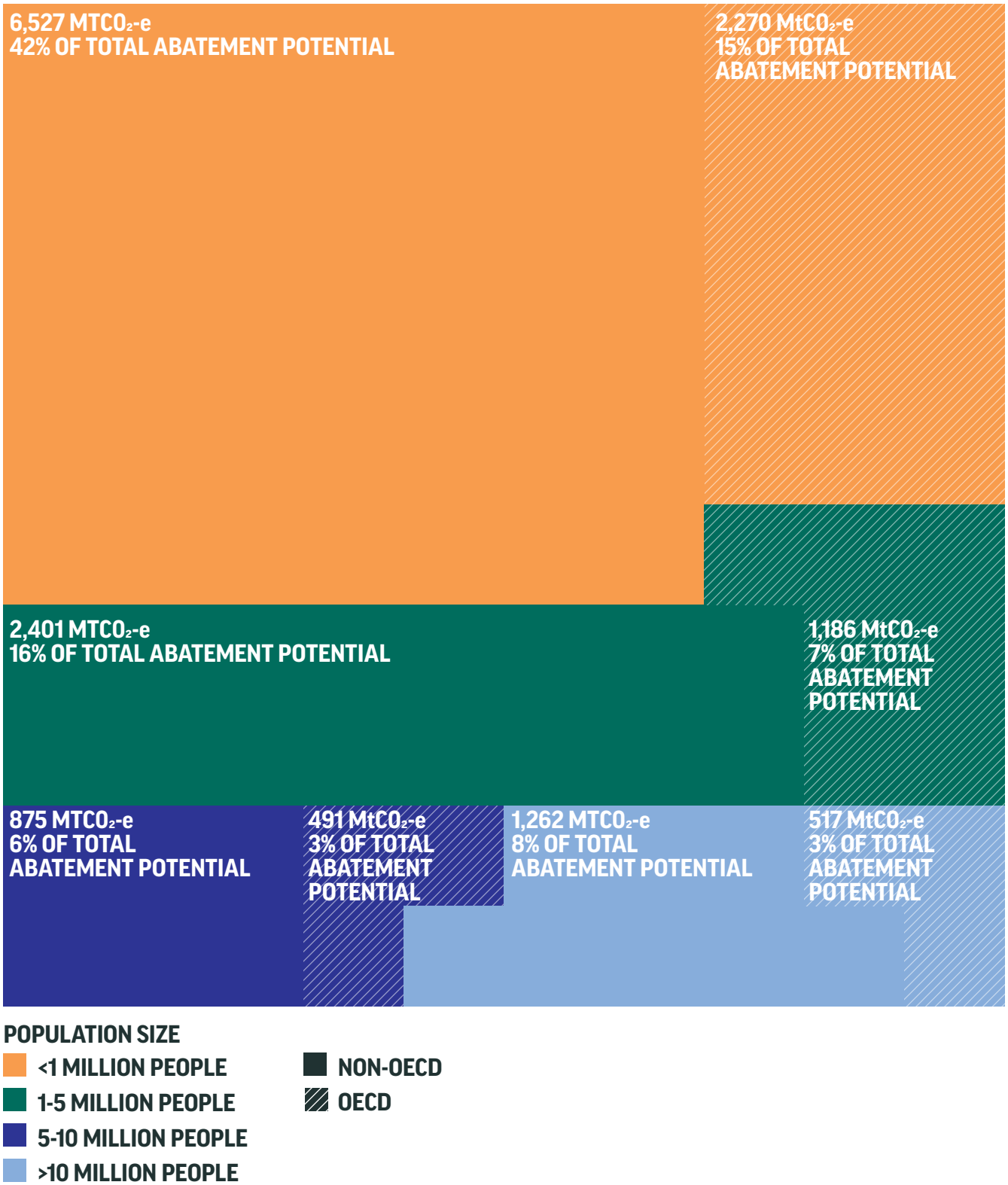
TABLE 1. ENERGY SAVINGS AND EMISSION REDUCTIONS ASSOCIATED WITH AMBITIOUS DEPLOYMENT IN CITIES OF A RANGE OF TECHNICALLY FEASIBLE LOW-CARBON MEASURES.

	Energy savings (Mtoe)		Emission reductions ($GtCO_2$-e)		Share of abatement (%)	
	2030	2050	2030	2050	2030	2050
Buildings	**545.83**	**956.59**	**4.26**	**8.95**	**61.40%**	**57.70%**
Residential	**317.35**	**580.04**	**2.41**	**5.66**	**34.70%**	**36.50%**
Decarbonisation of electricity	-	-	1.25	3.38	18.10%	21.80%
Distributed solar photovoltaics (PV)	-	-	0.03	0.29	0.50%	1.80%
Fuel switching to low-carbon options	-	-	0.17	0.25	2.40%	1.60%
Cooking and water heating efficiency	100.67	237.33	0.24	0.61	3.40%	3.90%
Appliance and lighting efficiency	25.14	70.40	0.10	0.25	1.40%	1.60%
Heating and cooling efficiency	191.54	272.31	0.62	0.89	8.90%	5.70%
Commercial	**228.48**	**376.55**	**1.85**	**3.29**	**26.70%**	**21.20%**
Decarbonisation of electricity	-	-	0.92	1.84	13.20%	11.80%
Distributed solar photovoltaics (PV)	-	-	0.01	0.08	0.10%	0.50%
Fuel switching to electricity and biomass	-	-	0.14	0.21	2.00%	1.40%
Cooking and water heating efficiency	21.54	44.58	0.06	0.12	0.80%	0.80%
Appliance and lighting efficiency	62.23	141.16	0.24	0.49	3.50%	3.20%
Heating and cooling efficiency	144.71	190.81	0.49	0.55	7.00%	3.60%
Transport	**249.31**	**652.37**	**1.13**	**3.29**	**16.40%**	**21.20%**
Passenger	**216.01**	**567.71**	**0.97**	**2.71**	**14.00%**	**17.40%**
Decarbonisation of electricity	-	-	0.11	0.55	1.60%	3.60%
Fuel switching to advanced biofuels	-	-	0.07	0.16	1.00%	1.00%
Vehicle efficiency and electrification	92.70	210.18	0.32	0.71	4.60%	4.60%
Motorised mode shift	62.94	199.93	0.24	0.73	3.50%	4.70%
Reduced motorised travel demand	60.37	157.61	0.23	0.56	3.30%	3.60%
Freight	**33.30**	**84.66**	**0.17**	**0.58**	**2.40%**	**3.70%**
Decarbonisation of electricity	-	-	0.01	0.19	0.10%	1.30%
Fuel switching to advanced biofuels	-	-	0.03	0.06	0.40%	0.40%
Vehicle efficiency and electrification	24.15	62.02	0.09	0.23	1.30%	1.50%
Logistics improvements	9.15	22.63	0.04	0.09	0.50%	0.60%
Infrastructure	**220.42**	**423.59**	**1.26**	**2.45**	**18.20%**	**15.80%**
Decarbonisation of electricity	-	-	0.70	1.16	10.10%	7.50%
Reduced cement process emissions	-	-	0.21	0.48	3.00%	3.10%
Reduced materials – vehicles	19.32	36.55	0.02	0.05	0.30%	0.30%
Reduced materials – road and rail	18.91	37.43	0.02	0.02	0.30%	0.10%
Reduced materials – buildings	182.19	349.61	0.31	0.73	4.40%	4.70%
Waste	**64.22**	**134.36**	**0.28**	**0.84**	**4.10%**	**5.40%**
Recycling	18.81	30.46	0.10	0.15	1.40%	1.00%
Landfill methane capture and utilisation	-	-	0.04	0.30	0.60%	2.00%
Waste prevention	45.42	103.89	0.15	0.39	2.10%	2.50%
TOTAL	**1,075.18**	**2,133.81**	**6.93**	**15.53**	**100.00%**	**100.00%**

Source: Stockholm Environment Institute for the Coalition for Urban Transitions. For the full methodology, see Annex 1.

FIGURE 3. TECHNICALLY FEASIBLE MITIGATION POTENTIAL IN CITIES IN 2050, BY REGION AND CITY SIZE.

Annual average abatement (million tonnes CO2-e) in 2050.
Source: Stockholm Environment Institute for the Coalition for Urban Transitions. For the full methodology, see Annex 1.



The urban abatement potential is dispersed across cities of different sizes and in different regions (see *Figure 3*). Megacities – those with over 10 million inhabitants – make an outsized contribution to global emissions and also have the largest scope for climate mitigation: the world's 29 megacities in 2015 account for 12% of the identified urban abatement potential in 2050. Including cities with over 5 million inhabitants brings the share to over a fifth of the world's urban abatement potential. These larger cities often have relatively well-resourced and capable city governments, so local leadership and action will be particularly significant in these contexts.

However, over half of all urban abatement potential is in cities with populations of less than 750,000 (as of 2015). These cities often lack the financial and technical resources of their larger counterparts. And even for cities with sufficient capacity, taking aggressive unilateral efforts to reduce emissions may be untenable if their economic peers fail to act. It is for these cities that national support and standards are most important.

Nearly three quarters (71%) of urban abatement potential identified in this analysis is in countries outside the Organisation for Economic Co-operation and Development (OECD). Cities in China account for 22% and cities in India account for 12% of the identified emission reductions. In OECD countries, meanwhile, over half of the urban abatement potential is in US cities, which account for 15% of the global potential identified. National and state governments in China, India and the US thus have particularly important roles to play in supporting a zero-carbon urban transition.

Crucially, the bundle of measures identified in this report would not be quite enough to reach net-zero emissions in the selected urban sectors by 2050. They could reduce emissions by 96% from commercial and residential buildings, 76% from materials use, 86% from passenger and freight transport, and over 99% from solid waste management. But reaching net-zero emissions by mid-century would require still more aggressive deployment of existing measures or additional innovations. Moreover, this analysis focuses mainly on emissions from energy use within city boundaries, electricity production, materials use and municipal waste. Reaching net-zero emissions worldwide will demand much greater attention to emissions from consumption,[61] including air travel, meat and dairy products, and goods manufactured and disposed of beyond city boundaries.[62] Because of cities' economic heft, a small subset of urban residents have especially high levels of consumption and particularly strong influence over global supply chains. The nearly 100 cities that are members of the C40 Cities Climate Leadership Group alone represent 10% of global greenhouse gas emissions when using consumption-based accounting.[63] A suite of additional climate actions will be required to engage citizens around this issue and cut emissions from unsustainable levels of consumption.[64]

Over half of all urban abatement potential is in cities with populations of less than 750,000 (as of 2015).

2.2 What might life be like in zero-carbon cities?

The bundle of measures identified above could rapidly improve quality of life by making cities at all levels of development more compact, connected and clean (see *Figure 4*). These three aspects are closely interrelated and complementary. Good connectivity – with safe sidewalks, cycling lanes and mass transit – facilitates compactness by reducing dependence on space-hungry private cars. More compact cities are more resource-efficient, because they use less space per resident and provide more opportunities for mass transit, active travel and district heating and cooling systems.[65] This section spells out the characteristics of compact, connected and clean cities, and explores what life in such cities might look and feel like. It highlights the wide range of social and environmental benefits of an urban transition (*Chapter 3* examines the economic benefits), then considers the wider societal and technological forces that can be harnessed to realise these benefits.

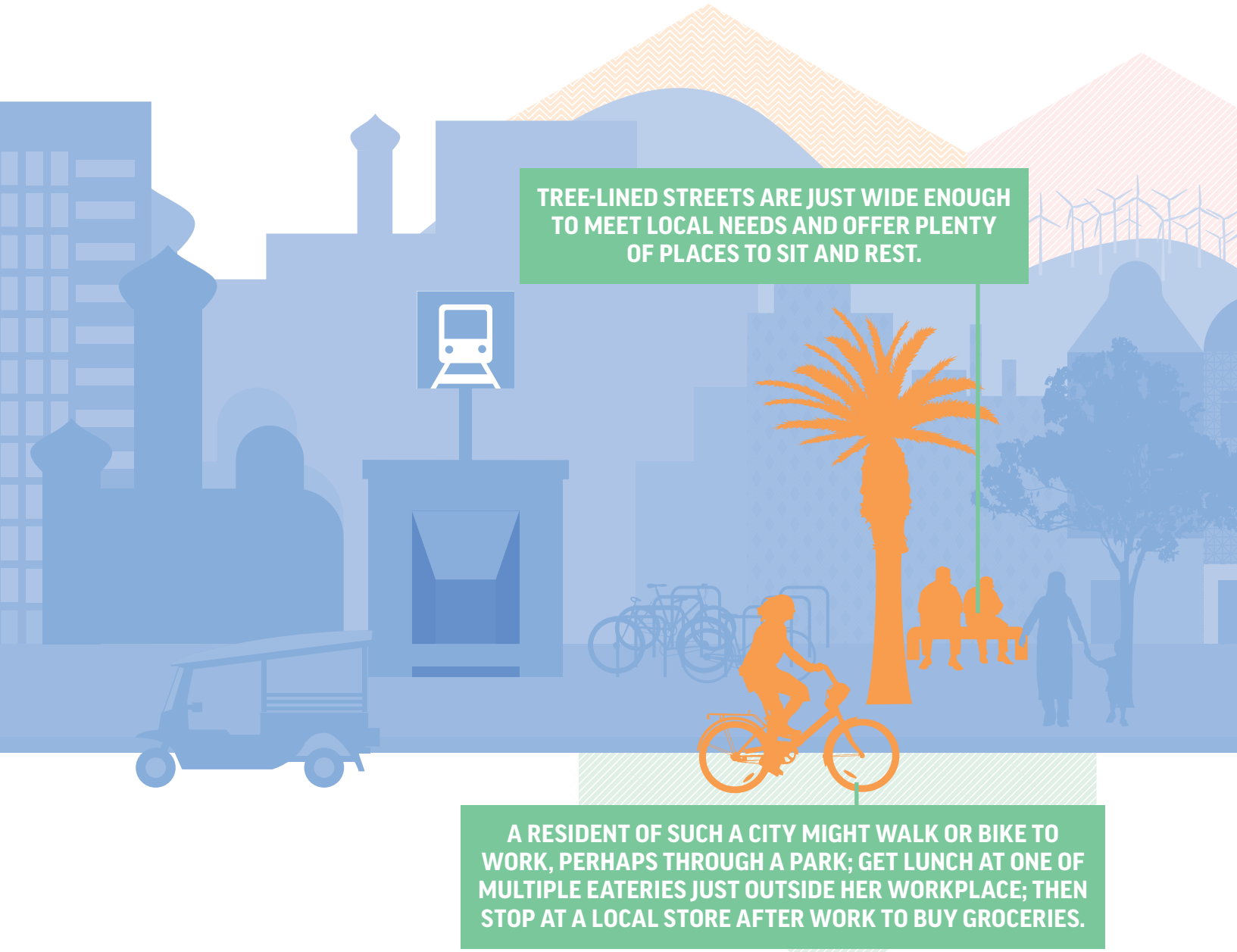
This bundle of low-carbon measures could raise living standards and improve urban environments, but complementary actions are needed to realise their full potential. For instance, effective rule of law is crucial to improving public safety and the ease of doing business; strong labour standards are needed to ensure working people have decent jobs that pay a living wage; and careful macroeconomic policies are crucial to reducing investment risk. Additional measures will also be needed to achieve the Sustainable Development Goals (SDGs) and make cities truly resilient to climate change impacts. Governments need to pursue an inclusive urban transition that ensures that markets are regulated, services are provided and space is used in ways that meet the needs of disadvantaged groups, such as the poor, women, the elderly, children, people with disabilities, migrants and minorities. Exclusionary urban development can lead to informality, fragility and insecurity that are hard to redress in the longer term.[66] While the poor bear the most severe consequences, everyone suffers if a city is less productive and more violent. Climate change will only deepen poverty and inequality. Policies must therefore be designed to address the social and economic drivers of vulnerability, as well as physical exposure to hazards.[67] Meeting the needs and building the adaptive capacity of the urban poor is a precondition for creating resilient cities with flourishing economies, healthy communities and clean environments[68] – and sustaining public appetite for a zero-carbon urban transition.

More compact cities are more resource-efficient because they use less space per resident and provide more opportunities for mass transit, active travel and district heating and cooling systems.

FIGURE 4. KEY LOW-CARBON MEASURES ASSOCIATED WITH COMPACT, CONNECTED AND CLEAN CITIES.

The benefits of compact cities

Envision a city that truly makes the most of its land. Countless cities like this already exist, especially in places settled well before cars became common. But they are not the norm.



The shape and layout of cities greatly affects their economic, social and environmental performance. Compact cities have three key characteristics:[69]

- Economic density, with a high concentration of people living, doing business and working in a given area;
- Morphological density, making the most efficient use of available land and built space to meet people's needs; and
- Mixed land use, putting residential, employment, retail, and leisure opportunities close to one another.

The average population density of cities is falling in every region of the world.[70] This is largely because greenfield land around the urban periphery tends to be cheaper (at least from the perspective of property developers and households), and building there is easier than redeveloping and/or densifying existing urban areas.[71] Many subnational governments also generate revenues from land sales, so they are incentivised to favour sprawl rather than densification: in China, local land revenues now fund nearly a quarter of local fiscal expenditure.[72] Policies at all levels of government typically mean that residents in outlying areas do not bear the full costs of sprawl, which are outlined in *Section 3.1*. Cultural preferences for larger homes, private gardens and car-based transport may reinforce those economic factors.

Reversing this trend by pursuing more compact urban development could deliver better living standards and more vibrant cities. People could enjoy easier access to jobs, services and amenities.[73] Public services could be cheaper, as they could be delivered more efficiently.[74] More time in shared spaces could help to connect people across class and cultural lines.[75] Higher densities could support a greater variety of shops, restaurants and public spaces within neighbourhoods. By safeguarding farmland and natural habitats around the city, compact urban growth could conserve biodiversity and maintain ecosystem services that enhance climate resilience.[76] Compactness is not a panacea – in particular, increasing the density of people living and working in cities can drive up housing prices significantly, with the burden borne disproportionately by the poor and the young.[77] But if this risk is carefully managed, the potential economic, social and environmental benefits of compactness are substantial.

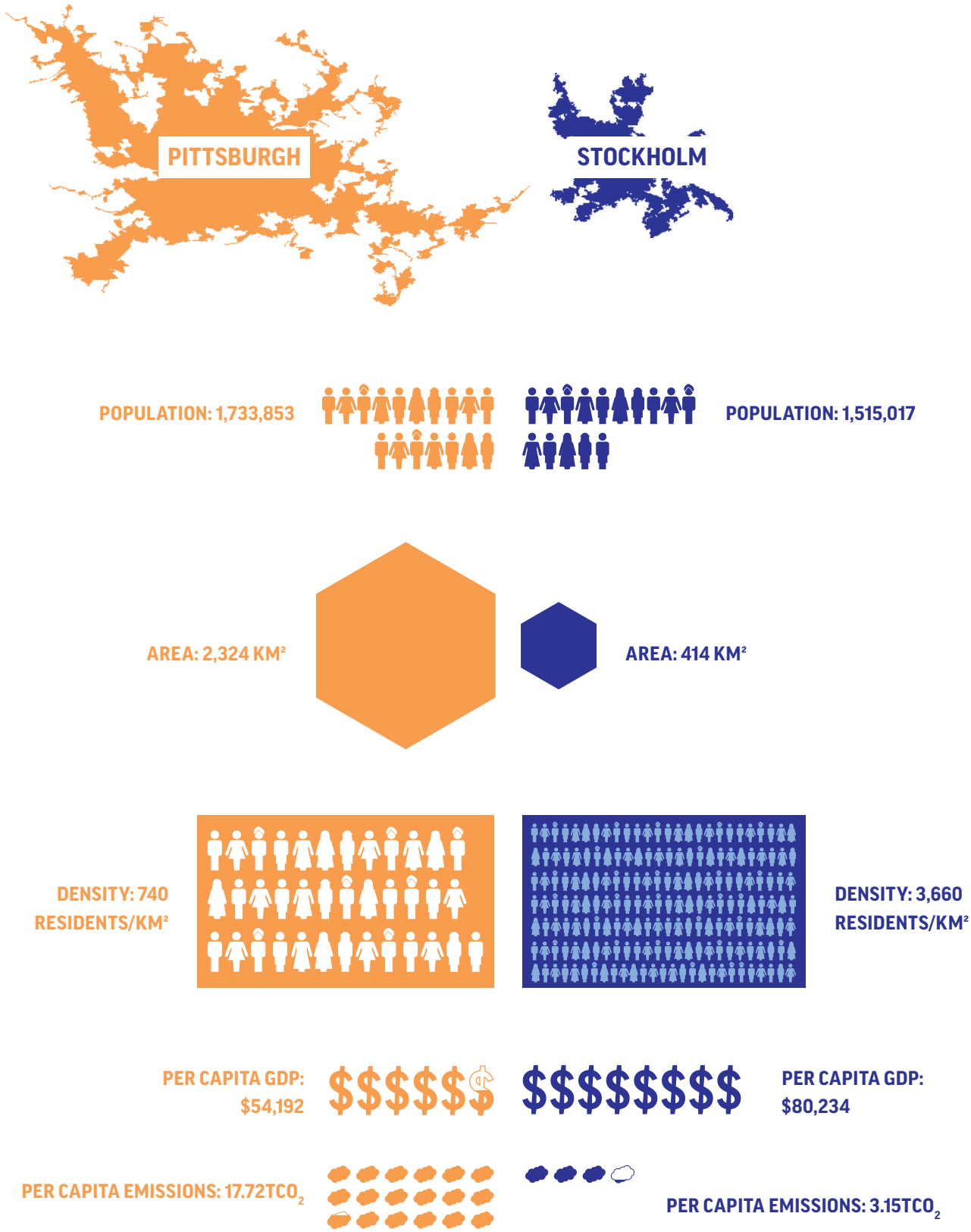
Figure 5 compares the spatial footprint of two cities: Stockholm (Sweden) and Pittsburgh (US). These cities have roughly the same population, but Pittsburgh occupies five times as much land area. This means that people need to travel farther, at greater personal and environmental expense, excluding many of them from economic and social opportunities. Meanwhile, Stockholm is widely recognised as having a very high quality of life and a thriving, inclusive economy thanks in part to its compact, connected form.

Demographic change, cultural change and urbanisation offer a window of opportunity to achieve more compact urban forms. Many cities in high-income countries have ageing populations and smaller households than they did historically. These trends are complemented by an increasing preference for city life over suburbia. The result is falling demand for larger homes around the urban periphery and growing demand for smaller homes with better access to the city centre. These changes in the housing market offer a chance to encourage densification around transport hubs. Seoul in South Korea demonstrates how a relatively established city can align land use, transport and housing strategies to create dense, vibrant, mixed-use neighbourhoods (see *Box 2*).

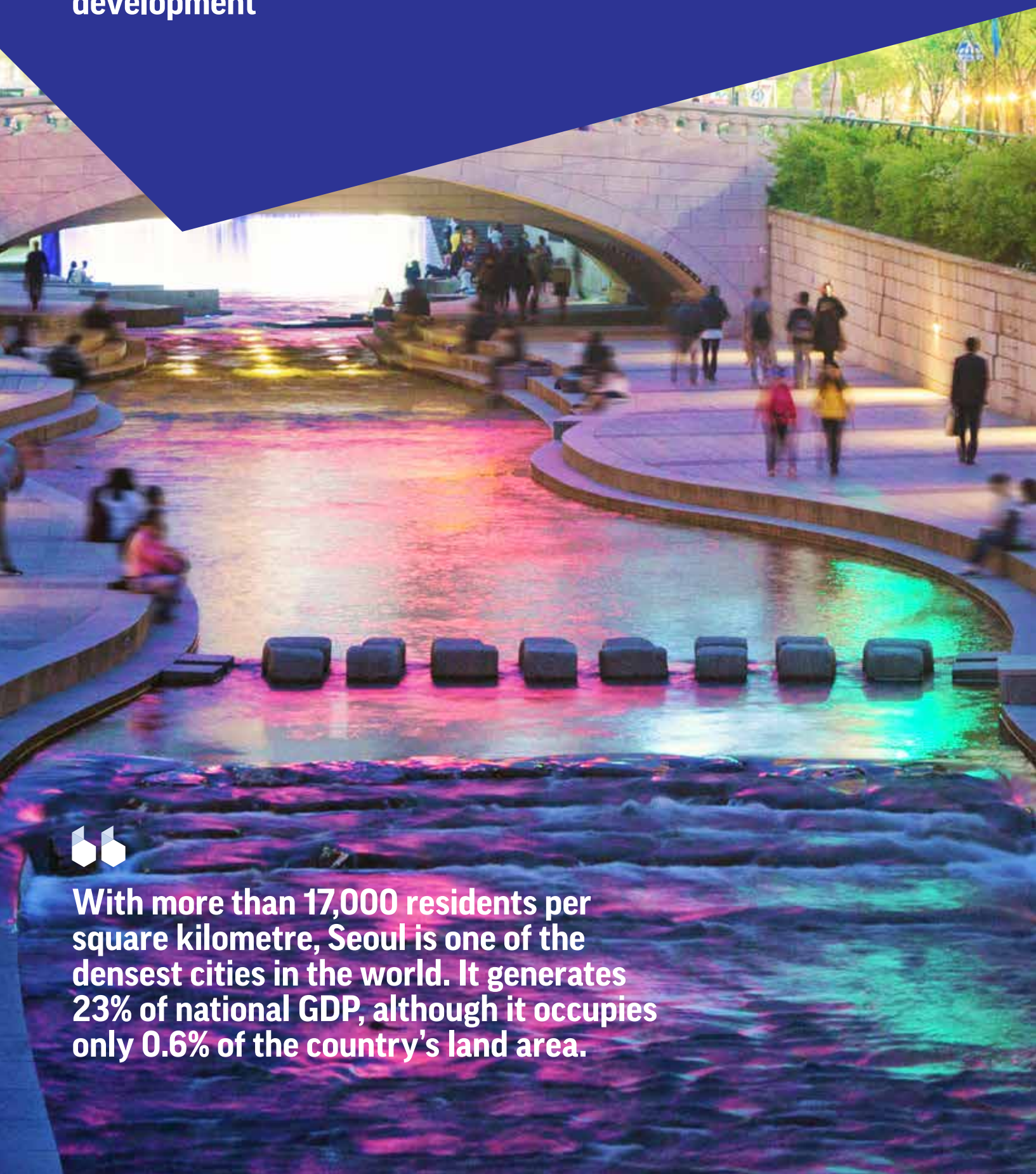
By comparison, many cities in developing Africa and Asia have rapidly expanding populations with large youth bulges and severe infrastructure deficits. Governments need to proactively prepare for this growth, recognising that people at all income levels have a right to the city and that meeting their needs is crucial to long-term economic, social and environmental success.[78] The urban poor need special attention to ensure that competition for well-located land does not lead to eviction or gentrification. Windhoek, Namibia, for example, made small plots of competitively priced and serviced land available to poor residents, reducing the heavy health burden associated with informal settlement and making it cheaper to upgrade housing and services over time (see *Box 3*).

FIGURE 5. URBAN EXTENT OF PITTSBURGH AND STOCKHOLM, SHOWN AT THE SAME SCALE.

Source: Coalition for Urban Transitions. For the full methodology, see Annex 2.



Box 2. Seoul: How planning for urban density fuelled a nation's economic development



With more than 17,000 residents per square kilometre, Seoul is one of the densest cities in the world. It generates 23% of national GDP, although it occupies only 0.6% of the country's land area.

As the engine of the world's 11th largest economy,[79] Seoul is an ultra-modern megacity with exceptionally high quality of life.[80] But this wasn't always the case. After the Korean War (1950–1953) destroyed much of Seoul's traditional society and infrastructure, the Republic of Korea was one of the world's poorest countries. The journey to present-day Seoul involved tripling the population, developing or reconstructing 70% of the city, and increasing its gross value added by a factor of 330.[81] The national and city government worked closely together to foster high but liveable density, creating bustling neighbourhoods around efficient transport systems.[82]

Between 1950 and 1980, Seoul's population grew eightfold, from about 1 million people to over 8.2 million.[83] As formal markets did not meet demand for urban infrastructure and housing, informal settlements proliferated around the city. In response, the national government introduced the Urban Planning Act, Land Expropriation Act and Land Readjustment Act to regularise and improve these settlements. Fragmented land parcels were consolidated into contiguous, standardised tracts that enabled large-scale property development and much-needed infrastructure investment. While the original land owners and occupiers saw the size of their land parcels shrink, their land was worth more because it was serviced.[84] Between the 1960s and 1980s, land readjustment was implemented on 14,000 hectares – 23% of the Seoul Metropolitan Area.

In the late 1970s, it became apparent that land readjustment alone would not deliver enough housing or contain sprawl. Seoul's city centre remained low-density and grew dilapidated. In response, the national government passed the Urban Redevelopment Act and the Housing Site Development Promotion Act. This enabled local authorities and property developers to replace low-rise, central houses and medium-rise peripheral apartments with high-rise buildings. A further 7,950 hectares were densified and redeveloped over the following two decades.[85] The process garnered some criticism for uprooting communities and replacing traditional Korean architecture with a culturally indistinct urban landscape. However, the expansion of well-situated housing interspersed with commercial and public facilities kept prices affordable and commutes short.

Seoul's density both enabled, and was enabled by, the rapid construction of a world-class metro, which opened in 1971. New lines were added roughly every five years between 1980 and 2009.[86] Today, the metro comprises 22 lines over 155 miles and carries over 10 million riders every day for about US$2.50 per trip. The system is notably clean and easy to use, offering WiFi, air conditioning, and sliding doors along platforms. The metro lines are operated largely by public rail companies, some of which are owned by the national government and others by the city governments of Seoul, Uijeongbu and Incheon (which fall within the greater metropolitan area).[87] The metro is complemented by an extensive bus system and a comprehensive sidewalk network. The efficiency and connectivity of Seoul's public transportation allows households and firms in the city to enjoy the benefits of agglomeration without severe traffic congestion.

About 10 million people live within Seoul's city limits,[88] and the greater metropolitan area houses over 25.5 million – more than half the population of South Korea.[89] With more than 17,000 residents per square kilometre,[90] Seoul is one of the densest cities in the world. It generates 23% of national GDP,[91] although it occupies only 0.6% of the country's land area.[92] Countries across developing Asia and Africa today could replicate Korea's success in regularising informal settlements and expanding core infrastructure, laying the foundations for the private sector to provide high-quality, high-density housing in vibrant, well-connected neighbourhoods.

Box 3. Windhoek: How a participatory approach delivered affordable housing and services at scale

Under the colonial and apartheid regimes, Windhoek was deeply segregated. White Namibians enjoyed high-quality services and amenities in suburban homes, while black Namibians were relegated to under-developed townships.[93]

Since independence in 1990, Windhoek's population has nearly tripled, to over 400,000 people.[94] The increase was driven largely by migration, as oppressive apartheid restrictions on black Namibians were lifted and civil war in Angola displaced families in the north.[95] In the absence of sufficient formal housing, informal settlements proliferated on the outskirts of the city. 85% of households in these settlements had incomes below subsistence levels and lacked access to public services, jobs and legal tenure. Neither household incomes nor public budgets were sufficient to finance the large-scale provision of land, housing and services for these households.[96]

The national and local government together pioneered incremental and participatory approaches that have enabled low-cost shelter provision at scale.

In 1991, the national government introduced the National Housing Policy, shortly followed by the Build Together Programme in 1992. These measures established housing as a development priority, provided low-cost loans for households that could not access formal credit and granted local authorities some of the powers and resources needed to provide basic services.[97]

Within this enabling national framework, Windhoek City Council introduced two radical innovations, decriminalising squatting and designating "reception areas" to accommodate new urban residents. The reception areas had plots of 100–200 square metres laid out in a grid, with a communal water point and toilet block within one kilometre. Certain national building regulations were relaxed in the reception areas: the minimum plot was 300 square metres and water points were supposed to be no more than 200 metres from each plot.[98] These adjustments promoted higher-density development and reduced plot prices. Each household could then incrementally construct housing and infrastructure as its limited funds permitted, borrowing under

Windhoek stands out for its low-cost shelter solutions and land use planning. Most African cities have much higher rates of informal settlement and much deeper service deficits, which impose a heavy health burden on their residents.

the auspices of the national Build Together Programme.[99]

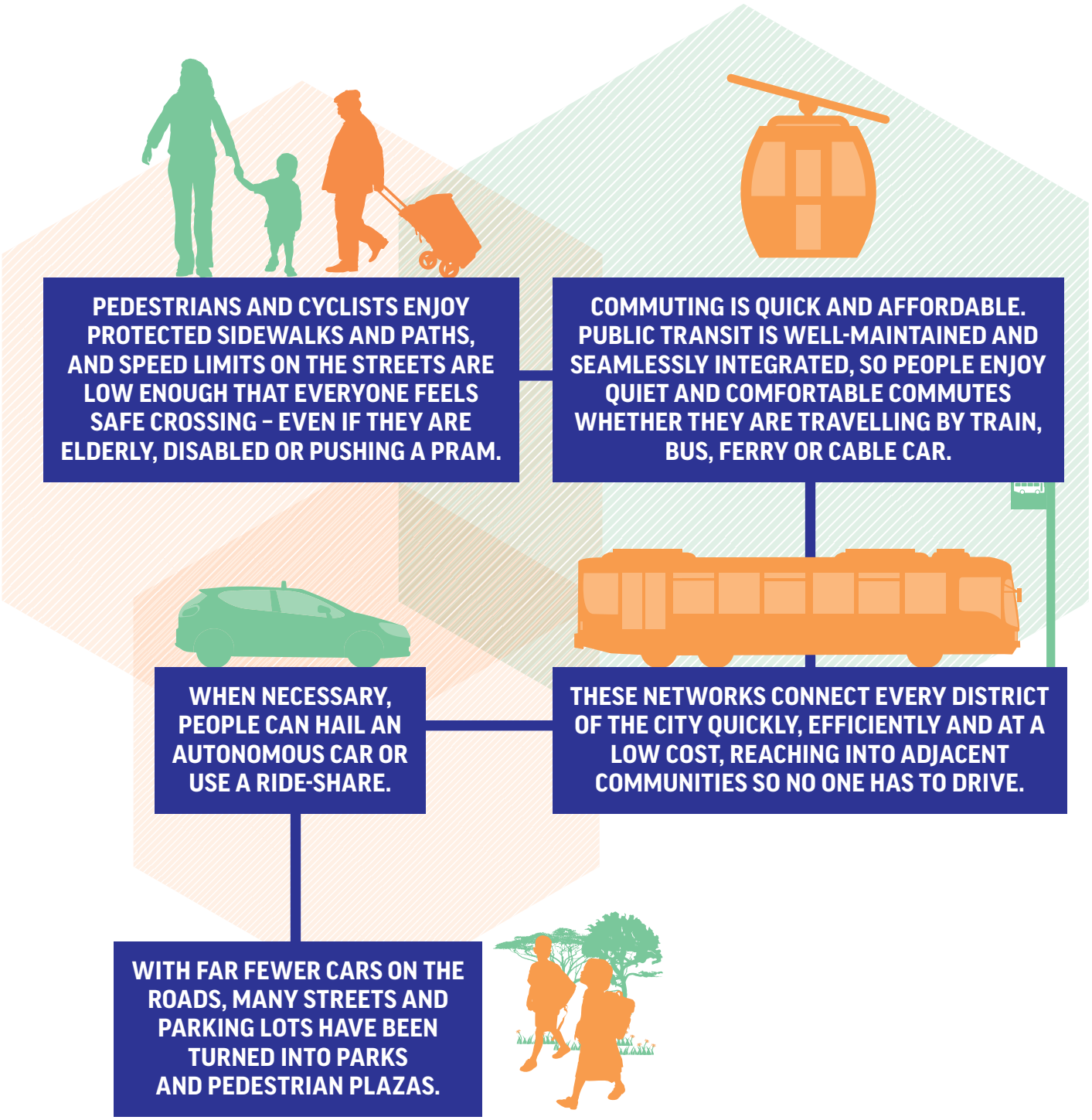
The Windhoek City Council later refined its approach by providing low-cost loans to support informal settlement upgrading (as well as greenfield construction) and demarcating better-situated land in anticipation of continued urban population growth. The new plots were provided with a range of different levels of services in order to charge differential prices. These innovations were developed in close partnership with organised communities of the urban poor, particularly the Shack Dwellers Federation of Namibia, supported by the Namibia Housing Action Group.[100] These policies have ensured that a majority of Windhoek's residents were settled on regularised plots with acceptable services. In 2011, for instance, 81% of Windhoek's households had access to a flush toilet and two thirds used electricity as their main source of energy.[101]

Windhoek has not solved its housing crisis. Many urban residents live in low-quality accommodation with poor services. Informal settlement remains common, particularly around the urban periphery, where it contributes to sprawl. National experiments with public housing construction have proven unaffordable and inefficient,[102] while private developers remain uninterested in low-income housing because of the small profit margins.[103] The city remains deeply unequal and still needs to do much more to meet residents' basic needs.

Still, Windhoek stands out for its low-cost shelter solutions and land use planning. Most African cities have much higher rates of informal settlement and much deeper service deficits, which impose a heavy health burden on their residents.[104] By comparison, Windhoek shaped land use and installed basic infrastructure before most informal settlements had emerged, and supported informal settlers to contribute shelter solutions.[105] Low- and lower middle-income countries with fast-growing cities could emulate Namibia's far-sighted approach, reducing the costs of service provision up to two thirds[106] and laying the foundation for more compact, healthier cities.

The benefits of connected cities

Let's go back to that city we visited earlier. It's not just compact; it's also very easy to move around. The air is much cleaner. And with commuting times sharply reduced, people have much more free time, which they spend enjoying the city with their loved ones.



People are drawn to cities for economic and social opportunities – but access to those opportunities depends on the time, cost and convenience of moving around. Good connectivity helps maximise and share the benefits of agglomeration, while reducing greenhouse gas emissions. Connected cities have transport systems that link people's homes to areas with employment opportunities and services such as schools, hospitals and parks. Connectivity may be achieved through compact, mixed-use neighbourhoods with safe sidewalks and cycle lanes that allow people to live, work, shop, study and meet one another without long trips. Meanwhile, high-capacity transport systems can seamlessly connect people with jobs, services and amenities all across the city.[107] Options include railways, metro lines, trams, buses, cable cars and ferries, complemented by ride-sharing and e-hailing services to fill any gaps in transport services.

Cars in cities contribute to:

- **Up to 70% of air pollution.**
- **1.3 million deaths globally every year.**
- **78.2 million traffic injuries warranting medical care.**
- **Inefficient and expensive urban sprawl.**
- **23% of carbon emissions from final energy use (up to 40% in urban areas).**

Through most of the 20th century, urban transport planning has focused on moving cars efficiently. The result has been chronic congestion, toxic air pollution, and unacceptable traffic fatalities. Many people assume these are inherent features of cities, but they are not. In cities of the global South, up to 70% of air pollution can be attributed to cars.[108] Road crashes account for 1.3 million deaths globally every year, and 78.2 million traffic injuries warranting medical care.[109] Cars also require huge amounts of land, exacerbating urban sprawl. Moreover, the transport sector globally accounts for 23% of carbon emissions from final energy use, with up to 40% of that energy use in urban areas.[110] Simply electrifying established transport systems will not solve these issues. The next generation of urban transport planning must focus primarily on moving people, not cars.[111]

Urbanisation, technological innovation and public concerns about air quality and congestion can be harnessed to create more connected cities. Rapid population growth offers an opportunity for transit-oriented development, in which attractive residential and commercial neighbourhoods are built up around high-capacity transit stations. Once "the murder capital of the world",[112] Medellín in Colombia exemplifies how creative transport solutions – complemented by better service delivery and iconic cultural projects – can reduce commuting times and improve social inclusion (see *Box 4*). Meanwhile, advances in cashless payments, data collection and analytics, mobile communications and machine learning have led to the proliferation of new mobility services. Car- and bike-sharing systems, mobile trip-planning apps and ride-hailing networks are now common, while self-driving cars may soon be a common sight in cities.[113] Governments can influence the development and uptake of these innovations so that they not only improve convenience for passengers, but also tackle pollution, congestion and greenhouse gas emissions. Transport planning and policy must bring urban residents along on the journey – or follow their lead. Copenhagen in Denmark is arguably the world's cycling capital, a legacy of its visionary citizenry, who protested against highways and petitioned for better cycle lanes. National and local governments embraced their demand, and today nearly half of Copenhagen's population cycles to work (see *Box 5*).[114]

Box 4. Medellín: How connecting informal settlements helped transform an embattled city

Medellín is Colombia's second-largest city, with a population of nearly 4 million people.[115] Since the early 1990s, it has transformed from a violent and poverty-stricken city to a safe, vibrant centre studded with striking parks and buildings. Thanks to a combination of transport investments, upgrades to informal settlements, and iconic architectural projects in the most deprived neighbourhoods, its residents now enjoy higher living standards and a sense of civic pride. Medellín's experience shows how bold, creative interventions to connect people to opportunities can revitalise a city.

Medellín originally prospered thanks to railways, coffee exports, and a robust manufacturing sector. In the 1960s and '70s, the city's economy stagnated even as its population grew, with many Colombians fleeing guerrilla violence in the countryside and settling in comunas. These informal settlements lacked basic services such as water and sanitation, and often sat precariously on the steep hills around Medellín, making it difficult to reach the city centre. With a shrinking formal economy, Medellín's residents resorted to selling goods such as black-market whiskey, appliances, marijuana – and eventually cocaine. This thrust Medellín into the epicentre of Colombia's burgeoning drug trade. As drug cartels and local militias clashed with the national government, Medellín became the world's deadliest city, with a murder rate of 4 per 1,000 in 1992.

In 1991, Colombia approved a new constitution that granted more power and resources to city governments. It required them to create municipal development plans, promised significant fiscal transfers, and strengthened accountability and transparency.[116] In 1993, a Presidential Council was convened specifically to address poverty and violence in Medellín, bringing together the national and local government, private businesses, community-based organisations and academics.

Thus emerged PRIMED (Programa Integral de Mejoramiento de Barrios Subnormales en Medellín), a programme to integrate the comunas into the rest of Medellín. PRIMED granted over 2,100 households legal tenure, improved over 3,500 houses, built and improved vital infrastructure, and relocated or stabilised almost 70% of the neighbourhoods

The Medellín Metro transports around 256 million passengers every year with only a fraction of the pollutants and emissions of a car-based network.

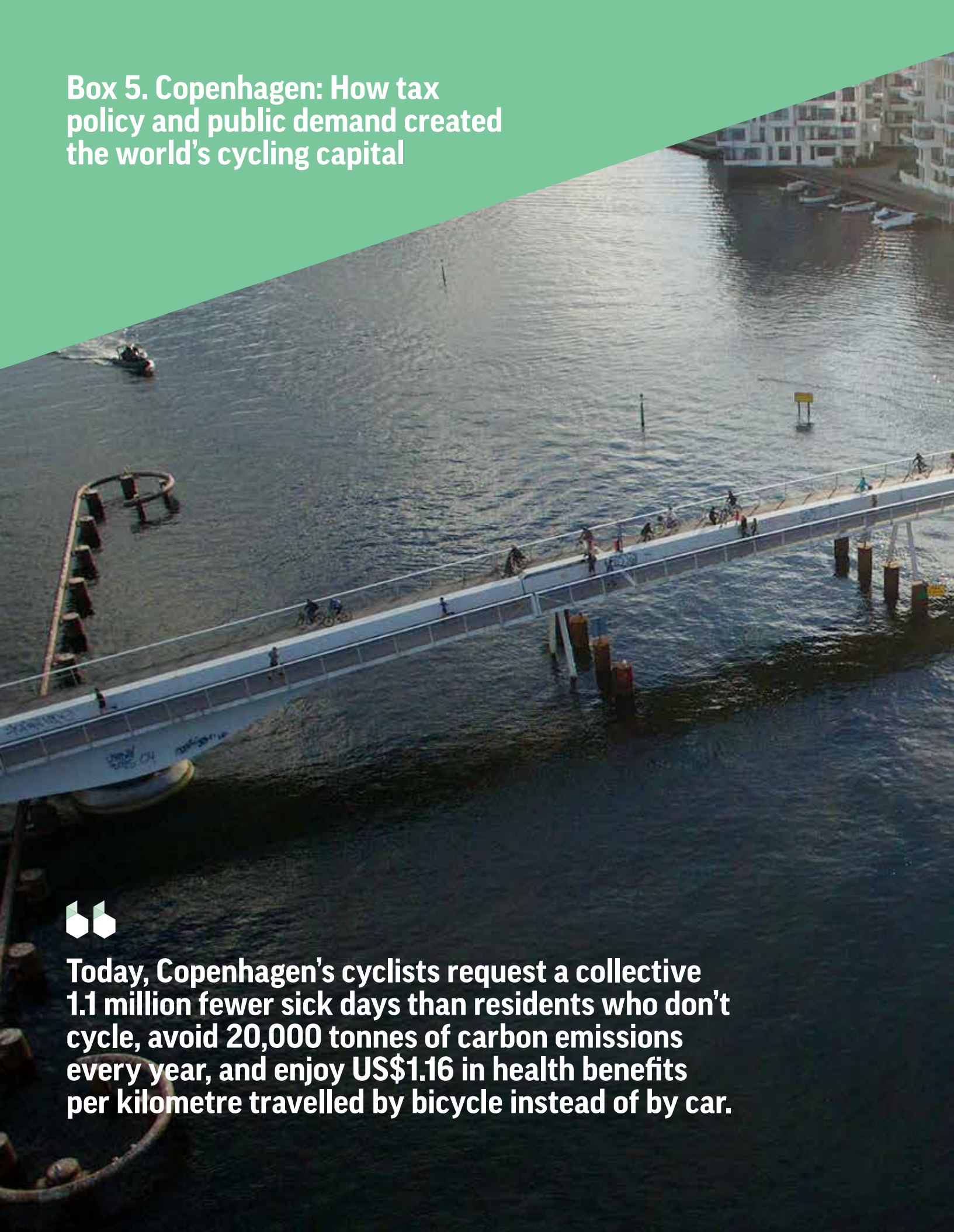
where steep slopes made construction unsafe.[117] It benefitted over 100,000 residents, prioritising neighbourhoods that scored lowest on the Human Development Index – all for the relatively low price tag of US$23 million. In addition to improving tenure and basic services, the Presidential Council oversaw public investment in schools, libraries and parks. These projects were designed to be both beautiful and functional, and symbolised Medellín's commitment to transforming the comunas.

Improvements in transport were also essential to physically connect the comunas to the rest of the city. Construction of a cable car began in 2000,[118] and less than three years later, Line K made its inaugural trip up the hillside.[119] It carries up to 3,000 passengers per hour and has cut travel time by up to an hour.[120] Two additional Metrocable lines were subsequently opened in 2008 and 2010. The Metrocables were critical because they helped connect the poorest to economic and social opportunities in the city centre, but were complemented by an impressive array of other transport investments. Most significant of these was the urban rail network, the only one in Colombia. Although designed and operated by the city government, the national government provided 70% of the funds for this huge project.[121] The Medellín Metro transports around 256 million passengers every year[122] with only a fraction of the emissions of a car-based network.

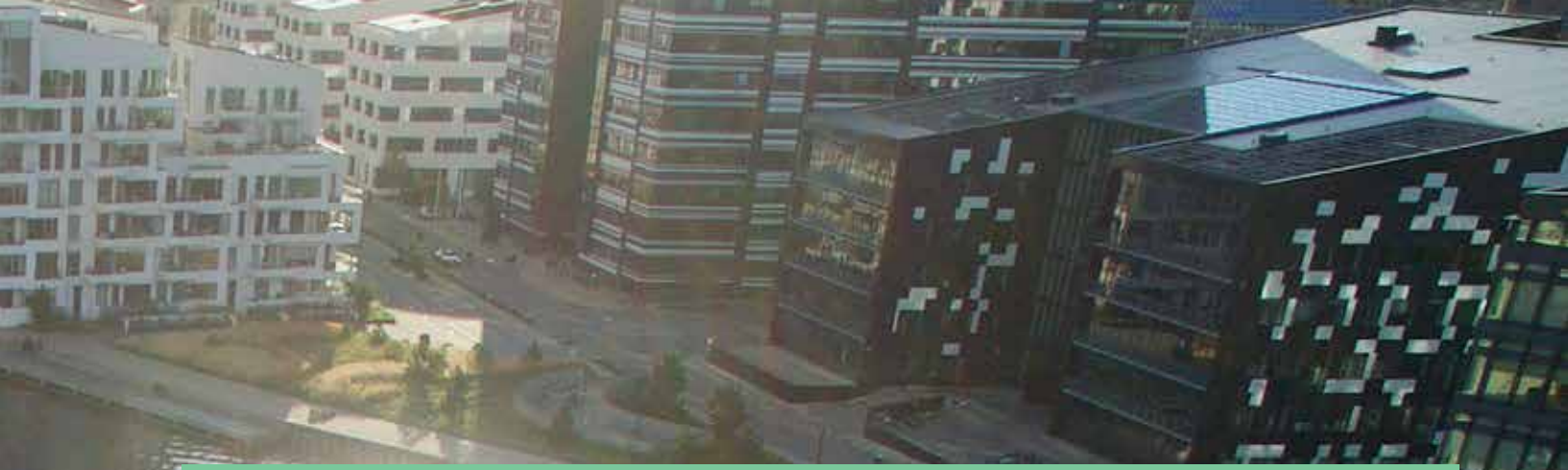
The aesthetically striking projects, participatory approach and improved accessibility helped attract direct foreign investment to Medellín: between 2008 and 2011, 46 international businesses moved there, collectively investing over US$600 million. Medellín has also hosted world-class cultural and political events, from the 2014 World Urban Forum to recent tours by Madonna and Beyoncé.[123] Per capita incomes are the highest of any Colombian city, and inequality within the city has fallen.

Though far from perfect, modern Medellín is a world apart from the violence and despair of the 1990s. Innovative approaches to improving connectivity – particularly for the lowest-income residents – could help other fragile cities to tackle poverty, exclusion and vulnerability, an even greater priority as climate hazards become more frequent and severe.

Box 5. Copenhagen: How tax policy and public demand created the world's cycling capital



Today, Copenhagen's cyclists request a collective 1.1 million fewer sick days than residents who don't cycle, avoid 20,000 tonnes of carbon emissions every year, and enjoy US$1.16 in health benefits per kilometre travelled by bicycle instead of by car.



Copenhagen is known for its beautiful public spaces, the colourful houses that line its waterways, and its cycling culture. Danish bike culture goes back at least 100 years.[124] However, as the city grew more prosperous in the wake of World War II, people started to switch to mopeds and cars.[125] In 1948, Copenhagen's urban planners put forward the "Finger Plan", which concentrated urban development along five arteries extending from the city centre to nodes of high-rise housing and development on the periphery.[126] Through the 1950s and 1960s, Copenhagen's tram and cycling infrastructure was incrementally replaced by highways.

However, in the late 1960s and early 1970s, Copenhagen's finances floundered. Rising oil prices hit Denmark hard, forcing Copenhagen to shut off every other streetlight and implement car-free Sundays.[127] Public opposition to highways grew more vocal, with petitions and protests proliferating.[128] Lacking both funding and support for the "Finger Plan", the national government established Greater Copenhagen's Capital Regional Authority to facilitate integrated transport planning.[129] Over decades, this local agency has steadily expanded the cycle track network[130] and converted planned highways to parks and housing.[131] As of 2017, 43% of Copenhagen's commutes to work or school are by bicycle,[132] which residents rate as most convenient.[133] Copenhagen today has 375 kilometres of dedicated lanes, and there are further plans for a network of 45 "cycle superhighways", about 746 kilometres, to connect the entire capital region.[134] Today, Copenhagen's cyclists request a collective 1.1 million fewer sick days than residents who don't cycle, avoid 20,000 tonnes of carbon emissions every year, and enjoy US$1.16 in health benefits per kilometre travelled by bicycle instead of by car.[135]

Cycling is the most visible part of Copenhagen's transport networks, but the city also benefits from an excellent mass transit system. The Ørestad Development Corporation, a joint venture between the national and local government, was established in 1992 with the mandate to build and operate a metro.[136] The first line opened in 2002,[137] and in the following year, car trips in the harbour corridor decreased by 2.9% on average workdays.[138] A new Circle Line is slated to open shortly, and is expected to bring 100,000 more passengers on to public transit every day.[139]

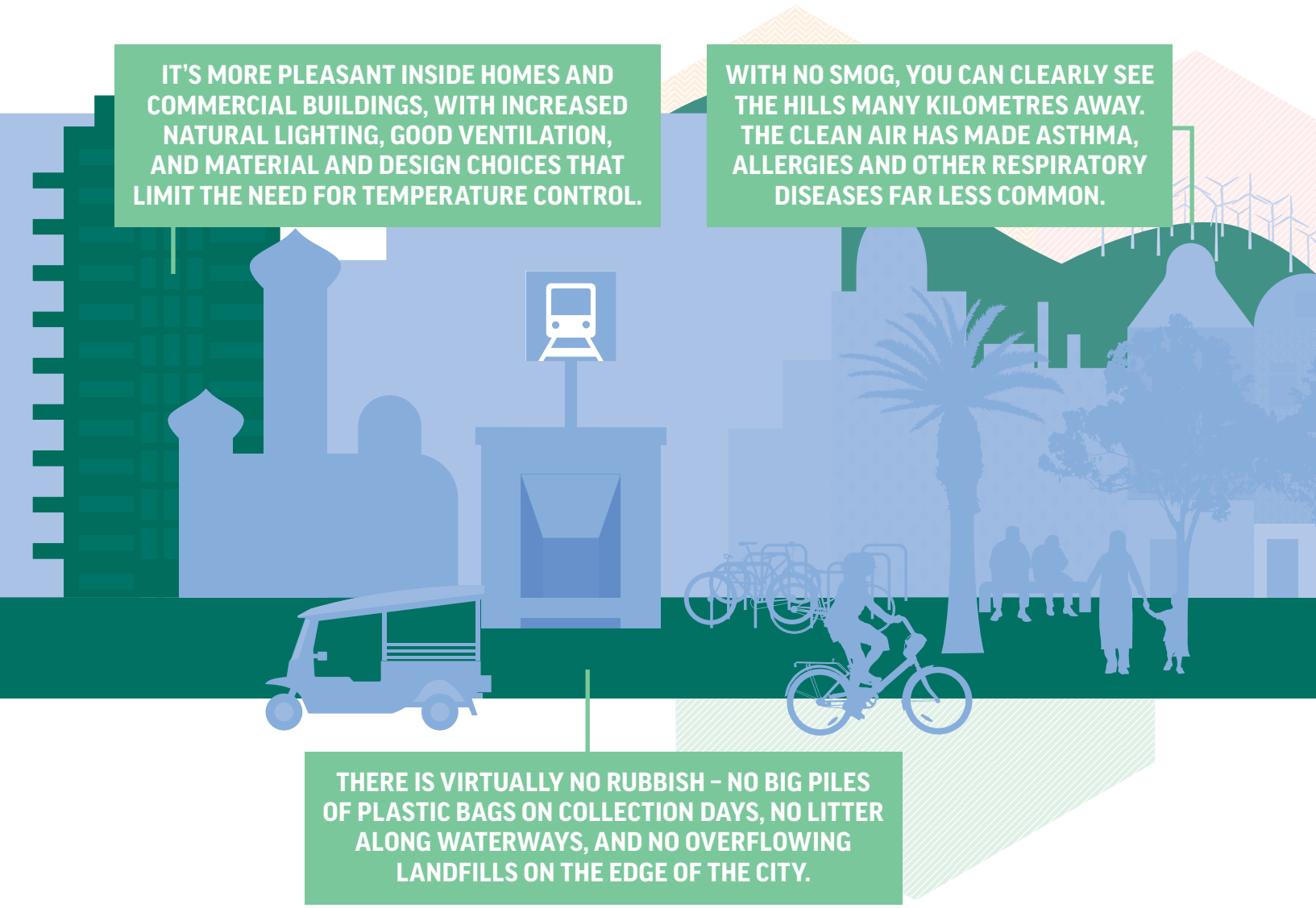
Cycling has flourished in Copenhagen not only because of the "pull" of good local infrastructure, but also national policies to "push" people away from car use.[140] The national government introduced a two-tier vehicle ownership tax in 1977, incentivising smaller and more fuel-efficient cars.[141] These national efforts have been complemented by city-scale initiatives, including a steady reduction in downtown parking and the creation of pedestrian-only zones. Car owners also pay a petrol tax and high fees for vehicle registration, insurance, parking and disposal.[142] As a result, in 2012, Copenhagen had 360 cars per 1,000 inhabitants, while Rome had 641 and Melbourne had 593.[143]

Copenhagen nearly became another congested city carved up by highways and choked with air pollution. Instead, the Government of Denmark and City of Copenhagen worked closely together to build a safe, easy and clean transport network. Today, many fast-growing cities face the same choice: invest in cars or invest in connectivity. They can look to Copenhagen for inspiration, with its vibrant streetscapes and healthy residents.

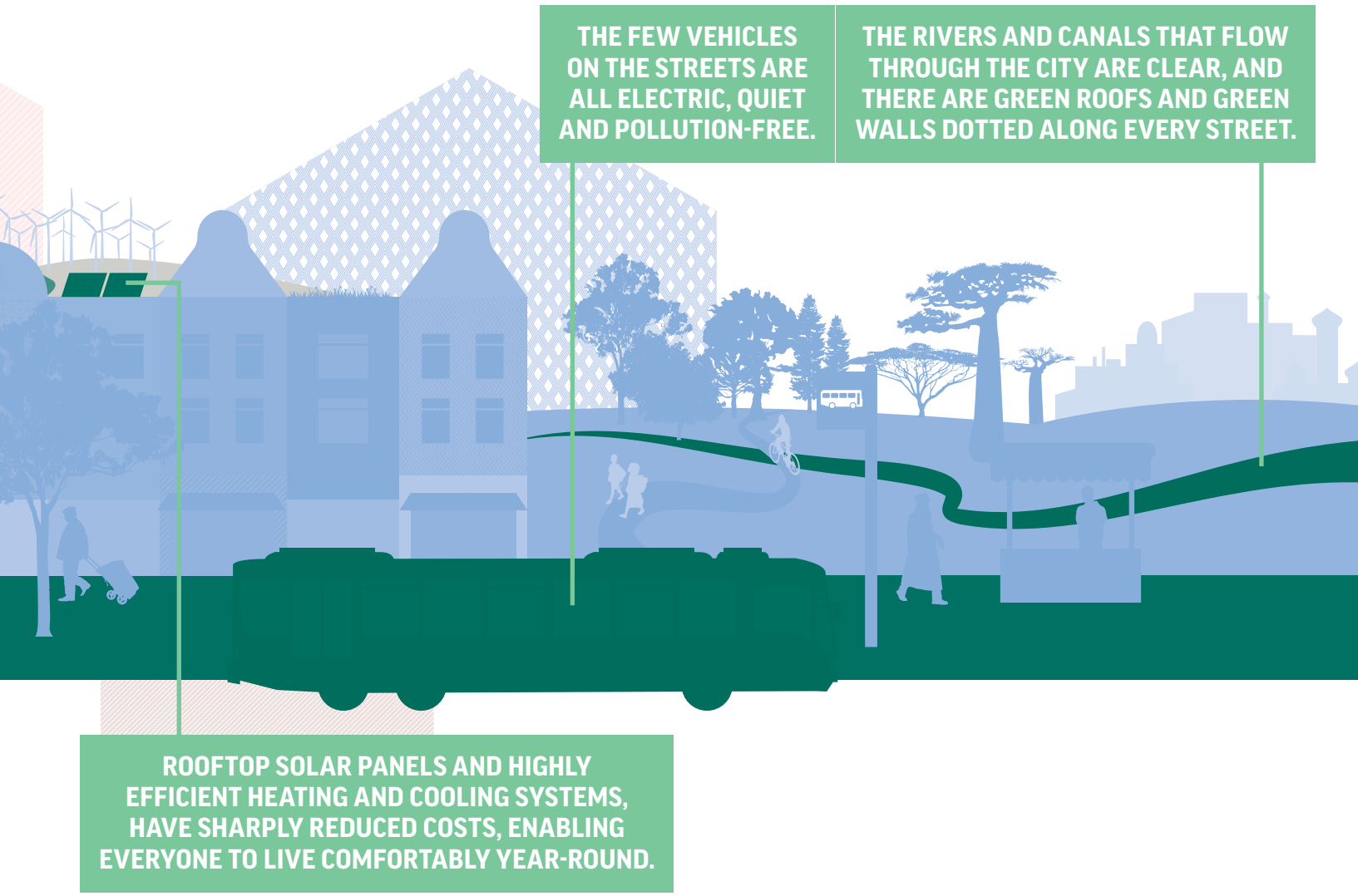
Greater compactness and improved connectivity will substantially reduce demand for materials and energy – but as the analysis in *Section 2.1* shows, getting to net-zero emissions will require a wide range of additional measures. "Clean" cities will be characterised by the highly efficient use of materials and energy; electrification of heating, cooking and transport; decarbonisation of the electricity supply; large-scale prevention and recycling of municipal solid waste; and use of nature-based solutions wherever possible. A recent review of the evidence, summarising the results of over 700 studies, illustrates how dramatically these low-carbon measures can improve public health and social inclusivity.[144] The poor, who tend to live in low-quality housing in the most polluted parts of a city, have the most to gain.[145]

The benefits of clean cities

Let's visit that city one more time. Look around...



Low-carbon cities would be much healthier, thanks to massive reductions in waste and pollution of all kinds. Illnesses and premature mortality associated with air pollution from road transport were estimated to cost US$1.7 trillion in 2010 in OECD countries alone. Electrification will cut much of this air pollution, particularly if vehicles are powered by clean electricity. Electrifying two-wheelers, cars, trucks and buses will also reduce noise pollution, which has been associated with disturbed sleep patterns,[146] impaired cognitive development in children[147] and poor mental health. Ambitious waste prevention and circular economy strategies would dramatically reduce the amount of materials, food and other items produced and discarded every day, while improved collection and management services will ensure proper disposal of the remainder. Better solid waste management would hugely improve public health: cleaner air, soil and water could reduce the prevalence of diseases from cholera, to encephalitis, to typhoid, while clearing solid waste from waterways could also reduce flooding and remove mosquito breeding grounds. Municipal waste strategies could be specifically designed to improve the incomes, health and social status of informal waste-pickers, enhancing their resilience to shocks and stresses of all kinds.[148] Indore (see *Box 6*) has proven how quickly a city's air and streets can be improved, and now cities across India are learning from its success.



Box 6. Indore: How public, private and civil society organisations collectively created India's cleanest city

Indore's organic waste plant now generates 800 kg of biogas every day, which fuels about 15 city buses. Based on this success, there are plans to build three more biogas plants that would fuel another 100 city buses.

Just a few years ago, the nearly 2 million people in Indore lived with noxious smog, thanks to 13,000 kg of plastic burned every year.[149] Piles of solid waste accumulated on the streets,[150] and open defecation remained a major concern for people's health and dignity. In January 2016, motivated by terrible pollution and widespread protests,[151] Indore Municipal Corporation (IMC) resolved to fix the waste problem. In 2018, Indore was named the cleanest city in India – a huge leap from 149th place in 2014.[152]

Instead of expecting residents to put their household waste in large public bins, Indore now offers twice-daily, door-to-door waste collection to households and businesses – including those in informal settlements.[153] This is highly unusual: only 77% of urban households in South Asia are covered by municipal waste collection services.[154] Households pay a monthly collection fee of INR 6 (US$0.86) and sort the waste themselves.[155] Door-to-door collection is complemented by twice-daily street sweeping and regular hosing down of larger roads. These have reduced Indore's chronic air pollution: particulate matter from dusty roads and other sources was halved between 2014 and 2017.[156]

As of 2018, over 90% of Indore's waste is collected and sorted.[157] Since this would mean little without improved waste recycling and disposal, Indore has constructed a biogas plant to process organic waste from Choithram Mandi market. The project cost INR 150 million (US$2.3 million), funded through a public-private partnership. The plant now generates 800 kg of biogas every day, which fuels about 15 city buses.[158] The city government is planning three more plants to serve other organic waste producers and fuel another 100 buses.[159] Plastic is also recycled for use in the construction of roads and buildings.[160] The sale of biogas and recycled plastic provides a stream of revenue to cover the costs of solid waste management.

Solid waste was only one part of Indore's problem; open defecation was an equally urgent issue. The city government has built 12,343 individual household latrines, 128 community toilets, and

Image: Kyle LaFerriere/WRI

189 public toilets.[161] Improved sanitation not only makes the city cleaner and prevents disease, but also offers dignity to those who used to lack the privacy of a toilet facility. The city government's ongoing investments in sanitation are partially funded through the national government's Swachh Bharat and Smart Cities Missions[162] and partially through the issuance of municipal bonds.[163] This was enabled by clear national legislation permitting city governments to borrow and a national programme to enhance their credit ratings.[164]

The city government has sought to engage both the workforce and the wider public with waste management. A rigorous focus on discipline and accountability improved labour attendance from less than 40% to 90%,[165] dramatically improving the cost-effectiveness of public spending on solid waste management. The city government also partnered with NGOs to educate residents,[166] including through creative channels such as street plays, street art and radio. Growing civic pride is complemented through warnings and fines: for instance, the city government fines litterbugs INR 50–500 (US$0.72–7.12).[167] The main weakness of Indore's waste management programme has been a lack of inclusion. Informal waste-pickers have been unable to get occupational identity cards and have not been significantly involved in reformed waste collection and operations – despite the national Solid Waste Management Rules 2016 that guaranteed these rights.[168] Similarly, there are now fines for open defecation, which punishes those who cannot afford the public toilets.

Those flaws notwithstanding, the national government has publicised Indore's waste transformation widely, and today cities across India are looking to replicate its success. City networks such as ICLEI are supporting knowledge-sharing,[169] and Indore plans to establish a training centre focused on waste management.[170] There is huge scope to scale these solutions to cities across India and the world, particularly with enabling national policies like the Swachh Bharat Mission.

2.3 Why urban mitigation and adaptation go hand-in-hand

Cities are hotspots of climate vulnerability, due to their concentration of people, assets and economic activity. Cities in arid regions will face water shortages, while cities along rivers or deltas will be battered by more regular and severe flooding. Some cities will face hellish heat waves, while others will suffer insect infestations that cause discomfort and disease. Most critically, many cities will face multiple climate hazards that interact and reinforce one another, making adaptation still harder. Any climate shocks that hit a city are likely to ripple across the country. Moreover, interactions between urban and rural areas will become increasingly complex and politically charged, as low agricultural yields raise urban food prices and drive rural migration to cities.

This is no distant apocalyptic future. Average global temperatures have already risen by more than 1°C since pre-industrial times, so cities face climate change impacts regardless of future emissions. In 2019, cities from Ahmedabad, to Melbourne, to Rome suffered heatwaves with highs of over 40°C, with authorities warning residents to stay indoors.[171] California's 2018 wildfire season was one of the worst on record, scorching more than 6,700 square kilometres of land.[172] Major cities such as Cape Town, Chennai and São Paulo have all but run out of water in recent years.[173] Within cities, the urban poor face the most severe climate impacts. Many live in informal settlements on land where formal development is prohibited due to hazards such as landslides, flooding and industrial contamination.[174] Many also live in poor-quality, overcrowded housing without the basic infrastructure, services or green space that could offset the worst impacts of climate hazards. It is thus unsurprising – though devastating – that low- and lower-middle-income countries suffer the most deaths in urban centres from extreme weather.[175]

A transition to zero-carbon cities will not, in itself, fully avoid the impacts of climate change. Even if global warming is kept below 1.5°C, climate shocks will be more frequent and severe, and make poverty eradication and economic development harder. Urban policies and investments must therefore seek to simultaneously reduce emissions, enhance resilience and support sustainable economic development to build cities where people can meet their needs and pursue their aspirations. A commitment to improving living standards and leaving no one behind can also serve to sustain public support for aggressive climate action: countries that do not make progress towards the Sustainable Development Goals are unlikely to reach the targets laid out in the Paris Agreement.

A closer look at coastal cities underscores the importance of pursuing these three agendas – mitigation, adaptation and development – simultaneously. Both urban disasters and fragile ecosystems occur disproportionately in low-lying coastal areas.[176] Floods and saltwater intrusion pose a hazard to coastal populations and infrastructure. Many coastal cities are exposed to hurricanes, which are becoming stronger and more frequent with rising ocean temperatures. Urban development can both exacerbate natural disasters and add environmental pressures.[177] Impervious surfaces such as asphalt and concrete disrupt natural drainage, increasing peak flows and flood risks. In many parts of the world, wetlands are drained and mangroves are cleared to enable property development, removing important buffers against floods and storms while damaging rich natural habitats. Many other coastal ecosystems such as coral reefs, seagrass and salt marshes are threatened by coastal development,

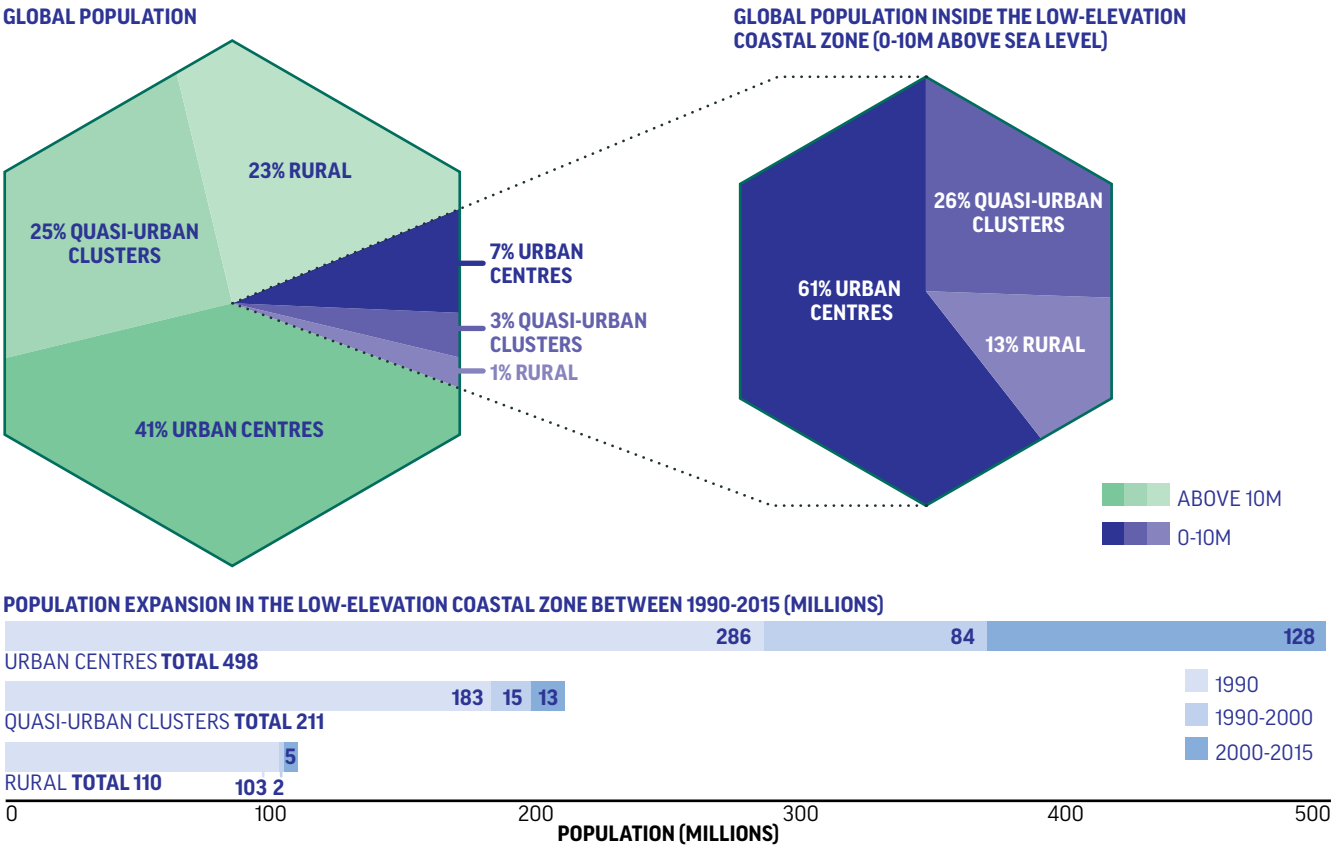
In 2015, over 710 million people lived in coastal urban centres and quasi-urban clusters less than 10 metres above sea level.

pollution, sea-level rise and temperature change.[178] Without further action on climate change, sea levels may rise by several metres by the end of the century.[179] This will threaten the very existence of low-lying cities such as Alexandria, Guangzhou, Miami, Osaka, Rio de Janeiro and Venice.

Despite these risks, coastal areas less than 10 metres above sea level are more densely populated than the rest of the world, and growing faster. New analysis for this report by CUNY Institute for Demographic Research, the Institute of Development Studies and the Center for International Earth Science Information Network (CIESIN) at Columbia University found that over 10% of the world's population – over 820 million people – lived within 10 metres above sea level in 2015, and 86% of those people lived in urban centres or quasi-urban clusters (which have lower densities than urban centres, and could include peri-urban or suburban areas). Nearly 10% of the land in this low-lying coastal zone is already urban or quasi-urban, compared with less than 2% elsewhere (see *Figure 6*), which contributes to the fact that coastal population densities are six times higher than the world average (309 versus 56 people per square kilometre). This means that storm surges and sea-level rise are now overwhelmingly urban threats. Moreover, population growth rates since 1990 have been higher in these low-lying coastal zones, and the growth rates in urban centres are about 20% higher in these areas than elsewhere. Growth rates in urban centres are actually highest in the lowest-lying areas – at less than 5 metres above sea level. Most of these settlements have developed with little regard for coastal environmental sensitivities, and almost no regard for growing climate risks.

FIGURE 6. SHARE OF GLOBAL POPULATION OUTSIDE AND INSIDE THE LOW-ELEVATION COASTAL ZONE, BY SETTLEMENT TYPE, 2015.

Source: CUNY Institute for Demographic Research, Institute for Development Studies and the Center for International Earth Science Information Network (CIESIN), Columbia University, for the Coalition for Urban Transitions and Global Commission on Adaptation. For the full methodology, see Annex 3.



Certain countries have much larger numbers or shares of their urban residents concentrated in low-elevation coastal zones, and consequently face greater risk. China, India and Bangladesh had the highest total number of people living in urban centres less than 10 metres above sea level, with 129.5 million, 55.2 million, and 40.9 million urban residents respecetively (see *Table 2*). Several countries had the vast majority of their urban populations in low-lying coastal zones, particularly small coastal or island nations such as Guyana, Maldives, Belize and Suriname, which all have 100% of their urban centre populations living in the low-elevation coastal zone, as well as populous deltaic countries like Thailand (81%), Netherlands (77%), and Viet Nam (62%). Cities in these countries are at risk of being stranded by climate change, with devastating repercussions for national economies and well-being.

Many countries have already begun to reckon with the reality of climate change and are preparing for inevitable shocks and stresses. But fewer countries are accounting for the ways that climate policies and market shifts will also provoke massive economic changes. These nations risk being left behind by the rapid evolution of global policies and markets. For example, stricter air quality controls and the falling costs of renewables mean that 42% of global coal capacity is already unprofitable.[180] Similarly, countries that develop polluting or carbon-intensive industries like steel or cement may struggle as regulation and innovation shift demand towards more recycled products and new green alternatives, or as mobile workers and companies "vote with their feet" for cities with cleaner air and water.

These economic shifts would leave both assets and workers stranded. Major capital projects could become unprofitable or damaged by the effects of climate change, well short of their projected useful lifespan.[181] Public and private investors alike would lose out, forced to spend new funds for projects that they could have chosen in the first place – had their risk assessments accounted for climate change. Workers will be stranded too, scrambling for new jobs as the economy changes.[182] These impacts

TABLE 2. TOP 10 COUNTRIES WITH THE MOST URBAN RESIDENTS (LEFT) AND LARGEST SHARE OF THEIR URBAN POPULATION (RIGHT) LIVING IN URBAN CENTRES IN THE LOW-ELEVATION COASTAL ZONE IN 2015.

Ranked by total population living in urban centres in the low-elevation coastal zone		
Country	**Population (thousands)**	**%**
1. China	129,507	23%
2. India	55,216	8%
3. Bangladesh	40,912	47%
4. Indonesia	34,805	24%
5. Japan	26,593	32%
6. Viet Nam	23,871	62%
7. United States of America	17,607	12%
8. Thailand	16,811	81%
9. Egypt	14,200	24%
10. Philippines	12,998	33%

Ranked by share of urban population living in urban centres in the low-elevation coastal zone		
Country	**Population (thousands)**	**%**
1. Guyana	226	100%
2. Maldives	132	100%
3. Belize	72	100%
4. Suriname	201	100%
5. Bahrain	1,004	81%
6. Thailand	16,811	81%
7. Bahamas	169	80%
8. Netherlands	6,027	77%
9. Mauritania	1,175	76%
10. Djibouti	474	69%

Source: CUNY Institute for Demographic Research, Institute for Development Studies and the Center for International Earth Science Information Network (CIESIN), Columbia University, for the Coalition for Urban Transitions and the Global Commission on Adaptation. For the full methodology, see Annex 3.

Note: Countries with a total population of under 100,000 people, or smaller than 1,000 square kilometres were excluded from this list.

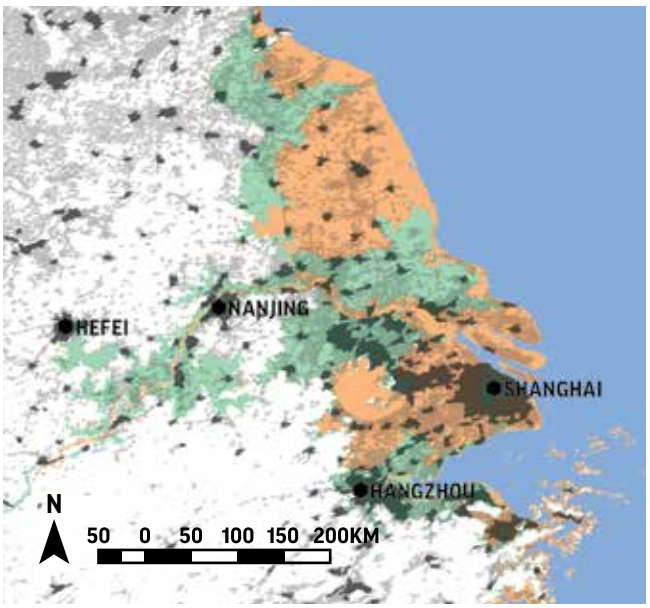
will be felt first in cities, where jobs and infrastructure are concentrated, but will have nationwide impacts. Cities and countries with a narrow, high-carbon economic base will likely struggle most to recover and redefine themselves. Detroit has yet to recover from the loss of auto industry jobs in the 1950s, and Wales has endured widespread economic stagnation due to the closure of coal mines. National governments that do not actively manage these transitions face the risk of widespread job loss and economic insecurity as industries fail or relocate. They will increasingly struggle to secure low-cost capital, as investors and lenders find they cannot get the returns they require. And future taxpayers will bear the costs of refurbishing or replacing unsustainable infrastructure investments. These unnecessary burdens will fuel political anger against a system that failed the people.

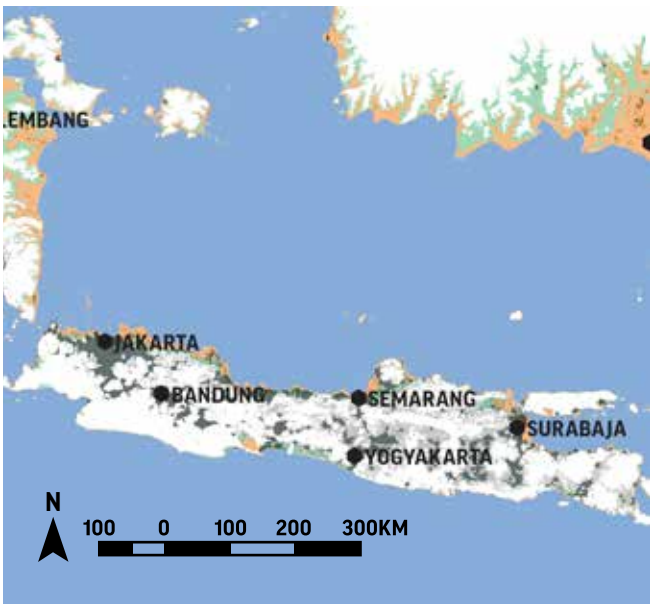
There really is no viable high-carbon growth story in the 21st century. However, a zero-carbon urban transition would raise living standards for all residents and – as the next chapter outlines – help secure national economic prosperity for the decades to come.

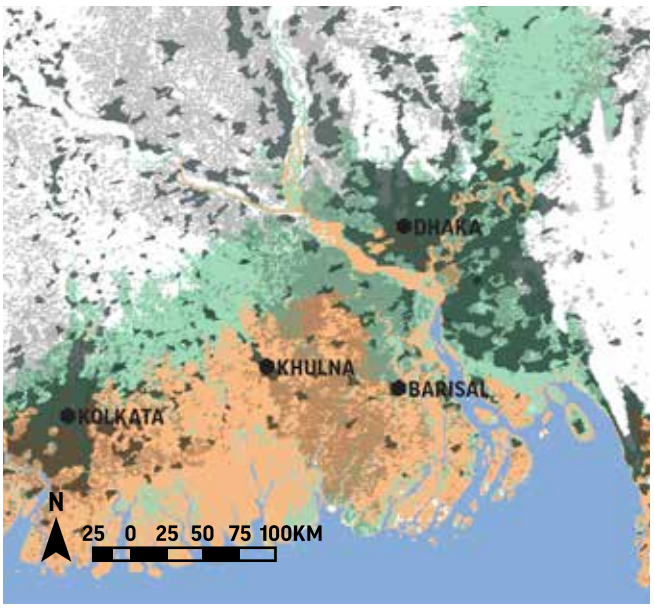
FIGURE 7. BUILT-UP AREA IN LOW-ELEVATION COASTAL ZONES AROUND THE JIANGSU PROVINCE AND SHANGHAI MUNICIPALITY IN CHINA (RIGHT), JAVA IN INDONESIA (BOTTOM LEFT) AND THE BAY OF BENGAL IN INDIA AND BANGLADESH (BOTTOM RIGHT).

Source: CUNY Institute for Demographic Research, Institute for Development Studies and the Center for International Earth Science Information Network (CIESIN), Columbia University, for the Coalition for Urban Transitions and the Global Commission on Adaptation. For the full methodology, see Annex 3.

- UP TO 5 METRES ABOVE SEA LEVEL
- UP TO 10 METRES ABOVE SEA LEVEL
- URBAN CENTRES
- QUASI-URBAN CLUSTERS

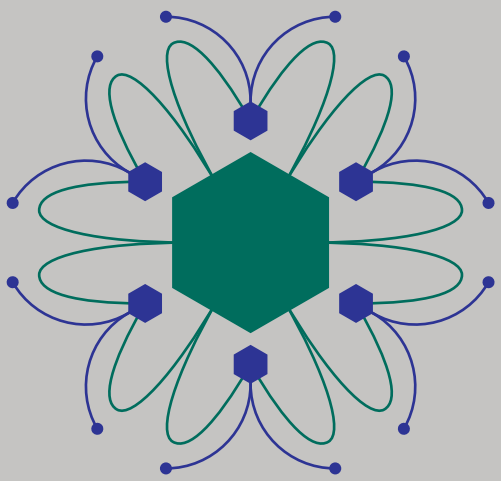






3. The economic case for inclusive, zero-carbon cities

Smaller cities can leverage their proximity to larger cities to develop specialised industries and services – or in less-urbanised areas, become hubs in their own right, bringing new economic opportunities to local residents. Inclusive urban development can also support and stimulate rural development.



The global economy is fundamentally misaligned with the needs of most people. Growth in industrialised countries has stagnated since the mid-2000s, and many workers are in precarious jobs, with limited economic security and little hope for a better future. Meanwhile, in many emerging and developing economies, the robust growth enjoyed for years has slowed significantly, limiting new job opportunities and improvements in living standards. Inequality is rising in many countries. The wealthiest 1% have enjoyed a 40% increase in real incomes over the last three decades,[183] but middle-class people in wealthier countries are feeling squeezed, and in most low-income countries, a majority of people still face serious deprivation. All of this has caused growing discontent and a loss of faith in the public institutions that shape economic policy.[184]

The development models of recent decades are not sustainable: China's coal dependence, North America's oil and gas boom and Brazil's deforestation, for instance, are driving the world to the brink of multiple ecological crises.[185] As the global population continues to grow, pressures on key resources such as water and arable land will intensify. At the same time, advances in digitalisation and automation could soon make millions of jobs obsolete,[186] creating an urgent need for structural economic transformation. It is not enough to re-energise national economies to pursue business-as-usual growth. Fundamental changes are needed to ensure that economic development strategies tackle inequalities, use resources more efficiently, and enhance social and environmental resilience. National governments need new approaches that improve living standards, create opportunities for all, use resources more efficiently, and can respond nimbly to a changing global environment. Zero-carbon cities could do that particularly well.

Sustainable cities offer a powerful lever to address national macroeconomic challenges. Cities are hubs of economic activity, where wealth, finance and people are concentrated. Higher education institutions provide skilled workers, retraining opportunities, and a broad range of innovations ready to be commercialised. This, in turn, attracts more inventors and entrepreneurs. Cities are also hubs for arts and culture, which are important for local quality of life and can fuel a vibrant "creative economy", sustained by local audiences and attracting tourism. With a critical mass of customers, retailers and service providers can thrive as well.

The prosperity generated in urban areas can extend to large swathes of a country. Some demographic shifts will occur naturally as economies industrialise and agriculture is modernised, which can push people left behind into deeper poverty. However, if cities have robust transport linkages, they can provide economic vitality to entire regions, as residents of surrounding areas are able to commute to get better jobs or advance their education. Smaller cities can leverage their proximity to larger cities to develop specialised industries and services – or in less-urbanised areas, become hubs in their own right, bringing new economic opportunities to local residents. Inclusive urban development can also support and stimulate rural development. Rising incomes in cities increase demand for high-value food and agricultural products, which benefits farmers. Cities also provide modern farming inputs and consumer goods to rural households.[187] Rural residents who secure training or jobs in the city can bring those skills or innovations back to rural areas, or send money back to their families, making them more resilient to shocks and enabling them to invest in improving the productivity of their land.[188] This is not to say that broad-based prosperity is an inevitable outcome of urbanisation, but rather that urban and rural well-being are closely linked. Even when economic development is centred in cities, the benefits of agglomeration can be distributed nationwide.[189]

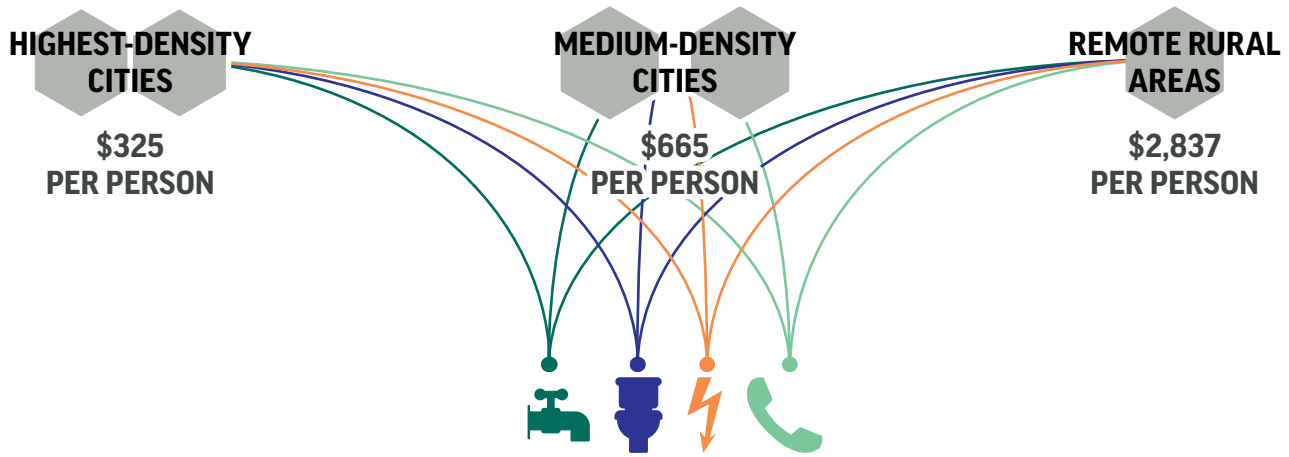
This chapter explores the economic case for national governments to develop smart, deliberate policies and investments that support a zero-carbon urban transition. *Section 3.1* outlines the economic benefits that accrue from greater proximity and density in more compact, connected cities. *Section 3.2* quantifies the economic returns that might accrue from choosing low-carbon options that create more connected, clean cities, and explores how ambitious climate action in cities can build a country's innovation capabilities. *Section 3.3* goes on to consider how compact, connected and clean cities can give countries an advantage in the global competition for talent and investment. Careful planning and policies are needed to prioritise the needs of the poor and the middle class and ensure no one is left behind. Otherwise, projects that enhance growth and reduce emissions can sometimes exacerbate inequality and economic insecurity. *Section 3.4* highlights two critical preconditions for creating thriving, inclusive zero-carbon cities.

3.1 The economic case for compact and connected cities

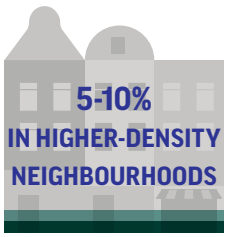
There is robust evidence of the economic benefits of compact, connected cities around the world, in countries at all stages of development. As discussed in greater detail below, higher population density significantly decreases the cost of infrastructure required to meet people's needs. Indeed, it makes a whole range of investments more economically feasible, from metro systems to district heating and cooling. Moreover, compact, connected cities tend to be more productive and innovative, which helps them achieve sustained economic development. At the same time, they can significantly reduce their residents' carbon footprint by reducing energy use and land use change.

Infrastructure development is most cost-effective in compact urban areas because it takes less land, materials and energy to physically connect households and firms when they are closer together. Higher population densities thus reduce the per capita investment needs for network infrastructure such as roads, railways, electricity grids, telecommunications lines, water supplies and sewage systems.[190] In sub-Saharan Africa, for instance, the capital costs of providing piped water, flush toilets, power, and landline telephones average US$325 per person in the highest-density cities, but US$665 in medium-density cities and up to US$2,837 in remote rural areas.[191] Moreover, access to a higher concentration of users can reduce the per capita operating costs of infrastructure and service delivery, since providers can exploit their fixed

THE CAPITAL COSTS OF PROVIDING INFRASTRUCTURE AT DIFFERENT POPULATION DENSITIES IN SUB-SAHARAN AFRICA



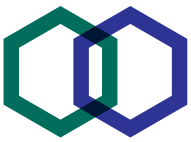
HEAT LOSS IN DISTRIBUTION NETWORK OF DISTRICT HEATING SYSTEMS



costs better with each additional user.[192] For instance, most of the costs of operating a public transport system are constant, so higher ridership reduces per capita costs while boosting fare revenue. At very high levels of density, costs can increase again due to high land prices and the need to manage the interests of so many residents and businesses: evidence from Latin America suggests that expenditure for municipal services is optimised at densities close to 9,000 residents per square kilometre.[193]

Many highly effective low-carbon infrastructure options are only economically viable at certain levels of density.[194] In neighbourhoods with single-family dwellings, a district heating network might lose 20–30% of the heat in the distribution network; this falls to 5–10% in higher-density neighbourhoods.[195] Similarly, below a certain threshold, individual air conditioners make more economic sense than district cooling, and bus networks are more viable than a rail system. More compact cities therefore offer a significant opportunity to make infrastructure investments more cost-effective and provide services more affordably. These savings will be particularly important for countries that are tackling the challenges of urbanisation while still at low levels of income.

The economic benefits of density and proximity go beyond these direct cost savings. Compact, connected cities produce agglomeration effects with broad economic benefits. The productivity of workers and businesses is higher in larger, more densely populated cities,[196] particularly those with good public transport networks that enable people to easily reach jobs and services. Density and proximity can also stimulate higher rates of innovation.[197] Agglomeration generates economic benefits through three main channels:[198]



Sharing benefits: Where many firms seek a common set of inputs, suppliers of those inputs are able to specialise and achieve economies of scale. This in turn means that purchasers benefit from lower costs and/or increased productivity. For example, the automobile manufacturing industry in Bangkok has grown steadily, initially thanks to an enabling policy environment and subsequently due to the co-location of related establishments including additional automakers, parts suppliers and R&D centres.

Matching benefits: Larger markets allow firms to find a better fit with their specialised needs, by employing workers with distinct skills and/or by linking to suppliers with distinct products. Greater specialisation of both labour and firms enables greater efficiency. For example, Johannesburg's origins as a mining town contributed to the growth of firms that made machinery and equipment for mining companies, as well as firms manufacturing metal products, chemicals, plastic products and jewellery from the mining products.[199]

Learning benefits: Geographic proximity of workers and firms enables more frequent interactions both within and across sectors. This facilitates the spread of existing knowledge, in particular tacit knowledge that is hard to codify in documents or formulas. For example, the co-location of automobile and battery manufacturing in Chinese cities has supported the development of the electric vehicle industry, since knowledge and technology from both sectors is required to produce electric vehicles.[200]

There is a growing body of evidence on the productivity gains associated with larger and denser cities. A recent review of over 300 studies on compactness found that in higher-income countries, when 10% more people live and work in a city, annual gross value added per person is US$182 higher due to higher productivity, greater job accessibility and better access to services.[201] In developed countries, a doubling of urban employment or population density is associated with 3–5% higher wages.[202] Employment density is found to explain over half of the variation in labour productivity across US states.[203] Though there have been fewer such studies in developing countries, China appears to have enjoyed unusually large agglomeration effects: a worker moving from a low-density city (in the first decile of density) to a high-density one (in the last decile) would experience a wage gain of 53%.[204] Large agglomeration effects are also found for India.[205] New analysis conducted by the London School of Economics and Political Science for this report finds that there is a strong positive relationship between urban population density and economic performance. In Europe, a 10% higher urban population density (measured by number of inhabitants per square kilometre) is linked to an increase of 1.9% in gross value added. In the US, the relationship is even stronger: a 10% increase in population density correlates with an increase of 4.6% in high-skilled wages and 5.5% in medium-skilled wages (see *Annex 4* for the methodology).[206]

10% HIGHER URBAN POPULATION DENSITY IS LINKED TO:

- ^ 1.1% PATENTS PER 1,000 PEOPLE
- ^ 1.9% INCREASE IN GROSS VALUE ADDED

- ^ 1.9% PATENTS PER 1,000 PEOPLE
- ^ 5.5% MEDIUM-SKILLED WAGES
- ^ 4.6% HIGH-SKILLED WAGES

More evidence is also emerging on the positive relationship between urban density and innovation. The capacity of countries to both create and absorb innovations will be increasingly important for economic competitiveness in the future. Innovation is a broad term, encompassing the introduction of new goods or quality improvements, new methods of production, the opening of new markets, the conquest of new sources of supply of materials or parts, or the new organisation of an industry.[207] It includes both the creation of entirely new technologies, products or processes, as well as their adoption and adaptation to different contexts. New analysis conducted by the London School of Economics and Political Science for this report finds a strong positive relationship between urban population density and innovation rates (measured by number of patents per person). In Europe, a 10% higher urban population density is associated with an increase of 1.1% in the number of patents per 1000 people. In the US, the relationship is even stronger: a 10% higher urban population density correlates with an increase of 1.9% in the number of patents per 1000 people (see *Annex 4* for the methodology). This is borne out by the wider literature. In France, for example, only six regions account for 75% of all corporate R&D workers, as opposed to 45% of production workers.[208] In the US a doubling of employment intensity (jobs per square mile) is linked to a 20% higher rate of patenting per 1000 people.

While delivering these economic benefits, higher urban density can reduce greenhouse gas emissions by cutting transport and residential energy consumption. A new analysis for this report of 120 cities found that, after controlling for per capita gross value added, a 10% increase in density correlates with a 2% decrease in per capita carbon emissions (see *Annex 5* for the methodology). This relationship is well documented in the US, where cars and homes contribute 40% of the country's carbon emissions. Vehicle fuel consumption is mainly determined by total distance travelled, which falls with higher urban density and proximity to the city centre. A household in a dense area with over 10,000 people per square mile consumed 3,123 litres of petrol per year, over 40% less than the 5,292 litres consumed by a household in an urban area with fewer than 1,000 people per square mile. Holding family income and size constant, a household's annual petrol consumption falls by 482 litres for every doubling of residents per square mile.[209] Dense cities also have lower emissions because their residents live in smaller homes, often in multi-unit buildings, consuming far less electricity and primary fuel for heating, cooling and other purposes than single-family detached homes.[210] Doubling population-weighted density in the US is accordingly associated with a reduction in carbon emissions from household travel and residential energy consumption by 48% and 35%, respectively.[211] The relationship between higher urban density and lower per capita emissions has also been documented for Japan[212] and China.[213]

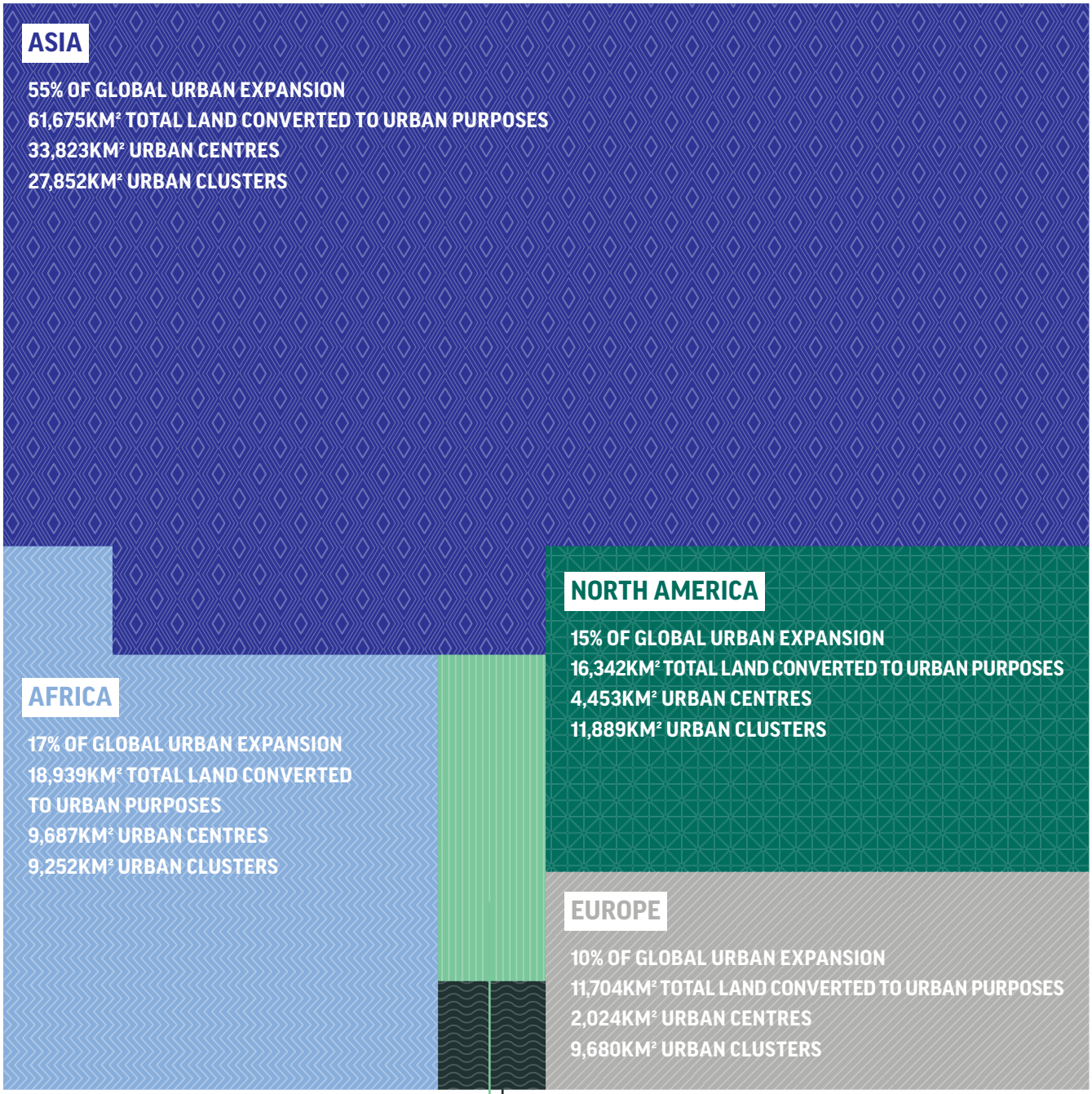
More compact urban growth can reduce greenhouse gas emissions from land use change as well. The conversion of land from non-urban to urban use is typically permanent: it rarely reverts to its prior state or to open space. This means that the amount of urban expansion over past and coming decades has huge significance for ecosystem services, biodiversity and food production. Higher rates of urban sprawl lead to greater loss of natural habitats and cultivated land.

A new analysis by New York University for this report found that urban settlements grew by nearly 113,000 square kilometres between 2000 and 2014, roughly equivalent to twice the size of Sri Lanka. Globally, the area of urban expansion was almost equally represented by urban centres and quasi-urban clusters (see *Figure 8*). Over half of this urban expansion occurred in Asia, and nearly one fifth in Africa. China alone accounted for 31.8% of the new urban extent, while a further 11.5% was in the US. Thereafter, India, Nigeria, Japan and Mexico saw the most urban expansion, accounting for 8.7%, 4.1%, 1.7% and 1.6% of new urban land, respectively. The way that urban areas are expanding is illustrated in *Figure 9*, which shows urban extent in 2000 and 2014 in parts of Brazil and Nigeria.

Controlling for gross value added, a new analysis of 120 cities suggests that 10% higher urban density correlates with a 2% decrease in per capita carbon emissions.

FIGURE 8. NET AMOUNT OF LAND CONVERTED TO URBAN PURPOSES BY REGION, 2000-2014.

Source: Marron Institute of Urban Management, New York University, for the Coalition for Urban Transitions and the Food and Land Use Coalition. For the full methodology, see Annex 6.

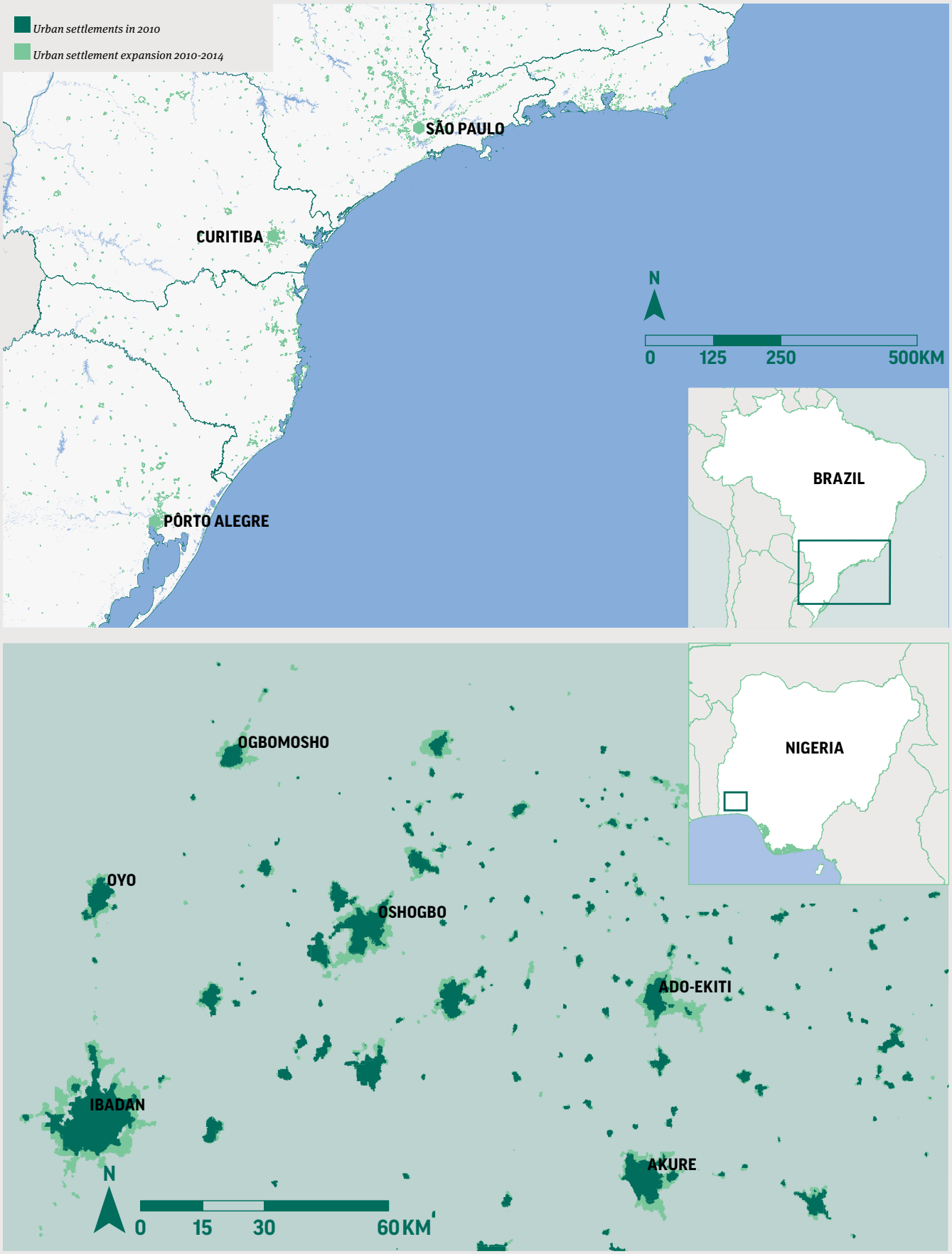


THE CONVERSION OF LAND IN URBAN EXPANSION AREAS, BY TYPE OF LAND COVER, 2000-2014, KM²

57,117	12,375	9,983	2,532	1,371	25,068	2,598	1,381	NO DATA	TOTAL
CULTIVATED LAND	FOREST	GRASSLAND	SHRUBLAND	WETLAND	RURAL BUILT-UP AREA	WATER	BARELAND	98	112,524

FIGURE 9. URBAN EXPANSION BETWEEN 2000 AND 2014 IN A REGION OF BRAZIL (ABOVE) AND NIGERIA (BELOW).

Source: Marron Institute of Urban Management, New York University, the Coalition for Urban Transitions and the Food and Land Use Coalition. For the full methodology, see Annex 6.



The conversion of cultivated land to urban uses can then trigger the further loss of natural habitats, as agriculture spreads into new areas. For instance, this analysis finds that croplands in Brazil, the Democratic Republic of the Congo and Myanmar still saw a net expansion since 2000 – even though urban areas had displaced agriculture. It was forested areas that shrank. The conversion of these carbon-rich ecosystems releases substantial greenhouse gas emissions that would otherwise be stored in biomass and soils.

More compact cities can also make national economies more resilient and safeguard human well-being by avoiding the loss of natural ecosystems and biodiversity. Land (and sea) use change is the largest driver of biodiversity loss, with around 1 million animal and plant species now threatened with extinction.[214] The resulting loss of ecosystem services such as pollination, soil formation and nutrient recycling directly affects oceanic and agricultural productivity. At the same time, climate change is reducing yields from fish stocks and staple crops such as wheat, maize and rice.[215] In this context, it is crucial to avoid losing arable land, yet more than 60% of the world's irrigated croplands are near urban areas, many of which continue to sprawl.[216] In Asia and Africa, where most urban expansion is happening, limiting urban sprawl is also critical for protecting agricultural livelihoods. Moreover, conserving natural ecosystems can keep CO_2 sequestered in biomass and soils, thereby reducing the extent of global heating.

3.2 The economic case for connected and clean cities

A shift to more compact, connected urban development can greatly enhance economic prosperity while reducing climate risks. But cities can do even better. By adopting additional measures to decarbonise buildings, transport and solid waste management, countries can gain further economic advantages while reducing urban greenhouse gas emissions. Even countries that have already "locked in" to urban sprawl, for example, could significantly improve quality of life and carbon efficiency by electrifying their vehicle fleets, retrofitting their building stock and making it safer to walk and cycle. This section explores the compelling economic case for large-scale low-carbon investments to make cities more connected and cleaner.

A new analysis conducted by Vivid Economics for this report finds that investing in the bundle of abatement options identified in *Section 2.1* will not only allow countries to approach zero-carbon cities, but also has a net present value of US$23.9 trillion – equivalent to 28.2% of global GDP in 2018.[217] With higher learning rates, this would rise to US$25.51 trillion. In the central scenario, US$1.83 trillion would need to be invested each year between 2020 and 2050 – equivalent to about 2% of global GDP in 2018. However, these measures – all technically feasible – would generate annual savings worth US$2.80 trillion in 2030 and US$6.98 trillion in 2050. While there are potentially significant opportunity costs, this means that these low-carbon measures would generate a very attractive commercial return. The findings are summarised in *Table 3*.

Those investments could also create good jobs. Many studies in high-income countries suggest that a transition to a greener or more circular economy would yield an increase in both the number and quality of jobs.[218] Just how significant the employment benefits would be is debated in the literature, as there are relatively few data points on which to base conclusions. Vivid Economics calculates that adopting all the abatement options

presented in *Section 2.1* would support the equivalent of 87 million jobs in 2030 and 45 million jobs in 2050. In 2030, most of these jobs would be from deep building efficiency improvements. In 2050, most of these jobs would be in the transport sector. These employment estimates usefully illustrate the magnitude of the impacts expected, but have not been modelled to reflect specific supply chains or labour market dynamics. They therefore provide a short-term picture which may not account for the skills profile or absorptive capacity of an urban area, or other regional differences.

These findings are conservative estimates of the economic returns from low-carbon investment in cities. The returns and payback periods associated with these abatement options are sensitive to energy prices, interest rates and technological learning rates (i.e. price and performance improvements as technologies are more widely deployed). The findings presented in *Table 3* are based on a central scenario

TABLE 3. THE ECONOMICS OF SELECTED LOW-CARBON INVESTMENTS IN CITIES BETWEEN 2020 AND 2050.

	Total incremental investment (US$ trillions)	Annual returns (US$ billions)		Net present value (US$ trillions)	Average payback (years)	Jobs supported (millions)	
Measure		2030	2050			2030	2050
BUILDINGS –RESIDENTIAL							
Deep building efficiency	25.42	338.63	945.30	-12.99	N/A	59.4	-
Efficient lighting	0.07	23.65	39.89	0.42	1	<0.1	0.1
Efficient appliances	2.13	24.42	185.07	-0.22	N/A	0.8	2.5
Efficient cooking	-	36.17	133.66	0.90	9	n/a	n/a
Rooftop solar PV	0.42	8.11	87.79	0.16	12	0.3	1.3
BUILDINGS –COMMERCIAL AND PUBLIC							
Deep building efficiency	13.09	294.02	722.77	-4.09	N/A	18.1	-
Efficient lighting	0.04	27.08	234.56	1.51	1	<0.1	<0.1
Efficient appliances	0.04	-16.55	51.67	-0.05	N/A	<0.1	0.1
Rooftop solar PV	0.12	2.44	23.87	0.05	11	0.1	0.3
MATERIALS EFFICIENCY							
More efficient material use (cement and steel)	-	87.96	359.30	2.15	-	n/a	n/a
TRANSPORT – PASSENGER							
More efficient and electric vehicles	8.61	320.42	1,095.59	3.66	8	3.6	20.4
Mode shift to mass transit	4.01	1,024.96	660.46	19.62	1	2.6	11.8
Reduced motorised travel demand	0.58	513.12	1,762.66	10.25	1	1.1	3.8
TRANSPORT – FREIGHT							
More efficient and electric vehicles	0.59	79.85	529.20	2.29	1	0.1	2.4
Improved logistics	1.59	36.69	143.93	0.18	1	0.6	2.7
WASTE							
Landfill gas utilisation	0.01	1.02	8.53	0.03	5	<0.1	<0.1

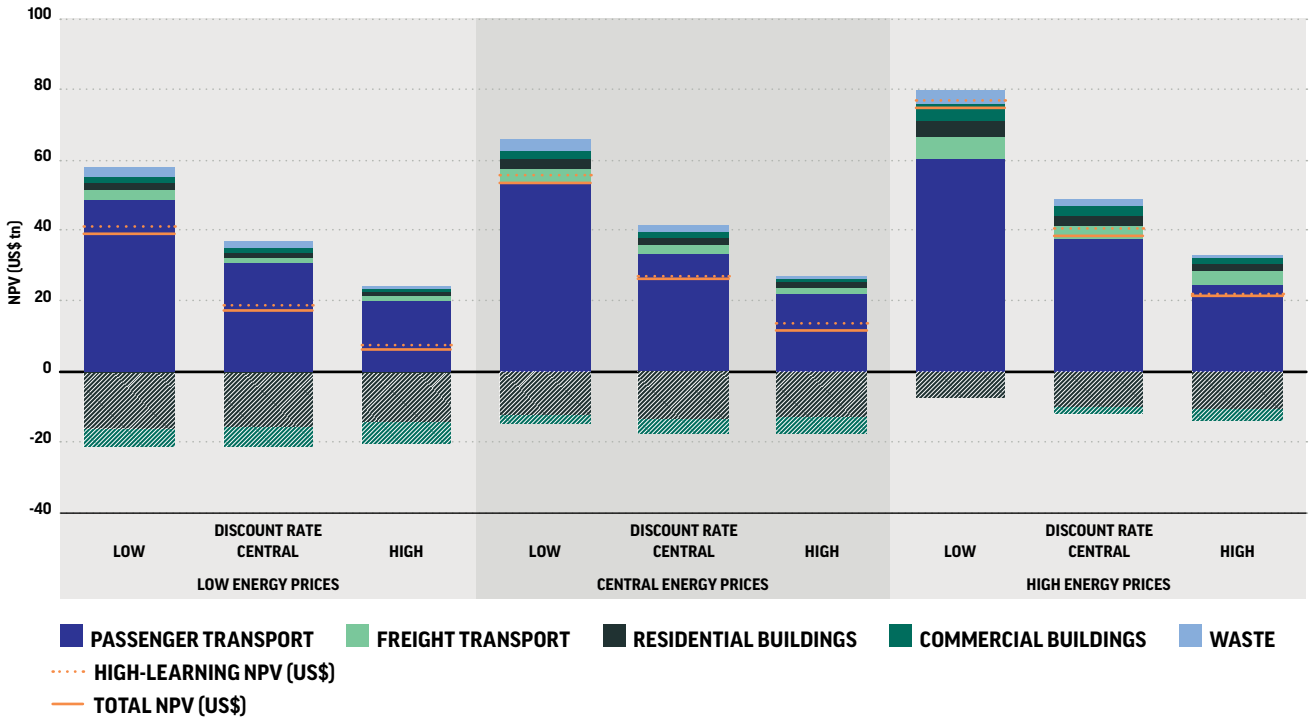
Note: These figures assume a discount rate of 3.5%, annual energy prices increases of 2.5% and low technological learning rates.
Source: Vivid Economics for the Coalition for Urban Transitions. For the full methodology, see Annex 7.

where real discount rates are 3.5% per year, real energy prices rise by 2.5% per year, and there is no increase in rates of technological learning. This analysis also considers the economic case under a range of different scenarios, as shown in *Figure 10*. Even under the least favourable conditions modelled (an annual energy price increase of only 1% per year and a discount rate of 5.5%), the bundle of measures still has a positive net present value of US$4.2 trillion.

The net present value of these investments would be even greater in scenarios with higher energy prices or faster technological learning rates. These conditions could be created through enabling national policies, such as fossil fuel subsidy reform or support for low-carbon research and development. With an energy price increase of 4% per year and high technological learning rates, the net present value of these investments rises to US$38.19 trillion with a standard public-sector discount rate of 3.5%. With a higher discount rate of 5.5%, which offers substantial scope to attract private investment, the net present value is still an attractive US$19.17 trillion.

Some low-carbon measures have bigger and quicker payoffs than others, but enabling national policy frameworks can make the whole bundle more economically attractive. As *Figure 10* demonstrates, the proposed low-carbon investments in materials efficiency, transport and waste have a positive net present value under nearly all scenarios. Most of the abatement options in the buildings sector are also very economically attractive. However, deep building efficiency seems likely to have a negative net present value. This finding reflects the design of the analysis:

FIGURE 10. THE NET PRESENT VALUE (NPV) OF AMBITIOUS CLIMATE ACTION IN CITIES BETWEEN 2020 AND 2050 (US$ TRILLIONS).



Source: Vivid Economics for the Coalition for Urban Transitions. For the full methodology, see Annex 7.

Note: Under the 'low', 'medium' and 'high' scenarios, the real discount rates used are 1.4%, 3.5% and 5.5%, and the increases in real energy prices are 1%, 2.5% and 4%. Learning rates are sector- and technology-specific.

significant capital investments are projected to 2050, but the analysis only accounts for economic savings to 2050. Investments in deep building efficiency would pay for themselves by 2089 and continue to generate a stream of energy savings throughout the buildings' lifespan. Moreover, this analysis only considers direct energy savings and is thus partial. The economic returns increase dramatically if decision-makers take into account the benefits in terms of more productive workers, reduced health care expenditure and the wider costs of carbon emissions.[219] In the absence of such a comprehensive approach, these findings underscore the importance of establishing enabling national policy frameworks (for example, pricing carbon and improving access to low-cost capital) and of investing in the whole bundle of low-carbon measures together rather than cherry-picking the most profitable options.

In summary, this bundle of abatement options offers an attractive economic opportunity, generating substantial returns for investors and lenders. Actively supporting the deployment of these measures would also lay the foundations for sustained economic development by driving further innovation. Many low-carbon technologies have broad applications across the economy and generate high knowledge spillovers comparable to those in information and communications technologies or nanotechnologies.[220] Their development and deployment can strengthen local skills, equipping firms and workers to further expand their capacity to innovate. Some scholars have likened the scale and pace of innovation needed for a zero-carbon urban transition to those of past industrial revolutions – with commensurate productivity gains and economic welfare benefits as well.[221] A strategic approach to low-carbon policy and investment can therefore build workers' and firms' ability to harness other innovations, such as digitalisation. It can also enable countries to avoid "lock-in" to outdated systems and take advantage of emerging markets for low-carbon goods and services.

Cities are important hubs not only for low-carbon technological innovation in high-income countries, but also for the adaptation of existing technologies in emerging and developing economies. Cities provide an ideal scale to experiment with new goods, services and governance arrangements, including many of the abatement options in this bundle. Indeed, many low-carbon measures are already coming together to radically change how cities function. The simultaneous rise of decentralised renewables, smart metering, e-hailing and electric vehicles, for instance, is reshaping power and transport systems in tandem. This "network innovation" could have profound implications for the carbon intensity of urban activities – for good or bad. For example, the rise of e-hailing may encourage more people to use passenger vehicles to commute or fewer to purchase their own car in the first place. Similarly, the rise of autonomous cars may render parking spaces unnecessary, enabling densification or the creation of new green spaces – or it may lead people to opt out of mass transit, leading to sprawl and congestion.[222] Because these services are novel, it is not yet clear how to maximise their benefits while mitigating potential costs. Cities are at the right scale to experiment with deployment and to coordinate these intersecting innovations to maximise the economic, social and environmental advantages. This is illustrated by China's experience in electrifying its own transport fleet. The national government systematically supported city governments and utilities to experiment with different configurations, and the country has now successfully positioned itself at the forefront of the electric vehicle market (see *Box 7*).

Box 7: China: Driving an electric transport revolution

China is home to 40% of the world's electric passenger cars and over 99% of the world's electric buses and electric two-wheelers.

It is difficult to overstate China's dominance of the global electric vehicle (EV) landscape. As of 2017, China was home to 40% of the world's electric passenger cars, with 1.2 million battery or plug-in hybrid EVs.[223] China also accounts for over 99% of the 370,000 electric buses and the 250 million electric two-wheelers in the world.[224] China's sustained commitment to EVs is grounded in their potential to improve air quality and energy security. China's air pollution is among the world's most extreme, leading to 1.37 million premature deaths every year,[225] and the country depends heavily on oil imports.[226] EVs, especially when powered by renewable electricity, can address both these pressing issues.

China's dominance in this market can be largely attributed to the national New Energy Vehicles (NEV) programme, which, since its launch in 2001, has systematically dismantled both supply- and demand-side barriers to large-scale deployment. The NEV programme initially focused on research and development (R&D) in three key technologies: powertrain control systems, motor control systems, and battery management systems. In the last few years, the Government of China has primarily channelled its R&D towards integrating NEVs into cities, particularly by improving and expanding charging infrastructure.[227] Innovations have not just been technological: the city government of Shenzhen, for instance, has developed new business models such as leasing rather than purchasing electric buses, and has coordinated utilities and bus operators to optimise EV charging. In 2018, Shenzhen became the first city in the world to electrify its entire public bus fleet.[228]

Complementing these efforts, the national government partnered with 10 pioneering city governments to increase demand for EVs. The 10

city governments received subsidies and technical support for public procurement of EVs and installation of public EV chargers. This strategy helped manufacturers to achieve the economies of scale and technological breakthroughs that eventually made EV production cost-competitive with internal combustion engine vehicles. Public procurement policies were accompanied by policies to incentivise the private purchase of EVs. In 2006, the national government reduced consumer tax on NEVs[229] and in 2010, it extended purchase subsidies from the public sector to support private purchases of battery EVs.[230] The NEV programme was subsequently expanded to a further 39 cities.[231] The country's fleet is accordingly expanding rapidly: over half of all electric cars sold worldwide in 2017 were sold in China.[232]

As EVs became more cost-competitive, the national government has been able to deploy a different set of policy instruments. First, it has steadily rolled back EV subsidies and replaced them with a cap-and-trade system to reduce the pressure on government budgets.[233] Second, the national government now mandates that any company manufacturing vehicles in China has to produce at least 10% NEVs. The quota will increase incrementally to 20% by 2025. Companies that fail to meet the target can buy NEV credits from manufacturers who exceeded the target, or else face federal fines.

China's NEV programme has built domestic and international capacity to cost-effectively produce EVs,[234] paving the way for a more rapid global uptake. By crafting regulation, providing incentives and offering technical support, China's national government turned its cities into test beds for innovation and public procurement. This has ensured that cities such as Beijing and Shenzhen are at the forefront of emerging technologies.

3.3 Securing competitive advantage through compact, connected and clean cities

Actively supporting a transition to compact, connected and clean cities makes countries more attractive to global talent and investment. Sustained productivity improvements depend on a country's ability to attract tradeable goods (and services) sectors. Because these industries can sell their products to a global market, they are not constrained by the size of local or regional markets. Firms in these industries make decisions about where to invest based on factors such as the cost and quality of labour, the regulatory environment, and access to key technologies and infrastructure (particularly a reliable, cheap energy supply, as outlined in *Section 2.1*). In addition to all the inherent benefits of urban areas, compact, connected, clean cities could have three significant advantages in the race to attract these industries.

First, they offer a better value proposition in terms of accessibility, efficiency and ways to reduce companies' own emissions. As outlined in *Section 3.1*, compact and connected cities can have lower costs and higher productivity than those plagued by sprawl and congestion.[235] This is attractive to businesses, as it can boost profit margins. As outlined in *Section 3.2*, connected and clean cities can also have lower running costs and greater innovation capabilities than cities "locked in" to outdated, high-carbon modes of development. Moreover, a growing number of firms have made ambitious climate commitments and are tracking their emissions: as of 2018, nearly 7,000 firms representing around 50% of global market capitalisation disclosed their climate impacts through the CDP platform.[236] These companies cannot reach net-zero emissions unless they locate in cities with clean energy and transport systems. Cities and countries at the forefront of the zero-carbon urban transition will have a competitive advantage in the race to attract these environmental pioneers.

7,000 firms representing around 50% of global market capitalisation disclosed their climate impacts through the CDP platform

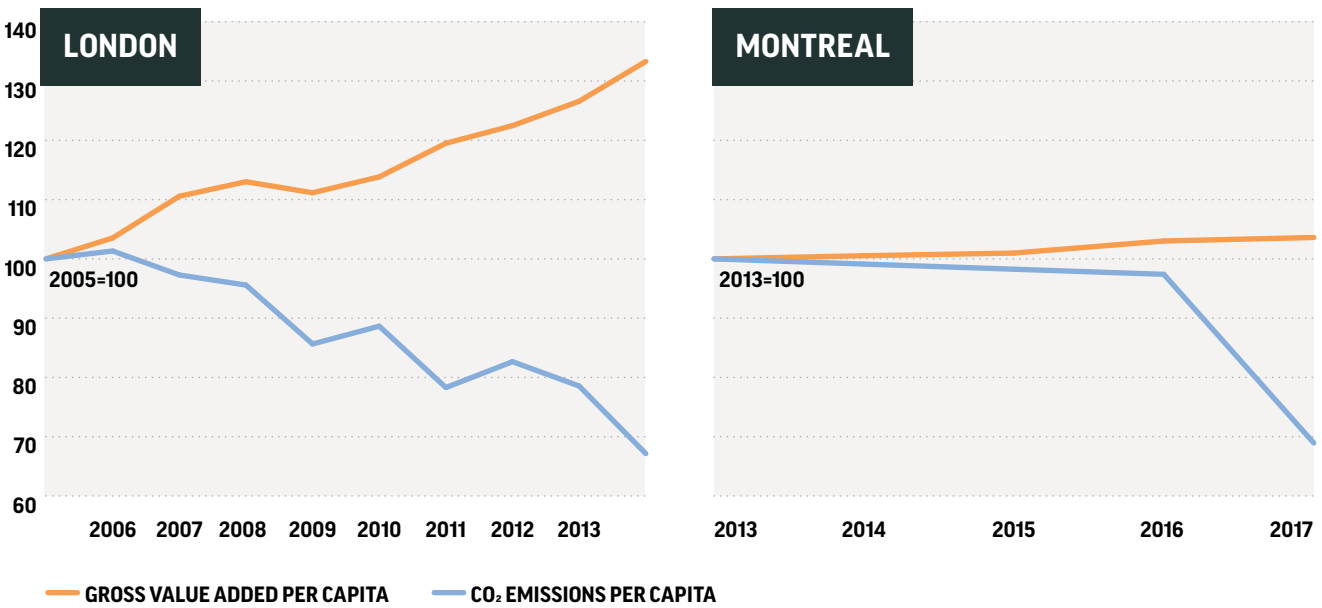
Second, compact, connected, clean cities are more attractive to the workers that top companies want to recruit. High-value industries depend on highly skilled workers, who are very mobile. They can move across national borders to cities that offer better employment opportunities and/or higher living standards.[237] Liveability is therefore a necessary (if not sufficient) condition to attract the kinds of workers who form the basis of knowledge-based and creative economies. And as *Section 2.2* outlines, compact, connected and clean cities can be very attractive places to live and work. They are likely to have cleaner air, more walkable neighbourhoods and better homes. As a result, they attract both skilled workers and investment. This manifests even within cities. In the US, for instance, there is evidence that young adults prefer neighbourhoods that are dense, walkable and well-connected by public transport, as these tend to be richer in amenities and offer greater socio-economic opportunities.[238] These trends, in turn, are reshaping property markets in much of the developed world, most notably reducing demand for suburban housing while more walkable developments with more mixed land use earn higher rents.[239] Although it is unclear the extent to which these preferences are held in emerging economies, promoting compact, connected urban development offers many national governments an opportunity to simultaneously deliver the kind of homes that young workers desire while attracting and nurturing the businesses that can offer them employment.

Conversely, high-carbon cities can be less liveable, and therefore less able to compete for firms and workers. High-carbon cities can often be less attractive places to live and work than their lower-carbon counterparts. This manifests most visibly through the

air quality crisis facing cities around the world, which in many cases can be attributed to the use of fossil fuels for cooking, heating, energy generation and transport. 1.2 billion workdays are lost every year due to air pollution, while related health care costs reach US$21 billion.[240] In China, for instance, an increase of 10 micrograms of small particulate matter (PM10) per cubic metre reduces home prices by 4.1%;[241] the effect of air pollution on rents is very similar in the US.[242] In some cases, excessive pollution can actually lead households and firms to migrate from cities. There is evidence from China and Russia, for instance, that smog leads to brain drain, with skilled workers leaving for cleaner cities to reduce their exposure to air pollution.[243] Sprawling cities also struggle to offer the cultural and recreational richness that people desire. Many people choose to live in cities because they want to enjoy a range of restaurants, shops and cultural facilities; higher population density supports greater variety.[244] Cities with lower quality of life are not able to attract as much capital or such skilled workers, so they have lower rents and wages. Rapid improvements in telecommunications – and the resulting rise of remote working – will only make it more difficult for dirty cities to retain high-skilled workers. High-carbon cities therefore face a distinct disadvantage in the global competition for capital and talent.

One of the key take-aways from this chapter is that there are large opportunities to decouple urban economic development from greenhouse gas emissions. A few cities around the world are already showing how it can be done, including London and Montreal (see *Figure 11*). The carbon savings in London are substantially due to a cleaner electricity mix based on natural gas and renewables instead of coal. More efficient buildings, industry and vehicles have also contributed to the city's falling emissions. The carbon savings in Montreal can be attributed to falling oil consumption from stationary energy sources, as well as the closure of one oil refinery and more efficient collection of landfill gas. The economic case for national governments to support compact, connected and clean cities is clear; the challenge is to ensure that the costs and benefits of a zero-carbon transition are distributed fairly.

FIGURE 11. EXAMPLES OF METROPOLITAN AREAS THAT HAVE ACHIEVED AN ABSOLUTE DECOUPLING OF PER CAPITA ECONOMIC ACTIVITY AND PER CAPITA PRODUCTION-BASED GREENHOUSE GAS EMISSIONS.



Source: Coalition for Urban Transitions. For the full methodology, see Annex 8.

3.4 Securing the economic benefits through an inclusive and just transition

Compact, connected and clean cities can support inclusive growth and broad-based improvements in quality of life – but there is no guarantee that they will fulfil this potential. In the absence of careful land governance and infrastructure provision, the higher population densities associated with cities can lead to chronic traffic congestion, intense overcrowding, crime, infectious diseases, severe air and water pollution, and spiralling housing costs. Even positive changes can have some negative side effects. Building a new metro line, for example, can connect low-income people to new job opportunities and sharply reduce their travel costs, but it can also lead to eviction or displacement. A boom in low-carbon technologies can create significant new wealth, but may displace jobs in other sectors (for instance, by leading a coal power plant to shut down). Thus, if national governments want to realise the full potential of compact, connected and clean cities to "lift all boats", they need carefully designed policies and infrastructure investments. Two issues are particularly critical for national governments: creating fair and efficient land and housing markets, and ensuring a just transition.

For cities to achieve their economic and social potential, urban residents need affordable homes with secure tenure and reliable access to transport, energy, telecommunications, sanitation and water. However, cities worldwide face a housing affordability crisis. Problematically, greater compactness often correlates with higher housing prices. The high housing costs in Hong Kong, London, New York, Sydney and Vancouver have made global headlines, but the worst of the crisis is concentrated in the developing world, in cities like Buenos Aires, Caracas, Hanoi, Kiev, Mumbai and Rio de Janeiro.[245] Across the global South, a quarter of urban residents live in slum conditions without decent housing, safe drinking water, basic sanitation or legal tenure,[246] often paying a very high share of their income for these substandard shelters.[247] National governments need coherent, far-sighted strategies to deliver affordable and decent homes while creating vibrant, walkable urban communities.

Urban housing markets are shaped by local, national and even global trends and policies. National and state governments typically design the financial, legal and tax structures that incentivise certain housing or occupancy types, such as mortgage interest tax deductions that boost single-family home ownership, or strong tenant protections that encourage long-term renting.[248] They also shape and fund national land reform and housing programmes. Local governments, in turn, typically implement those programmes and set land use regulations and building codes that shape the decisions of property developers.[249] For instance, large minimum plot sizes (or even a lack of qualified surveyors) can limit the supply of affordable new homes, irrespective of demand. National policies and investments can help overcome local deficiencies, and they have a critical role to play in addressing deeper structural inequalities in order to fully realise the "right to the city" of all urban dwellers.[250]

National, regional and local governments have a range of measures at their disposal to expand the supply of affordable housing while promoting compact urban growth, such as split-rate property taxes, impact fees, transferable development rights, strong tenant protection laws and well-located social housing.[251] However, there are challenges to reforming housing and land use policies that have contributed to the exclusionary housing markets in many cities today. The inherently slow process of housing construction and the long lifespan of buildings means that it can take many years for policy reforms to achieve their goals. Land ownership and occupancy are poorly documented in many cities in the global South. City governments often depend on revenue from property taxes or land sales, so they are incentivised to support luxury developments and sprawl. In almost every context, developers can earn more by catering to the rich than by building homes for the poor or middle class (even if liveable density is likely to yield higher returns to real estate investors in the long-run).[252] Moreover, property developers too often bypass or exploit local regulations in pursuit of profits.[253] Meanwhile, with housing increasingly treated as a global financial commodity rather than as a human right,[254] a city's development may primarily reflect the interests of foreign investors and lenders rather than local communities. There is therefore a fundamental political economy challenge in delivering affordable housing: when only a few (powerful) people own land, they are rarely keen to see taxes extract their rents; when many (voting) people own land, they are equally reluctant to see their major asset fall in value. Bold leadership by all tiers of government is needed to tackle this challenge and deliver truly inclusive cities.

Any strong housing policy starts with a comprehensive cadastre and land registry. The absence of reliable public information about land ownership and occupancy is arguably the primary obstacle to efficient property tax collection and spatial planning.[255] Rwanda demonstrates how rapidly progress can be made, having built a transparent digital land cadastre that covered the whole country – including its informal settlements – in just seven years. This has laid the foundation for greater tenure security, improved property tax collection and more effective spatial planning (see *Box 8*).[256]

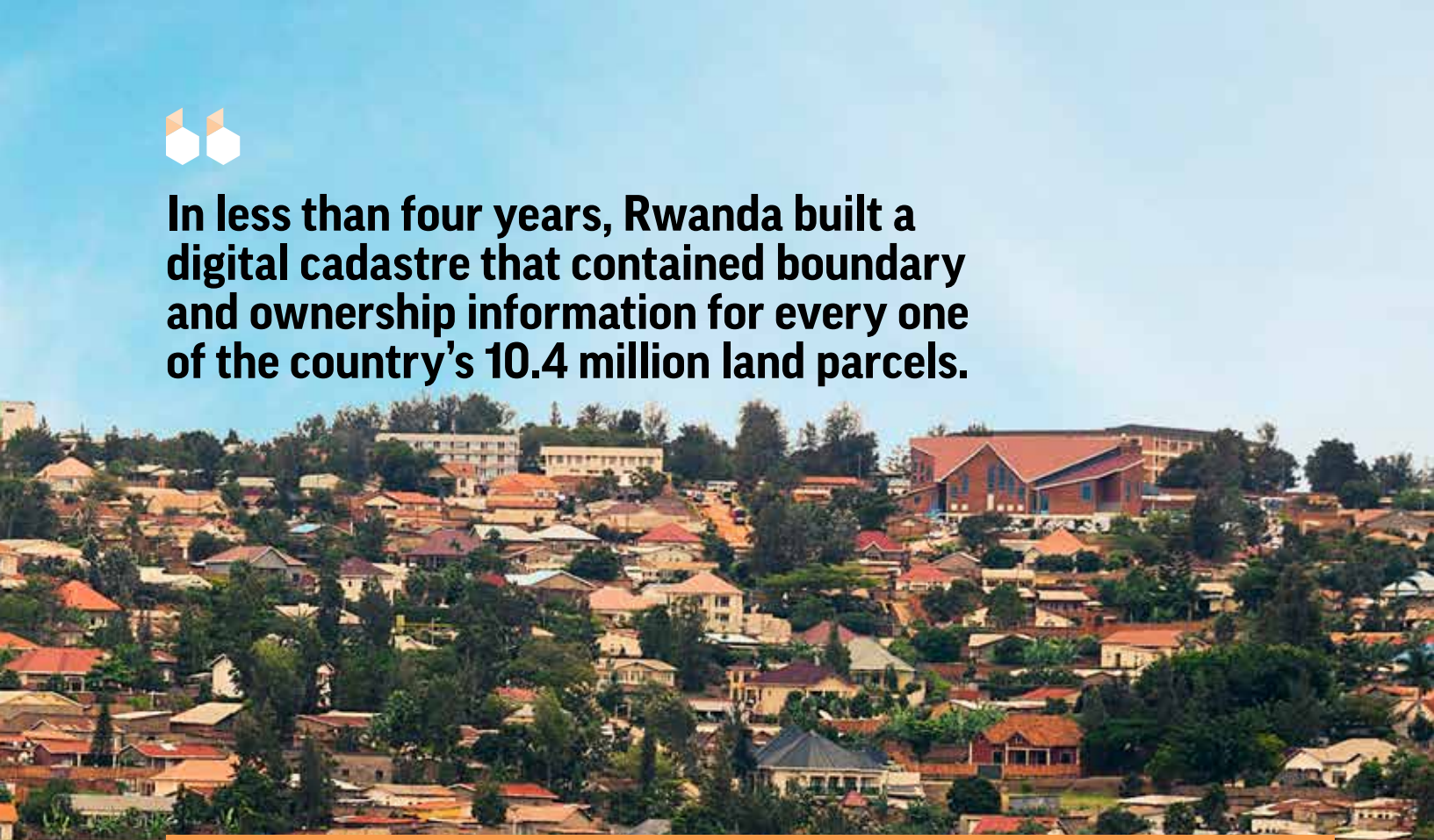
Two issues are particularly critical for national governments seeking to nurture compact, connected and clean cities: creating fair and efficient land and housing markets, and ensuring a just transition.

Box 8. Rwanda: Creating effective land and tax administrations

Rwanda has seen extraordinary progress over the last two decades. Since 2000, it has been one of the fastest-growing economies in the world. The proportion of Rwandans living in extreme poverty fell from 68.3% to 55.5% in the last decade,[257] child mortality has fallen by two thirds, and the country has achieved near-universal primary school enrolment.[258] Rwanda also performs exceptionally well in terms of women's political participation and economic empowerment.[259] Many of these gains have been made possible through land governance reforms and tax modernisation, which have equipped all levels of government to harness rapid urbanisation.

With respect to its fiscal reforms, the national government has focused strongly on building citizens' trust in public administration. In 1997, it created the Rwanda Revenue Authority (RRA) with the mandate to expand the tax base and improve tax collection. The RRA was also tasked with making it simpler to pay taxes and, in 2003, introduced an e-Tax Information System. Simultaneously, the national government explicitly reoriented public spending towards essential services like water supply, sanitation, health care and education, which helped to make taxes more politically palatable. In higher-density areas of Rwanda, further increases in density have been associated with low multidimensional poverty index scores, indicating that in cities these service improvements were equitable enough to harness the benefits of urbanisation for poverty reduction.[260] Fiscal reform has also provided an opportunity to strengthen local government capacity, with the decentralisation of trading license tax, property tax and rental income tax in 2002. The first of these, in particular, proved very effective, with up to 95% of businesses reportedly paying the trading license tax by 2009.[261] Thanks to these and other reforms, tax revenue as a share of GDP rose from 3.6% in 1994 to 13.4% in 2013.[262]

With the vast majority of workers concentrated in the agricultural sector (88% in 2012),[263] land is Rwandans' most important economic and social asset. Prior to the land reforms of 2004, most land in Rwanda was acquired through inheritance, gifting, informal occupation, or government land allocation. This was often fiercely contentious; exclusionary



In less than four years, Rwanda built a digital cadastre that contained boundary and ownership information for every one of the country's 10.4 million land parcels.

and restrictive land governance is thought to have contributed to the 1994 genocide.[264] Land reform was therefore a politically sensitive and urgent issue. In 2003, the national government introduced legislation that abolished customary tenure, initiated a participatory process for land registration, established inclusive dispute resolution mechanisms and created dedicated institutions to implement the land reforms.[265] This framework underpinned a land tenure regularisation programme, which employed a pioneering aerial-mapping technique supported by official visits to verify plot boundaries and ownership. By June 2012 – less than four years after the pilot was completed – the registry team had built a digital cadastre that contained boundary and ownership information for every one of Rwanda's 10.4 million land parcels.[266] Women especially benefitted from this programme, as male children traditionally inherited property. In 2016, 63.7% of titles were owned by women or co-owned by men and women.[267]

While these programmes were being rolled out between 2002 and 2015, the share of Rwanda's population living in urban areas increased from 16% to 27% due to a mix of rural-to-urban migration, natural increase, and refugees returning after the genocide.[268] The tax and land reforms collectively laid the foundations for the government to better manage this rapid urbanisation. Clear land ownership has enabled governments to determine who should be compensated when land is expropriated for the public interest, enabling large-scale property and infrastructure investment anchored by much higher public revenues. The process has not been perfect: land pricing continues to be fiercely disputed as the government struggles to provide adequate compensation to established residents while ensuring that land prices are competitive for prospective investors.[269] An unaccountable and ineffective property tax system (subsequently re-centralised) has also incentivised the construction of high-end real estate rather than more affordable housing.[270] These issues are explicitly raised in Rwanda's National Urbanization Policy, introduced in 2015 by the Ministry of Infrastructure.[271] Addressing them will position the country to harness the economic potential of its rapid urbanisation – a necessity to lift Rwandans out of poverty and achieve middle-income status.

Another priority for national governments is delivering the transition to zero-carbon cities in an inclusive and equitable way. Although ambitious climate action will overall increase prosperity and equality compared with a high-carbon path, the profound system change required to reach net-zero emissions entails real trade-offs. People who work in high-carbon sectors may lose their jobs, and many low-carbon measures may have a disproportionate impact on low-income people. Requiring appliances to be more energy-efficient, for instance, may raise their cost, even if they are cheaper to run; that could put them out of the reach of poorer families. A just transition – in which both the benefits and the burdens of climate mitigation actions are equitably shared – is not only a moral imperative, it is also essential for sustained political support for climate action. Moreover, a commitment to a just transition can create opportunities to address wider inequalities and enhance resilience to the climate change that is already locked in.

National governments have important roles to play in ensuring a just transition because of their capacity to share costs and benefits across a country (or even further afield through their engagement in the multilateral system). This is especially critical when entire cities are threatened by the decline or change of carbon-intensive industries, such as steel manufacturing, food processing or chemical production.[272] It falls primarily to national and state governments to anticipate these profound structural economic changes, and carefully design policies and projects to capture the benefits while mitigating the costs. For example, China's far-sighted investment in clean energy over recent decades means that the country is now home to five of the world's 10 largest wind turbine companies and three of the 10 largest solar panel companies;[273] it is similarly poised to dominate electric vehicle markets, creating domestic jobs and boosting public revenues (see *Box 6*). This is an imperative for all ministries: for instance, finance ministries can ensure that the gains from a zero-carbon transition are distributed equitably, transport ministries can ensure that workers are connected to new economic opportunities, and education ministries can ensure that young people have the skills and knowledge that they need to succeed in a low-carbon, climate-resilient economy.

A participatory approach is key to negotiating politically acceptable and socially just solutions, providing legitimacy and enhancing public ownership of the transition. For instance, the construction of mass transit infrastructure often entails the eviction of low-income urban residents without compensation. Experiences in Mumbai and Nairobi demonstrate that governments can partner with local communities to design strategies that simultaneously enable the construction of urban rail and reduce poverty in surrounding settlements.[274] Similarly, the transition to clean energy and zero-carbon cities demands the closure of coal-fired power plants. Lessons from the Coal Commission in Germany underscore the importance of including those most affected (both in terms of job losses and climate impacts) in decision-making processes, and of creating space for region-specific planning and policy within national frameworks.[275]

A just transition depends on wider policies and programmes that lay the foundations for inclusive, equitable, resilient development. These go beyond the scope of this report, but might include implementing appropriate social protection measures for all (SDG1), guaranteeing universal access to primary and secondary education for all girls and boys (SDG4) and protecting labour rights to ensure that all working people have safe and secure working conditions (SDG8). This perspective demonstrates that ambitious action to reduce greenhouse gas emissions cannot be undertaken in isolation; mitigation, adaptation and sustainable development must be pursued in tandem. This is an immensely complex proposition, but it is essential to respond to the three connected challenges of a slowing global economy, widening inequality and accelerating climate change. The case studies throughout this report demonstrate that a handful of countries and cities have seen transformation at the pace and scale required, and that their efforts have yielded immense improvements in citizens' quality of life. Local governments cannot drive such radical system change alone. The next chapter considers the unique and crucial roles that national governments need to play in driving a zero-carbon urban transition if they are to seize this immense economic opportunity.

The case studies throughout this report demonstrate that a handful of countries and cities have seen transformation at the pace and scale required, and that their efforts have yielded immense improvements in citizens' quality of life.

4. The unique and crucial roles of national government

Smaller cities are home to over half the global urban population and half the urban mitigation potential – but they lack the same tax base or capabilities as larger cities. They particularly benefit from national support and standards.

The performance of cities is of huge consequence to national governments everywhere. In the largely urbanised Americas, Europe and Oceania, the concentration of people, economic activity and infrastructure means that urban policy is one of the most powerful instruments to address pressing political priorities from high unemployment to inadequate public services to climate change.

In rapidly urbanising Africa and Asia, urban-influencing policies and investments made in next decade will increasingly determine countries' economic and social performance, including their capacity to attract and nurture industry, their demand for energy and resources, and their ability to lift people out of poverty. In each context, fostering compact, connected and clean cities can yield multiple benefits, from a safer climate, to a more vibrant economy, to cleaner air.

Local action is critical but, on its own, insufficient to create inclusive, zero-carbon cities with all their economic, social and environmental advantages. Recent decades have seen a groundswell of local climate action,[276] including by local governments, utilities, firms, social movements, non-governmental organisations, traditional or customary authorities, research institutes and citizens. City governments have shown particular leadership: nearly 10,000 cities and local governments worldwide have committed to setting emission reduction targets and crafting strategic plans to deliver on those commitments.[277] Many are taking climate action within unsupportive national contexts. However, even the largest, most empowered and committed city governments can only realise a small proportion of their mitigation potential on their own.[278] Small- and medium-sized cities have still fewer resources and capabilities than large cities, but are home to over half the global urban population and half the urban mitigation potential (see *Figure 3*).[279] In these cities, the support provided and standards introduced by higher levels of government are particularly important. A transition to zero-carbon cities demands collaborative climate action based on meaningful partnerships between national, state and local governments.[280]

National and regional governments have a critical role to play in preparing a national strategy to deliver shared prosperity while reaching net-zero emissions – with cities at its heart. Such a strategy should be co-produced with local governments, businesses and civil society, with enough space to allow local flexibility and innovation. Working in partnership with all these different stakeholders, national and regional governments have four unique and crucial key roles to play in implementing this strategy:

- Aligning national policies behind compact, connected, clean cities;
- Funding and financing sustainable urban infrastructure;
- Coordinating and supporting local climate action in cities; and
- Building a multilateral system that fosters inclusive, zero-carbon cities.

In addition, national governments have a critical contribution to make to ensure a just transition.

It is important to recognise the size and complexity of national governments. They are not single, unified entities, and they differ from country to country. There is a legislative branch, or parliament, which crafts the laws and sets the budget, and an executive branch, which implements and enforces the law. The power of the executive varies significantly across different countries and among unitary or federal systems. The two branches may be controlled by different political parties with competing agendas, and answer to electoral systems that may not hold them equally

accountable. There is also a bureaucracy, the civil servants who implement policies, whose priorities may differ depending on which agency employs them. Courts settle how policies are interpreted and enforced. Each of these entities and actors has a set of responsibilities, ideologies, ways of working and sources of power and support. To be successful, national leaders will need buy-in and engagement from all relevant branches and units of the national government. Achieving the transition to zero-carbon cities will only be possible if they all recognise the urgency of action and seize the opportunity before them.

4.1 Crafting a national strategy for cities

Cities develop and change over time through the discrete decisions of planners, politicians, real estate developers, bankers, investors, architects, engineers, property owners, businesses, media and other city dwellers. Some may be focused on a single parcel of land, while others look at the whole neighbourhood, or even the whole city. Sometimes they work in concert, but they are driven by different goals. Each has a different idea of what makes a city successful, and each comes to the table with different amounts and types of power. Building consensus among such diverse constituencies is immensely challenging, yet that diversity also gives cities their energy and inventiveness.

National governments have a central role to play in bringing together these different groups to develop a strategy that harnesses the potential of cities to deliver prosperity for all in a resource-efficient way. Within cities, it falls primarily to local governments to set an agenda that will fulfil the needs and aspirations of urban residents – current and future – while responding to environmental pressures. But cities are inextricably linked to one another and to their surrounding regions. National governments can bring together governors and mayors (as well as business, community and thought leaders) to craft a national strategy that recognises the importance of cities and their interconnectedness with rural development. This strategy can be embedded into the national development plan or be a standalone platform such as a National Urban Policy.

The process of developing and revising the national strategy is as important as the result. The strategy needs to be co-produced by the head of government, key line ministries and city leaders. This can ensure that it is subsequently mainstreamed into spatial plans and sectoral strategies, such as energy, housing, land use and transport. It should ideally link different communities and facilitate difficult conversations about the costs and trade-offs of different development paths. National and state governments will only be able to channel the creativity and activities of local governments, businesses and civil society if they jointly own a vision for cities that retains the flexibility to accommodate local priorities. In turn, local governments have a responsibility to make themselves more effective partners to national and provincial governments, so these different levels can genuinely co-design and co-deliver sustainable urban development.

A central plank of any national vision for cities must be a commitment to mutual accountability between national and local governments. There need be no contradiction between having a more coherent, effective national urban strategy and giving city governments the autonomy they need to innovate and act on climate change. This is not an argument for decentralisation, which has proven both contentious and imperfect, but rather for ensuring that all levels of government have the capacity, space and support to work together towards a shared vision. What matters is how and why power might be devolved, and how interests at different scales are represented. National and state governments need to increase the capabilities of local governments so that they are able to fulfil their responsibilities,[281] and ensure they receive or can raise enough resources so they do not struggle with unfunded mandates.[282] National governments are also uniquely positioned to address issues like rule of law, corruption, fiscal health and trade, which prevent local action, reduce public trust in government (and therefore local politicians' ability to manoeuvre), and deter private investment and entrepreneurship. Local governments, for their part, can systematically streamline their departmental operations and strengthen their capabilities so they can engage more straightforwardly and effectively with other levels of government.

A national vision for cities also needs to be sensitive to space and circumstance. All countries should build upon the Sustainable Development Goals and the Paris Agreement, but tailor their agenda to domestic contexts. National and provincial governments are typically better placed than local governments to consider spatial questions: where and how much might people be concentrated in a country, and how could cities of different sizes be connected to one another and to rural areas? A functional "system of cities" is important for distributing economic and social opportunity, realising regional comparative advantages and, increasingly, minimising exposure to climate risk. A national vision for cities also needs to be grounded in current political realities and priorities.[283] This means the entry point for climate action might be improving air quality, or upgrading informal settlements, or revitalising post-industrial cities. What is crucial is that the national vision include a commitment to cities with inclusive economies and net-zero greenhouse gas emissions.

Once national governments have established an overarching strategy that harnesses the power of cities to deliver shared prosperity while reaching net-zero emissions, they can build the main pillars required to achieve it.

National and state governments need to increase the capabilities of local governments so that they are able to fulfil their responsibilities, and ensure local governments receive or can raise enough resources that they do not struggle with unfunded mandates.

4.2 Aligning national policies behind compact, connected, clean cities

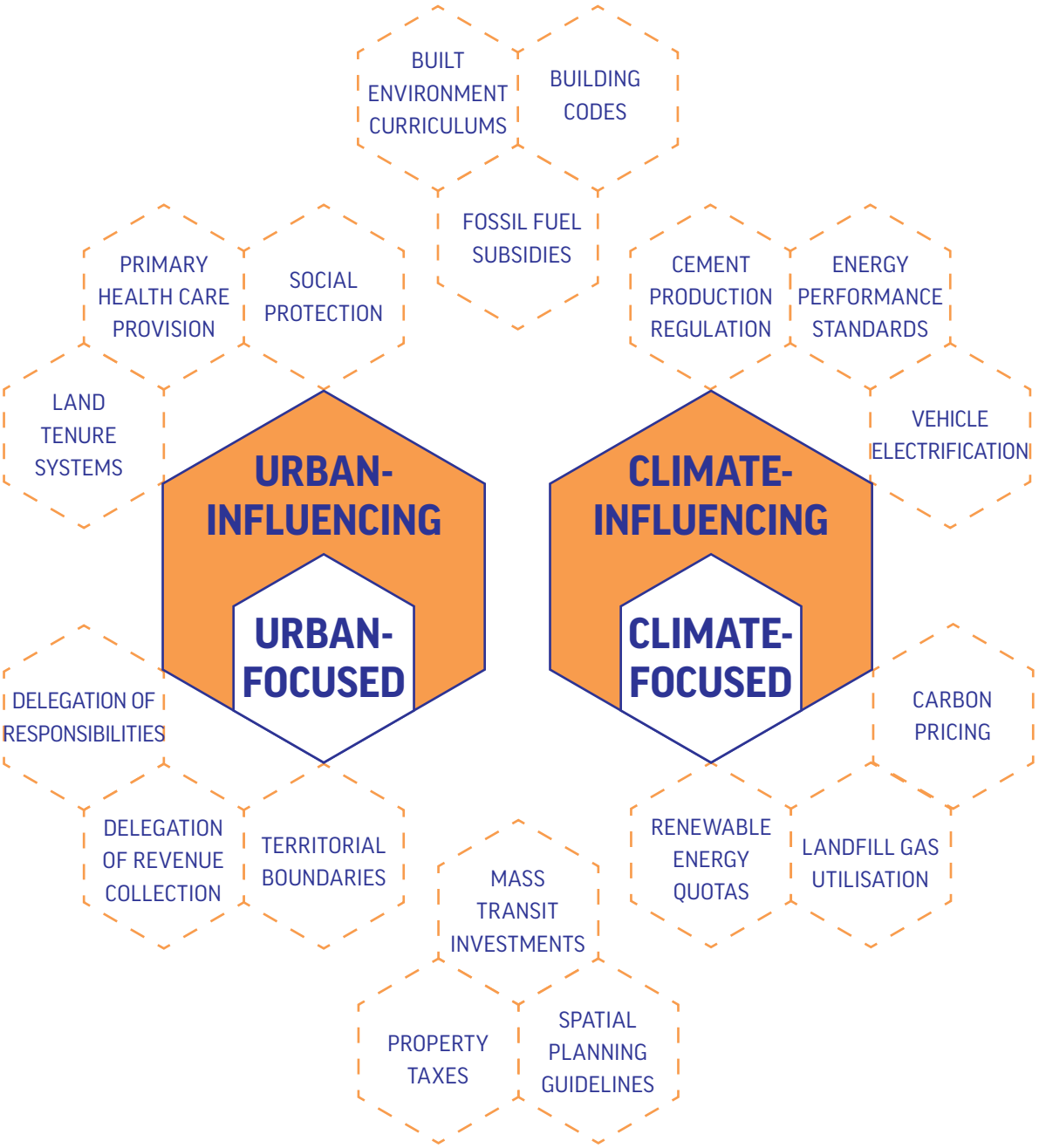
A wide range of national and regional policies affect urban development. The relative powers of national, state and local governments vary by country. However, in all cases, there are national (and often regional) policies that have a significant impact on the quality and direction of urban development. Taxes may incentivise households' and firms' choices about where to locate and how much space to occupy; infrastructure investments may shape the mass transit options within and among cities; and mandatory performance standards for cars, lighting and appliances may influence total energy demand as well as local air quality and living costs. National and regional governments' influence over cities is not limited to the built environment. Industrial regulations shape local air, soil and water quality, and a growing share of health and education budgets is spent in cities.

Yet national and regional policies are often designed without regard to urban or climate issues.[284] China, Mexico and Nigeria, for instance, have until recently focused on expanding the supply of affordable housing without necessarily considering how residents would travel to jobs, services or amenities.[285] This has contributed to costly sprawl and even the abandonment of new housing stock around the urban periphery. The experience of Chile illustrates the importance of integrating housing, spatial and social policies to foster thriving communities (see *Box 9*), although looming climate catastrophe means that countries must in the future also layer in policies to reduce emissions and enhance resilience. The siloed approach that too often prevails creates perverse incentives that waste taxpayers' money and undermine the long-term viability of cities.

It should be a priority to align policies across all ministries to systematically promote compact, connected and clean urban development. This should involve removing and reforming established policies, as well as introducing new policies. Housing, industrial, land use and transport policies, for instance, need to be designed in concert to favour the development of mixed-use, walkable neighbourhoods where people can easily access their jobs.[286] National governments are well placed to disentangle conflicting incentives and establish a baseline of policies that support a zero-carbon urban transition. Policy clarity is especially important for stimulating and shaping private-sector activity, increasing the ease of doing business and de-risking low-carbon investment. National and state governments can also go farther by empowering local governments to set more ambitious climate targets – for example, through building codes, renewable energy quotas or electric vehicle deployment. This approach can ensure that emissions from all cities across a country fall steadily, while frontrunning city governments have the space to advance faster.

A wide range of national and regional policies affect cities, yet these are often designed without regard to urban or climate issues.

FIGURE 12. SCOPE OF MEASURES TO CONSIDER TO ACHIEVE BOTH URBAN DEVELOPMENT AND CLIMATE MITIGATION GOALS.



Source: Coalition for Urban Transitions.

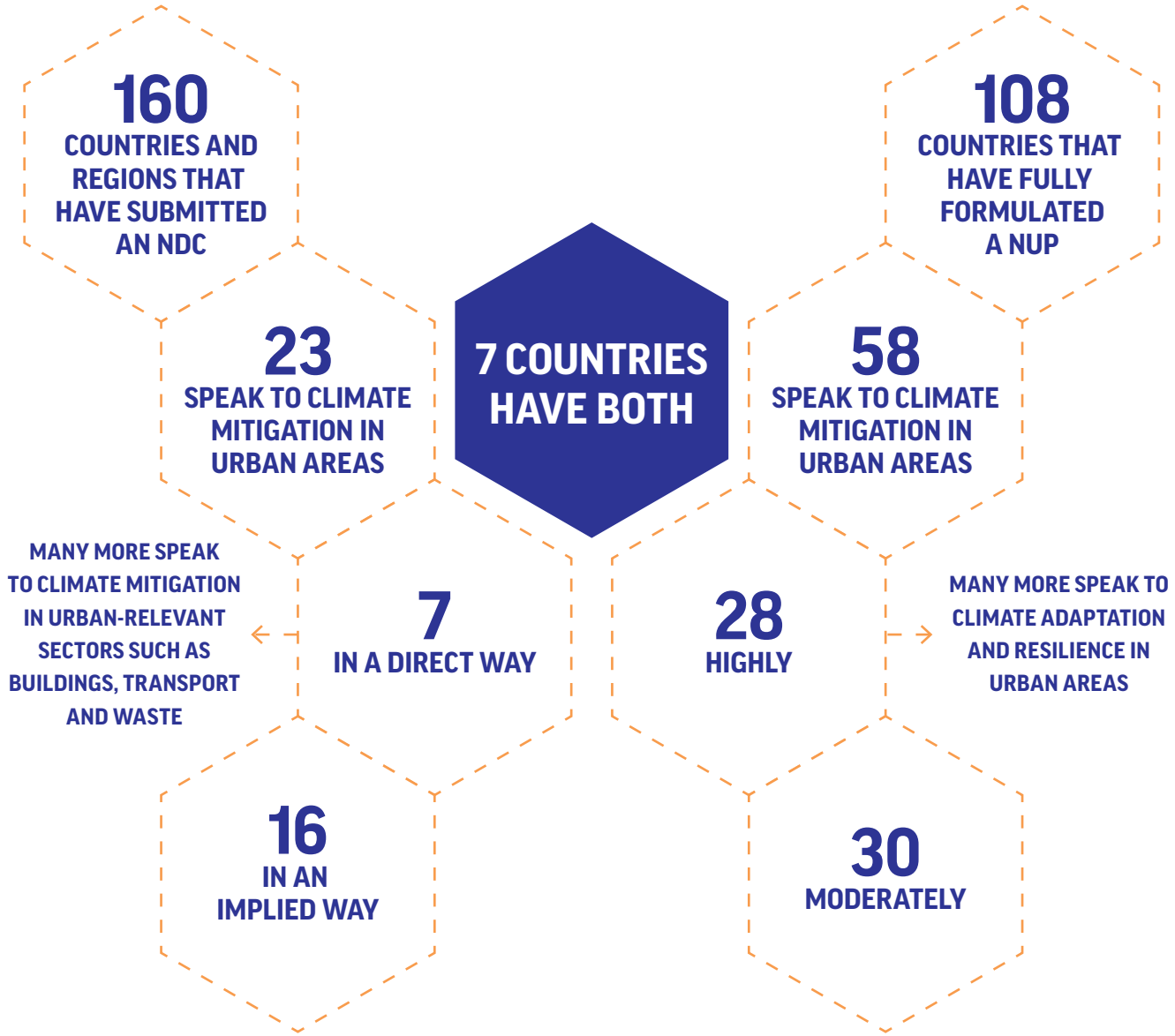
Only 39% of National Urban Policies and 14% of Nationally Determined Contributions speak specifically to climate mitigation in urban areas.

Meaningful policy alignment requires looking beyond the narrow bundle of instruments that might be explicitly urban-focused or climate-focused, and considering the much wider suite of policies that influence urban or climate outcomes. Almost every ministry makes choices that influence cities or emissions (see *Figure 12*), and accordingly needs to ensure that the policies and programmes in its purview favour a zero-carbon urban transition.[287]

National Urban Policies (NUPs) and Nationally Determined Contributions (NDCs) could be valuable instruments to ensure that national policies systematically promote compact, connected and clean cities. A NUP is intended to govern cities and urbanisation within a country by aligning different sectoral policies, clarifying roles of all actors (including the private sector and civil society) involved in the urban sphere and creating spaces for them to convene. Today, only 76 countries – fewer than two in five – have an explicit NUP, and many of these are still in the feasibility or diagnosis stage.[288] An NDC is intended to communicate the climate mitigation targets of a country, articulating where and how it might reduce emissions. With renewed attention to NUPs since Habitat III in 2016 and a commitment to enhance NDCs in 2020, many national governments are currently reviewing their overarching urban and climate policies. This offers a strategic international moment to harness the potential of cities to simultaneously improve living standards while tackling emissions.

New analysis for this report finds that only seven countries have both an NDC and a NUP that speak to climate mitigation in urban areas. 23 countries have an NDC that speaks to climate mitigation in urban areas, while 58 countries have a NUP that speaks to this topic. But new analysis for this report finds that only Colombia, Fiji, Indonesia, Mongolia, Rwanda, South Sudan and Tonga have both NUPs and NDCs that address this issue (see *Figure 13*), although many more countries have NDCs and NUPs that speak to urban adaptation and resilience.[289] NUPs and NDCs are, of course, a deeply imperfect proxy for national policy alignment on cities and climate change, let alone policy implementation: several countries, such as Sweden, have longstanding commitments to urban climate action that are not captured in their NDCs. Many more countries have urban-relevant pledges in their NDCs, promising to reduce emissions from buildings, electricity generation, transport and waste. These sector-based commitments are welcome. However, sectoral approaches miss two important opportunities in cities. First, they fail to capture the mitigation potential associated with spatially concentrating people, infrastructure and economic activity. For example, higher densities enable people to walk or cycle rather than using motorised transport. Second, sectoral approaches may not sufficiently empower local governments to pursue ambitious climate action within their jurisdictions. It is therefore important that national governments explicitly recognise cities as systems in their climate policies and plans. This analysis effectively illustrates that most national governments could go much farther to mainstream urban and climate perspectives across decision-making. If NDCs are not already addressing urban opportunities, there is immense scope to raise ambition during the climate negotiations.

FIGURE 13. THE PROPORTION OF COUNTRIES WHOSE NATIONAL URBAN POLICIES AND NATIONALLY DETERMINED CONTRIBUTIONS SPEAK TO CLIMATE MITIGATION IN URBAN AREAS.



Source: Coalition for Urban Transitions, Organisation for Economic Co-operation and Development, UN-Habitat and the University of Southern Denmark. See Annex 9 for the full methodology.
Note: This analysis was performed using:
– A database of 160 NDCs developed by UN-Habitat and the University of Southern Denmark. The European Union entered a single NDC that covered all 28 member states, which largely explains why the number of NDCs is lower than the number of countries.
– A database of 108 NUPs developed by the Organisation for Economic Co-operation and Development and UN-Habitat. A further 42 NUPs are still in the feasibility and design phases, so they could not yet be assessed for their thematic scope.
The Coalition for Urban Transitions has not been able to independently verify the databases.

Box 9. Chile: Building a vibrant and affordable housing market

Over two decades, Chile reduced its housing deficit by two thirds.[290] This achievement is particularly striking as it took place during Chile's transition to democracy and as the country's urban population grew from 10.1 million to 15.5 million.[291] Chile was able to rapidly increase the supply of decent housing through an increasingly integrated approach spanning the banking, construction, education, industry, social development and transport sectors.

Historically, the national government has either built or financed most formal housing in Chile. Through the 1990s, the Ministry of Housing and Urbanism (MINVU) was the most prominent real estate actor in Chile, building 30% of housing units, and co-financing the construction of another 30%.[292] In this decade alone, subsidies were paid to 515,000 mostly low- and lower-middle-income families. The massive scale of housing subsidies in Chile stimulated the growth of private property development, including (almost uniquely) large-scale housing construction for low- and middle-income groups.[293] These efforts were complemented by relaxing regulations that constrained densification and interventions to expand private mortgage finance.[294] By enabling the growth of the property development and real estate industries, the national government has been able to reform housing policy to reduce its own role in construction (although as late as 2010, government programmes of some kind were responsible for around half of all housing constructed in Chile).[295]

Alongside these programmes to expand the formal housing stock, the national government supported upgrading of the "campamentos" (informal settlements) and integrating them into the cities. Initially, this was through regularisation of plots of land and supporting communities to incrementally improve their housing and basic services. These early efforts evolved into a more comprehensive programme called "Chile Barrio" (Chile Neighbourhood). Distinguished by its strong emphasis on reaching the poorest, the Chile Barrio programme mandated that local municipal plans

The country achieved an impressive reduction in its formal housing deficit, and the number of people living in campamentos fell from 500,000 in 1996 to just 84,000 in 2011 despite rapid urban population growth.

consider neighbourhood upgrading, poverty reduction, social inclusion and employment generation in an integrated way.[296] The programme ended in 2006 with the successful formalisation of all the campamentos that had been identified in a 1990 survey.

Chile's housing policies have been successful by many measures. Despite significant urban population growth, the country achieved an impressive reduction in its formal housing deficit, and the number of people living in campamentos fell from 500,000 in 1996 to just 84,000 in 2011.[297] Housing also remains very affordable relative to regional and international averages: two thirds of households in Santiago can afford to buy a formal house, whereas only a third can do so in Brazil and less than 10% in Argentina.[298] Improved access to shelter and services also means that urban residents are much healthier, more mobile and generally better placed to cope with environmental shocks and stresses. Their resilience has been further enhanced by Chile's comprehensive disaster relief infrastructure, originally developed to help manage earthquake risk. Chilean cities now benefit from early warning systems, building codes and emergency services that can reduce the impacts of a wide suite of climate-related hazards.

The national government has also undertaken far-sighted reforms to improve the housing policy in response to new evidence. For instance, early emphasis on expanding the quantity and reducing the cost of housing led to construction around the urban periphery, where land was cheaper.[299] This contributed to significant loss of agricultural land and the emergence of large low-income, low-density neighbourhoods with few amenities.[300] Chile's housing policy today prioritises the quality of housing stock and its connectivity to jobs and services.[301] Chile's strategic and integrated approach to housing policy has inspired governments across Latin America, including Bolivia, Colombia, Ecuador, Mexico, Panama and Peru.[302]

4.3 Funding and financing sustainable urban infrastructure

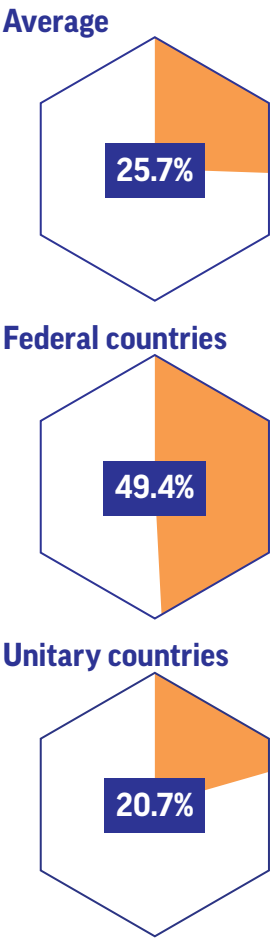
To realise the potential of cities to drive sustainable development across a country, national governments need a far-sighted approach to revenue collection, spending decisions and financing choices. First, they need to work with state and local governments to establish tax (and spending) systems that raise sufficient revenue and incentivise sustainable choices and behaviours. Second, they need to mobilise private investment for sustainable urban infrastructure at scale by creating an enabling environment and managing fiscal risks.

National governments need to foster a fiscal system that generates the desired amount of public revenues and creates appropriate incentives for firms, households and subnational governments. Worldwide, national revenues represent an average of 74.3% of total public revenues.[303] Most of these funds are typically collected through wide-area taxes at the national level, as this is very efficient. A portion is then typically allocated to provincial and local governments: indeed, grants and subsidies are the primary source of subnational government revenue in most countries.[304] However, the share of fiscal transfers varies significantly among countries: grants and subsidies account for less than 25% of subnational revenue in Argentina, Iceland and Zimbabwe, but over 80% in Malta, Peru and Tanzania.[305] Fiscal transfers must be reliable and adequate to enable effective budget planning and management across all tiers of government.

Because of the large share of revenues collected through the national tax system, it is a key driver for structural economic change. Different tax instruments serve different purposes and should be deployed in tandem to achieve equity, efficiency and environmental goals. For instance, value-added taxes not only generate significant revenues but also provide useful information about the whole value chain – i.e. profits and wages. However, if not carefully designed, a VAT can disproportionately fall on lower-income people, who spend a larger share of what they earn. Progressive income taxes, on the other hand, are more equitable – but in much of the world, the burden falls disproportionately on a small number of formal workers. By using value-added taxes and income taxes together, governments can generate the data necessary for a genuinely redistributive tax system. Getting these fiscal choices right can expand the resource envelope for both social protection and public investment in sustainable infrastructure – and do so fairly and efficiently.[306]

State and local governments need the authority and capacity to control a range of own-source revenues, including the power to set rates at the margin. Responsible fiscal decentralisation can enhance their accountability for local service delivery and underpins their creditworthiness so that they can access capital markets.[307] Own-source revenue options may include taxes, grants and subsidies, user charges and fees, and property income. While regional governments often depend largely on "piggybacks" on national taxes, property taxes are typically the cornerstone of local taxation.[308] A property tax can be politically and technically difficult to administer but, when well designed, is considered very economically efficient: it is typically predictable and progressive, and reflects the value of both public and private investments in the neighbourhood.[309] State and local governments in federal countries collect a much higher share of public revenues (49.4% on average) than those unitary countries (20.7%).[310] Subnational control over own-source revenues also varies significantly. In many countries, provincial and local governments are not allowed to set tax rates at the margin, grants are earmarked for specific purposes, and certain user charges are

Share of public revenues collected by subnational governments

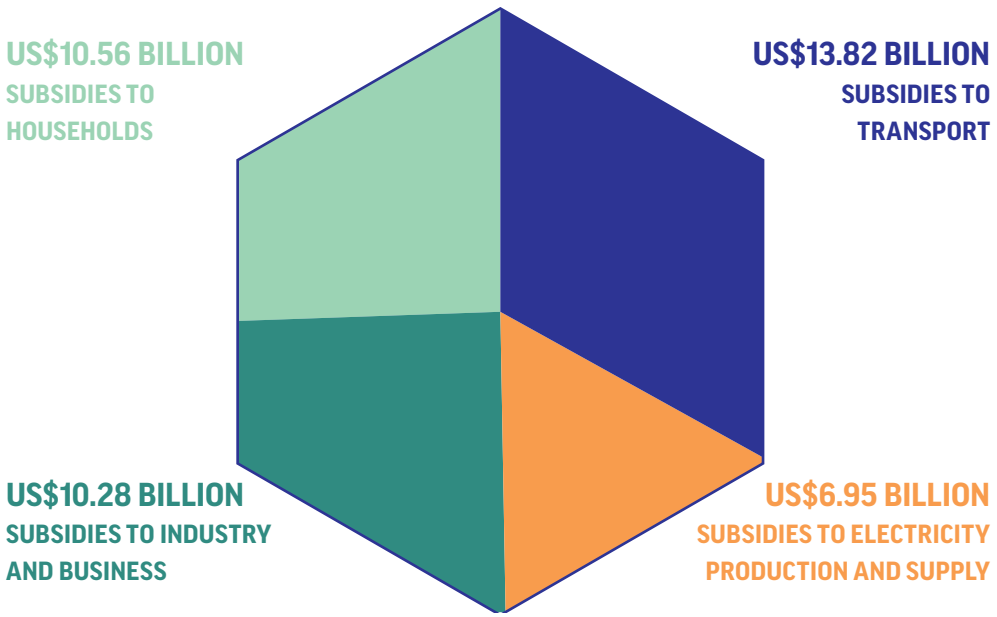


set by national regulations. For instance, national governments may regulate energy and water prices, while local governments may be able to determine waste collection fees and bus fares. A certain amount of fiscal autonomy at the state and local level is important both to improve budget management and to anchor access to credit.

Fiscal systems not only generate revenue; they also establish incentives for certain economic decisions and behaviours. Today, tax policy, financial regulation and public spending often skew urban markets in favour of high-carbon growth. New analysis by the Overseas Development Institute for this report finds that governments in the OECD and BRIICS* countries spend US$41.6 billion each year subsidising fossil fuel consumption in urban areas. Subsidies were identified in most countries. Subsidies flowing to the transport sector amount to over US$13.82 billion per year; subsidies for households (for cooking, heating, lighting, etc.) amount to $US10.56 billion per year; subsidies for industry and commerce follow closely behind at US$10.28 billion per year; and subsidies for the generation of fossil fuel-based electricity consumed in urban areas reach almost US$6.95 billion per year (see *Figure 14*). A further, small amount (US$27.7 million) was identified for fossil fuel consumption in social and public services in urban areas not covered by the above categories. These are conservative estimates, because many fossil fuel subsidies are hidden, and even when they are identified, they often cannot be quantified. Accounting for the costs of urban air pollution, road accidents and climate change would increase the value of these subsidies by several orders of magnitude.[311]

Governments in the OECD and BRIICS countries spend at least US$41.6 billion per year supporting the consumption of fossil fuels and fossil fuel-powered electricity in urban areas. 33% of this flows to the transport sector, 26% to households, 25% to industry and business and 17% to fossil fuel electricity generation.

FIGURE 14. THE VALUE OF SUBSIDIES FOR FOSSIL FUEL CONSUMPTION IN URBAN AREAS IN THE OECD AND BRIICS COUNTRIES BY SECTOR (2015-2016 ANNUAL AVERAGE).



Source: Overseas Development Institute for the Coalition for Urban Transitions. See Annex 10 for the full methodology.
Note: A further US27.7 million was used to subsidise social and public services. This value is too small to see on the figure.

* *Brazil, Russia, India, Indonesia, China and South Africa.*

Significant fiscal reform is needed to eradicate these perverse incentives, by eliminating fossil fuel subsidies and introducing a price on carbon. The political economy challenges of subsidy reform are hugely complex: though the wealthiest typically capture the largest share, energy subsidies are proportionately worth more to those on lower incomes, so reducing them can be deeply unpopular. The Yellow Vests movement in France has demonstrated the importance of a socially inclusive approach, as the protest against specific fuel taxes coalesced into a call for a more equitable approach to climate action.[312] Subsidy reforms could free up significant fiscal space that can be used to manage the trade-offs – as illustrated by Indonesia's recent success (see *Box 10*). And these efforts would also quickly show returns in the form of better air quality and improved energy efficiency. Parallel to subsidy reform, a price on carbon is widely considered to be the most efficient way to mitigate climate change, freeing markets to identify the most cost-effective opportunities to reduce emissions.[313] An international carbon price floor could help to mitigate concerns about economic competitiveness and carbon leakage (i.e. when high-carbon activities relocate to countries without carbon pricing), making fossil fuel subsidy reform more palatable.[314]

Once national governments have the fundamentals of a fair, efficient and sustainable fiscal system in place, they can work with state and local governments to mobilise private investment in sustainable urban infrastructure. As outlined in *Chapter 2*, a wide range of investments are needed for cities to realise their potential as engines of national job creation and low-carbon innovation, including in buildings, electricity generation and distribution, mass transit, telecommunications, sanitation, water supply and waste management. These public works can support economic activity and human development, enhancing the benefits of urban agglomeration outlined in *Section 3.1* while reducing potential costs. However, the financing gap for sustainable urban infrastructure currently exceeds US$1 trillion a year[315] – and that does not include the incremental investment needed to reach net-zero emissions. In most countries (with the notable exception of China), domestic public budgets and international development assistance fall far short of what is required. Even if public revenues and spending were to significantly increase, achieving the SDGs and the Paris Agreement will still demand a step change in private sector investment.[316]

There are a wide range of financing instruments available for this purpose. Debt financing distributes the costs of infrastructure projects equitably over the generations who benefit. Land-based financing instruments can enable governments to benefit from the relationship between more productive use of land and rising land values, yielding revenues that can be used to ensure that rising land values don't displace residents or punish renters. Public-private partnerships (PPPs), when designed well, can secure private sector capabilities in the design, construction and management of infrastructure projects, as well as share risks across the public and private sectors.[317] These instruments can potentially catalyse private investment – but they need to be firmly grounded in a government's ability to pay to effectively manage potential liabilities and risks.

Financing instruments with high potential include:

Debt financing

Land-based financing

Public-private partnerships

Decisions about which level of government should oversee these investments and which financing instruments are appropriate should be based on the specific project and wider national context. Large infrastructure investments such as metro systems have high upfront costs and capital risks, so they need close oversight by higher levels of government (whether line ministries or national development banks). Building efficiency retrofits have much smaller investment needs and can be undertaken incrementally, so they are more manageable for local governments. Projects such as bus networks or electricity generation systems will generate tariffs or user fees that enable at least some cost recovery, while others, such as cycling lanes and sewer systems, may not generate a direct economic return, even if they yield substantial wider benefits. In larger cities in higher-income countries, municipal governments may be able to structure infrastructure projects in a way that satisfies the criteria of prospective financiers; few smaller cities will have these sophisticated project preparation capabilities or the tax base to fund large projects.[318]

Long-term use of these financing mechanisms depends on collaboration across tiers of government to overcome critical obstacles to investment. Developing countries in particular (but by no means exclusively) often lack the robust fiscal underpinnings, enabling regulation, institutional capacity or investment environment needed to attract private finance or manage the attendant risks.[319] There are solutions for each of these obstacles, but they often lack scale as well as coordination and co-operation among key stakeholders. National governments have a key role to play in dismantling these barriers. They can introduce and enforce good budgeting, accounting and reporting standards at all levels of government to ensure disclosure of actual and prospective liabilities. This enables the national government to monitor total borrowing relative to total revenues, which is essential to avoid debt crises.[320] South Africa, for example, has introduced standard criteria and methodologies for appraising, procuring and disclosing public-private partnerships.[321] Once these fundamentals are in place, national governments can introduce solid legislation that clearly articulates the conditions under which municipal governments can use different financing instruments.[322] Today, fewer than half of all countries allow borrowing by local governments.[323] Examples of good practice include Brazil's Status of the City 2001 and Colombia's Law 388 of 1997, which both explicitly authorise and enable the use of land value capture by municipal governments.[324]

Above all, national and regional governments can strengthen the capacities of local governments to manage finance, plan capital investments and engage citizens, as well as the capacities of national development banks to finance climate-smart urban infrastructure. Municipal staff may need training and support to enhance own-source revenues, manage expenditures, maintain assets, track liabilities, scope out financing options and structure prospective projects. Local governments must take some responsibility for improving their creditworthiness and transparency – as, for example, the Kampala Capital City Authority has done in Uganda.[325] But national governments can support local initiatives by investing in professional development, establishing effective systems and offering competitive salaries in order to secure talented, dedicated civil servants. Effective, accountable local governments can improve financial performance and access to private capital for all levels of government.

Box 10: Indonesia: Financing development through fossil fuel subsidy reform

Indonesia began subsidising the consumption of fossil fuels in the mid-1960s, aiming to reduce poverty, limit inflation, and share the wealth of the country's growing fossil fuel export industry.[326] However, the poor have benefitted least from the subsidies. In 2012, nearly 40% of fuel subsidies went to the richest 10% of households, and less than 1% went to the poorest 10%.[327] Access to cheap transport fuel also meant that Indonesia's car ownership rates rose faster than in similar countries, contributing to the sprawl, pollution and congestion for which Jakarta is especially notorious.[328]

Fossil fuel subsidies may also have stunted Indonesia's economic and human development by precluding public investments in infrastructure, health and education.[329] In 2014, the government spent 3.5 times more on fossil fuel subsidies than on social welfare, and twice as much as on capital investments.[330] Fuel subsidies have exposed Indonesia to volatile global oil prices and exchange rates too, and decreased incentives to improve energy efficiency and reduce emissions.[331] Despite the negative and regressive impacts of fossil fuel subsidies, reform proved deeply politically unpopular throughout the late 1990s and early 2000s.

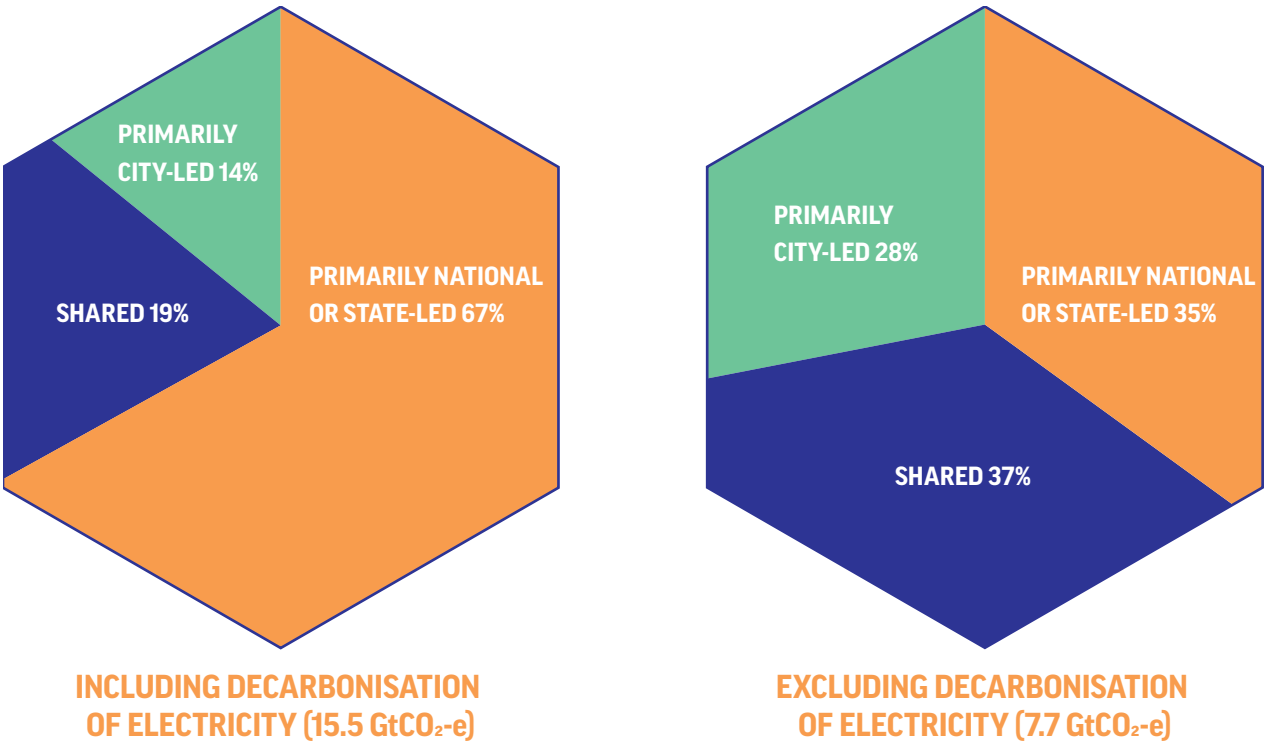
When international oil prices rose sharply in 2005, the costs of subsidies spiked correspondingly, reaching 24% of government expenditure.[332] Under pressure to reduce the budget deficit, the government increased energy prices by 29% in March 2005 and 114% in October. This saved US$4.5 billion and US$10 billion, respectively.[333] This time, the national government avoided public backlash by coupling subsidy reforms with a bundle of spending targeted at the poor: cash transfers, health insurance, financial assistance for students, and low-interest loans for small businesses.[334]

In 2014, the national government removed the subsidy on petrol and gave diesel a smaller subsidy tied to the market price – just as world oil prices fell. The fortuitous timing meant that consumers did not see a significant increase in fuel prices, reducing resistance and the need for compensation.[335] Subsidy reform saved IDR 211 trillion (US$15.6 billion) or 10.6% of government expenditure,[336] which was explicitly reallocated to social welfare, infrastructure, and transfers to regional and local governments to improve local services.[337] The highly visible and pro-poor nature of these investments fostered popular support and redressed concerns about corruption. By 2017, public spending on subsidies had been cut to 0.7% of GDP.[338] Indonesia's track record of investing these savings into poverty alleviation and economic development has secured public appetite for further subsidy reform as well as strengthening public confidence in the government.

4.4 Coordinating and supporting local climate action in cities

National, state and local governments all have important roles to play in the transition to zero-carbon cities. New analysis by the Stockholm Environment Institute for this report finds that few of the low-carbon measures identified in *Section 2.1* fall exclusively within the sphere of local government influence – nor are there many areas that are exclusively national or regional concerns. However, national and regional governments tend to have primary authority or influence over two thirds of this urban abatement potential. These higher levels of government generally hold the reins with respect to decarbonising the electricity supply, switching to lower-emission fuels (in buildings and transport), introducing efficiency standards for equipment and appliances, and improving the fuel economy of vehicles. Meanwhile, local governments tend to have primary responsibility for 14% of urban mitigation potential. This includes urban form, travel demand measures, waste management and – in many countries – public transport and mode shifting. For the remaining urban abatement potential, national/state and local governments both have important roles to play in delivery (see *Figure 15*).

FIGURE 15. PROPORTION OF 2050 URBAN ABATEMENT POTENTIAL OVER WHICH DIFFERENT LEVELS OF GOVERNMENT HAVE PRIMARY AUTHORITY OR INFLUENCE.



Source: Stockholm Environment Institute for the Coalition for Urban Transitions. See Annex 11 for the full methodology.

If electricity decarbonisation is excluded from the analysis, the importance of local action and multi-level governance becomes more apparent. In this case, national and regional governments have primary authority or influence over 35% of urban abatement potential, while local governments are primarily accountable for 28%. For the remaining 37% of the urban abatement potential, responsibilities are much more varied across countries and typically require greater collaborative climate action among different tiers of government. The nature of such collaboration will vary by policy area. Local governments may be instrumental in implementing and enforcing state- or national-level policies, such as building codes, or can complement national efforts with local initiatives, for example by expanding charging infrastructure so that more households can take advantage of national incentives for electric vehicles.[339] This analysis clearly demonstrates that a transition to zero-carbon cities depends on meaningful partnerships among different tiers of government, with national governments actively enabling and supporting climate action at the local level.

National governments can support local climate action in cities in three key ways: clarifying the responsibilities and powers of different parts of government; supporting local actors to design, finance and implement low-carbon measures; and fostering a culture of experimentation, participation and learning that enables successful local initiatives to be scaled and replicated across the country.[340] If national governments do not provide this support, they effectively hinder local climate action – and miss an important lever to achieve national economic, social and environmental goals.

First, national governments can clarify the responsibilities and powers of different parts of government. A clear framework, whether composed of legislation, judicial rulings or executive decisions, can establish the formal structures within which both public and private decisions impacting cities are made. This can enable more effective local decision-making within a vertically integrated framework. For example, it falls to national governments to explicitly articulate the own-source revenues available to local governments, and the conditions under which they can borrow from commercial banks, issue bonds, undertake public-private partnerships, or implement new charges and user fees.[341] This is not necessarily about devolution. For instance, only 29% of countries allow local governments to reduce speed limits or have urban speed limits of 50 km/hour or below.[342] Whether directly or indirectly, national governments have a clear opportunity to reduce air pollution, noise and traffic injuries in cities. While clarity is important, it will not guarantee effective coordination within government. As in any other organisation, personal relationships and institutional norms hugely shape learning and decision-making, and need to be considered when introducing new ideas.[343]

Second, national governments can support local actors to design, finance and implement low-carbon projects in cities. They can create a collaborative platform for city governments to say what data, support or enabling policies they need from national governments. National governments can then provide targeted information, funding and capacity-building – for example, to help city governments collect own-source revenues and enhance their creditworthiness. They can facilitate uptake of best practices, for instance, by helping city officials learn from their peers through national and international

networks of municipal governments,[344] such as the Global Covenant of Mayors for Climate & Energy and its member city networks. National statistical agencies can routinely ensure that large datasets (such as the national census or demographic and health surveys) include spatial information, so local authorities can make more informed decisions. For larger one-off projects such as the construction and financing of mass transit infrastructure, national governments can provide dedicated technical assistance. For example, while some of the larger and more empowered city governments may benefit from dedicated project preparation facilities, it will often make more sense for national and regional governments to provide specialised inputs into project design and contracting – particularly for smaller urban areas.[345] In much of the global South, it will be important to support people living and working in the informal sector (and their social movements) to ensure that informal settlements are upgraded in a sustainable, resilient way and that informal workers also have opportunities in a greener urban economy.[346]

Third, national governments can foster a culture of experimentation and participation around climate action. It will not be possible to reach net-zero emissions without an evolution of behaviours, social norms, financing mechanisms, institutions, policies and urban design. Cities are an appropriate scale to experiment with new climate strategies and engage citizens with the difficult choices involved. National governments can purposefully and strategically work with city governments, fostering partnerships that stimulate innovation and focusing on enabling (rather than regulating) climate action.[347] They can then further help local governments monitor, report and evaluate on these experiments to enable learning. Supporting local action can ensure that climate actions are rooted in on-the-ground realities and priorities, while advancing national objectives. Success stories can then be replicated at a larger scale.[348] Germany's Energiewende offers a powerful example of the ways that national governments can partner with municipalities, businesses and citizens to accelerate low-carbon innovation and foster a culture of environmental citizenship (see *Box 11*).

National and state governments have primary authority over 35% of urban abatement potential, while local governments have primary authority over 28%. For the rest, collaborative climate action is needed across different tiers of government. *

* *excluding electricity decarbonisation*

Box 11. Germany: Powering a renewable energy transition

In the 1990s, the German government introduced the Energiewende (Energy Transition), a plan to decarbonise the energy system through a combination of increased renewable energy generation, improved energy efficiency, and energy demand management.[349] The national strategy addresses four priorities: fighting climate change, reducing dependence on nuclear power, improving energy security and securing economic competitiveness.

The Energiewende has met with great success: the share of renewable energy increased from 6% of electricity production in 2000 to 38% in 2018.[350] Renewables are also an increasingly important source of employment in Germany, accounting for about 370,000 jobs in 2013.[351] Moreover, the Energiewende has remained politically popular. New legislation passed in 2010 raised the ambition of Germany's emission reduction targets and more than 90% of German citizens supported the energy transition in 2017.[352] The success of the Energiewende can be attributed to three key factors: a comprehensive and ambitious national policy framework, strong national-local partnerships and large-scale citizen buy-in.

The Energiewende employs a wide range of policy instruments including quotas, taxes, feed-in tariffs, efficiency standards, permits, pilot projects and carbon pricing. Arguably the most important policy has been higher feed-in tariffs for renewable energy, which enable investors to more quickly recoup their capital expenditure. The average supplement to the standard electricity price for a private residential consumer was €0.0624 per kilowatt hour in 2014.[353] This temporarily increased energy bills in Germany. However, complementary investments in energy efficiency mean that household energy expenditure is comparable to other European countries.[354] Germany protected energy-intensive industries through rebates, exemptions and other preferential treatments worth €17 billion in 2016.[355] This was politically and economically important for safeguarding jobs, but may have hindered climate

The Energiewende has met with great success: the share of renewable electricity increased from 6% of electricity production in 2000 to 38% in 2018.

mitigation efforts by shielding these firms from the real costs of energy inefficiency and fossil fuels.

The national policy framework explicitly supports and empowers municipalities to advance the Energiewende. Many German municipalities have established local energy utilities (Stadtwerke) that have set even more ambitious renewable energy targets than the national government.[356] Stadtwerke München, for instance, plans to increase the city's renewable energy share from 39% in 2019 to 100% by 2025.[357] In 2013, municipal utilities owned 6% of Germany's generation capacity.[358] Some municipal utilities are purchasing their local grids from larger operators in order to accelerate the renewable energy transition. Others plan to become net producers of renewable energy, generating a stream of revenue to support municipal investment.

The Energiewende has benefitted from enthusiastic public participation. Citizens across Germany have formed local cooperatives that collectively invest in solar, wind and energy-from-waste systems. The number of energy cooperatives grew from 66 in 2001 to almost 900 at the end of 2013, which collectively had around 130,000 members. In 2012, these citizen-owned projects accounted for 46.6% of all installed renewable capacity in Germany.[359] The democratisation of energy ownership has contributed to the ongoing popularity of the Energiewende, since so many Germans are personally invested in a renewable-powered future.

Germany cut its own greenhouse gas emissions by 27% between 1990 and 2014. Moreover, its early leadership enabled technological learning and expanded renewable markets, which drove down the cost of decentralised energy technologies worldwide.[360] The Energiewende faces two significant challenges going forward: fairly distributing the costs and benefits of the transition, and managing an intermittent electricity supply. National and local governments are already looking ahead to these issues, ensuring that Germany will remain at the forefront of the global energy transition.

4.5 Building a multilateral system that fosters inclusive, zero-carbon cities

National governments are the principal actors and shareholders in the international legal system. They shape, enact and deliver international treaties and agreements, such as the Sustainable Development Goals, the New Urban Agenda and the Paris Agreement. These set the global agenda and have huge impacts on cities by establishing obligations and practices on a vast range of issues, from the use of force to the rights of individuals and groups, to the governance of the global commons, to the patterns of world trade. It is then up to national governments to interpret and implement them. National governments can build a multilateral system that fosters inclusive, zero-carbon cities in three ways: setting a zero-carbon urban transition firmly on the global agenda, strengthening international frameworks that accelerate rather than undermine the transition, and using multilateral architecture – particularly the multilateral development banks – to support countries' own urban climate actions.

First, national governments set the global agenda. Although they may invite others to participate and contribute, international agreements are ultimately decided by sovereign states. It therefore falls to national governments to ensure that these global agendas nurture inclusive, zero-carbon cities. This means ensuring that international agreements are supportive of strong local governments and sensitive to urban contexts. The seventh Millennium Development Goal (MDG), for instance, set targets for "improved water" and "improved sanitation" that were not appropriate for urban areas: a protected dug well and pit latrine can work well where there are low densities and large plots, but are not adequate in large, dense concentrations of people. The problematic design of this MDG meant that national and international statistics grossly underestimated the number of urban dwellers without access to safe drinking water and sanitation.[361] In addition, the national-level targets in the MDGs often masked stark differences among a country's cities and regions.[362] National governments should strategically use multilateral agreements to create the space, incentives and recognition for frontrunning cities to pursue more ambitious action towards low-carbon, climate-resilient development.

National governments can build a multilateral system that fosters inclusive, zero-carbon cities by: (1) setting a zero-carbon urban transition firmly on the global agenda; (2) strengthening international frameworks to accelerate the transition; and (3) using multilateral architecture to support countries' own zero-carbon urban strategies.

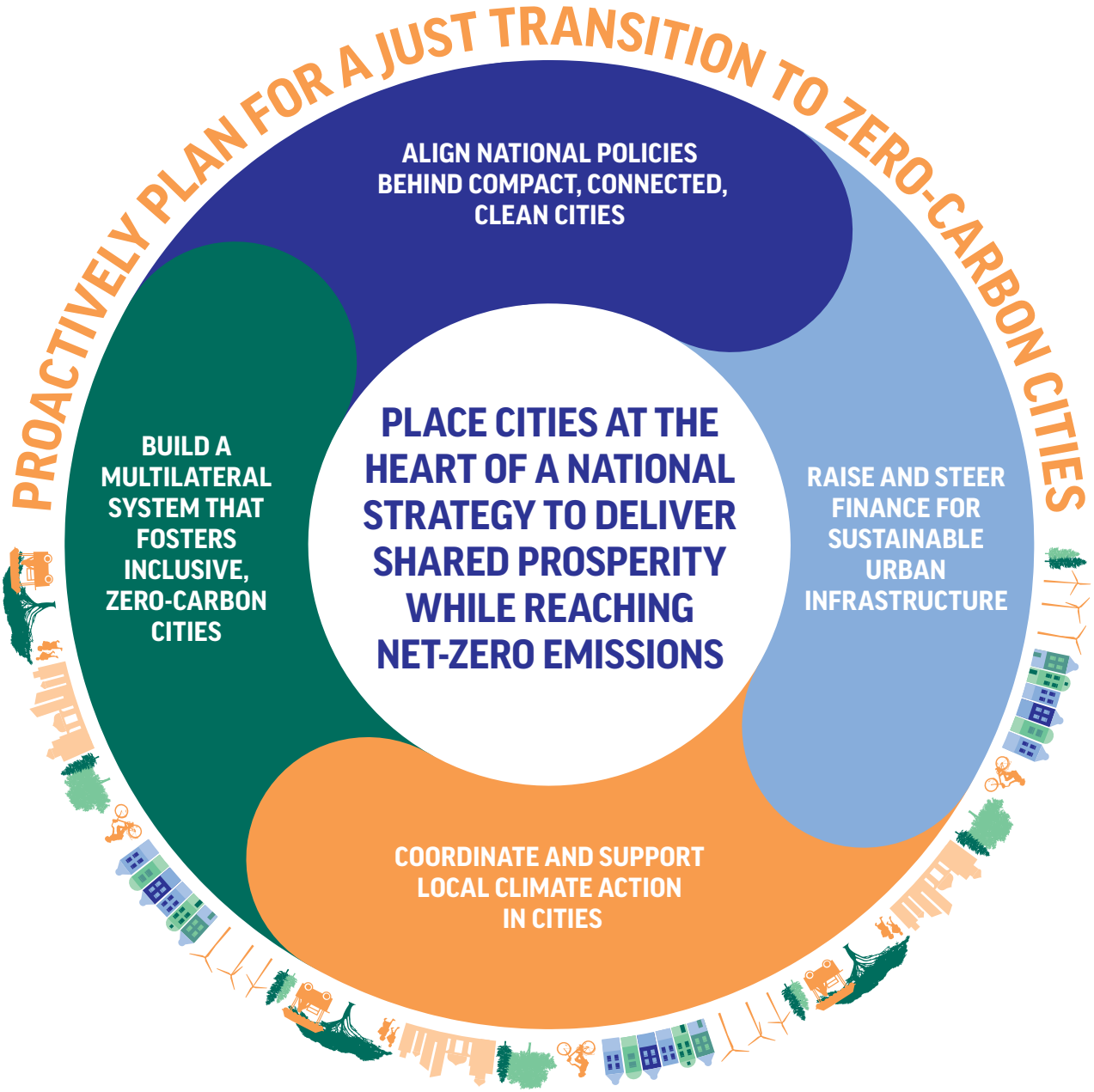
Second, national governments govern transboundary activities that influence urban development. Cities are often shaped by, and depend on, international relations and policies. For instance, trade agreements significantly dictate where new jobs are created and new urban centres emerge; cities may depend on regional electricity grids or sit in water catchments that span national boundaries; and immigration policies determine whether cities can attract international entrepreneurs, investors and workers. National governments also regulate multi-national corporations that span boundaries and shape urban centres, especially through foreign direct investment in real estate. In this context, they need to ensure that international policy-making and legislation foster thriving cities and do not compromise the zero-carbon urban transition. An important stepping stone is encouraging and supporting governments at all levels to use standardised platforms to set emission reduction targets, develop climate plans and publicly report on progress towards net-zero emissions.[363] This can facilitate vertical integration of Nationally Determined Contributions to quickly increase ambition.

Third, national governments can use the international architecture – particularly the multilateral development banks – to accelerate a zero-carbon urban transition. Development banks and agencies, research institutes, city networks and other international organisations have a strong track record of supporting cities (and countries) to respond to climate change. National governments can facilitate these relationships. This might include supporting cities to undertake peer-to-peer learning so they can improve their creditworthiness or adopt low-carbon innovations; securing technical assistance to prepare "investment-ready" urban programmes; or supporting city governments and utilities to access grants and concessional capital (with appropriate fiscal safeguards). Indeed, national governments can go farther by reforming the multilateral architecture to create a more favourable environment for a zero-carbon urban transition. This might include more effectively climate-proofing capital lending or creating direct access modalities for low-carbon urban projects.[364] In particular, as the development banks' traditional shareholders and clients, national governments drive country investment strategies. If inclusive and sustainable cities aren't prominently on national agendas (and in the absence of consultation with city governments), development banks may overlook the importance of cities and agency of local governments.

5. Priorities for national action

A transition to zero-carbon cities offers an immense opportunity to secure national economic prosperity and improve quality of life while tackling the existential threat posed by climate change. Realising the potential of cities demands bold action by national governments, working in close collaboration with city governments, businesses, civil society, research institutes and other partners.

FIGURE 16. SIX PRIORITIES FOR NATIONAL ACTION TO ACHIEVE INCLUSIVE, ZERO-CARBON, CLIMATE-RESILIENT CITIES.



Now is the time to act not only because of the urgency of the climate crisis, but because 2020 is a critical year. The Paris Agreement includes a "ratchet" mechanism to encourage countries to increase their climate commitments over time.[365] New pledges are submitted every five years, with the next round due at the 26th Conference of the Parties in late 2020 (COP26). COP26 offers an international platform for national governments to showcase their climate leadership and stimulate greater global ambition.

This chapter presents key actions that national governments can take to foster thriving, resilient cities with net-zero emissions. The first and overarching recommendation is for national governments to prepare a national strategy to deliver shared prosperity while reaching net-zero emissions – and to put cities at the heart of it. Once this clear vision is in place, it can guide decision-making across different ministries, including how national governments (1) reform national policies, (2) fund and finance sustainable urban infrastructure, (3) empower local governments, and (4) engage with the multilateral system. All these national actions will be most successful if underpinned by a commitment to a just transition, as illustrated in *Figure 16*.

Within those high-level priorities, this chapter offers a toolbox of policy options. While not all will be relevant to every country, the toolbox as a whole has relevance to countries at all levels of development. Income levels should not constrain ambition: many low-income countries are undertaking ambitious and complex actions that high-income countries could emulate. The recommendations are presented in three sequential categories:

- Laying a strong foundation;
- Seizing the opportunity; and
- Raising the ambition.

These categories reflect the diverse starting points from which national governments pursue climate action in cities. This is not solely based on levels of income. For instance, eliminating fossil fuel subsidies and introducing a carbon price (*Priority 3.1* and *Priority 3.2*) are fundamental for systematically steering investment towards sustainable urban infrastructure – yet high-income countries such as Australia and Israel do not have a carbon price, while middle-income countries such as Colombia and South Africa do.[366] These categories also recognise the importance of sequencing climate mitigation and adaptation policies appropriately. For instance, a country can use its position on the board of international financing institutions to encourage them to end all fossil fuel financing (*Priority 5.2*) as a step towards ensuring that all international public finance flows align with the Paris Agreement and the 2030 Agenda for Sustainable Development (*Priority 5.3*). The breadth of these recommendations reflects the interconnectedness and centrality of cities to wider national development, and the myriad ways in which they are influenced by national policies.

These priorities draw on three years of research by the Coalition for Urban Transitions, supplemented by a consultation process involving over 50 institutions, including research institutes, networks of national and city governments, investors, infrastructure providers, strategic advisory companies, non-government organisations and grassroots organisations. All have been tested with representatives of national and city governments to confirm their relevance and viability.

PRIORITY 1:
PLACE CITIES AT THE HEART OF A NATIONAL STRATEGY TO DELIVER SHARED PROSPERITY WHILE REACHING NET-ZERO EMISSIONS.
PRIORITY 2:
ALIGN NATIONAL POLICIES BEHIND COMPACT, CONNECTED, CLEAN CITIES.
PRIORITY 6:
PROACTIVELY PLAN FOR A JUST TRANSITION TO ZERO-CARBON CITIES.
PRIORITIES FOR NATIONAL ACTION
PRIORITY 3:
FUND AND FINANCE SUSTAINABLE URBAN INFRASTRUCTURE.
PRIORITY 5:
BUILD A MULTILATERAL SYSTEM THAT FOSTERS INCLUSIVE, ZERO-CARBON CITIES.
PRIORITY 4:
COORDINATE AND SUPPORT LOCAL CLIMATE ACTION IN CITIES.

PRIORITY 1

PLACE CITIES AT THE HEART OF A NATIONAL STRATEGY TO DELIVER SHARED PROSPERITY WHILE REACHING NET-ZERO EMISSIONS.

Priority 1: Place cities at the heart of a national strategy to deliver shared prosperity while reaching net-zero emissions.

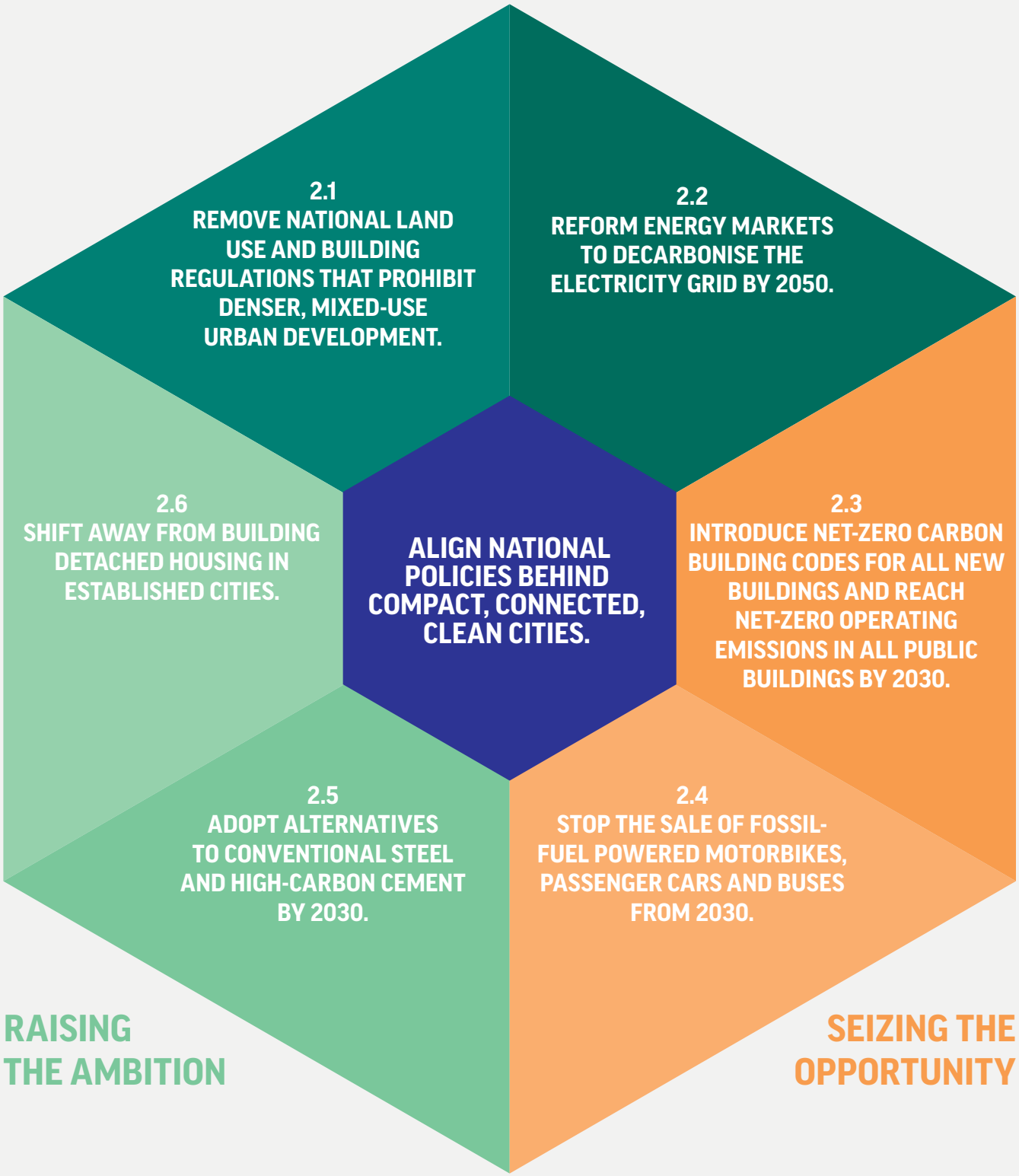
Business-as-usual approaches to economic growth are not delivering a decent standard of living for most people, and are pushing the world to the brink of multiple ecological crises. Yet few national governments have a long-term strategy to deliver economic and social development in the context of a climate emergency. Because people, economic activity and emissions are increasingly concentrated in cities, achieving SDG11 and transitioning to inclusive, zero-carbon cities is a powerful lever to deliver faster, fairer economic development while tackling the climate crisis.

Local governments cannot realise this opportunity on their own, as even the wealthiest and most empowered among them are subject to national policies and depend on national funding.[367] Yet national policies are often designed without considering their impact on cities.[368] For example, taxes incentivise households' and firms' choices about where to locate and how much space to occupy; mandatory performance standards for cars, lighting and appliances influence total energy demand as well as local air quality and living costs; and national education curricula determine whether the civil service, businesses and non-government organisations have the knowledge and skills to act on climate change. Almost every ministry makes choices that influence cities and climate change (see *Figure 12*), and accordingly needs to ensure that the policies and programmes in their purview favour a zero-carbon urban transition.[369] Yet most national governments are missing their chance to harness the power of cities.

A long-term national strategy, focused on cities and underpinned by meaningful partnerships between national and local governments, is needed to seize this opportunity. It should offer a shared vision for compact, connected and clean cities, support coordination across levels and sectors of government, and set ambitious targets for reaching net-zero emissions by mid-century while delivering decent standards of living for all. This in turn can drive the structural economic transformation and behaviour changes needed to avoid climate catastrophe. Such a strategy may be embedded in national development plans or stand alone as a National Urban Policy. The key is that it achieves its primary purpose: equipping all branches of national governments to systematically and purposefully work towards inclusive, zero-carbon and resilient cities.

The national strategy needs to be co-produced by the head of state, key line ministries and city leaders, as well as civil society and private actors to ensure its legitimacy. No single ministry can drive this agenda. Ministries of education, energy, finance, housing, industry, infrastructure, transport and more have important roles to play. Every department and agency needs this mandate to proactively consider how their decisions may impact on cities' potential to deliver shared prosperity and climate safety, and to shape their sector-specific strategies accordingly. They also need it to work together to create the mutually reinforcing policies and complementary investments that foster inclusive, zero-carbon cities. National governments can then implement the long-term strategy through policy, fiscal reforms, an infrastructure investment plan, support for local climate action, and efforts to influence the international agenda, as outlined in the remainder of this section.

PRIORITY 2


LAYING A STRONG FOUNDATION
2.1 REMOVE NATIONAL LAND USE AND BUILDING REGULATIONS THAT PROHIBIT DENSER, MIXED-USE URBAN DEVELOPMENT.
2.2 REFORM ENERGY MARKETS TO DECARBONISE THE ELECTRICITY GRID BY 2050.
2.6 SHIFT AWAY FROM BUILDING DETACHED HOUSING IN ESTABLISHED CITIES.
ALIGN NATIONAL POLICIES BEHIND COMPACT, CONNECTED, CLEAN CITIES.
2.3 INTRODUCE NET-ZERO CARBON BUILDING CODES FOR ALL NEW BUILDINGS AND REACH NET-ZERO OPERATING EMISSIONS IN ALL PUBLIC BUILDINGS BY 2030.
2.5 ADOPT ALTERNATIVES TO CONVENTIONAL STEEL AND HIGH-CARBON CEMENT BY 2030.
2.4 STOP THE SALE OF FOSSIL-FUEL POWERED MOTORBIKES, PASSENGER CARS AND BUSES FROM 2030.
RAISING THE AMBITION
SEIZING THE OPPORTUNITY

Priority 2: Align national policies behind compact, connected, clean cities.

Laying a strong foundation

2.1 **Remove national land use and building regulations that prohibit denser, mixed-use urban development.** Many cities have density restrictions, sometimes for public safety reasons but mainly to limit demand on public services and preserve the character of neighbourhoods. Many of these regulations have roots in economic or racial exclusion. Even when well intentioned, land use and zoning policies that limit density can stimulate urban sprawl, which can depress productivity, contribute to local air pollution and encroach on surrounding ecosystems. Responsibility for this issue falls to different tiers of government in different countries. Where it falls in their remit, national governments can reform the overarching frameworks and champion reforms to minimum lot areas, maximum building heights, plot coverage ratios and land use restrictions, while safeguarding green space and avoiding the displacement of disadvantaged residents. This can stimulate markets to make better use of land and increase the supply of housing, reducing costs and enhancing the productivity of urban centres. In the US, relaxing restrictions on housing supply in just three cities – New York, San Francisco and San Jose ("Silicon Valley") – would have improved the national allocation of labour enough to boost the country's GDP in 2009 by 3.7%, or an additional US$3,685 in average annual earnings.[370] In Namibia, reforms to minimum plot sizes enabled legal settlement at much higher densities and much lower costs (see *Box 3*).

2.2 **Reform energy markets to decarbonise the electricity grid by 2050.** Half the total urban mitigation potential identified in this report comes from decarbonisation of energy, primarily electricity (see *Figure 2*). Indeed, it is impossible to achieve zero-carbon cities without switching to clean electricity. At the same time, emerging economies must massively expand the supply of affordable electricity to meet their economic and human development goals, including industrial activity in cities, as outlined in SDG7. The economic case for clean energy options is increasingly compelling, especially when national governments remove fossil fuel subsidies and price carbon emissions (see *Priority 3.1* and *Priority 3.2*). Decarbonising the grid also offers the opportunity to cut fossil fuel consumption – and the associated air pollution – through electrification of transport, buildings and industry.[371] National governments can accelerate the energy transition by using quotas and targets, renewable portfolio standards, feed-in tariffs, tax exemptions, targeted auctions with long-term contracts, and green public procurement to encourage private investment and innovation in clean technologies. In some contexts, national governments can remove regulations that constrain the decentralisation of electricity generation, distribution and storage; this can empower local governments and utilities to adopt clean energy technologies even faster. The UK has seen impressive progress towards grid decarbonisation, with electricity sector emissions falling 46% between 2013 and 2016 alone thanks to combination of fuel switching from coal to gas, rapid uptake of renewables and falling electricity demand.[372]

Emissions from the electricity sector fell by 46% between 2013 and 2016 in the UK

Seizing the opportunity

2.3 Introduce net-zero carbon building codes for all new buildings and reach net-zero operating emissions in all public buildings by 2030.[373] The majority of current and future building stock is concentrated in cities, and there are many economically attractive ways to improve its carbon-efficiency.[374] Zero-carbon buildings are attainable with widely available technologies and well-understood architectural techniques such as passive design. This report finds that 58% of the urban abatement potential in cities can be attributed to the buildings sector. This equates to 3.3GtCO_2-e, or 9.0GtCO_2-e with the decarbonisation of electricity. All buildings need to have net-zero emissions (with minimal use of carbon offsets) by mid-century, and national building codes and public procurement policies can play an important role in transforming urban markets, growing local capacities to construct ultra-low energy buildings and deliver deep building retrofits.[375] This should be accompanied by reforms to national policies on building construction and energy performance to favour more efficient and sustainable use of materials and energy (see *Priority 2.5*), enabling innovation and private sector leadership. City governments from Eskişehir in Turkey to Kochi in India to eThikwini in South Africa have already announced their intention to reach net-zero operating emissions in their buildings by 2030.[376] At the UN Secretary-General's Climate Summit, a number of national governments will build upon these local actions by committing to ensure that all new buildings have net-zero carbon emissions from 2030, and existing buildings by 2050.[377]

2.4 Stop the sale of fossil-fuel powered motorbikes, passenger cars and buses from 2030. Transport contributes 14.3% of global greenhouse gas emissions[378] and up to 70% of urban air pollution, with the highest levels in developing countries.[379] This report finds that a shift to more efficient and electric vehicles in cities could avoid 0.94GtCO_2-e, with the mitigation potential of this measure rising to 1.68 GtCO_2-e if the electricity supply is carbon-neutral. Maximising the benefits of electrification depends on decarbonising the electricity grid (see *Priority 2.2*)[380] and using vehicles more intensively through car- and ride-sharing platforms, as this can minimise ecological degradation from rare-earth mining and battery disposal. To build momentum and incentivise investment in charging infrastructure and electric vehicles, national governments can ban the sale and production of fossil-fuel powered vehicles, fund or support urban e-mobility pilot projects to build public appetite, and publish guidelines to assist cities in the procurement of public electric vehicles. This should be complemented by support to city governments and utilities to map out electric vehicle infrastructure needs over the next decade. Electrification of urban transport is already happening at pace, particularly in China (see *Box 7*). In India, senior decision-makers have suggested ending the sale of fossil-fuelled passenger cars and two-wheelers in 2030.[381] At the UN Secretary-General's Climate Summit, a number of national governments will recognise the opportunity to simultaneously improve air quality and reduce greenhouse gas emissions, and will commit to implement sustainable mobility and e-mobility policies that can realise this potential.[382]

Senior decision-makers in India have suggested ending the sale of fossil-fuelled passenger cars and two-wheelers in 2030

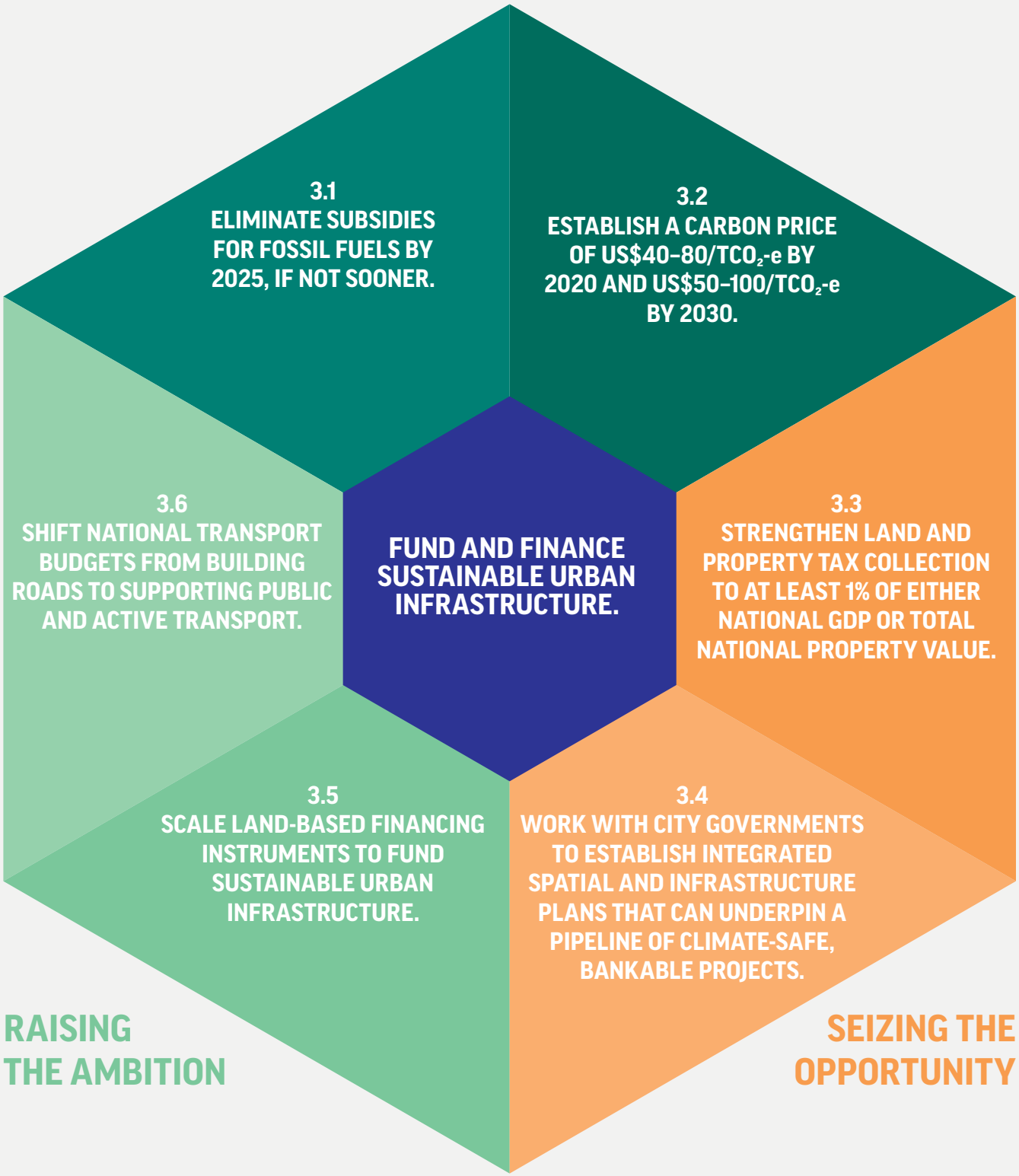
Raising the ambition

2.5 Adopt alternatives to conventional steel and high-carbon cement by 2030. Steel production generates 7% of global greenhouse gas emissions, and cement production, another 6%.[383] A growing share of the projects that use these materials are in and around cities. Keeping global warming below 1.5°C will require that less steel and cement is used in the future. National urban policies have a crucial role to play in cutting emissions by reducing total demand for cement and steel (particularly through greater materials efficiency in buildings and transport systems); promoting reuse instead of manufacturing (particularly for steel, which can be recycled relatively cost-effectively);[384] regulating production to ensure that best-practice processes and technologies are used; and reforming national building standards to encourage low-carbon building materials such as bamboo, earth, processed wood and stone.[385] These national standards can then serve as a template or baseline for local building codes. National governments can also reform professional certification processes to ensure that architects, engineers and other built-environment professionals are trained to use new materials (see *Priority 4.2*) and to use nature-based solutions more extensively. To meet massive demand for building materials without high-carbon steel or cement, new options may be needed. National governments can direct R&D budgets to developing alternative building materials such as carbon-eating cement (see *Priority 4.6*), and streamline their approval processes. The cost to consumers of decarbonising even these hard-to-abate sectors could be relatively small: 1% on the cost of a car or 3% on the cost of a house.[386]

The cost to consumers of decarbonising cement and steel could be relatively small: 1% on the cost of a car or 3% on the cost of a house.

2.6 Shift away from building detached housing in established cities. Many cities will need to expand their spatial footprint to accommodate rapid urban population growth while delivering high quality of life. However, many relatively mature cities – particularly in land-rich countries – continue to sprawl needlessly and expensively, as detached houses keep being built in suburbs and exurbs. This is a problem from Athens, to Atlanta, to Concepción (Chile), to Perth (Australia), to Quebec City. The economic, social and environmental costs of such sprawl are immense. Many cities already have an abundance of "single-family" homes, but demographic changes will raise demand for a greater diversity of housing types that can accommodate households ranging from single people, to flatmates, to large multi-generational or cooperative households, to older adults who value independence at home. Building on the reforms outlined in *Priority 2.1*, national governments can support brownfield development and densification of established neighbourhoods, as well as compact and transit-oriented new development. They can write supportive national urban planning guidelines (for example, by revising fee structures so that property developers bear the costs of sprawling infrastructure provision); release publicly owned, vacant urban land for dense development; and reform national tax and financial structures that make detached homes cheaper to build or own than row houses or apartments (for example, by reforming mortgage interest deduction policies).

PRIORITY 3


LAYING A STRONG FOUNDATION
3.1 ELIMINATE SUBSIDIES FOR FOSSIL FUELS BY 2025, IF NOT SOONER.
3.2 ESTABLISH A CARBON PRICE OF US$40–80/TCO$_2$-e BY 2020 AND US$50–100/TCO$_2$-e BY 2030.
3.6 SHIFT NATIONAL TRANSPORT BUDGETS FROM BUILDING ROADS TO SUPPORTING PUBLIC AND ACTIVE TRANSPORT.
FUND AND FINANCE SUSTAINABLE URBAN INFRASTRUCTURE.
3.3 STRENGTHEN LAND AND PROPERTY TAX COLLECTION TO AT LEAST 1% OF EITHER NATIONAL GDP OR TOTAL NATIONAL PROPERTY VALUE.
3.5 SCALE LAND-BASED FINANCING INSTRUMENTS TO FUND SUSTAINABLE URBAN INFRASTRUCTURE.
3.4 WORK WITH CITY GOVERNMENTS TO ESTABLISH INTEGRATED SPATIAL AND INFRASTRUCTURE PLANS THAT CAN UNDERPIN A PIPELINE OF CLIMATE-SAFE, BANKABLE PROJECTS.
RAISING THE AMBITION
SEIZING THE OPPORTUNITY

Priority 3: Fund and finance sustainable urban infrastructure.

Laying a strong foundation

3.1 **Eliminate subsidies for fossil fuels by 2025, if not sooner.** Subsidies mask the true costs of coal, oil and gas, and undermine the case for investment in energy efficiency and renewable energy. They eat up fiscal space and are regressive, mainly benefiting middle- and high-income households. There are better ways of supporting low-income households than by subsidising fuels, such as providing cash transfers or funding efficiency measures. Yet, as of 2017, the OECD and BRIICS countries allocated at least US$41.6 billion to subsidise the consumption of fossil fuels in urban areas (see *Figure 14*) – and the value of these subsidies is likely to rise as urban populations and economies grow. By eliminating fossil fuel subsidies, national governments can systematically favour cleaner fuels and free up fiscal space to support pro-poor, low-carbon development. More accurate fossil fuel pricing in 2015 would have lowered global CO_2 emissions by 28%, reduced deaths from fossil fuel air pollution by 46%, and raised government revenues by 3.8% of global GDP.[387] Indonesia has recently demonstrated how fossil fuel subsidy reform can yield rapid returns, as the national government was able to increase public spending on health, education and other popular issues (see *Box 10*).

3.2 **Establish a carbon price of US$40–80/t$CO_2$-e by 2020 and US$50–100/tCO_2-e by 2030.** Market prices for high-carbon goods and services fail to reflect carbon's true social, economic and environmental costs – particularly where depressed by fossil fuel subsidies (see *Priority 3.1*). In 2015, fossil fuel energy was underpriced by US$5.3 trillion, or 6.5% of global GDP.[388] Cities, as hotspots of transport emissions, polluting industries, and climate risk, suffer disproportionately from this market failure. Carbon pricing could improve local air quality and systematically incentivise compact, connected, clean cities, while enabling the market to determine the most efficient way to reduce emissions. A study of 70 cities worldwide found that a switch from low to high fuel taxes significantly reduces car ownership and increases urban density by over 40%.[389] The Carbon Pricing Leadership Coalition recommends a price of at least US$40 per tonne of CO_2 from 2020, rising to US$50 from 2030, to achieve the Paris Agreement, with higher-income countries adopting even higher carbon prices.[390] Revenues from these taxes should be redistributed to low-income and other marginalised groups at risk of being left behind by the zero-carbon urban transition (see *Priority 6.3*). As of 2018, 45 countries are putting a price on carbon, including emerging economies such as Chile, China, Colombia, Mexico and South Africa.[391]

More accurate fossil fuel pricing in 2015 would have:

lowered global CO_2 emissions by 28%,

reduced deaths from fossil fuel air pollution by 46%,

and raised government revenues by 3.8% of global GDP.

Seizing the opportunity

3.3 Strengthen land and property tax collection to at least 1% of either national GDP or total national property value. In many countries, land and property tax collection is stymied by limited capacity, unclear ownership, and challenges in assessing the value of land. In much of Africa, for instance, land and property tax collection is often worth less than 0.5% of GDP.[392] In other countries, land and property are taxed in ways that incentivise sprawl or punish low-income households.[393] However, land and property taxes can be the bulwark of municipal finance,[394] giving local governments more fiscal space to deliver core services and act on climate change. If well designed, a land or property tax can also incentivise more intensive use of urban land, promoting higher densities.[395] One option is to introduce a simple tax based on basic features such as occupancy, plot size, location or floor area (for an individually owned apartment in a multi-unit building).[396] Another option is to establish a comprehensive land and property registry, as Rwanda has done (see *Box 8*), which can help identify prospective taxpayers while improving tenure security for residents of informal settlements (see *Priority 6.1*). In South Korea, progressive property taxes have been used since the 1970s to redistribute the benefits of rising land values more equitably and finance public services (see *Box 2*).[397] In 2016, property-related taxes accounted for over 10% of total tax revenue in South Korea.[398]

Property-related taxes accounted for over 10% of total tax revenue in South Korea

3.4 Work with city governments to establish integrated spatial and infrastructure plans that can underpin a pipeline of climate-safe, bankable projects. Trillions of dollars will be invested in urban infrastructure to 2030. To arrest increasing inequality and avoid climate catastrophe, these investments must be compatible with a 1.5°C trajectory with net-zero greenhouse gas emissions and greater resilience to climate impacts. Few local governments have the capacity to develop and implement detailed land use and infrastructure plans, particularly taking into account new climate constraints. National governments can support city governments to develop integrated land use, housing and transport plans that specify the desired infrastructure investments in electricity distribution, mass transit, sanitation and water supply. These plans should accommodate anticipated population growth (see *Priority 6.6*). Clear capital investment plans can then form the basis for a coherent financing strategy based on projected tax receipts, land value increases and other revenues.[399] These bundles of core infrastructure investments can anchor the growth of compact, connected and clean cities, creating the basis for agglomeration economies and virtuous cycles of development.[400] They can also enhance the creditworthiness of municipal governments by building and demonstrating their ability to design, implement and manage projects. At the UN Secretary-General's Climate Summit, a number of national governments will collectively commit to support 2,000 cities to strengthen their project preparation capabilities, create 1,000 bankable, climate-smart urban projects and link 1,000 such projects to finance by 2030.[401]

Raising the ambition

3.5 Scale land-based financing instruments to fund sustainable urban infrastructure. Public infrastructure, zoning changes and other interventions can significantly increase urban land values – but the economic returns are often captured entirely by a handful of private individuals or firms. Prudent use of land-based financing instruments such as betterment levies and transferable development rights can ensure that public funds are used primarily for public benefit by enabling national and local governments to capture some of the increase in real estate values. Land-based financing instruments benefit from effective spatial and infrastructure planning (see *Priority 3.4*), since they generate more revenue if the area is accessible and intensively used. National governments can both deploy land-based financing instruments directly, and create policies to enable state and city governments to deploy them in fiscally and environmentally sustainable ways. Land value capture instruments have been successfully deployed from Tokyo in Japan, to Hyderabad in India, to Córdoba in Argentina.[402] The Hong Kong Mass Transit Railway (MTR) Corporation alone raises up to US$1.5 billion annually via their LVC model.[403]

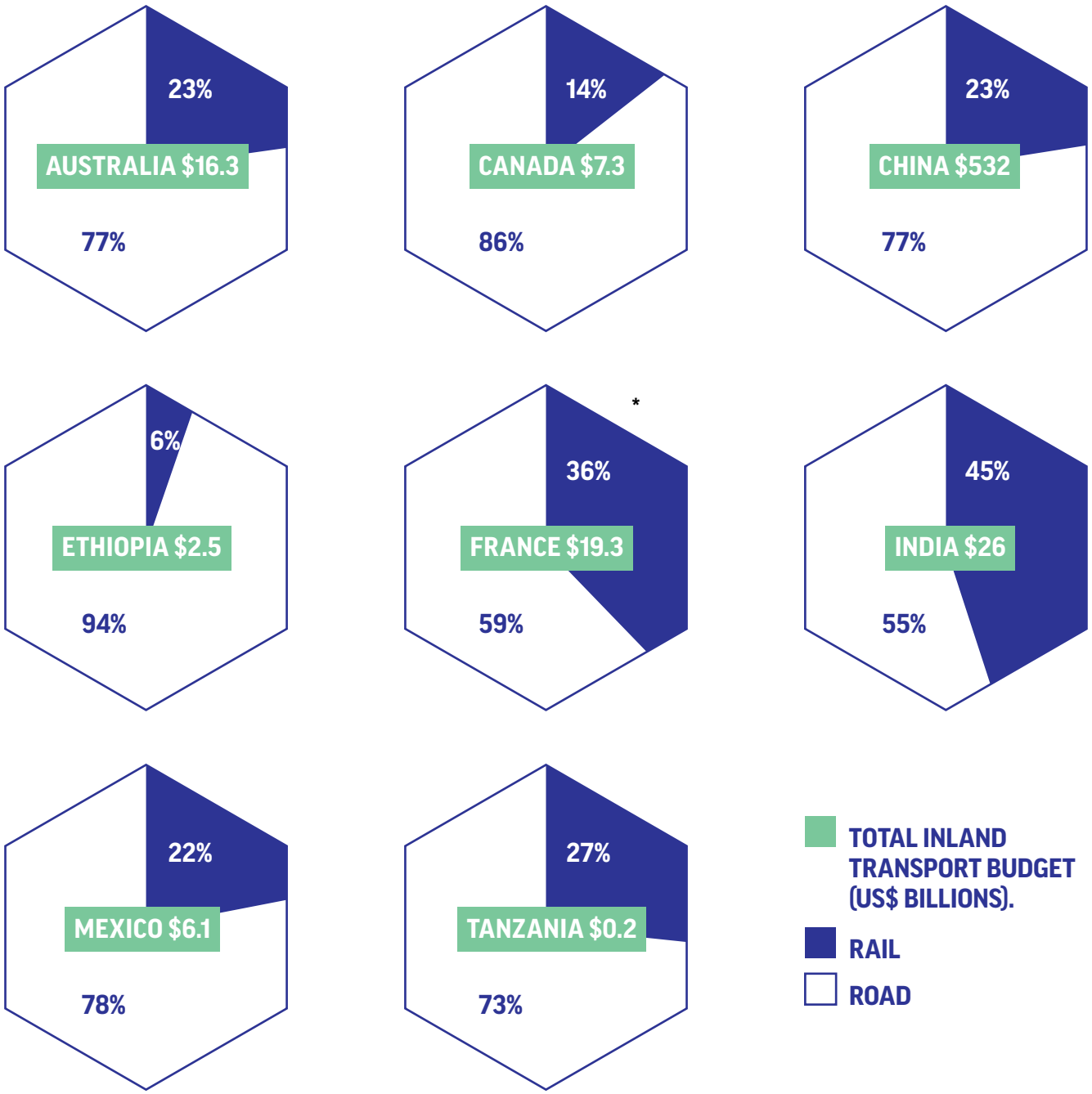
Land value capture instruments have been successfully deployed from Tokyo in Japan, to Hyderabad in India, to Córdoba in Argentina.

3.6 Shift national transport budgets from building roads to supporting public and active transport. Urban land is expensive and in demand. Streets make up the majority of public space, and their design fundamentally shapes a city's identity, appearance and connectivity. Some road-related spending is necessary to maintain existing networks, to serve (electric) public transport, emergency vehicles and cyclists, and to fill gaps in road networks within and among cities. In cities, this spending should support slow, safe and shared streets rather than fast, wide roads. Intra-city and inter-city rail and high-capacity bus systems should all be attractive long-term investments to promote compact cities and cut emissions from freight and aviation. This is why two thirds of transport experts recommend shifting road budgets towards funding public transport, sidewalks and cycle lanes.[404] This could be achieved by reallocating capital expenditure or by adopting road pricing (which may require national legislation) to internalise the costs of driving and generate revenue to make alternative modes of travel more affordable, efficient and pleasant.[405] A new analysis by the Overseas Development Institute for this report focused on eight geographically and economically diverse countries and found that all spend far more on roads than on rail infrastructure. Australia, China, Mexico and Tanzania spent roughly US$3 on roads for every US$1 spent on rail. Spending on roads was even more dominant in Ethiopia and Canada, consuming 94% and 86% of their inland transport budgets, respectively. Ethiopia is already seeking to re-balance its spending, with a new Light Rail Transit project within Addis Ababa and a new railway connecting the capital to Djibouti. Meanwhile, India was found to have the most balanced portfolio, with 55% of all inland transport investment being directed to roads while 45% was spent on railways (see *Figure 17*). For fast-growing cities, shifting national transport budgets to support public and active transport projects could "lock in" more efficient use of urban land; for more established cities, it could accelerate densification. For all countries, improving rail networks among cities could do much to reduce the emissions from both personal travel and freight transport.

In cities, public transport budgets should support slow, safe and shared streets rather than fast, wide roads. Intra-city and inter-city rail and high-capacity bus systems should also be attractive long-term investments to promote compact cities and cut emissions from freight and aviation.

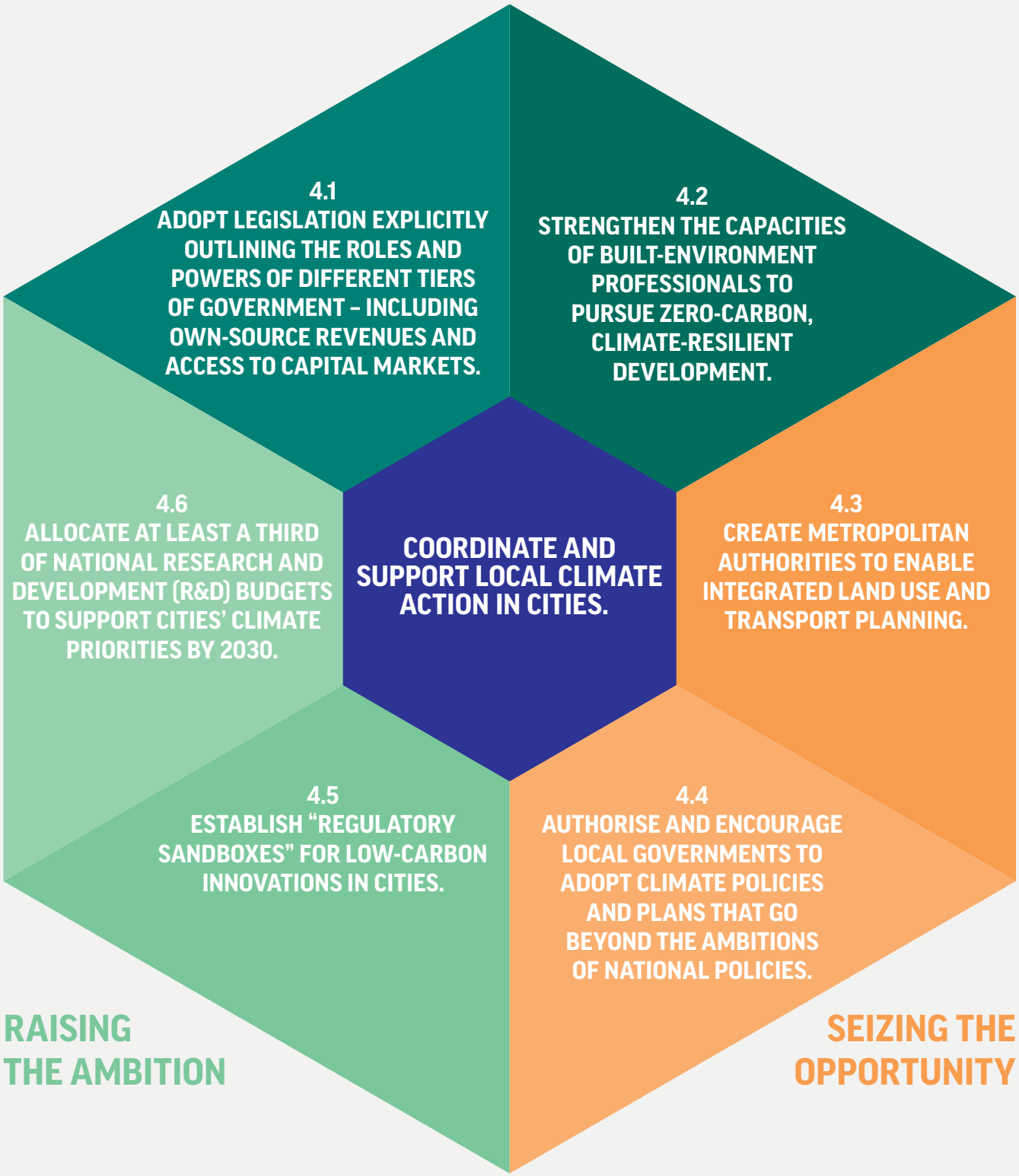
FIGURE 17. THE SHARE OF TOTAL INLAND TRANSPORT INVESTMENT ALLOCATED TO ROADS AND RAIL, 2014-2016 AVERAGE.

Source: Overseas Development Institute for the Coalition for Urban Transitions. For the full methodology, see Annex 12.



*Percentages do not add up to 100% because 5% of inland transport spending was on investments other than road and rail.

PRIORITY 4


LAYING A STRONG FOUNDATION
4.1 ADOPT LEGISLATION EXPLICITLY OUTLINING THE ROLES AND POWERS OF DIFFERENT TIERS OF GOVERNMENT – INCLUDING OWN-SOURCE REVENUES AND ACCESS TO CAPITAL MARKETS.
4.2 STRENGTHEN THE CAPACITIES OF BUILT-ENVIRONMENT PROFESSIONALS TO PURSUE ZERO-CARBON, CLIMATE-RESILIENT DEVELOPMENT.
4.6 ALLOCATE AT LEAST A THIRD OF NATIONAL RESEARCH AND DEVELOPMENT (R&D) BUDGETS TO SUPPORT CITIES' CLIMATE PRIORITIES BY 2030.
COORDINATE AND SUPPORT LOCAL CLIMATE ACTION IN CITIES.
4.3 CREATE METROPOLITAN AUTHORITIES TO ENABLE INTEGRATED LAND USE AND TRANSPORT PLANNING.
4.5 ESTABLISH "REGULATORY SANDBOXES" FOR LOW-CARBON INNOVATIONS IN CITIES.
4.4 AUTHORISE AND ENCOURAGE LOCAL GOVERNMENTS TO ADOPT CLIMATE POLICIES AND PLANS THAT GO BEYOND THE AMBITIONS OF NATIONAL POLICIES.
RAISING THE AMBITION
SEIZING THE OPPORTUNITY

Priority 4: Coordinate and support local climate action in cities.

Laying a strong foundation

4.1 **Adopt legislation explicitly outlining the roles and powers of different tiers of government – including own-source revenues and access to capital markets.** Many local governments struggle because their legal responsibilities and rights are unclear. Many more struggle with unfunded mandates: most African city governments, for example, have less than US$30 to spend per person per year,[406] leaving huge unmet needs for urban infrastructure and services. National governments can codify the roles and rights of subnational governments in law. It is particularly important to clarify the revenue streams available to municipal governments, and the conditions under which they can use debt financing. Clear frameworks to govern fiscal transfers, revenue collection and spending across ties of government can empower local authorities to act on climate change, give confidence to investors and lenders looking to finance sustainable urban infrastructure and offer security to national governments that are ultimately liable for subnational debts. Johannesburg and Cape Town, for example, were two of the first cities in the global South to issue green municipal bonds. This achievement was made possible by the Government of South Africa, which alone on the continent has explicitly and constitutionally enshrined the right of municipalities to borrow while putting in place clear conditions to safeguard the creditworthiness of all levels of government.[407]

4.2 **Strengthen the capacities of built-environment professionals to pursue zero-carbon, climate-resilient development.** There is much to learn still about how to achieve net-zero emissions and adapt to climate risks – and do so in ways that maximise the economic and social benefits. National governments can nurture the ecosystem of knowledge and skills that cities will need for this transition. They can ensure that sustainability and inclusion criteria are rigorously included in relevant curricula and industry certification systems, so public education budgets are used to train or reskill built environmental professionals in emerging urban and climate "best practices". This should span architects, commercial bankers, engineers, ICT officers, mechanics, surveyors, town planners and more. National governments can also support the dissemination of learning and best practices by facilitating membership of professional associations, city networks, global alliances, federations and citizens' assemblies. They can also ensure that relevant national datasets (such as censuses and demographic and health surveys) have spatial components and are publicly accessible, which can support built-environment professionals in the public, private and civic sectors to make more informed decisions. A systematic approach to building the knowledge and skills of built environment professionals can help city governments, firms and civil society access the capabilities that they need to pursue ambitious climate action, and support the emergence of community-led efforts and new business models.

Johannesburg and Cape Town were two of the first cities in the global South to issue green municipal bonds. This was possible because South Africa's constitution enshrines the right of municipalities to borrow.

Seizing the opportunity

4.3 **Create metropolitan authorities to enable integrated land use and transport planning.** Many people who work in a city commute from beyond its official boundaries. In other cases, urban governance is fragmented, undermining efforts to make cities more compact and connected: Dakar, for instance, is divided into 19 municipalities, while Sydney is divided among 29 city councils. In large cities and urban agglomerations, establishing a single transport and land use authority with responsibility for the metropolitan region can enable the development of more coherent strategies that effectively link people to jobs, services and amenities. These land use and transport authorities should hold sufficient power over infrastructure delivery and operations, budget management and land use planning to meaningfully shape urban transport systems,[408] but should also have strong representation by local governments within the metropolitan area. Transport for London is a good example of an integrated authority, with responsibility not only for the public transport within Greater London but also several of the rail lines serving its commuter belt.

4.4 **Authorise and encourage local governments to adopt climate policies and plans that go beyond the ambitions of national policies.** In some parts of the world, cities and states are adopting more ambitious building codes, vehicle efficiency standards, road pricing policies and renewable energy targets than their national governments. London's Ultra-Low Emission Zone, for instance, will drive change throughout the regional vehicle fleet, while Stadtwerke München plans to meet the city's entire energy demand with renewables by 2025 (see *Box 11*). National governments can adopt policies that empower local governments to set their own regulations and procurement policies, provided that they aim higher than the national environmental standards. This can support local leadership and innovation and build private-sector capacity to produce climate-compatible goods and services.

Raising the ambition

4.5 **Establish "regulatory sandboxes" for low-carbon innovations in cities.** A regulatory sandbox offers a space where novel technologies, systems, processes, business models and institutional arrangements can be tested without the usual constraints. Such spaces can help reduce the cost of experimentation and barriers to entry; they also allow policy-makers to collect evidence on emerging innovations to inform the design of regulation. Appropriate supervision and safeguards are essential: a regulatory sandbox should be regarded as the equivalent of a pharmaceutical clinical trial, but for low-carbon products. Cities offer an ideal scale to pilot many low-carbon innovations (such as new mobility or energy services), so they are a good fit with regulatory sandboxes. The UK launched the world's first energy regulatory sandbox in 2014. It revealed a suite of energy innovators in local energy, peer-to-peer trading, energy storage, digital platforms and electric vehicles, and helped the national energy regulator navigate the complex mix of industry norms, codes, licenses and fee structures that might inhibit scaling of new low-carbon options.[409]

Many countries have vast R&D budgets:

The US government spends over US$140 billion per year in laboratories and universities across the country.

Universities in the top 100 metropolitan areas receive on average US$500 million in federal R&D funds.

National governments can use these budgets strategically to enhance economic competitiveness by bolstering local entrepreneurs, leveraging private R&D investments and strengthening regional innovation clusters.

4.6 **Allocate at least a third of national research and development (R&D) budgets to support cities' climate priorities by 2030.**[410] Reaching net-zero emissions in cities depends on developing and deploying innovations that can fill key data, technology and institutional gaps. Many countries have vast R&D budgets: the US government, for instance, spends over US$140 billion per year in laboratories and universities across the country. Universities in the top 100 metropolitan areas average US$500 million in federal R&D funds.[411] National governments can use these budgets strategically to enhance economic competitiveness by bolstering local entrepreneurs, leveraging private R&D investments and strengthening regional innovation clusters to support the advancement and adoption of technologies, products and processes that accelerate the zero-carbon urban transition. China has demonstrated how effective this strategy can be, as its targeted R&D investments have positioned its cities and firms at the forefront of the electric vehicle revolution: Shenzhen was the first city in the world to electrify its entire public bus fleet (see *Box 7*). Particular attention should now be paid to harder-to-abate sectors that often serve or locate in cities, such as aviation, trucking, cement and steel.[412]

China has demonstrated how effective this strategy can be, as its targeted R&D investments have positioned its cities and firms at the forefront of the electric vehicle revolution.

PRIORITY 5

LAYING A STRONG FOUNDATION

5.1
ENSURE THAT COLLABORATIVE CLIMATE ACTION IN CITIES IS REFLECTED IN THE NATIONALLY DETERMINED CONTRIBUTIONS SUBMITTED IN 2020 AND 2025.

5.2
REQUIRE INTERNATIONAL PUBLIC FINANCE INSTITUTIONS TO END ALL FOSSIL FUEL FINANCING BY 2024.

BUILD A MULTILATERAL SYSTEM THAT FOSTERS INCLUSIVE, ZERO-CARBON CITIES.

5.3
ENSURE THAT INTERNATIONAL DEVELOPMENT ASSISTANCE IS ALIGNED WITH NATIONAL URBAN STRATEGIES, THE PARIS AGREEMENT AND THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT.

5.4
ESTABLISH AN INTERNATIONAL CARBON PRICE FLOOR FROM 2025.

5.5
HELP CITY GOVERNMENTS ACCESS INTERNATIONAL PUBLIC FINANCE FOR LOW-CARBON, CLIMATE-RESILIENT DEVELOPMENT.

5.6
ENFORCE EXISTING TRADE RULES ON FOSSIL FUEL SUBSIDIES, PARTICULARLY THOSE WITH THE MOST HARMFUL IMPACTS ON CITIES.

RAISING THE AMBITION

SEIZING THE OPPORTUNITY

Priority 5: Build a multilateral system that fosters inclusive, zero-carbon cities.

Laying a strong foundation:

5.1 **Ensure that collaborative climate action in cities is reflected in the Nationally Determined Contributions submitted in 2020 and 2025.** NDCs should commit to reach net-zero emissions by mid-century, harnessing the power of cities and local action to drive low-carbon innovation and behavioural change. Today, only 23 countries have NDCs that speak directly to climate mitigation in cities (see *Figure 13*), although many more have made urban-relevant commitments – for instance, to cut emissions from buildings or transport. This is a huge missed opportunity to raise national ambition, since nearly 10,000 local governments worldwide have committed to set emission reduction targets that go above and beyond existing national commitments under the Paris Agreement.[413] In the lead-up to COP26 in 2020, national governments should involve local governments in the design of their NDCs and integrate city-scale actions and targets into their next round of commitments. Effective dialogue and collaborative strategy development can also strengthen implementation, ensuring that different levels of government are aligned behind common goals and that climate actions are matched to their budgets and powers.[414] Mexico, for example, has been systematically recording climate policies and projects by states and municipalities, and will use these to enhance its ambition in the next round of climate negotiations.

5.2 **Require international public finance institutions to end all fossil fuel financing by 2024.**[415] Between 2008 and 2015, 30% of multilateral development banks' energy financing went to fossil fuels. This investment was worth US$7 billion in 2015 alone[416] – and excludes fossil fuel-friendly investments such as car-based infrastructure in cities. As the primary shareholders and clients, national governments can require international finance institutions to end all fossil fuel financing except in very rare circumstances, where it is the only way to secure energy access for the poor. The next business plans of the international finance institutions should reflect this shift in their energy and transport portfolios in particular, redirecting lending towards low-carbon, urban-relevant infrastructure projects such as metros, electric buses, building efficiency or solar farms. Since these institutions encourage blended finance approaches, that reform should have a multiplier impact by reducing the incentives for commercial banks to lend to or underwrite private companies in the coal, oil and gas sectors.

Today, only 23 countries have Nationally Determined Contributions that speak directly to climate mitigation in cities. Scaling urban climate action therefore offers a huge opportunity for national governments to enhance ambition at COP26 in 2020.

Seizing the opportunity

5.3 **Ensure that international development assistance is aligned with national urban strategies, the Paris Agreement and the 2030 Agenda for Sustainable Development.** Public climate finance from developed to developing countries reached US$54.5 billion in 2017.[417] This is progress towards the pledge in the Paris Agreement to mobilise US$100 billion per year by 2020. However, even if this goal is reached, it is not sufficient to reach net-zero emissions and adapt to climate impacts. All international development assistance must be consistent with net-zero emissions by mid-century and fully mainstream climate resilience.[418] International development assistance is usually allocated according to country strategies, ideally developed by national governments in tandem with multilateral development banks. National governments can ensure that inclusive, zero-carbon cities – particularly sustainable urban infrastructure projects – are prominent parts of these agencies' country strategies, and that municipal governments are consulted in their development. Donors can further reinforce the importance of this alignment.

5.4 **Establish an international carbon price floor from 2025.** Although a carbon price is a very efficient way to systematically incentivise compact, connected and clean cities, many national governments are concerned about the perceived economic costs of unilaterally enacting one. An internationally agreed carbon price floor – consistent with *Priority 3.2* – could provide reassurance that the near-term economic competitiveness of frontrunning cities and countries will not be affected, while still offering flexibility in domestic policies: national governments could use emission trading schemes, carbon taxes or minimum price auctions to implement the carbon price.[419] If a coalition of large emitting countries were to jointly champion this policy, it would help to overcome domestic political barriers to action – particularly if any revenues are used to ensure a just transition (see *Priority 6.3*).

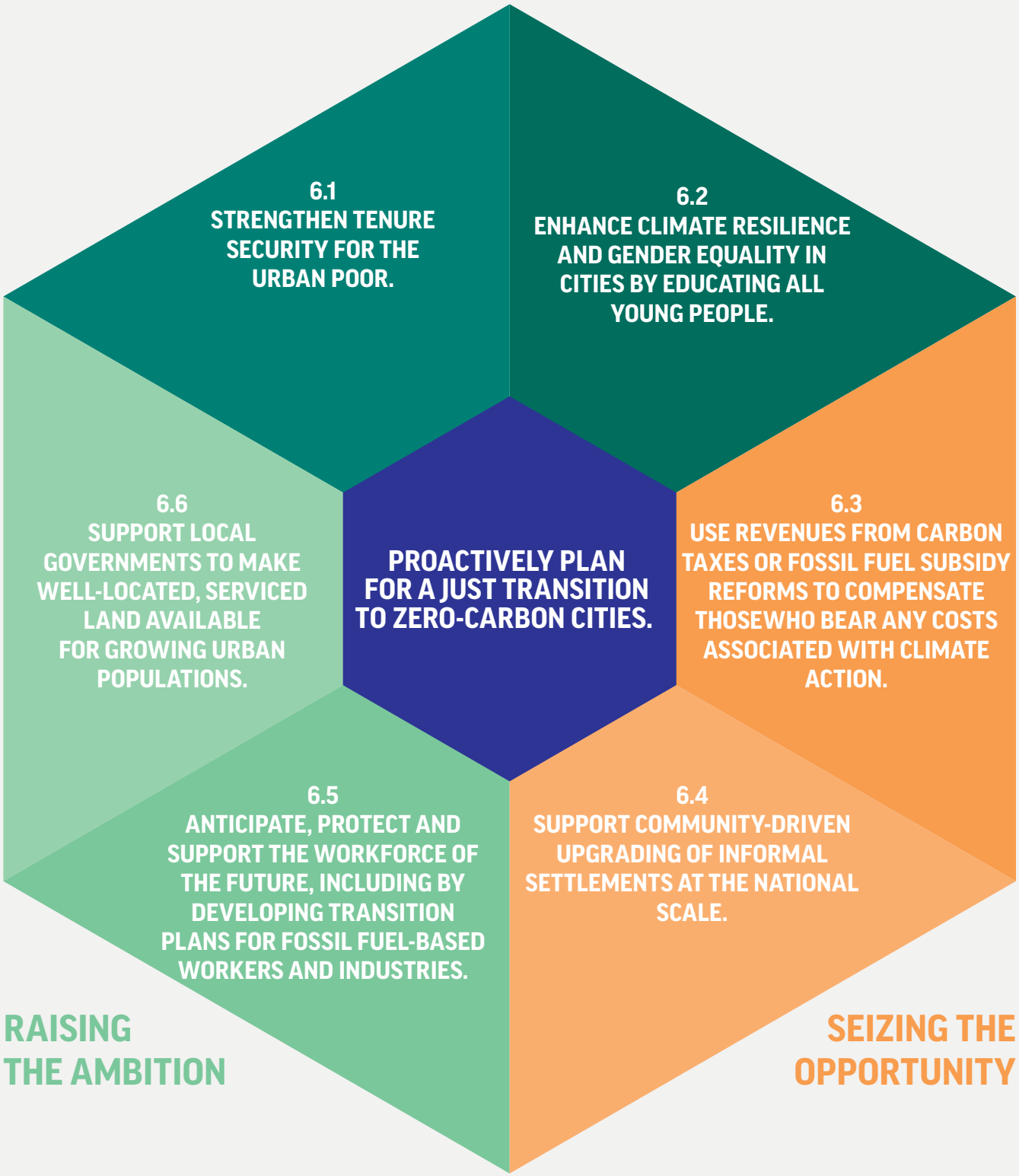
Raising the ambition

5.5 **Help city governments access international public finance for low-carbon, climate-resilient development.** While financing for sustainable urban infrastructure exists, there is a critical lack of funding and resources necessary to mature projects from the concept phase through to actual financing solutions. Moreover, many projects are not well-positioned to attract private finance because they do not generate a commercial return and the governments commissioning them are not creditworthy. National governments can help to mobilise much-needed investment in urban infrastructure in two critical ways. First, national governments can provide financial and technical assistance in the earliest stages of project development to support detailed feasibility studies and project planning. This can accelerate capital deployment into urban infrastructure projects, especially where countries have established robust fiscal and regulatory frameworks to reassure investors. Second, national governments can support subnational governments to access international development assistance and climate finance, which is typically lower-cost than private finance. A few international finance institutions, such as the European Bank for Reconstruction and Development, have well-developed lines of lending to municipal authorities and utilities. These arrangements have proven valuable not only for the low-cost capital flowing to sustainable urban infrastructure, but also for building private-sector experience with lending to subnational governments.

5.6 **Enforce existing trade rules on fossil fuel subsidies, particularly those with the most harmful impacts on cities.** Within countries, fossil fuel subsidies exacerbate inequality, exacerbate air pollution (which is concentrated in cities), incentivise costly urban sprawl, take up fiscal space and contribute to the climate crisis. Fossil fuel subsidy reform and carbon pricing could lead to the displacement of production, investment and fuel consumption to cities and countries with lower levels of climate ambition.[420] To avoid this perverse outcome, national governments could use the multilateral trade system to accelerate fossil fuel subsidy reform – for instance, by making a case under the World Trade Organization's Agreement on Subsidies and Countervailing Measures.[421] Many countries have successfully used multilateral trade systems to reduce harmful subsidies in other sectors, such as agriculture. Indeed, many disputes on renewable energy support have been brought before the WTO, though national governments have yet to initiate legal proceedings against subsidies for oil, coal or gas.[422] Globally, fiscal reform to eliminate subsidies that support fossil fuel consumption – US$41.6 billion in cities alone (see *Figure 14*) – could redeploy substantial government revenue to support a just transition to zero-carbon cities.

Globally, fiscal reform to eliminate subsidies that support fossil fuel consumption – US$41.6 billion in cities alone – could release substantial public funds revenue to support a just transition to zero-carbon cities.

PRIORITY 6


LAYING A STRONG FOUNDATION
6.1 STRENGTHEN TENURE SECURITY FOR THE URBAN POOR.
6.2 ENHANCE CLIMATE RESILIENCE AND GENDER EQUALITY IN CITIES BY EDUCATING ALL YOUNG PEOPLE.
6.6 SUPPORT LOCAL GOVERNMENTS TO MAKE WELL-LOCATED, SERVICED LAND AVAILABLE FOR GROWING URBAN POPULATIONS.
PROACTIVELY PLAN FOR A JUST TRANSITION TO ZERO-CARBON CITIES.
6.3 USE REVENUES FROM CARBON TAXES OR FOSSIL FUEL SUBSIDY REFORMS TO COMPENSATE THOSEWHO BEAR ANY COSTS ASSOCIATED WITH CLIMATE ACTION.
6.5 ANTICIPATE, PROTECT AND SUPPORT THE WORKFORCE OF THE FUTURE, INCLUDING BY DEVELOPING TRANSITION PLANS FOR FOSSIL FUEL-BASED WORKERS AND INDUSTRIES.
6.4 SUPPORT COMMUNITY-DRIVEN UPGRADING OF INFORMAL SETTLEMENTS AT THE NATIONAL SCALE.
RAISING THE AMBITION
SEIZING THE OPPORTUNITY

Priority 6: Proactively plan for a just transition to zero-carbon cities.

Laying a strong foundation

6.1 Strengthen tenure security for the urban poor. A legal address is often required to enrol as a voter, open a bank account, access entitlements such as health care or primary education, and get formal connections to water, sanitation and electricity networks.[423] Secure tenure thus enables families to access risk-reducing services and infrastructure that improves their quality of life and enhances their resilience to climate shocks and stresses. A lack of comprehensive land registries and cadastres, meanwhile, limits governments' ability to shape urban growth for enhanced economic productivity or reduce exposure to climate hazards. National governments can help city governments improve tenure security in informal settlements by supporting partnerships between formal and informal actors, as Namibia has done (see *Box 3*); setting up simplified registration systems as Rwanda has done (*Box 7*); reforming land regulation to favour the consolidation of occupancy rights (particularly protection against eviction) over the provision of property titles; devising tenure formulas that support collective ownership and prioritise collective rather than individual interests; and training and employing surveyors to accelerate regularisation, tenure and titling programmes (see *Priority 4.2*).

Fair, efficient urban land governance is critical for a just transition.
A legal address is often required to:

enrol as a voter

open a bank account

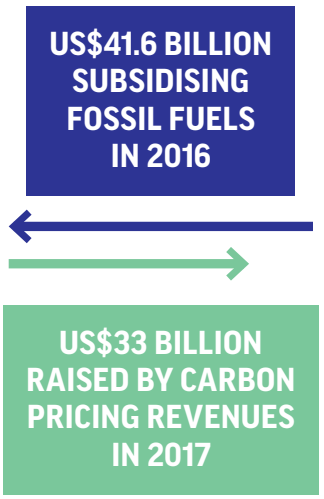
access health care or education

connect to water, sanitation and electricity networks

6.2 Enhance climate resilience and gender equality in cities by educating all young people. Recognising the wide range of factors that shape climate resilience, women are – on average – more vulnerable to environmental hazards than men. They have lower incomes, fewer assets, less formal education and less access to support, despite having more responsibility for children and the elderly, especially in the Global South. This means that women face greater risk during and after extreme weather events,[424] so there is a need to implement gender-responsive climate change action plans, policies or strategies. Mandating and resourcing universal, high-quality education for all young people irrespective of gender – in line with SDG4 and SDG5 – can further enhance climate resilience. Better-educated women tend to be healthier, earn more, find (formal) jobs, marry at a later age and have fewer children, who in turn have better access to health care and education opportunities. This has huge relevance to cities where formal labour markets are overwhelmingly concentrated and where most population growth will take place over the next 30 years.[425] Education of all forms can also be provided very cost-effectively in urban areas.

Seizing the opportunity

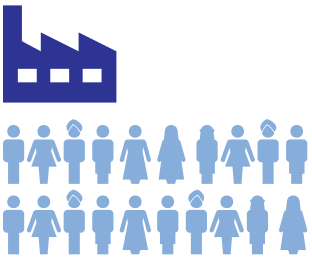
6.3 Use revenues from carbon taxes or fossil fuel subsidy reforms to compensate those who bear any costs associated with climate action. Poorer households tend to spend a greater share of their income on essentials, such as fuel. Consequently, vulnerable groups such as fixed-income households and informal workers in urban areas can suffer more from actions such as fossil fuel subsidy reform, even though energy subsidies are generally regressive.[426] National governments can redress this inequality by explicitly using the savings from fossil fuel subsidy reform and carbon pricing (see *Priority 3.1* and *Priority 3.2*) to fund social protection and invest in new low-carbon industries with high potential for job creation. This strategy can also minimise the potential political fallout,[427] as Indonesia's recent successes demonstrate (see *Box 10*). Governments spent about US$41.6 billion subsidising fossil fuels in urban areas in 2016 (see *Figure 14*) and raised about US$33 billion in carbon pricing revenues in 2017.[428] This offers significant fiscal space to fund social protection and productive infrastructure.



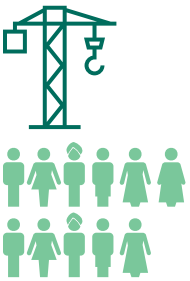
6.4 Support community-driven upgrading of informal settlements at the national scale. Sustaining appetite for climate mitigation and enhancing urban resilience will depend on more inclusive development policies and practices. Participatory upgrading programmes can help to transform "slums" into neighbourhoods that are dense, liveable and affordable.[429] To date, there are few examples of large-scale informal settlement upgrading schemes; most examples are at the project or (occasionally) city scale. While upgrading is primarily delivered by local authorities working in partnership with grassroots organisations of the urban poor, national governments have important roles to play in: reforming minimum plot sizes and maximum floor-area ratios that limit density and increase costs; reforming construction regulations to allow for incremental housing solutions as the incomes of the residents permit; providing funding for core infrastructure to both municipal governments and organised communities; and allowing collective ownership to resist pressures of gentrification.[430] The Chile Barrio programme illustrates how national and local governments can work with communities to systematically upgrade informal settlements (see *Box 9*). At the UN Secretary-General's Climate Summit, a number of national governments will commit to bolster community adaptation in citywide planning and national policies, including by putting the urban poor at the centre of Nationally Determined Contributions and National Adaptation Plans.[431]

Raising the ambition

Nearly 1.5 billion workers around the world are in sectors critical to climate stability, including



200 MILLION PEOPLE IN MANUFACTURING



110 MILLION IN BUILDINGS

88 MILLION IN TRANSPORT

30 MILLION IN ENERGY

6.5 **Anticipate, protect and support the workforce of the future, including by developing transition plans for fossil fuel-based workers and industries.** Nearly 1.5 billion workers around the world are in sectors critical to climate stability, including 200 million people in manufacturing, 110 million in buildings, 88 million in transport and 30 million in energy.[432] Some cities are largely dependent on carbon-intensive industries.[433] In these cases, local governments cannot manage the consequences of a zero-carbon transition alone. National governments need to anticipate and respond to shifts in the labour market, including the spatial distribution of employment opportunities. They can support local governments, trade unions, employers, investors and communities to collaboratively plan for a just transition through establishing joint management-labour committees with transparent terms of reference and appointment processes. These forums can seek ways to minimise the trade-offs of climate action, forecast employment opportunities, and plan for appropriate retention, reskilling and redeployment of workers.[434] National governments can also ensure adequate and sustainable social protection for job losses and displacement. At the UN Secretary-General's Climate Summit, a number of national governments will commit to support a just ecological transition, pledging to create mechanisms for inclusive social dialogue, supporting skills development to enable people to find work in a changing labour market, and designing social protection policies to protect workers and vulnerable groups in the context of long-term climate strategies.[435]

6.6 **Support local governments to make well-located, serviced land available for growing urban populations.** The urban population is expected to expand by 1.5 million people every week to 2050, with 90% of this growth concentrated in Africa and Asia.[436] There is no evidence that policies to slow rural-to-urban migration are effective.[437] Actively preparing for this population growth offers national governments an opportunity to create compact, connected and clean cities with healthy, productive residents. Otherwise, these people will largely end up in costly, unsafe informal settlements. Retrofitting infrastructure after settlement has occurred can be three times more expensive than investing beforehand.[438] National governments can help municipal governments make well-situated, serviced urban land available by opening up new areas for managed urban expansion; altering jurisdictional boundaries so that municipal governments can develop and implement plans in this extended area; providing funding for core infrastructure such as transit systems, sewers and water mains to connect these parts of the city; and allowing some flexibility in planning standards to accommodate the needs of poorer households.[439]

The Coalition for Urban Transitions encourages national governments to draw on the evidence and recommendations in this report to craft their next Intended Nationally Determined Contribution and inform a long-term strategy to nurture inclusive, zero-carbon, resilient cities. The organisations and individuals who contributed to this report will play our part in supporting bold national leadership.

There is no time to lose.

CLIMATE EMERGENCY, URBAN OPPORTUNITY

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Advisory boards

The Steering Group of the Coalition for Urban Transitions:
Aziza Akhmouch (*Organisation for Economic Co-operation and Development*), David Dodman (*International Institute for Environment and Development*), Dan Dowling (*PwC*), Andy Gouldson (*University of Leeds*), Rajat Kathuria (*Indian Council for Research on International Economic Relations*), Qi Ye (*Tsinghua University*), Philipp Rode (*LSE Cities)*, Elaine Trimble (*Siemens*), Andrew Tucker (*African Centre for Cities*) and Shelagh Whitley (*formerly Overseas Development Institute; now UN Principles for Responsible Investment*).

The Urban Leadership Council of the Coalition for Urban Transitions:
Amanda Eichel (*Global Covenant of Mayors for Climate & Energy*), Andrew Higham (*Mission 2020*), Andrew Steer (*World Resources Institute*), Dominic Waughray (*World Economic Forum*), Emilia Sáiz (*United Cities and Local Governments*), Gino van Begin (*ICLEI–Local Governments for Sustainability*), Guido Schmidt-Traub (*UN Sustainable Development Solutions Network*), Helen Clarkson (*The Climate Group*), Helen Mountford (*Global Commission on the Economy and Climate*), Jeremy Oppenheim (*Energy Transitions Commission*), Mark Watts (*C40 Cities Climate Leadership Group*), Nigel Topping (*We Mean Business*), Richard Baron (*2050 Pathways Platform*), Sheela Patel (*Slum Dwellers International (SDI)*) and William Cobbett (*Cities Alliance*).

Contributing authors

2050: A pathway to inclusive, zero-carbon cities:
Adriana Lobo (*World Resources Institute*), Helen Clarkson (*The Climate Group*), Rachel Huxley (*C40 Cities Climate Leadership Group*), Sue Parnell (*African Centre for Cities/University of Bristol*), Ben Smith (*Arup*), and Samantha Smith (*Just Transitions Centre*).

The economic case for inclusive, zero-carbon cities:
Tilman Altenburg (*German Development Institute*), Jason Eis (*Vivid Economics*), Susannah Fisher (*EIT Climate-KIC*), Vernon Henderson (*London School of Economics and Political Science*), Sue Parnell (*African Centre for Cities/University of Bristol*), Jake Wellman (*Vivid Economics*) and Tony Venables (*University of Oxford*).

The unique and crucial roles of national government:
Aziza Akhmouch (*Organisation for Economic Co-operation and Development*), Yunus Arikan (*ICLEI–Local Governments for Sustainability*), Steven Bland (*UN-Habitat*), Harriet Bulkeley (*Durham University*), Andy Gouldson (*University of Leeds*), Tadashi Matsumoto (*Organisation for Economic Co-operation and Development*), Sue Parnell (*African Centre for Cities/University of Bristol*), and Seth Schultz (*Urban Breakthroughs*).

Priorities for national action:
Elleni Ashebir (*World Resources Institute*), Rachel Huxley (*C40 Cities Climate Leadership Group*), Günter Meinert (*Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH*), Philipp Rode (*LSE Cities*), Guido Schmidt-Traub (*United Nations Sustainable*

Development Solutions Network), Shelagh Whitley (*formerly Overseas Development Institute; UN Principles for Responsible Investment*) and Kerem Yilmaz (*Global Covenant of Mayors for Climate & Energy*).

Research contributors

The technically feasible mitigation potential in cities:
Derik Broekhoff and Taylor Binnington (*Stockholm Environment Institute*).

Economic case for large-scale, low-carbon investment in urban areas, 2020-2050:
Jason Eis, Naina Khandelwal, James Patterson-Waterston, Jake Wellman, Karishma Gulrajani and Julian Tollestrup (*Vivid Economics*).

Proportion of urban residents and urban land less than 10m above sea level:
Deborah Balk (*CUNY Institute for Demographic Research, City University of New York*), Gordon McGranahan (*Institute for Development Studies*) Kytt MacManus (*Center for International Earth Science Information Network, Columbia University*) and Hasim Engin (*CUNY Institute for Demographic Research, City University of New York*).

Relationship between urban density and urban economic performance:
Yohan Iddawela and Neil Lee (*London School of Economics and Political Science*).

Net loss of land to urban expansion:
Alejandro Blei, Shlomo Angel and Xinyue Zhang (*Marron Institute of Urban Management, New York University*).

Linkages between National Urban Policies and Nationally Determined Contributions:
Databases developed by Steven Bland (*UN-Habitat*), Johannes Hamhaber (*Technical University of Cologne*), Tadashi Matsumoto (*Organisation for Economic Co-operation and Development*), Marcus Mayr (*UN-Habitat*) and Nicola Tollin (*University of Southern Denmark*).

Subsidies for fossil fuel consumption in urban areas:
Ipek Gençsü and Sam Pickard (*Overseas Development Institute*).

Urban-relevant powers at the national and local level:
Derik Broekhoff (*Stockholm Environment Institute*).

The allocation of national inland transport budgets:
Ipek Gençsü and Sam Pickard (*Overseas Development Institute*).

Expert reviewers and contributors

Aarsi Sagar (*Global Green Growth Institute*), Adriana Lobo (*World Resources Institute*), Alice Charles (*World Economic Forum*), Amanda Eichel (*Global Covenant of Mayors for Climate & Energy*), Andreas Vetter (*Bundesministerium für Umwelt*), Andrew Scott (*Overseas Development Institute*), Andrew Sudmant (*University of Leeds*), Andrew Tucker (*African Centre for Cities*), Andy Gouldson (*University of Leeds*), Angela Falconer (*Climate Policy Initiative*), Anjali Mahendra (*World Resources Institute*), Anton Cartwright (*African Centre for Cities*), Barbara Buchner (*Climate Policy Initiative*), Benjamin Jance (*Global Covenant of Mayors for Climate & Energy*), Carlos Muñoz Piña (*World Resources Institute*), Conor Ritchie (*UK Department for Business Energy and Industrial Strategy*), Constanze Boening (*Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH*), Dan Dowling (*PwC*), David Dodman (*International Institute for Environment and Development*), Deborah Balk (*City University of New York*), Debra Roberts (*eThekwini Municipality*), Denise Chan (*PwC*), Donovan Storey (*Global Green Growth Institute*), Ehtisham Ahmad (*London School of Economics and Political Science*), Eliza Northrop (*World Resources Institute*), Emma Stewart (*World Resources Institute*), Gabrielle Drinkwater (*UK Department for Business, Energy and Industrial Strategy*), Gordon McGranahan (*Institute for Development Studies*), Guillaume Long, Günter Meinert (*Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH*), Harriet Bulkeley (*Durham University*), Helen Clarkson (*The Climate Group*), Helen Mountford (*World Resources Institute/New Climate Economy*), Ipek Gençsü (*Overseas Development Institute*), Isabelle Chatry (*Organisation for Economic Co-operation and Development*), James Alexander (*C40 Cities Climate Leadership Group*), Jason Eis (*Vivid Economics*), Jeremy Oppenheim (*SYSTEMIQ*), Jessica Brand (*New Climate Economy*), Jessica Suplie (*Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH*), Jonathan Woetzel (*McKinsey & Co*), Jorge Macías (*World Resources Institute*), Josué Tanaka (*European Bank for Reconstruction and Development*), Kerem Yilmaz (*Global Covenant of Mayors for Climate & Energy*), Kevin Austin (*C40 Cities Climate Leadership Group*),

Kristian Teleki (*World Resources Institute*), Lavanya Kadirvelarasan (*UK Department for Business Energy and Industrial Strategy*), Leo Barasi, Madhav Pai (*World Resources Institute*), Manisha Gulati, Mariana Orloff (*World Resources Institute*), Marion Davis, Michael Westphal (*World Resources Institute*), Michelle Manion (*World Resources Institute*), Milan Brahmbhatt (*World Resources Institute*), Molly Webb (Energy Unlocked), Natalia García (*World Resources Institute*), Neil Lee (*London School of Economics and Political Science*), Nigel Jollands (*European Bank for Reconstruction and Development*), Patrick Curran (*London School of Economics and Political Science*), Peter Erickson (*Stockholm Environment Institute*), Philipp Rode (*LSE Cities*), Priscilla Negreiros (*Climate Policy Initiative/ Cities Climate Finance Leadership Alliance*), Rachel Huxley (*C40 Cities Climate Leadership Group*), Rachel Spiegel (*New Climate Economy*), Remy Sietchiping (*UN-Habitat*), Ricardo Cepeda-Marquez (*C40 Cities Climate Leadership Group*), Robin King (*World Resources Institute*), Rory Moody (*UK Department for International Development*), Rubbina Karruna (*UK Department for International Development*), Sam Pickard (*Overseas Development Institute*), Samantha Smith (*Just Transition Centre*), Shannon Bouton (*McKinsey.org*), Sheela Patel (*Slum Dwellers International (SDI)*), Shipra Narang Suri (*UN-Habitat*), Shlomo Angel (*New York University*), Stephen Alan Hammer (*World Bank*), Steven Bland (*UN-Habitat*), Sue Parnell (*African Centre for Cities/ University of Bristol*), Tadashi Matsumoto (*Organisation for Economic Co-operation and Development*), Tilman Altenburg (*German Development Institute*), Toni Lindau (*World Resources Institute*), Tony Venables (*University of Oxford*), Vera Rodenhoff (*Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit*)), Yohan Iddawela (*London School of Economics and Political Science*), Yunus Arikan (*ICLEI–Local Governments for Sustainability*) and Zoe Sprigings (*C40 Cities Climate Leadership Group*).

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Annexes

The annexes are available as a separate document from the website of the *Coalition for Urban Transitions*.

Annex 1: The technically feasible mitigation potential in cities
Analysis conducted by the Stockholm Environment Institute.

Annex 2: Urban sprawl and emissions: case studies of Pittsburgh and Stockholm
Analysis conducted by the Coalition for Urban Transitions.

Annex 3: Proportion of urban residents and urban land less than 10m above sea level
Analysis conducted by the Center for International Earth Science Information Network (Columbia University), CUNY Institute for Demographic Research (City University of New York) and the Institute of Development Studies.

Annex 4: Relationship between urban population density and urban economic performance
Analysis conducted by the London School of Economics and Political Science.

Annex 5: Relationship between urban density and urban greenhouse gas emissions
Analysis conducted by the Coalition for Urban Transitions.

Annex 6: Global conversion of land to urban purposes
Analysis conducted by the Marron Institute of Urban Management, New York University.

Annex 7: The economics of the technically feasible mitigation potential
Analysis conducted by Vivid Economics.

Annex 8: Decoupling economic growth and carbon emissions: case studies of Montreal and London
Analysis conducted by the Coalition for Urban Transitions.

Annex 9: Linkages between National Urban Policies and Nationally Determined Contributions
Analysis conducted by the Coalition for Urban Transitions, the Organisation for Economic Co-operation and Development, UN-Habitat and the University of Southern Denmark.

Annex 10: Subsidies for fossil fuel consumption in urban areas
Analysis conducted by the Overseas Development Institute.

Annex 11: Analysis of the climate-relevant powers of different tiers of government
Analysis conducted by the Stockholm Environment Institute.

Annex 12: The allocation of national inland transport budgets
Analysis conducted by the Overseas Development Institute.

References

1 UN-DESA, 2018. *World Urbanization Prospects 2018*. United Nations Department of Economic and Social Affairs, New York. Available at: *http://esa.un.org/unpd/wup/*

Dobbs, R., Smit, S., Remes, J., Manyika, J., Roxburgh, C., Restrep, A., 2011. *Urban World: Mapping the Economic Power of Cities*. McKinsey Global Institute. Available at: *https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Urbanization/Urban%20world/MGI_urban_world_mapping_economic_power_of_cities_full_report.ashx*

Seto, K.C., Dhakal, S., Bigio, A., Blanco, H., Delgado, G.C., et al., 2014. Human settlements, infrastructure, and spatial planning. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. Available at: *https://www.ipcc.ch/report/ar5/wg3/*

2 Bazaz, A., Bertoldi, P., Cartwright, A., de Coninck, H., Engelbrecht, F., et al., 2018. *Summary for Urban Policymakers: What the IPCC Special Report on Global Warming of 1.5°C Means for Cities*. Intergovernmental Panel on Climate Change, Geneva. Available at: *https://www.ipcc.ch/site/assets/uploads/sites/2/2018/12/SPM-for-cities.pdf*

3 Global Covenant of Mayors for Climate & Energy, 2019. *Implementing Climate Ambition: Global Covenant of Mayors 2018 Global Aggregation Report*. Brussels. Available at: *https://www.globalcovenantofmayors.org/wp-content/uploads/2018/09/2018_GCOM_report_web.pdf*

4 C40 Cities Climate Leadership Group, 2014. *C40 Cities: The Power to Act*. London. Available at: *https://www.c40.org/researches/c40-cities-the-power-to-act*

5 76 countries have an explicit National Urban Policy (NUP), i.e. a country has a policy called "National Urban Policy", "National Urbanisation Policy", "National Urban Strategy" or a similarly close variant. 74 countries have an implicit or partial NUP, i.e. a country has many of the elements of a NUP in place but these are not brought together in a formal or explicit NUP. There are 195 countries. Source: UN-Habitat and OECD, 2018. *Global State of National Urban Policy*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://read.oecd-ilibrary.org/urban-rural-and-regional-development/global-state-of-national-urban-policy_9789264290747-en#page1*

6 UN-DESA, 2018. *World Urbanization Prospects 2018*.

7 UN-Habitat, 2016. *Slum Almanac 2015–16*. United Nations Human Settlements Programme, Nairobi. Available at: *https://unhabitat.org/slum-almanac-2015-2016/*

8 New Climate Institute, Ecofys and Climate Analytics, 2018. *Climate Action Tracker*. Available at: *https://climateactiontracker.org/global/temperatures/*

9 IPCC, 2014. *Climate Change 2014: Synthesis Report*. Core Writing Team, R. K. Pachauri, and L. A. Meyer (eds.). Intergovernmental Panel on Climate Change, Geneva. Available at: *http://www.ipcc.ch/report/ar5/syr/*

Goodell, J., 2017. *The Water Will Come: Rising Seas, Sinking Cities, and the Remaking of the Civilized World*. Hachette, New York.

Hansen, J. E., 2007. Scientific reticence and sea level rise. *Environmental Research Letters*, **2**(2). 024002. DOI:10.1088/1748-9326/2/2/024002.

Vermeer, M. and Rahmstorf, S., 2009. Global sea level linked to global temperature. *Proceedings of the National Academy of Sciences of the United States of America*, **106**(51). 21527–21532. DOI:10.1073/pnas.0907765106.

10 Bazaz et al., 2018. *Summary for Urban Policymakers*.

11 China and the US had combined energy-related emissions of 15.1GtCO_2-e in 2015. See: WRI, 2019. *Climate Watch Data Explorer*. World Resources Institute, Washington, DC. Available at: *https://www.climatewatchdata.org/*

12 Based on global GDP of US$84.74 trillion. See: IMF Data Mapper, 2019. *GDP, current prices: Billions of US dollars*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD*

13 Based on global GDP of US$84.74 trillion. See: IMF Data Mapper, 2019. *GDP, current prices*.

14 Ahlfeldt, G., and Pietrostefani, E., 2017. *Demystifying Compact Urban Growth: Evidence From 300 Studies From Across the World*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/09/NCE2017_OECD_CompactUrbanGrowth_02012018.pdf*

15 IEA, 2018. *Global EV Outlook 2018: Towards Cross-Modal Electrification*. International Energy Agency, Paris. Available at: *http://centrodeinnovacion.uc.cl/assets/uploads/2018/12/global_ev_outlook_2018.pdf*

16 Lawson, M., Chan, M.K., Rhodes, F., Butt, A.P., Marriott, A., et al., 2019. *Public Good or Private Wealth?* Oxfam. Available at: *https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620599/bp-public-good-or-private-wealth-210119-en.pdf*

17 IPCC, 2018. Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, et al. (eds.). Intergovernmental Panel on Climate Change, Geneva. Available at: *https://www.ipcc.ch/sr15/*

18 2019. Heat wave: Red alert over heat in Gujarat during weekend. *Times of India*. Available at: *https://timesofindia.indiatimes.com/city/ahmedabad/heat-wave-red-alert-over-heat-in-gujarat-during-weekend/articleshow/69034317.cms*

Snaith, E., 2019. 'The worst is still to come': Heatwave sees roads melt, rail tracks buckle and schools closed as 44C temperatures scorch Europe. *The Independent*, 27 June. London. Available at: *https://www.independent.co.uk/news/world/europe/europe-heatwave-weather-record-temperatures-wildfires-deaths-spain-germany-france-a8978071.html*

Wahlquist, C., 2019. Melbourne heatwave: city expecting 44C as Victoria faces hottest day since Black Saturday. *The Guardian*, 25 January. Available at: *https://www.theguardian.com/australia-news/2019/jan/25/melbourne-heatwave-city-expecting-44c-as-victoria-faces-hottest-day-since-black-saturday*

19 Alexander, C., 2019. Cape Town's 'Day Zero' Water Crisis, One Year Later. *CityLab*, April. Available at: *https://www.citylab.com/environment/2019/04/cape-town-water-conservation-south-africa-drought/587011/*

Pathak, S., 2019. No Drips, No Drops: A City Of 10 Million Is Running Out Of Water. *National Public Radio*, 25 June. Available at: *https://www.npr.org/sections/goatsandsoda/2019/06/25/734534821/no-drips-no-drops-a-city-of-10-million-is-running-out-of-water?t=1561722012946*

Ritter, K., 2018. *São Paulo Heading To Another Dry Spell*. Circle of Blue. São Paulo, Brazil. Available at: *https://www.circleofblue.org/2018/water-climate/drought/sao-paulo-heading-to-another-dry-spell/*

20 IPCC, 2018. *Summary for Policymakers*.

21 Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., et al., 2018. Impacts of 1.5°C global warming on natural and human systems. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, et al. (eds.). Intergovernmental Panel on Climate Change, Geneva. Available at: *https://www.ipcc.ch/sr15/*

22 Sanjai, P. R., Singh, R. K., 2017. 10,000 Electric Cars Highlight Steep Path to India's Ambitions. *Bloomberg News*. Available at: *https://news.bloombergenvironment.com/environment-and-energy/10-000-electric-cars-highlight-steep-path-to-indias-ambitions*

23 World Bank and Ecofys, 2018. *State and Trends of Carbon Pricing 2018*. World Bank, Washington, DC. Available from: *https://openknowledge.worldbank.org/bitstream/handle/10986/29687/9781464812927.pdf?sequence=5&isAllowed=y*

24 Roy, J., Tschakert, P., Waisman, H., Abdul Halim, S., Antwi-Agyei, P., et al., 2018. Sustainable development, poverty eradication and reducing inequalities. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, et al. (eds.). Intergovernmental Panel on Climate Change, Geneva. Available at: *https://www.ipcc.ch/sr15/*

25 Dobbs, R., Smit, S., Remes, J., Manyika, J., Roxburgh, C., Restrep, A., 2011. *Urban world: Mapping the economic power of cities*. McKinsey Global Institute. Available at: *https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Urbanization/Urban%20world/MGI_urban_world_mapping_economic_power_of_cities_full_report.ashx*

26 UN-DESA, 2018. *World Urbanization Prospects 2018*.

27 Angel, S., 2012. *Planet of Cities*. Lincoln Institute of Land Policy. Cambridge, MA, US.

Dodman, D. 2009. *Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories*. Environment and Urbanization. **21**(1): 185–201

28 Seto et al., 2014. *Human settlements, infrastructure, and spatial planning.*

29 This report uses terms such as "shared prosperity" and "economic development" to describe broad-based improvements in people's quality of life. While fully recognising that many countries will need to see a significant increase in material consumption to eradicate poverty and achieve a decent quality of life for all, this report avoids the use of the term 'economic growth'. This is because economic growth is widely understood to mean increases in gross domestic product (GDP), which is not necessarily an adequate measure of welfare or utility. For instance, GDP does not capture the distribution of wealth and opportunity within a country, nor does it capture the human and economic costs associated with greenhouse gas emissions, air pollution or environmental degradation. By using alternative terms to "economic growth", this report highlights the importance of using a more comprehensive set of metrics to measure socio-economic progress and welfare gains. Many alternatives to GDP are in use or under development: for example, Bhutan measures Gross National Happiness and Finland uses a Genuine Progress Indicator. More information is Available at: Stiglitz J, Sen A, Fitoussi J-P. 2009. *Report of the Commission on the Measurement of Economic Performance and Social Progress*. The Commission on the Measurement of Economic Performance and Social Progress. Available at: *https://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+Commission+report*

30 Global Covenant of Mayors for Climate & Energy, 2019. *Implementing Climate Ambition*.

31 C40 Cities Climate Leadership Group, 2014. *C40 Cities: The Power to Act*. London. Available at: *https://www.c40.org/researches/c40-cities-the-power-to-act*

32 Broekhoff, D., Piggot, G., Erickson, P., 2018. *Building Thriving, Low-Carbon Cities: An Overview of Policy Options for National Governments*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/02/Building-Thriving-Low-Carbon-Cities-An-Overview-Full-Paper-1.pdf*

33 76 countries have an explicit National Urban Policy (NUP), i.e. a country has a policy called "National Urban Policy", "National Urbanisation Policy", "National Urban Strategy" or a similarly close variant. 74 countries have an implicit or partial NUP, i.e. a country has many of the elements of a NUP in place but these are not brought together in a formal or explicit NUP. There are 195 countries. Source: UN-Habitat and OECD, 2018. *Global State of National Urban Policy*.

34 IPCC, 2018. *Summary for Policymakers*.

35 Page 4 and page 213: Hoegh-Guldberg et al., 2018. Impacts of 1.5°C global warming on natural and human systems.

36 Table 3.4 in: Hoegh-Guldberg et al., 2018. Impacts of 1.5°C global warming on natural and human systems.

37 Goodell, J., 2017. *The Water Will Come: Rising Seas, Sinking Cities, and the Remaking of the Civilized World*. Hachette, New York.

Hansen, J.E. 2007. *Scientific reticence and sea level rise*. Environmental Research Letters. 2. 024002

Vermeer, M., Rahmstorf, S. 2009. *Global sea level linked to global temperature*. Proceedings of the National Academy of Sciences of the United States of America. **106**(51) 21527-21532

Wallace-Wells, D., 2019. *The Uninhabitable Earth: Life After Warming*. Tim Duggan Book

38 Bazaz et al., 2018. *Summary for Urban Policymakers*.

39 IPCC, 2018. *Summary for Policymakers*.

40 Pushter, J., Huang, C., 2019. *Climate Change Still Seen as the Top Global Threat, but Cyberattacks a Rising Concern*. Pew Research Center, Washington, DC. Available at: *https://www.pewglobal.org/2019/02/10/climate-change-still-seen-as-the-top-global-threat-but-cyberattacks-a-rising-concern/*

41 Haynes, S., 2019. *Students From 1,600 Cities Just Walked Out of School to Protest Climate Change. It Could Be Greta Thunberg's Biggest Strike Yet*. Time. Available at: *https://time.com/5595365/global-climate-strikes-greta-thunberg/*

42 WEF, 2019. *The Global Risks Report 2019*. World Economic Forum. Geneva. Available at: *http://www3.weforum.org/docs/WEF_Global_Risks_Report_2019.pdf*

43 IRENA, 2018. *Renewable Power: Climate-Safe Energy Competes on Cost Alone*. International Renewable Energy Agency. Abu Dhabi. Available at: *https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Dec/IRENA_COP24_costs_update_2018.pdf*

44 IEA, 2018. *Global EV Outlook 2018*.

45 IEA, 2018. *Energy Efficiency 2018: Analysis and Outlooks to 2040*. International Energy Agency. Paris. Available at: *https://webstore.iea.org/download/direct/2369?fileName=Market_Report_Series_Energy_Efficiency_2018.pdf*

46 Global Commission for the Economy and Climate, 2018. *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times*. Washington, DC. Available at: *https://newclimateeconomy.report/2018/*

47 ILO, 2018. *World Employment Social Outlook 2018: Greening with Jobs*. International Labour Organization. Geneva. Available at: *https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_628654.pdf*

48 UN-DESA, 2018. *World Urbanization Prospects 2018*.

49 Beard, V. A., Mahendra, A., Westphal, M. I., 2016. *Towards a More Equal City: Framing the Challenges and Opportunities*. World Resources Institute, Washington, DC. Available online at: *www.citiesforall.org*

50 IPCC, 2018. *Summary for Policymakers*.

51 Gouldson, A., Colenbrander, S., Sudmant, A., McAnulla, F., Kerr, N., Sakai, P., Hall, S., Papargyropoulou, E., Kuylenstierna, J., 2015. *Exploring the economic case for climate action in cities*. Global Environmental Change. **35** 93-105

52 Bazaz et al., 2018. *Summary for Urban Policymakers*.

53 China and the US had combined energy-related emissions of 15.1GtCO_2-e in 2015, according to: WRI, 2019. *Climate Watch Data Explorer*. World Resources Institute, Washington, DC. Available at: *https://www.climatewatchdata.org/*

54 SEI's modelling draws heavily on the International Energy Agency's energy scenarios presented in Energy Technology Perspectives (2017 edition). The first of these is the baseline or reference scenario, which takes into account existing energy- and climate-related commitments by countries. The second of these is a decarbonisation scenario consistent with holding the average global temperature increase to no more than 2°C. The third scenario is a more ambitious decarbonisation scenario consistent with holding the average global temperature increase to "below two degrees", which is consistent with holding the average global temperature increase to no more than 1.75°C. This third scenario is based on the IEA's analysis of how far clean energy technologies could go if pushed to their practical limits. Urban sectors could deliver 44% of global energy-related GHG reductions needed for a 1.75°C pathway in 2050.

55 Nuclear power is carbon-neutral, but carries other significant environmental risks.

56 Africa Progress Panel, 2015. *Power, People, Planet: Seizing Africa's Energy and Climate Opportunities*. Available at: *https://www.cleancookingalliance.org/binary-data/RESOURCE/file/000/000/389-1.pdf*

57 IEA, 2018. *Renewables: Analysis and Forecasts to 2023*. International Energy Agency, Paris. Available at: *https://www.iea.org/renewables2018/*

58 IRENA, 2019. Renewable Capacity Highlights. International Renewable Energy Agency, Abu Dhabi. Available at: *https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Mar/RE_capacity_highlights_2019.pdf?la=en&hash=BA9D38354390B001DC0CC9BE03EEE559C280013F*

59 IRENA, 2019. *Renewable Capacity Highlights*.

60 Energy Transitions Commission, 2016. *Shaping Energy Transitions*. Available at: *http://www.energy-transitions.org/sites/default/files/20160426%20ETC%20Position%20Paper%20vF.pdf*

61 Steininger, K., Lininger, C., Droege, S., Roser, D., Tomlinson, L. and Meyer, L., 2014. *Justice and cost effectiveness of consumption-based versus production-based approaches in the case of unilateral climate policies*. Global Environmental Change, 24. 75–87. DOI:10.1016/j.gloenvcha.2013.10.005.

62 Doust, M., Jamiseon, M., Wang, M., Miclea, C., Wiedmann, T., Chen, G., Owen, A., Barrett, J., Steele, K., Hurst, T., Lumsden, C., Sunyer, M., 2019. *Consumption-based GHG Emissions of C40 Cities*. C40 Cities Climate Leadership Group, University of New South Wales, University of Leeds and Arup. Available at: *https://www.c40.org/researches/consumption-based-emissions*

63 Bailey, T., Berensson, M., Huxley, R., Smith, B., Steele, K., et al., 2019. *The Future of Urban Consumption in a 1.5°C World*. C40 Cities, Arup and the University of Leeds. Available at: *https://c40-production-images.s3.amazonaws.com/other_uploads/images/2259_C40_CBE_MainReport_190613-HDA3.original.pdf?1561382579*

64 Broekhoff, D., Piggot, G., and Erickson, P., 2019. *CBEI Guidebook: Addressing Consumption-based GHG Emissions in Cities*. Prepared by the Stockholm Environment Institute for the Urban Sustainability Directors Network. Available at: *https://sustainableconsumption.usdn.org/climate/cbei-guidebook/overview*

65 Lucon, O., Ürge-Vorsatz, D., Ahmed, A. Z., Akbari, H., Bertoldi, P., et al., 2014. Buildings. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. Available at: *https://www.ipcc.ch/report/ar5/wg3/*

66 McGranahan, G., Schensul, D., Singh, G., 2016. *Inclusive urbanization: Can the 2030 Agenda be delivered without it?* Environment and Urbanization. **28**(1): 13–34

67 Leichenko, R., Silva, J. A., 2014. *Climate change and poverty: vulnerability, impacts, and alleviation strategies*. Wiley Interdisciplinary Reviews: Climate Change. **5**(4) 539-556

Satterthwaite, D., Huq, S., Reid, H., Pelling, M., Romero Lankao, P., 2007. *Adapting to Climate Change in Urban Areas: the Possibilities and Constraints in Low and Middle Income Nations*. International Institute for Environment and Development, London. Available at: *https://pubs.iied.org/10549IIED/*

68 Beard, V. A., Mahendra, A., Westphal, M. I., 2016. *Towards a More Equal City: Framing the Challenges and Opportunities*. World Resources Institute, Washington, DC. Available online at: *www.citiesforall.org*

69 Ahlfedlt and Pietrostefani, 2017. *Demystifying Compact Urban Growth*.

70 Global Commission for the Economy and Climate, 2018. *Unlocking the Inclusive Growth Story of the 21st Century*.

71 Global Commission for the Economy and Climate, 2018. *Unlocking the Inclusive Growth Story of the 21st Century*.

72 Zhu, X., Wei, Y., Lai, Y., Li, Y., Zhong, S., Dai, C., 2019. *Empirical Analysis of the Driving Factors of China's 'Land Finance' Mechanism Using Soft Budget Constraint Theory and the PLS-SEM Model*. Sustainability. 11(3) 1-21

73 Ahlfeldt and Pietrostefani, 2017. *Demystifying Compact Urban Growth*.

74 Carruthers, J. I., Ulfarsson, G. F. 2003. *Urban sprawl and the cost of public services*. Environment and Planning B: Planning and Design. 30(4) 503-522.

75 Savage, M. 1988. *The Missing Link? The Relationship between Spatial Mobility and Social Mobility*. The British Journal of Sociology. 39(4). 554–577.

76 Alberti, M., Marzluff, J. M. 2004. *Ecological resilience in urban ecosystems: Linking urban patterns to human and ecological functions*. Urban Ecosystems. 7(3) 241-265

Ernston, H., van der Leeuw, S. E., Redman, C. L., Meffert, D. J., Davis, G., Alfsen, C., Elmqvist, T., 2010. *Urban transitions: on urban resilience and human-dominated ecosystems*. Ambio. 39(8) 531-545

77 Ahlfeldt and Pietrostefani, 2017. *Demystifying Compact Urban Growth*.

78 McGranahan, G., Martine, G., 2014. *Urban Growth in Emerging Economies: Lessons from the BRICS*. Routledge. Oxon.

79 IMF, 2019. *IMF Datamapper: Datasets*. Washington, DC. Available from *https://www.imf.org/external/datamapper/datasets*

80 Arcadis, 2015. *Arcadis Sustainable Cities Index*. Amsterdam. Available at: *www.arcadis.com/media/E/F/B/{EFB74BBB-D788-42EF-A761-4807D69B6F70}9185R_Arcadis_whitepaper_2015.pdf*

81 Kim, S. H., 2013. *Changes in urban planning policies and urban morphologies in Seoul, 1960s to 2000s*. Architectural Research. 15(3) 133-141.

Seoul Metropolitan Government, Urban Planning Bureau, and Advisory Group for Urban Planning, 2016. *Seoul, Ready to Share with the World! Seoul Urban Planning*. Available at: *https://www.metropolis.org/sites/default/files/seoul_urban_planningenglish.pdf*

82 Kim, S. H. 2013. *Changes in urban planning policies and urban morphologies in Seoul, 1960s to 2000s*. Architectural Research. 15(3) 133-141.

83 UN-DESA, 2018. *World Urbanization Prospects 2018*.

84 Lee, S. K., You, H., Kwon, H. R. 2015. *Korea's Pursuit for Sustainable Cities through New Town Development: Implications for LAC*. Inter-American Development Bank, Washington, DC.

85 Kim, S. H. 2013. *Changes in urban planning policies and urban morphologies in Seoul, 1960s to 2000s*. Architectural Research. 15(3) 133-141.

86 Korail. (n.d.). KORAIL. Available at: *http://info.korail.com/mbs/www/subview.jsp?id=www_020203010000*

87 Hill, M. 2018. *Everything you ever wanted to know about the Seoul Metro System but were too afraid to ask*. CityMetric, London. Available at: *https://www.citymetric.com/transport/everything-you-ever-wanted-know-about-seoul-metro-system-were-too-afraid-ask-3702*

88 UN Data, 2017. *City population by sex, city and city type*. United Nations Statistics Division. Available at: *http://data.un.org/Data.aspx?d=POP&f=tableCode:240*

89 Kostat, 2017. *Population and Housing Census: Complete Enumeration Results of the 2017 Population and Housing Census*. Available at: *http://kostat.go.kr/portal/eng/pressReleases/8/7/index.board?bmode=download&bSeq=&aSeq=370993&ord=1*

90 Seoul Metropolitan Government, Urban Planning Bureau, and Advisory Group for Urban Planning, 2016. *Seoul, Ready to Share with the World!* Seoul Urban Planning.

91 Oxford Economics, 2015. *Global Cities 2030*. Oxford.

92 Seok-Hoi, Y. 2003. Geographical features of social polarization in Seoul, South Korea. In: *Representing Local Places and Raising Voices from Below*. T. Mizuuchi (ed).Osaka City University. Osaka. 31-40.

93 Remmert, D., Ndhlovu, P., 2018. *Housing in Namibia: Rights, Challenges and Opportunities*. Institute for Public Policy Research. Windhoek. Available at: *https://ippr.org.na/wp-content/uploads/2018/03/IPPR_HousingBook_PRINT.pdf*

94 Weber, B., Mendelsohn, J., 2017. *Informal Settlements in Namibia: Their Nature and Growth*. Development Workshop Namibia. Windhoek.

95 Pendleton, W., Crush, J., Nickanor, N. 2014. *Migrant Windhoek: Rural–Urban Migration and Food Security in Namibia*. Urban Forum. 25(2) 191–205.

96 NSA, 2015. *The Namibia Labour Force Survey 2014 Report*. Namibian Statistics Agency. Windhoek.

97 Remmert and Ndhlovu, 2018. *Housing in Namibia*.

98 Chitekwe-Biti, B., 2018. *Co-producing Windhoek: the contribution of the Shack Dwellers Federation of Namibia*. Environment and Urbanization, 30(2). 387–406. DOI:10.1177/0956247818785784.

99 Chitekwe-Biti, B., 2018. *Co-producing Windhoek*

100 Chitekwe-Biti, B., 2018. *Co-producing Windhoek*

101 Weber, B., and Mendelsohn, J., 2017. *Informal Settlements in Namibia: Their Nature and Growth*. Development Workshop Namibia. Windhoek.

102 Weber and Mendelsohn, 2017. *Informal Settlements in Namibia*.

103 Sweeny-Bindels, E. 2011. *Housing Policy and Delivery in Namibia*. Institute for Public Policy Research. Windhoek. Available at: *https://ippr.org.na/wp-content/uploads/2011/10/Housing%20Report%20IPPR.pdf*

104 Ezeh, A., Oyebode, O., Satterthwaite, D., Chen, Y. F., Ndugwa, R., Sartori, J., Mberu, B., Melendez-Torres, G. J., Haregu, T., Watson, S. I., Caiaffa, W., Capon, A., Lilford, R. J. 2017. *The history, geography and sociology of slums and the health problems of people who live in slums*. The Lancet. 389(10068) 547-558

105 Remmert and Ndhlovu, 2018. *Housing in Namibia*.

106 Fernandes, E. 2011. *Regularization of Informal Settlements in Latin America*. Lincoln Institute for Land Policy. Cambridge, MA, US. Available at: *https://www.lincolninst.edu/sites/default/files/pubfiles/regularization-informal-settlements-latin-america-full_0.pdf*

107 Rode, P., Heeckt, C., da Cruz, N.F., 2019. *National Transport Policy and Cities: Key Policy Interventions to Drive Compact and Connected Urban Growth*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2019/03/CUT2019_national_transport_policy_and_cities_final.pdf*

Venter, C., Mahendra, A., Hidalgo, D., 2019. F*rom Mobility to Access for All: Expanding Urban Transportation Choices in the Global South*. World Resources Institute, Washington, DC. Available at: *www.citiesforall.org*

108 WHO, 2019. *Air pollution*. World Health Organization. Geneva. Available at: *https://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/*

109 Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation, 2014. *Transport for Health: The Global Burden of Disease from Motorized Road Transport*. Seattle and Washington, DC.

110 Sims, R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D'Agosto, M., et al., 2014. Transport. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. Available at: *https://www.ipcc.ch/report/ar5/wg3/*

111 Rode et al., 2019. *National Transport Policy and Cities*.

112 Beard, V.A., Mahendra, A., Westphal, M.I. 2016. *Towards a More Equal City: Framing the Challenges and Opportunities*. World Resources Institute, Washington, DC. Available at: *www.citiesforall.org*

113 Canales, D., Bouton, S., Trimble, E., Thayne, J., Da Silva, L., Shastry, S., Knupfer, S., Powell, M. 2017. *Connected Urban Growth: Public-Private Collaborations for Transforming Urban Mobility*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/11/NCE2017_CUT_UrbanMobility_02012018.pdf*

114 Ministry of Foreign Affairs of Denmark, 2019. *A nation of cyclists: 100 years of biking*. Available at: *https://denmark.dk/people-and-culture/biking*

115 UN-DESA, 2018. *World Urbanization Prospects 2018*.

116 Republic of Colombia. 1991. *Text of the Constitution of Colombia*. Available at: *http://confinder.richmond.edu/admin/docs/colombia_const2.pdf*

117 Betancur, J.J. 2007. *Approaches to the regularization of informal settlements: the case of PRIMED in Medellín, Colombia*. Global Urban Development Magazine **3**(1) 1-15.

118 Brand, P., and Dávila, J., 2011. *Aerial Cable-car Systems for Public Transport in Low-income Urban Areas: Lessons from Medellín, Colombia*. Presented at the 3rd World Planning Schools Congress. Perth. Available at: *https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/11788/Aerial_cable_car.pdf?sequence=1*

119 Brand and Dávila, 2011. *Aerial Cable-car Systems for Public Transport in Low-income Urban Areas*.

120 Dávila, J.D., 2013. *Urban Mobility and Poverty: Lessons from Medellín and Soacha, Colombia*. Development Planning Unit, UCL and Universidad Nacional de Colombia, London.

121 Murray, C., Monetti, E., Ween, C. 2017. *Real Estate and Urban Development in South America: Understanding Local Regulations and Investment Methods in a Highly Urbanised Continent*. Routledge.

122 Martínez-Jaramillo, J. E., Arango-Aramburo, S., Álvarez-Uribe, K. C. and Jaramillo-Álvarez, P., 2017. *Assessing the impacts of transport policies through energy system simulation: The case of the Medellín Metropolitan Area, Colombia*. Energy Policy, 101. 101–108. DOI:10.1016/j.enpol.2016.11.026.

123 Brand and Dávila, 2011. *Aerial Cable-car Systems for Public Transport in Low-income Urban Areas*.

124 Jensen, J.S., and Jørgensen, U., 2018. The professional knowledge politics of urban transport transitions in the greater Copenhagen region. In: *The Politics of Urban Sustainability Transitions: Knowledge, Power and Governance*. Jensen, J.S., Späth, P., Cashmore, M. (eds.). Routledge.

125 Jensen, J.S., Cashmore, M., Elle, M., 2017. *Reinventing the bicycle: how calculative practices shape urban environmental governance*. Environmental Politics. 26(3) 459-479.

126 Knowles, R.D., 2012. Transit oriented development in Copenhagen, Denmark: from the finger plan to Ørestad. *Journal of transport Geography*. **22** 251-261.

127 Ministry of Foreign Affairs of Denmark, 2019. A nation of cyclists.

128 Jensen and Jørgensen, 2018. The professional knowledge politics of urban transport transitions in the greater Copenhagen region.

129 Knowles, R.D., 2012. *Transit oriented development in Copenhagen, Denmark: from the finger plan to Ørestad*. Journal of transport Geography. **22** 251-261.

130 Pucher, J., Buehler, R. 2008. *Making cycling irresistible: lessons from the Netherlands, Denmark and Germany*. Transport Reviews. **28** (4) 495-528.

131 Jensen and Jørgensen, 2018. The professional knowledge politics of urban transport transitions in the greater Copenhagen region.

132 City of Copenhagen, 2017. *Copenhagen City of Cyclists: Facts and Figures 2017*. Available at: *https://urbandevelopmentcph.kk.dk/sites/urbandevelopmentcph.kk.dk/files/city_of_cyclists_facts_and_figures_2018.pdf*

133 City of Copenhagen, 2017. *Copenhagen City of Cyclists*.

134 Super Cykelstier, 2017. The routes of cycle superhighways. Available at: *https://supercykelstier.dk/the-routes/*

135 Ministry of Foreign Affairs of Denmark, 2019. A nation of cyclists.

136 Knowles, R.D. 2012. *Transit oriented development in Copenhagen, Denmark: from the finger plan to Ørestad*. Journal of transport Geography. **22** 251-261.

137 Vuk, G. 2005. *Transport impacts of the Copenhagen Metro*. Journal of Transport Geography. **13** (3) 223-233

138 Vuk, G. 2005. *Transport impacts of the Copenhagen Metro*.

139 City of Copenhagen, 2019. *Mobility in Copenhagen*. Copenhagen. Available at: *https://urbandevelopmentcph.kk.dk/artikel/mobility-copenhagen*

140 Pucher, J., Buehler, R. 2008. *Making cycling irresistible: lessons from the Netherlands, Denmark and Germany*. Transport Reviews. **28** (4) 495-528.

141 Hirota, K., Poot, J. 2005. Taxes and the environmental impact of private car use: Evidence from 68 cities. *Methods and Models in Transport and Telecommunications*. Springer. Berlin and Heidelberg. 299-317.

142 Buydens, S. 2016. *Consumption Tax Trends: VAT/GST and Excise Rates, Trends and Policy Issues*. Organisation for Economic Co-operation and Development, Paris, France.

143 UITP, 2015. *Mobility in Cities Database*. Union Internationale des Transports Publics. Brussels. Available at: *https://www.uitp.org/sites/default/files/MCD3-sample%20data_0.pdf*

144 Gouldson, A., Sudmant, A., Khreis, H., Papargyropoulou, E. 2018. *The Economic and Social Benefits of Low-Carbon Cities: A Systematic Review of the Evidence*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/06/CUT2018_CCCEP_final_rev060718.pdf*

145 Lucon et al., 2014. Buildings.

146 Omlin, S., Bauer, G.F., Brink, M. 2011. Effects of noise from non-traffic-related ambient sources on sleep: Review of the literature of 1990-2010. *Noise and Health*. **13**(53), 299.

147 Stansfeld, S.A., Berglund, B., Clark, C., Lopez-Barrio, I., Fischer, P., Ohrström, E., Haines, M.M., Head, J., Hygge, S., van Kamp, I., Berry, B.F. 2005. Aircraft and road traffic noise and children's cognition and health: a cross-national study. *The Lancet*. **365**(9475). 1942–1949.

Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., Stansfeld, S. 2014. Auditory and non-auditory effects of noise on health. *The Lancet*. **383**(9925) 1325–1332.

148 Oates, L., Sudmant, A., Gouldson, A., Gillard, R. 2018. *Reduced Waste and Improved Livelihoods for All: Lessons on Waste Management from Ahmedabad, India*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/09/CUT18_Leeds_Waste_Final-1.pdf*

149 Bapat, S., Bhatia, R.K. 2018. Comparative analysis of solid waste management in developing smart cities of India. *International Journal of Advanced Research*. **6**(10). 1330-1339

150 Smart City Indore, 2019. *Solid Waste Management*. Indore. Available at: *www.smartcityindore.org/solid-waste/*

151 Bansal, R., 2017. The curious case of a clean clean Indore. *Business Today*. Available at: *https://www.businesstoday.in/magazine/columns/the-curious-case-of-a-clean-clean-indore/story/254144.html*

152 Bansal, R., 2017. The curious case of a clean clean Indore.

Bhargava, A., 2017. How Indore became garbage-free and beat every other city to it. *The Better India*, September. Available at: *https://www.thebetterindia.com/114040/indore-madhya-pradesh-clean-garbage-free-india/*

153 Bhargava, A., 2017. How Indore became garbage-free and beat every other city to it.

Bapat, S., Bhatia, R.K. 2018. Comparative analysis of solid waste management in developing smart cities of India. *International Journal of Advanced Research*. **6**(10). 1330-1339

154 Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F. 2018. *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. World Bank, Washington, DC.

155 Bansal, R., 2017. The curious case of a clean clean Indore.

156 Smart City Indore, 2019. *Solid Waste Management*. Indore. Available at: *www.smartcityindore.org/solid-waste/*

157 Sambyal, S.S., Agarwal, R. 2018. *Forum of Cities that Segregate: Assessment Report 2017-2018*. Centre for Science and Environment. New Delhi.

158 Smart City Indore, 2019. *Solid Waste Management*. Indore. Available at: *www.smartcityindore.org/solid-waste/*

159 Ministry of Housing and Urban Affairs, 2019. *2019 Innovations and Best Practices*. Available at: *http://164.100.228.143:8080/sbm/content/writereaddata/SS2019%20Innovations%20Report_compressed.pdf*

160 Smart City Indore, 2019. *Solid Waste Management*. Indore. Available at: *www.smartcityindore.org/solid-waste/*

161 Sinha, M. 2018. Swachh lessons for Noida, from Indore. *Times of India*. Available at: *https://timesofindia.indiatimes.com/city/noida/swachh-lessons-for-noida-from-indore/articleshow/65801971.cms*

162 Ministry of Jal Shakti, 2019. *Swachh Bharat Mission – Gramin*. Available at: *http://swachhbharatmission.gov.in/sbmcms/index.htm*

163 Kumar, A., 2018. Indore Municipal Corporation to start issuing municipal bond. *Times of India*, 20 June. *https://timesofindia.indiatimes.com/city/indore/indore-municipal-corporation-to-start-issuing-municipal-bonds/articleshow/64670674.cms*

164 UCLG and OECD, 2016. *Profile – India*. United Cities and Local Governments and the Organisation for Economic Co-operation and Development. Barcelona and Paris. Available at: *https://www.oecd.org/regional/regional-policy/profile-India.pdf*

165 Bansal, R., 2017. The curious case of a clean clean Indore.

166 Bhargava, A., 2017. How Indore became garbage-free and beat every other city to it.

167 Bhargava, A., 2017. How Indore became garbage-free and beat every other city to it.

168 Alliance of Indian Waste Pickers, 2018. *India's cleanest city Indore evicting waste-pickers from work*. Available at: *https://globalrec.org/2018/12/17/indias-cleanest-city-indore-evicting-waste-pickers-from-work/*

169 ICLEI-Local Governments for Sustainability, 2019. *Municipal Solid Waste Management Exposure Workshops in Indore*. New Delhi. Available at: *http://southasia.iclei.org/newsdetails/article/municipal-solid-waste-management-exposure-workshop-at-indore.html*

170 Bansal, R., 2017. The curious case of a clean clean Indore.

171 2019. Heat wave: Red alert over heat in Gujarat during weekend. *Times of India*. Available at: *https://timesofindia.indiatimes.com/city/ahmedabad/heat-wave-red-alert-over-heat-in-gujarat-during-weekend/articleshow/69034317.cms*

Snaith, E., 2019. 'The worst is still to come': Heatwave sees roads melt, rail tracks buckle and schools closed as 44C temperatures scorch Europe. *The Independent*, London. Available at: *https://www.independent.co.uk/news/world/europe/europe-heatwave-weather-record-temperatures-wildfires-deaths-spain-germany-france-a8978071.html*

Wahlquist, C., 2019. Melbourne heatwave: city expecting 44C as Victoria faces hottest day since Black Saturday. *The Guardian*. Available at: *https://www.theguardian.com/australia-news/2019/jan/25/melbourne-heatwave-city-expecting-44c-as-victoria-faces-hottest-day-since-black-saturday*

172 van der Voo, L. 2018. California wildfire survivors face new challenge: rebuilding. Reuters. Available at: *https://uk.reuters.com/article/us-california-wildfires-insurance/california-wildfire-survivors-face-new-challenge-rebuilding-idUKKBN1O10D2*

173 Alexander, C., 2019. Cape Town's 'Day Zero' Water Crisis, One Year Later. *CityLab*. Available at: *https://www.citylab.com/environment/2019/04/cape-town-water-conservation-south-africa-drought/587011/*

Pathak, S., 2019. *No Drips, No Drops: A City Of 10 Million Is Running Out Of Water*. NPR. Available at: *https://www.npr.org/sections/goatsandsoda/2019/06/25/734534821/no-drips-no-drops-a-city-of-10-million-is-running-out-of-water?t=1561722012946*

Ritter, K. 2018. *São Paulo Heading To Another Dry Spell*. Circle of Blue. São Paulo, Brazil. Available at: *https://www.circleofblue.org/2018/water-climate/drought/sao-paulo-heading-to-another-dry-spell/*

174 Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Patel, S., 2018. *Responding to Climate Change in Cities and in their Informal Settlements and Economies*. Background paper for the IPCC Cities and Climate Change Conference. Edmonton. Available at: *https://pubs.iied.org/pdfs/G04328.pdf*

175 UNISDR. 2009. G*lobal Assessment Report on Disaster Risk Reduction 2009 – Risk and Poverty in a Changing Climate*. United Nations International Strategy for Disaster Reduction. Geneva.

176 McGranahan, G., Balk, D., Anderson, B. 2007. *The rising tide: assessing the risks of climate change and human settlements in low-elevation coastal zones*. Environment and Urbanization. **19**(1). 17–37

177 McGranahan et al., 2007. The rising tide.

178 Beck, M.W., 2014. *Coasts at Risk: An Assessment of Coastal Risks and the Role of Environmental Solutions*. United Nations University, The Nature Conservancy and the University of Rhode Island Graduate School of Oceanography.

179 Goodell, J., 2017. *The Water Will Come: Rising Seas, Sinking Cities, and the Remaking of the Civilized World*. Hachette, New York.

Hansen, J.E., 2007. *Scientific reticence and sea level rise*. Environmental Research Letters. 2. 024002

Vermeer, M., Rahmstorf, S. 2009. *Global sea level linked to global temperature*. Proceedings of the National Academy of Sciences of the United States of America. **106**(51) 21527-21532

Wallace-Wells, D., 2019. *The Uninhabitable Earth: Life After Warming*. Tim Duggan Books.

180 Gray, M., Ljungwaldh, S., Watson, L., Kok, I., 2018. *Powering down coal: Navigating the economic and financial risks in the last years of coal power*. Carbon Tracker. Available at: *https://www.carbontracker.org/wp-content/uploads/2018/12/CTI_Powering_Down_Coal_Report_Nov_2018_4-4.pdf*

181 Batten, S., Sowerbutts, R., Tanaka, M., 2016. *Let's Talk About the Weather: the Impact of Climate Change on Central Banks*. Bank of England Working Paper No. 603. London.

182 Rosemberg, A., 2010. Building a Just Transition: The linkages between climate change and employment. *International Journal of Labour Research*. **2**(2). 125-162

183 Milanovic, B., 2016. Global Inequality: *A New Approach for the Age of Globalization*. Harvard University Press. Cambridge, US.

184 IMF, 2018. *IMF Annual Report 2018: Building a Shared Future*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/external/pubs/ft/ar/2018/eng/assets/pdf/imf-annual-report-2018.pdf*

185 Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., et al., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science*, 1259855. DOI:10.1126/science.1259855.

186 Berger, T., Frey, C.B., 2016. *Structural Transformation in the OECD: Digitalisation, Deindustrialisation and the Future of Work*. Organisation for Economic Co-operation and Development, Paris.

187 Martine, G., McGranahan, G., Montgomery, M., Fernández-Castilla, R., 2008. *The New Global Frontier: Urbanization, Poverty and Environment in the 21st Century*. Earthscan, London.

188 Tacoli, C., McGranahan, G., Satterthwaite, D., 2008. Urbanization, poverty and inequity: is rural-urban migration a poverty problem, or part of the solution? In: *The New Global Frontier: Urbanization, Poverty and Environment in the 21st Century*. Martine, G., McGranahan, G., Montgomery, M., Fernández-Castilla, R. (eds.). Earthscan, London.

189 World Bank. 2009. *World Development Report 2009: Reshaping Economic Geography*. World Bank, Washington, DC. Available at: *http://documents.worldbank.org/curated/en/730971468139804495/pdf/437380REVISED01BLIC1097808213760720.pdf*

190 Carruthers, J.I., Ulfarsson, G.F. 2003. Urban sprawl and the cost of public services. *Environment and Planning B: Planning and Design*. **30**(4) 503-522.

191 Foster, V., Briceno-Garmendia, C. 2010. *Africa's Infrastructure: A Time for Transformation*. World Bank, Washington, DC. Available at: *https://openknowledge.worldbank.org/handle/10986/2692*

192 Gill, I.S., Goh, C.C. 2010. *Scale Economies and Cities*. World Bank, Washington, DC. Available at: *http://documents.worldbank.org/curated/en/451181468325199804/pdf/768080JRN0WBR000Box374387B00PUBLIC0.pdf*

193 Guerrero Compeán, R., Libertun de Duren, N. 2016. Growing resources for growing cities: Density and the cost of municipal public services in Latin America. *Urban Studies*. **53**(4) 3082-3107

194 Foster and Briceno-Garmendia, 2010. *Africa's Infrastructure*.

Libertun de Duren, N., Guerrero Compeán, R. 2015. *Growing Resources for Growing Cities: Density and the Cost of Municipal Public Services in Brazil, Chile, Ecuador, and Mexico*. Inter-American Development Bank, Washington, DC.

195 IEA, 2013. *District Heating*. International Energy Agency, Paris. Available at: *https://iea-etsap.org/E-TechDS/PDF/E16_DistrHeat_EA_Final_Jan2013_GSOK.pdf*

196 It can be difficult to disentangle the economic benefits associated with scale and density, since the two are often interrelated: larger cities often have higher population density.

197 Carlino, G., Kerr, W.R., 2014. Agglomeration and Innovation. *NBER Working Paper 20367*. National Bureau of Economic Research. Cambridge, MA, US. Available at: *https://www.nber.org/papers/w20367.pdf*

198 Duranton, G., Puga, D. 2004. Micro-foundations of urban agglomeration economies. *Handbook of Regional and Urban Economics*. **4**. 2063–2117.

199 Turok, I. 2014. South Africa's tortured urbanisation and the complications of reconstruction. In: U*rban Growth in Emerging Economies: Lessons from the BRICS*. McGranahan, G., Martine, G. (eds). Routledge.

200 He, H., Jin, L., Cui, H., Zhou, H., 2018. *Assessment of Electric Car Promotion Policies in Chinese Cities*. The International Council on Clean Transportation, Washington, DC. Available from: *https://www.theicct.org/sites/default/files/publications/China_city_NEV_assessment_20181018.pdf*

201 Ahlfeldt and Pietrostefani, 2017. *Demystifying Compact Urban Growth*.

202 Combes, P.P., Gobillon, L. 2015. The Empirics of Agglomeration Economies. In: Duranton, G., Henderson, V., Strange, W. (eds). *The Handbook of Urban and Regional Economics*. **5** 247-348

203 Ciccone, A. 2008. Urban production externalities. In: *The New Palgrave Dictionary of Economics*. Durlauf, S.N., Blume, L.E. (eds.). Macmillan.

204 Combes, P., Démurger, S., Li, S. 2013. *Urbanisation and Migration Externalities in China*. Centre for Economic Policy Research, London.

205 Chauvin, J.P., Glaeser, E., Ma, Y., Tobio, K. 2016. What is Different about Urbanization in Rich and Poor Countries? Cities in Brazil, China, India and the United States. *NBER Working Paper No. 22002*. National Bureau of Economic Research. Available at *https://www.nber.org/papers/w22002*

206 The analysis of urban areas in the European Union uses NUTS (nomenclature of territorial units for statistics). It controls for national R&D investment, infrastructure stock, level of STEM employment, tertiary education rate and time/country fixed effects. The analysis of urban areas in the US uses MSAs (metropolitan statistical areas) and controls for share of high-skilled workers, employment rate, infrastructure stock, number of universities, time/country fixed effects and the share of biotech, ICT and manufacturing workers. MSAs are widely used to analyse economic geography in the US However, these are an imperfect proxy for urban density because the spatial units do not correspond to functional urban areas. MSAs will therefore often encompass both urban and rural areas. Recognising the large body of literature using MSAs, we include a comparable analysis here – but flag that the NUTS system used in Europe is a much more robust measure of urban density.

207 Schumpeter, J.A. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Harvard University Press. Cambridge, MA, US.

208 Carrincazeaux, C., Lunga, Y., Rallet, A. 2001. Proximity and localisation of corporate R&D activities. *Research Policy*. **30** 777-789

209 Glaeser, E., and Kahn, M., 2010. The Greenness of Cities: Carbon Dioxide Emissions and Urban Development. *Journal of Urban Economics*. **67**(3) 404-418.

210 Glaeser and Kahn, 2010. The Greenness of Cities.

211 Lee, S., Lee, B. 2014. The Influence of Urban Form on GHG Emissions in the US Household Sector. *Energy Policy*. **68** 534-549

212 Makido, Y., Dhakal, S., Yamagata, Y. 2012. Relationship Between Urban Form and CO_2 Emissions: Evidence from 50 Japanese Cities. *Urban Climate*. **2** 55-67

213 Wu, J., Wu, Y., Guo, X. 2016. Urban Density and Carbon Emissions in China. In: *China's New Sources of Economic Growth: Vol. 1: Reform, Resources and Climate Change*. Song, L., Garnaut, R., Fang, C., Johnston, L. (eds.). ANU Press, Canberra. 479–500.

214 IPBES, 2019. *Global Assessment Report on Biodiversity and Ecosystem Services*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Paris. Available at: *https://www.ipbes.net/system/tdf/ipbes_7_10_add-1-_advance_0.pdf?file=1&type=node&id=35245*

215 de Coninck, H., Revi, A., Babiker, M., Bertoldi, P., Buckeridge, M., et al., 2018. Strengthening and implementing the global response. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, et al. (eds.). Intergovernmental Panel on Climate Change, Geneva. Available at: *https://www.ipcc.ch/sr15/*

216 Thebo, A.L., Drechsel, P., Lambin, E.F., 2014. Global assessment of urban and peri-urban agriculture: Irrigated and rainfed croplands. *Environmental Research Letters*. **9**(11) 114002

217 Based on global GDP of US$84.74 trillion. See: IMF, 2019. *IMF Data Mapper: GDP, current prices: Billions of US dollars*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD*

218 ILO, 2018. *World Employment Social Outlook 2018: Greening with Jobs*. International Labour Organization. Geneva, Switzerland. Available at: *https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_628654.pdf*

219 Gouldson et al., 2018. *The Economic and Social Benefits of Low-Carbon Cities*.

220 Dechezleprêtre, A., Martin, R., Bassi, S. *Climate change policy, innovation and growth*. Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, London. Available at: *http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Dechezlepretre-et-al-policy-brief-Jan-2016.pdf*

221 Dechezleprêtre, A., Martin, R., Bassi, S. C*limate change policy, innovation and growth*. Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, London. Available at: *http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Dechezlepretre-et-al-policy-brief-Jan-2016.pdf*

OECD, 2015. *The Metropolitan Century: Understanding Urbanisation and its Consequences*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://doi.org/10.1787/9789264228733-en*

222 Canales D, Bouton S, Trimble E, Thayne J, Da Silva L, Shastry S, Knupfer S, Powell M. 2017. *Connected Urban Growth: Public-Private Collaborations for Transforming Urban Mobility*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/11/NCE2017_CUT_UrbanMobility_02012018.pdf*

223 IEA, 2018. *Global EV Outlook 2018*.

224 IEA, 2018. *Global EV Outlook 2018*.

225 Hou, X., Chan, C.K., Dong, G.H., Yim, S.H.L. 2019. Impacts of transboundary air pollution and local emissions on PM2.5 pollution in the Pearl River Delta region of China and the public health, and the policy implications. *Environmental Research Letters*. **14**(3) 034005

226 Yu, P., Zhang, J., Yang, D., Lin, X. and Xu, T., 2019. The evolution of China's new energy vehicle industry from the perspective of a technology–market–policy framework. *Sustainability*, **11**(6). 1711. DOI:10.3390/su11061711.

227 Yu et al., 2019. *The evolution of China's new energy vehicle industry from the perspective of a technology–market–policy framework*.

228 Poon, L. 2018. How China Took Charge of the Electric Bus Revolution. *CityLab*. Available at: *https://www.citylab.com/transportation/2018/05/how-china-charged-into-the-electric-bus-revolution/559571/*

229 Yu et al., 2019. *The evolution of China's new energy vehicle industry from the perspective of a technology–market–policy framework*.

230 Chen, K., Hao, H., Liu, Z. 2018. Synergistic Impacts of China's Subsidy Policy and New Energy Vehicle Credit Regulation on the Technological Development of Battery Electric Vehicles. *Energies*. **11**(11) 1-19

231 World Bank, 2011. *The China new energy vehicles program: challenges and opportunities*. World Bank, Washington, DC. Available at: *http://documents.worldbank.org/curated/en/333531468216944327/The-China-new-energy-vehicles-program-challenges-and-opportunities*

232 IEA, 2018. *Global EV Outlook 2018*.

233 Tian, Y. 2018. China Is About to Shake Up the World of Electric Cars. *Bloomberg News*. Available at: *https://www.bloomberg.com/news/articles/2018-11-14/china-is-about-to-shake-up-the-world-of-electric-cars-quicktake*

234 IEA, 2018. *Global EV Outlook 2018*.

235 Ahlfeldt and Pietrostefani, 2017. *Demystifying Compact Urban Growth*.

OECD, 2015. *The Metropolitan Century: Understanding Urbanisation and its Consequences*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://doi.org/10.1787/9789264228733-en*

236 CDP, 2019. *Company Scores*. Available at: *https://www.cdp.net/en/companies/companies-scores*

237 Bertaud, A. 2014. *Cities as Labor Markets*. The Marron Institute of Urban Management, New York. Available at: *https://pdfs.semanticscholar.org/2ed3/64242ef0d00f9c15a2a243f9249204a2aa7a.pdf*

238 Ehrenhalt, A. 2012. The Great Inversion and the Future of the American City. Vintage, New York.

Gallagher, L. 2014. *The End of the Suburbs: Where the American Dream is Moving*. Penguin Group, New York.

Speck, J. 2012. *Walkable City: How Downtown Can Save America, One Step at a Time*. Northpoint Press, New York.

239 Malizia, E., Song, Y. 2015. Does downtown office property perform better in live–work–play centers? *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*. **9**(4) 372-387

Pivo, G., Fisher, J.D. 2011. The Walkability Premium in Commercial Real Estate Investments. Real Estate Economics. **39**(2) 185-219.

240 OECD, 2016. *The economic consequences of outdoor air pollution*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://www.oecd.org/environment/indicators-modelling-outlooks/Policy-Highlights-Economic-consequences-of-outdoor-air-pollution-web.pdf*

241 Zheng, S.Q., Kahn, M.E. 2008. Land and residential property markets in a booming economy: New evidence from Beijing. *Journal of Urban Economics*. **63**(2) 743-757

242 Chay, K., Greenstone, M. 2005. Does air quality matter? Evidence from the housing market. *Journal of Political Economy*. **113**(2) 376–424.

243 Brown, A.N. 1997. *The economic determinants of internal migration flows in Russia during transition*. William Davidson Institute. Ann Arbor. Available at: *https://deepblue.lib.umich.edu/bitstream/handle/2027.42/39479/wp89.pdf?sequence=3&isAllowed=y*

Lu, H., Yue, A., Chen, H., Long, R., 2018. Could smog pollution lead to the migration of local skilled workers? Evidence from the Jing-Jin-Ji region in China. *Resources, Conservation and Recycling*. **130**. 177-187

Qin, Y. 2018. Run away? Air pollution and emigration interests in China. *Journal of Population Economics*. **31**(1) 235-266.

244 Glaeser, E.L., Kolko, J., Saiz, A., 2001. Consumer city. *Journal of Economic Geography*. **1**(1) 27-50

245 Tarter, A., Lu, W., 2017. These Cities Make NYC Housing Look Dirt Cheap. Bloomberg News. Available at: *https://www.bloomberg.com/news/articles/2017-10-19/these-cities-make-nyc-housing-look-dirt-cheap*

246 UN-Habitat, 2016. *Slum Almanac 2015–16*.

247 Smolka, M.O., and Larangeira, A.D.A., 2008. Informality and poverty in Latin American urban policy. In: *The New Global Frontier: Urbanization, Poverty and Environment in the 21st Century*. Martine, G., McGranahan, G., Montgomery, M., Fernández-Castilla, R. (eds). Earthscan, London.

248 Moreno Monroy, A., Gars, J., Matsumoto, T., Schumann, A., Ahrend, R., Crook, J., 2019 (forthcoming). *Housing Policies for Sustainable and Affordable Cities: Priorities for National Governments*. Coalition for Urban Transitions, London and Washington, DC.

249 Moreno Monroy et al., 2019 (forthcoming). *Housing Policies for Sustainable and Affordable Cities*.

250 Rodríguez-Pose, A., Storper, M., 2019. Housing, urban growth and inequalities: The limits to deregulation and upzoning in reducing economic and spatial inequality. PEEG Working Paper 19.14. *Papers in Evolutionary Economic Geography*. Available at: *http://econ.geo.uu.nl/peeg/peeg1914.pdf*

251 Moreno Monroy et al., 2019 (forthcoming). *Housing Policies for Sustainable and Affordable Cities*.

252 Roy, A. 2005. Urban Informality: Toward an Epistemology of Planning. *Journal of the American Planning Association*. **71**(2). 147-158

Watson, V. 2009. 'The planned city sweeps the poor away…'§: Urban planning and 21st century urbanisation. *Progress in Planning*. **72** 151-193

253 Pain, K., Black, D., Blower, J., Grimmond, S., Hunt, A., et al. 2018. *Supporting Smart Urban Development: Successful Investing in Density*. Urban Land Institute. London.

254 Farha, L., 2017. *Report of the Special Rapporteur on adequate housing as a component of the right to an adequate standard of living, and on the right to non-discrimination in this context*. UN Human Rights Council. Available at: *https://digitallibrary.un.org/record/861179?ln=en*

255 OECD, UCLG, 2019, 2019 *Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*. Organisation for Economic Co-operation and Development and United Cities and Local Governments. Paris and Barcelona. Available at: *http://www.sng-wofi.org/publications/2019_SNG-WOFI_REPORT_Key_Findings.pdf*

256 Hoza Ngoga, T., 2018. *A quick, cost-effective approach to land tenure regularisation: the case of Rwanda*. International Growth Centre. Kigali, Rwanda. Available at: *https://www.theigc.org/wp-content/uploads/2019/03/Land-tenure-regularisation-the-case-of-Rwanda-March19-FINAL.pdf*

257 World Bank, 2019. *Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)*. Washington, DC. Available at: *https://data.worldbank.org/topic/poverty*

258 World Bank, 2014. *Country Partnership Strategy for Rwanda for the Period FY2014-18*. Washington, DC. Available at: *http://documents.worldbank.org/curated/en/593791468107969027/Rwanda-Country-partnership-strategy-for-the-period-FY2014-2018*

259 WEF, 2014. *The Global Gender Gap Report 2014*. World Economic Forum. Geneva. Available at: *http://www3.weforum.org/docs/GGGR14/GGGR_CompleteReport_2014.pdf*

260 World Bank, 2017. *Reshaping Urbanization in Rwanda: Economic and Spatial Trends and Proposals*. Washington, DC. Available at: *http://documents.worldbank.org/curated/en/176291513839631396/pdf/122178-WP-P157637-PUBLIC-Synthesis-Note-Rwanda-Urbanization-12-07-17-rev.pdf*

261 Goodfellow, T., 2014. Rwanda's political settlement and the urban transition: expropriation, construction and taxation in Kigali. *Journal of Eastern African Studies*. **8**(2) 311-329

262 Nakamura, Y., Williamson, A., 2015. *Government health spending and tax reform in Rwanda, 2000-2013 – A case study*. Results for Development Institute, Washington, DC. Available at: *https://www.hfgproject.org/?download=13882*

263 Rurangwa, E. 2002. *Perspective of Land Reform in Rwanda*. Paper delivered at the FIG XXII International Congress, Washington, DC. Available at: *https://www.fig.net/resources/proceedings/fig_proceedings/fig_2002/Ts7-7/TS7_7_rurangwa.pdf*

Center for Public Impact, 2017. *Land Reform in Rwanda*. Available at: *https://www.centreforpublicimpact.org/case-study/land-reform-rwanda/*

264 Boudreaux, K. 2009. Land Conflict and Genocide in Rwanda. *The Electronic Journal of Sustainable Development*. **1**(3) 61-71

265 Center for Public Impact, 2017. *Land Reform in Rwanda*. Available at: *https://www.centreforpublicimpact.org/case-study/land-reform-rwanda/*

266 Center for Public Impact, 2017. *Land Reform in Rwanda*.

267 Center for Public Impact, 2017. *Land Reform in Rwanda*.

268 Center for Public Impact, 2017. *Land Reform in Rwanda*.

269 Goodfellow, T., 2014. Rwanda's political settlement and the urban transition: expropriation, construction and taxation in Kigali. *Journal of Eastern African Studies*. **8**(2) 311-329

270 Goodfellow, T., 2017. Taxing property in a neo-developmental state: The politics of urban land value capture in Rwanda and Ethiopia. *African Affairs*. **116**(465) 549–572

271 Ministry of Infrastructure, 2015. *National Urbanization Policy*. Available at: *http://www.mininfra.gov.rw/fileadmin/user_upload/Rwanda_National_Urbanization_Policy_2015.pdf*

272 Fischedick, M. and Roy, J., 2014. Industry. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. Available at: *https://www.ipcc.ch/report/ar5/wg3/*

273 Ng, S., Mabey, N., Gaventa, J., 2016. *Pulling Ahead on Clean Technology: China's 13th Five Year Plan Challenges Europe's Low Carbon Competitiveness*. E3G. Berlin. Available at: *https://www.e3g.org/docs/E3G_Report_on_Chinas_13th_5_Year_Plan.pdf*

274 Patel, S., Sharma, K. 1998. One David and three Goliaths: avoiding anti-poor solutions to Mumbai's transport problems. *Environment and Urbanization*. **10**(2) 149-160

275 Reitzenstein, A., Popp, R., 2019. *The German Coal Commission – A Role Model for Transformative Change?* E3G. Berlin. Available at: *https://www.e3g.org/library/a-role-model-for-european-coal-phase-out-five-lessons-from-the-german-coal*

276 van der Ven, H., Bernstein, S., Hoffmann, M., 2017. Valuing the contributions of nonstate and subnational actors to climate governance. *Global Environmental Politics*. **17** 1-20.

277 Global Covenant of Mayors for Climate & Energy, 2019. *Implementing Climate Ambition*.

278 C40 Cities Climate Leadership Group, 2014. *C40 Cities: The Power to Act*.

279 UN-DESA, 2018. *World Urbanization Prospects 2018*.

Broekhoff et al., 2018. *Building Thriving, Low-Carbon Cities*.

280 Fuhr, H., Hickmann, T., Kern, K., 2018. The role of cities in multi-level climate governance: local climate policies and the 1.5°C target. *Current Opinion in Environmental Sustainability*. 30 1-6

281 Cartwright, A., Palmer, I., Taylor, A., Pieterse, E., Parnell, S., Colenbrander, S., 2018. *Developing Prosperous and Inclusive Cities in Africa – National Urban Policies to the Rescue?* Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2018/09/CUT18_Africa_NatUrbanPolicies_final.pdf*

282 Ahmad, E., Dowling, D., Chan, D., Colenbrander, S., and Godfrey, N., 2019. *Scaling Up Investment for Sustainable Urban Infrastructure: A Guide to National and Subnational Reform*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2019/04/CUT2019_Scaling_up_investment_for_sustainable_urban_infrastructure.pdf*

283 Watson, V., 2013. African urban fantasies: dreams or nightmares? *Environment and Urbanization*. **26**(1) 215–231

284 OECD, 2014. OECD *Regional Outlook 2014: Regions and Cities: Where Policies and People Meet*. Organisation for Economic Co-operation and Development, Paris.

OECD, 2015. *Building Successful Cities: A National Urban Policy Framework Organisation for Economic Co-operation and Development, Paris*. Available at: *https://www.slideshare.net/OECD-GOV/oecd-national-urban-policy-framework?ref=https://www.oecd.org/gov/national-urban-policies.htm*

285 Rode, P., Heeckt, C., Ahrend, R., Huerta Melchor, O., Robert, A., Badstuber, N., Hoolachan, A., Kwami, C., 2017. *Integrating National Policies to Deliver Compact, Connected Cities: An Overview of Transport and Housing*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/12/NCE2017_OECD_LSE_NationalPolicies-1.pdf*

OECD, 2015. *OECD Urban Policy Reviews: Mexico 2015: Transforming Urban Policy and Housing Finance*. Organisation for Economic Co-operation and Development, Paris.

286 Rode et al., 2017. *Integrating National Policies to Deliver Compact, Connected Cities*.

287 Broekhoff et al., 2018. *Building Thriving, Low-Carbon Cities*.

288 76 countries have an explicit National Urban Policy (NUP), i.e. a country has a policy called "National Urban Policy", "National Urbanisation Policy", "National Urban Strategy" or a similarly close variant. 74 countries have an implicit or partial NUP, i.e. a country has many of the elements of a NUP in place but these are not brought together in a formal or explicit NUP. There are 195 countries. Source: UN-Habitat and OECD, 2018. Global State of National Urban Policy.

289 Tollin, N., Hamhaber, J., Frafakos, S., Lwasa, S., Morato, J., 2016. *Sustainable urbanization in the Paris Agreement: Comparative review of nationally determined contributions for urban content*. UN-Habitat. Nairobi.

290 Cociña Varas, C.L., 2017. *Housing as Urbanism: The role of Housing Policies in Reducing Urban Inequalities: A study of post 2006 Housing Programmes in Puente Alto, Chile*. PhD thesis, University College London, London. Available at: *http://discovery.ucl.ac.uk/1571836/14/20170831_FINAL%20THESIS_VIVA%20CORRECTIONS%20FINAL_med.pdf*

291 UN-DESA, 2018. *World Urbanization Prospects 2018*.

292 Tokman, A. 2006. El MINVU, la política habitacional y la expansión excesiva de Santiago. In: *Santiago. Dónde Estamos y Hacia Dónde Vamos*. Galetovic, A. (ed.) Santiago de Chile. 489–522.

293 OECD, 2016. *Housing policy in Chile*. OECD Social, Employment and Migration Working Papers No. 173. Organisation for Economic Co-operation and Development, Paris.

294 Rojas, E., 2019. "No time to waste" in applying the lessons from Latin America's 50 years of housing policies. *Environment and Urbanization*. **31**(1) 177-192

295 Rojas, E., 2016. Housing policies and urban development: lessons from the Latin American experience, 1960–2010. In: *Land and the City*. Lincoln Institute of Land Policy. McCarthy, G., Ingram, G., Moody, S. (eds). Cambridge, MA, US. 301–356. Available at *https://www.lincolninst.edu/sites/default/files/pubfiles/land-and-the-city-full_0.pdf*

296 Cities Alliance. 2003. *Annual Report*. World Bank, Washington, DC. Available at: *http://documents.worldbank.org/curated/en/827631468350157628/pdf/30087.pdf*

297 Jiron, P., 2013. The evolution of informal settlements in Chile. In: *Rethinking the Informal City: Critical Perspectives from Latin America*. Hernández, F., Kellett, P., Allen, L.K. (eds). Berghan Books, Oxford.

OECD, 2016. *Housing policy in Chile*. OECD Social, Employment and Migration Working Papers No. 173. Organisation for Economic Co-operation and Development, Paris.

298 Buillon, P., Azevedo, V., Medellin, N., Boruchowicz, C., 2012. Two bedrooms, two bathrooms and a big yard? Housing demand in Latin America and the Caribbean. In: *Room for Development: Housing Markets in Latin America and the Caribbean*. Bouillon, C. (ed). Palgrave Macmillan. 51–86.

299 Borsdorf, A., Hidalgo, R., Zunino, H., 2013. Social housing policies under changing framework conditions in Santiago de Chile. In: *Forschen Im Gebirge: Investigating the Mountains/Investigando Las Montanas*. Borsdorf, A. (ed). Austrian Academy Press.

300 Rojas, E., Greene, M., 1995. Reaching the poor: lessons from the Chilean housing experience. *Environment & Urbanization*. **7**(2) 31-50

301 OECD, 2016. *Housing policy in Chile*. OECD Social, Employment and Migration Working Papers No. 173. Organisation for Economic Co-operation and Development, Paris.

302 Rojas, E., 2019. "No time to waste" in applying the lessons from Latin America's 50 years of housing policies.

303 OECD/UCLG, 2019. 2019 *Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*. Organisation for Economic Co-operation and Development and United Cities and Local Governments, Paris and Barcelona. Available at: *http://www.sng-wofi.org/publications/2019_SNG-WOFI_REPORT_Key_Findings.pdf*

304 OECD/UCLG, 2019. *2019 Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*.

305 OECD/UCLG, 2019. *2019 Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*.

306 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

307 Lincoln Institute of Land Policy and World Bank, 2016. *Habitat III Policy Paper 5 – Municipal Finance and Local Fiscal Systems*. UN-Habitat. Nairobi. Available at: *http://habitat3.org/wp-content/uploads/Habitat%20III%20Policy%20Paper%205.pdf*

308 OECD/UCLG, 2019. 2019 *Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*.

309 Collier, P., and Venables, A.J., 2016. Urban infrastructure for development. *Oxford Review of Economic Policy*. **32**(3) 391-409

310 OECD/UCLG, 2019. *2019 Report of the World Observatory on Subnational Government Finance and Investment – Key Findings*.

311 Coady, D., Parry, I., Le, N.-P., Shang, B., 2019. *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509*

312 Bouyé, M., Dagnet, Y., 2018. *The Yellow Vests Movement Isn't Anti-Climate Action; It's Pro-Social Justice*. World Resources Institute. Available at: *https://www.wri.org/blog/2018/12/yellow-vests-movement-isn-t-anti-climate-action-it-s-pro-social-justice*

313 Stern, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge University Press. Cambridge, UK.

314 IMF, 2019. *Fiscal Policies for Paris Climate Strategies – From Principle to Practice*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/en/Publications/Policy-Papers/Issues/2019/05/01/Fiscal-Policies-for-Paris-Climate-Strategies-from-Principle-to-Practice-46826*

315 Floater, G., Dowling, D., Chan, D., Ulterino, M., Braunstein, J., McMinn, T., 2017. *Financing the Urban Transition: Policymakers' Summary*. Coalition for Urban Transitions, London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/workingpaper/financing-the-urban-transition-policymakers-summary/*

316 Floater et al., 2017. *Financing the Urban Transition: Policymakers' Summary*.

317 White, R., Wahba, S., 2019. Addressing constraints to private financing of urban (climate) infrastructure in developing countries. *International Journal of Urban Sustainable Development*. In press.

318 Colenbrander, S., Lindfield, M., Lufkin, J., Quijano, N., 2018. *Financing Low-Carbon, Climate-Resilient Cities*. Background paper for the Intergovernmental Panel on Climate Change (IPCC) Cities and Climate Change Conference. Edmonton. Available at: *https://citiesipcc.org/wp-content/uploads/2018/03/IPCC-Background-Paper-Financing-Low-Carbon-Climate-Resilient-Cities.pdf*

319 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

320 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

321 World Bank, 2018. *Procuring Infrastructure Public-Private Partnerships 2018: Assessing Government Capability to Prepare, Procure, and Manage PPPs*. Washington, DC.

322 Gorelick, J., 2018. Supporting the future of municipal bonds in sub-Saharan Africa: the centrality of enabling environments and regulatory frameworks. *Environment and Urbanization*. **30**(1) 103–122

323 Floater et al., 2017. *Financing the Urban Transition: Policymakers' Summary*.

324 Smolka, M.O., 2013. I*mplementing Value Capture in Latin America Policies and Tools for Urban Development*. Lincoln Institute of Land Policy. Cambridge, MA, US. Available at: *https://www.lincolninst.edu/sites/default/files/pubfiles/implementing-value-capture-in-latin-america-full_1.pdf*

325 Fallon, A., 2016. *How Kampala is building a culture of taxpaying. Citiscope*. Available at: *http://archive.citiscope.org/story/2016/how-kampala-building-culture-taxpaying*

326 Chelminski, K., 2018. *Fossil Fuel Subsidy Reform in Indonesia*. In: van Asselt, H., Skovgaard, J. (eds), *The Politics of Fossil Fuel Subsidies and their Reform*. Cambridge University Press. Cambridge, UK. 193-211

327 Diop, N., 2014. *Why Is Reducing Energy Subsidies a Prudent, Fair, and Transformative Policy for Indonesia?* World Bank, Washington, DC.

328 World Bank. 2009. *Imagine a New Indonesia: Spending to Improve Development*. World Bank, Washington, DC. Available at: *http://blogs.worldbank.org/eastasiapacific/imagine-a-new-indonesia-spending-to-improve-development*

Rosengard, J.K., McPherson, M.F., 2013. *The Sum Is Greater than the Parts: Doubling Shared Prosperity in Indonesia through Local and Global Integration*. Gramedia Pustaka Utama. Cambridge, MA, US.

329 Lontoh, L., Clarke, K., Beaton, C., 2014. *Indonesia energy subsidy review. A biannual survey of energy subsidy policies*. International Institute for Sustainable Development and Global Subsidies Initiative. Winnipeg.

Pradiptyo, R., 2016. *Financing development with fossil fuel subsidies: The reallocation of Indonesia's gasoline and diesel subsidies in 2015*. International Institute for Sustainable Development. Winnipeg.

330 Husar, J., Kitt, F., 2016. *Fossil Fuel Subsidy Reform in Mexico and Indonesia*. International Energy Agency, Paris. Available at: *https://www.iea.org/publications/freepublications/publication/PartnerCountrySeriesFossil_Fuel_Subsidy_Reform_Mexico_Indonesia_2016_WEB.pdf*

331 Colenbrander, S., Gouldson, A., Sudmant, A.H., Papargyropoulou, E., 2015. The economic case for low-carbon development in rapidly growing developing world cities: A case study of Palembang, Indonesia. *Energy Policy*. **80**(C) 24-35.

Rosengard, J.K., McPherson, M.F., 2013. *The Sum Is Greater than the Parts: Doubling Shared Prosperity in Indonesia through Local and Global Integration*. Gramedia Pustaka Utama. Cambridge, MA, US.

332 Chelminski, K., 2018. Fossil fuel subsidy reform in Indonesia. In: *The Politics of Fossil Fuel Subsidies and their Reform*. H. van Asselt and J. Skovgaard (eds.). Cambridge University Press, Cambridge, UK. 193-211

333 Chelminski, K., 2018. Fossil fuel subsidy reform in Indonesia.

334 Chelminski, K., 2018. Fossil fuel subsidy reform in Indonesia.

Clements, B., Coady, D., Fabrizio, S., Dizioli, A., Funke, K., et al., 2013. *Case Studies on Energy Subsidy Reform: Lessons and Implications*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/external/np/pp/eng/2013/012813a.pdf*

335 Lontoh, L., Clarke, K., and Beaton, C., 2014. *Indonesia Energy Subsidy Review. A Biannual Survey of Energy Subsidy Policies*. International Institute for Sustainable Development and Global Subsidies Initiative, Winnipeg.

336 Pradiptyo, R., 2016. *Financing Development with Fossil Fuel Subsidies: The Reallocation of Indonesia's Gasoline and Diesel Subsidies in 2015*. International Institute for Sustainable Development, Winnipeg.

337 Pradiptyo, R., 2016. *Financing Development with Fossil Fuel Subsidies*.

338 OECD, 2019. *Indonesia's effort to phase out and rationalize its fossil fuel subsidies: A report on the G-20 peer review of inefficient fossil fuel subsidies that encourage wasteful consumption in Indonesia*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://www.oecd.org/fossil-fuels/publication/G20%20peer%20review%20Indonesia_Final-v2.pdf*

339 Broekhoff, D., Erickson, P., Lee, C.M., 2015. *What cities do best: Piecing together an efficient global climate governance*. Stockholm Environment Institute. Seattle. Available at: *https://www.sei.org/publications/what-cities-do-best-piecing-together-an-efficient-global-climate-governance/*

340 Fuhr, H., Hickmann, T., Kern, K., 2018. The role of cities in multi-level climate governance: local climate policies and the 1.5°C target. *Current Opinion in Environmental Sustainability*. **30** 1-6

341 White, R., Wahba, S., 2019. Addressing constraints to private financing of urban (climate) infrastructure in developing countries. *International Journal of Urban Sustainable Development*. In press.

342 Archer, J., Fotheringham, N., Symmons, M., Corben, B., 2007. *The Impact of Lowered Speed Limits in Urban Areas*. Presented at the Australasian Road Safety Research Policing Education Conference. Melbourne. Available at: *http://acrs.org.au/files/arsrpe/RS07003.pdf*

343 Leck, H., Roberts, D., 2015. What lies beneath: understanding the invisible aspects of municipal climate change governance. *Current Opinion in Environmental Sustainability*. **13** 61-67

344 van der Ven, H., Bernstein, S., Hoffmann, M., 2017. Valuing the contributions of nonstate and subnational actors to climate governance. *Global Environmental Politics*. **17** 1-20.

345 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

346 Chen, M.A., Beard, V.A., 2018. *Including the Excluded: Supporting Informal Workers for More Equal and Productive Cities in the Global South*. World Resources Institute, Washington, DC. Available online at: *http://www.citiesforall.org*

Brown, D., McGranahan, G., 2016. The urban informal economy, local inclusion and achieving a global green transformation. *Habitat International*. **53** 97-105

347 Bulkeley, H., Castán Broto, V., 2013. Government by experiment? Global cities and the governing of climate change. *Transactions of the Institute of British Geographers*. **38**(3) 361-375

348 van der Ven, H., Bernstein, S., Hoffmann, M., 2017. Valuing the contributions of nonstate and subnational actors to climate governance. *Global Environmental Politics*. **17** 1-20.

349 Westphal, M.I., Thwaites, J., 2016. *Transformational Climate Finance: An Exploration of Low-Carbon Energy*. World Resources Institute, Washington, DC. Available at: *https://www.wri.org/publication/transformational-climate-finance*

350 BMU, 2019. *Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland*. Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety. Available at: *https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/zeitreihen-zur-entwicklung-der-erneuerbaren-energien-in-deutschland-1990-2018.pdf;jsessionid=FB7085E230ACCC888D5F0065C4B2B8DF?__blob=publicationFile&v=20*

351 Pescia, D., Graichen, P., Kleiner, M.M., Jacobs, D., 2015. *Understanding the Energiewende. FAQ on the ongoing transition of the German power system*. Agora Energiewende. Berlin. Available at: *https://www.agora-energiewende.de/fileadmin2/Projekte/2015/Understanding_the_EW/Agora_Understanding_the_Energiewende.pdf*

352 Setton, D., Matuschke, I., 2019. *Social Sustainability Barometer For The Energiewende Shows Broad Support Along With Doubts About Implementation*. Institute for Advanced Sustainability Studies. Potsdam. Available at: *https://www.iass-potsdam.de/en/news/social-sustainability-barometer-energiewende-shows-broad-support-along-doubts-about*

353 Burger, C., Weinmann, J., 2012. *The decentralized energy revolution: business strategies for a new paradigm*. Springer, London.

354 Neuhoff, K., Bach, S., Diekmann, J., Beznoska, M., El-Laboudy, T., 2013. Distributional effects of energy transition: impacts of renewable electricity support in Germany. *Economics of Energy & Environmental Policy*. **2**(1) 41-54.

355 Richards, J.A., Röhrig, K., McLynn, M., 2018. *European Fat Cats: EU Energy Intensive Industries: paid to pollute, not to decarbonise*. Climate Action Network. Available at: *http://www.caneurope.org/docman/fossil-fuel-subsidies-1/3310-european-fat-cats-report-april-2018/file*

356 Schönberger, P., 2013. *Municipalities as Key Actors of German Renewable Energy Governance. An Analysis of Opportunities, Obstacles, and Multi-Level Influences*. Wuppertal Papers. Nr. 186. Wuppertal Institute for Climate, Environment and Energy. Wuppertal. Available at: *https://epub.wupperinst.org/files/4676/WP186.pdf*

357 100% *Renewable Energy, 2019*. Munich, Germany. Available at: *https://www.100-percent.org/munich-germany/*

358 Hockenos, P., 2013. *Local, Decentralized, Innovative: Why Germany's Municipal Utilities are Right for the Energiewende*. Energy Transition: The Global Energiewende. Available at: *https://energytransition.org/2013/09/local-decentralized-innovative-why-germanys-municipal-utilities-are-right-for-the-energiewende/*

359 Leuphana Universität Lüneburg.2013. *Definition und Marktanalyse von Bürgerenergie in Deutschland*. Leuphana Universität Lüneburg. Lüneburg. Available at: *http://www.unendlich-viel-energie.de/media/file/198.trendresearch_Definition_und_Marktanalyse_von_Buergerenergie_in_Deutschland_okt13..pdf*

360 Westphal, M.I., Thwaites, J., 2016. *Transformational Climate Finance: An Exploration of Low-Carbon Energy*. World Resources Institute, Washington, DC. Available at: *https://www.wri.org/publication/transformational-climate-finance*

361 Satterthwaite D., 2016. Missing the Millennium Development Goal targets for water and sanitation in urban areas. *Environment and Urbanization*. **28**(1) 99-118

362 OECD, 2019. *A Territorial Approach to the SDGs*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://www.oecd.org/cfe/territorial-approach-sdgs.htm*

363 Gouldson, A., Colenbrander, S., Sudmant, A., Godfrey, N., Millward-Hopkins, J., Fang, W., Zhao, X., 2015. *Accelerating Low-Carbon Development in the World's Cities*. Global Commission for the Economy and Climate. London and Washington, DC. Available at: *https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/NCE2015_workingpaper_cities_final_web.pdf*

364 Global Environmental Facility and World Bank. 2008. *Mainstreaming Climate Change Mitigation in Cities*. Washington, DC. Available at: *http://siteresources.worldbank.org/GLOBALENVIRONMENTFACILITYGEFOPERATIONS/Resources/Publications-Presentations/MainstreamingClimateChangeMitigation.pdf*

365 Höhne, N., Kuramochi, T., Warnecke, C., Röser, F., Fekete, H., Hagemann, M., Day, T., Tewari, R., Kurdziel, M., Sterl, S., Gonzales, S., 2017. The Paris Agreement: resolving the inconsistency between global goals and national contributions. *Climate Policy*. **17**(1) 16-32

366 World Bank and Ecofys, 2018. *State and Trends of Carbon Pricing 2018*.

367 C40 Cities Climate Leadership Group, 2014. *C40 Cities: The Power to Act*.

368 OECD, 2014. *OECD Regional Outlook 2014: Regions and Cities: Where Policies and People Meet*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://doi.org/10.1787/9789264201415-en*

OECD, 2015. *Building Successful Cities: A National Urban Policy Framework Organisation for Economic Co-operation and Development, Paris*. Available at: *https://www.slideshare.net/OECD-GOV/oecd-national-urban-policy-framework?ref=https://www.oecd.org/gov/national-urban-policies.htm*

369 Broekhoff et al., 2018. *Building Thriving, Low-Carbon Cities*.

370 Hsieh, C.T., Moretti, E., 2018. *Housing Constraints and Spatial Misallocation*. NBER Working Paper 21154. National Bureau of Economic Research. Cambridge, MA, US. Available at: *https://www.nber.org/papers/w21154.pdf*

371 Energy Transitions Commission, 2017. *Better Energy, Greater Prosperity: Achievable Pathways to Low-carbon Energy Systems*. Available at: *http://energy-transitions.org/sites/default/files/BetterEnergy_fullReport_DIGITAL.PDF*

372 Staffell, I., 2017. Measuring the progress and impacts of decarbonising British electricity. *Energy Policy*. **102**. 463-475

373 WGBC, 2019. *The Net Zero Carbon Buildings Commitment*. World Green Building Council, London. Available at: *https://www.worldgbc.org/thecommitment*

374 McKinsey & Co. 2009. *Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*. Available at: *https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/sustainability/cost%20curve%20pdfs/pathways_lowcarbon_economy_version2.ashx*

375 WGBC, 2019. *The Net Zero Carbon Buildings Commitment*.

376 WGBC, 2019. *The Net Zero Carbon Buildings Commitment*.

377 "Net zero buildings for all by 2050" is one of the initiatives proposed by the Energy Coalition and the Infrastructure, Cities and Local Action Coalition in advance of the UN Climate Summit 2019.

378 IPCC, 2014. Summary for Policymakers. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. Available at: *https://www.ipcc.ch/report/ar5/wg3/*

379 WHO, 2019. Air pollution.

380 Kennedy et al., C., Stewart, I.D., and Westphal, M.I., 2019. *Shifting Currents: Opportunities for Low-Carbon Electric Cities in the Global South*. World Resources Institute, Washington, DC. Available at: *https://www.wri.org/publication/shifting-currents*

381 Sanjai, P. R., Singh, R. K., 2017. 10,000 Electric Cars Highlight Steep Path to India's Ambitions. Bloomberg. Available at: *https://news.bloombergenvironment.com/environment-and-energy/10-000-electric-cars-highlight-steep-path-to-indias-ambitions*

382 "Commitment from national and subnational governments to achieve air quality that is safe for their populations" is one of the initiatives proposed by the Social and Political Drivers Coalition in advance of the UN Climate Summit 2019.

383 IEA, 2018. *Energy Technology Perspectives: Catalysing Energy Technology Transformations*. International Energy Agency, Paris. Available at: *https://www.iea.org/etp/*

384 Energy Transitions Commission, 2018. *Mission Possible: Reaching Net-Zero Carbon Emissions from Hard-to-Abate Sectors by Mid-Century*. Available at: *http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf*

385 Cheong, C., Storey, D., 2019. *Meeting Global Housing Needs with Low-Carbon Materials*. GGGI Technical Report No. 4. Global Green Growth Institute. Seoul.

386 Energy Transitions Commission, 2018. *Mission Possible*.

387 Coady, D., Parry, I., Le, N.-P., Shang, B., 2019. *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509*

388 Farid, M., Keen, M., Papaioannou, M., Parry, I., Pattillo, C., Ter-Martirosyan, A., 2016. *After Paris: Fiscal, macroeconomic, and financial implications of climate change*. International Monetary Fund. Paris.

389 Glaeser, E., Kahn, M. 2004. Sprawl and Urban Growth. *Handbook of Regional and Urban Economics*. **4**. 2481-2527.

390 Carbon Pricing Leadership Coalition, 2017. *Report of the High-Level Commission on Carbon Pricing*. World Bank, Washington, DC. Available at: *https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f26b3c91f1bb0de2e41a/1505227373770/CarbonPricing_EnglishSummary.pdf*

391 World Bank and Ecofys, 2018. *State and Trends of Carbon Pricing 2018*.

392 Ali, M., Fjeldstad, O.-H., Katera, L., 2017. *Property Taxation in Developing Countries*. Chr. Michelse Institute, Bergen.

393 Collier, P., Venables, A.J. 2007. Who gets the urban surplus?. *Journal of Economic Geography*. **18**(3), 523-538.

394 Lincoln Institute of Land Policy and World Bank, 2016. *Habitat III Policy Paper 5 – Municipal Finance and Local Fiscal Systems*. UN-Habitat. Nairobi. Available from : *http://habitat3.org/wp-content/uploads/Habitat%20III%20Policy%20Paper%205.pdf*

395 OECD, 2018. *Rethinking Urban Sprawl: Moving Towards Sustainable Cities*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://www.oecd.org/environment/tools-evaluation/Policy-Highlights-Rethinking-Urban-Sprawl.pdf*

396 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

397 Dalsgaard, T. 2000. *The tax system in Korea: More fairness and less complexity required*. Organisation for Economic Co-operation and Development, Paris.

398 OECD, 2018. *Revenue Statistics 2018: Tax revenue trends in the OECD*. Organisation for Economic Co-operation and Development, Paris. Available at: *https://www.oecd.org/tax/tax-policy/revenue-statistics-highlights-brochure.pdf*

399 Colenbrander, S., Lindfield, M., Lufkin, J., Quijano, N., 2018. *Financing Low-Carbon, Climate-Resilient Cities*. Background paper for the Intergovernmental Panel on Climate Change (IPCC) Cities and Climate Change Conference. Edmonton, Canada. Available at: *https://citiesipcc.org/wp-content/uploads/2018/03/IPCC-Background-Paper-Financing-Low-Carbon-Climate-Resilient-Cities.pdf*

400 Duranton, G., Venables, A.J., 2018. *Place-Based Policies for Development*. World Bank, Washington, DC. Available at: *http://documents.worldbank.org/curated/en/547051523985957209/Place-based-policies-for-development*

401 "Leadership for urban climate investment" is one of the initiatives proposed by the Finance Coalition and the Infrastructure, Cities and Local Action Coalition in advance of the UN Climate Summit 2019.

402 Germáin, L., and Bernstein, A.E., 2018. *Land Value Capture: Tools to Finance our Urban Future*. Lincoln Institute of Land Policy. Cambridge, MA, US. Available at: *https://www.lincolninst.edu/sites/default/files/pubfiles/land-value-capture-policy-brief.pdf*

403 Germáin and Bernstein, 2018. *Land Value Capture*.

Leong, L., 2016. *The 'Rail plus Property' Model: Hong Kong's Successful Self-Financing Formula*. McKinsey & Co. *http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/the-rail-plus-property-model*

404 Based on a sample of 75 experts. See: Rode et al., 2019. *National Transport Policy and Cities*.

405 Rode et al., 2019. *National Transport Policy and Cities*.

406 Cartwright et al., 2018. *Developing Prosperous and Inclusive Cities in Africa*.

407 Gorelick, J., 2018. Supporting the future of municipal bonds in sub-Saharan Africa: the centrality of enabling environments and regulatory frameworks. *Environment and Urbanization*. **30**(1) 103–122

408 Rode et al., 2019. *National Transport Policy and Cities*.

409 Ofgem, 2018. *Insights from running the regulatory sandbox*. Available at: *https://www.ofgem.gov.uk/system/files/docs/2018/10/insights_from_running_the_regulatory_sandbox.pdf*

410 The one-third target is proposed by the Global Covenant of Mayors for Climate & Energy, and its member city networks. More information about this initiative and the cities' climate priorities is Available at: Global Covenant of Mayors for Climate & Energy, 2019. *Innovate4Cities*. Brussels. Available at: *https://www.globalcovenantofmayors.org/wp-content/uploads/2018/09/GCoM_Innovate4Cities-OPS_Booklet_8.5x11.pdf*

411 Ezell, S., Andes, S., 2016. L*ocalising the economic impact of research and development: Policy proposals for the Trump administration and Congress*. Information Technology and Innovation Foundation and the Anne T. and Robert M. Bass Initiative on Innovation and Placemaking, Washington, DC. Available at: *https://www.brookings.edu/wp-content/uploads/2016/12/bass_20161207_localizingeconomicdevelopment_paper.pdf*

412 Energy Transitions Commission, 2018. *Mission Possible*.

413 Global Covenant of Mayors for Climate & Energy, 2019. *Implementing Climate Ambition*.

414 Chevalier, O., Castillo, M., Larrue, C., Martinez Salgado, H., Ruiz, A., Doherty-Bigara, J., 2018. *Implementing the Paris Agreement at the Local Level: A Framework Proposal to Foster Vertical Integration in NDCs*. Urban20 with Agence Française de Développement, Corporación Andina de Fomento and Inter-American Development Bank. Available at: *http://www.urban20.org/item/ejes-y-documentos-clave/U20_WP_Paris_at_local_level.pdf*

415 This date was chosen assuming a five-year business plan cycle. This would suggest that most of the MDBs' would be in their next business plans by 2024 at latest.

416 Based on six multilateral development banks: the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, and the World Bank Group. See: Doukas, A., Bast, E., 2017. *Fossil Fuel Finance at the Multilateral Development Banks: The Low-Hanging Fruit of Paris Compliance*. Oil Change International. Available at: *http://priceofoil.org/content/uploads/2017/05/MDBs-Finance-Briefing-2017.pdf*

417 OECD, 2018. *Climate finance from developed to developing countries: Public flows in 2013–17*. Organisation for Economic Co-operation and Development, Paris. Available at: *http://www.oecd.org/environment/cc/Climate-finance-from-developed-to-developing-countries-Public-flows-in-2013-17.pdf*

418 Larsen, G., Smith, C., Krishnan, N., Weischer, L., Bartosch, S., Fekete, H., 2018. *Towards Paris Alignment: How the Multilateral Development Banks Can Better Support the Paris Agreement*. World Resources Institute, Washington, DC. Available at: *https://wriorg.s3.amazonaws.com/s3fs-public/toward-paris-alignment_1.pdf?_ga=2.95260564.928760613.1559818918-33025099.1559818918*

419 IMF, 2019. *Fiscal Policies for Paris Climate Strategies – From Principle to Practice*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/en/Publications/Policy-Papers/Issues/2019/05/01/Fiscal-Policies-for-Paris-Climate-Strategies-from-Principle-to-Practice-46826*

420 Mehling, M., van Asselt, H., Das, K., Droege, S., Verkuijl, C., 2019. Designing Border Carbon Adjustments for Enhanced Climate Action. *American Journal of International Law*. **113**(3) 433-481

421 ICTSD, 2018. *Reforming Fossil Fuel Subsidies through the Trade System*. International Centre for Trade and Sustainable Development. Geneva. Available at: *https://www.ictsd.org/sites/default/files/research/fossil_fuel_subsidies_negotiations-ictsd_policy_brief_2018.pdf*

422 Verkuijl, C., van Asselt, H., Moerenhout, T., Casier, L., and Wooders, P., 2017. *Tackling Fossil Fuel Subsidies through International Trade Agreements*. Climate Strategies, London. Available at: *https://climatestrategies.org/wp-content/uploads/2017/11/CS-Report_FFS-2017.pdf*

423 Satterthwaite et al., 2018. *Responding to Climate Change in Cities and in their Informal Settlements and Economies*.

424 Alston, M., 2013. Women and adaptation. *Wiley Interdisciplinary Reviews: Climate Change*. **4**(5) 351-358

425 Chen, N., Valente, P., Zlotnik, H. 1998. What do we know about recent trends in urbanization? In: *Migration, Urbanization and Development: New Directions and Issues*. Bilsborrow, R.E. (ed). UNFPA-Kluwer Academic Publishers. Norwell. 59-88

426 Ahmad et al., *Scaling Up Investment for Sustainable Urban Infrastructure*.

427 Nature, 2018. Wanted: a fair carbon tax. Editorial. *Nature*. **564**. 161. Available at: *https://www.nature.com/magazine-assets/d41586-018-07717-y/d41586-018-07717-y.pdf*

428 World Bank and Ecofys, 2018. *State and Trends of Carbon Pricing 2018*.

429 Satterthwaite D, Mitlin D., 2014. *Reducing Urban Poverty in the Global South*. Routledge, London.

King, R., Orloff, M., Virsilas, T., Pande, T., 2017. *Confronting the Urban Housing Crisis in the Global South: Adequate, Secure, and Affordable Housing*. World Resources Institute, Washington, DC.

430 Collier, P., Glaeser, E., Venables, T., Blake, M., Manwaring, P., 2019. *Policy options for informal settlements*. International Growth Centre, London. Available at: *https://www.theigc.org/wp-content/uploads/2019/03/informal-settlements-policy-framing-paper-March-2019.pdf*

Satterthwaite, D., Mitlin, D., 2014. *Reducing Urban Poverty in the Global South*. Routledge, London.

431 "Building the resilience for the urban poor" is one of the initiatives proposed by the Infrastructure, Cities and Local Action Coalition in advance of the UN Climate Summit 2019.

432 Most of these workers are in the agricultural sector. See: UNFCCC, 2016. *Just transition of the workforce, and the creation of decent work and quality jobs*. United Nations Framework Convention on Climate Change, Bonn. Available at: *http://unfccc.int/resource/docs/2016/tp/07.pdf*

433 ICLEI, 2019. *Urban Transitions Alliance Roadmaps: Sustainability Transition Pathways from Industrial Legacy Cities*. ICLEI-Local Governments for Sustainability, Bonn. Available at: *https://iclei.org/en/publication/urban-transitions-alliance-roadmaps*

434 Just Transition Centre and the B Team. *Just Transition: A Business Guide*. London. Available at: *https://www.ituc-csi.org/IMG/pdf/just_transition_-_a_business_guide.pdf*

435 "Commitment to support a just ecological transition" is one of the initiatives proposed by the Social and Political Drivers Coalition in advance of the UN Climate Summit 2019.

436 UN-DESA, 2018. *World Urbanization Prospects 2018*.

437 McGranahan, G., Martine, M., 2014. *Urban Growth in Emerging Economies: Lessons from the BRICS*. Routledge, London.

438 Fernandes, E., 2011. R*egularization of Informal Settlements in Latin America*. Lincoln Institute for Land Policy, Cambridge, MA, US. Available at: *https://www.lincolninst.edu/sites/default/files/pubfiles/regularization-informal-settlements-latin-america-full_0.pdf*

439 Angel, S., 2012. *Planet of Cities*.

McGranahan, G., Schensul, D., Singh, G., 2016. Inclusive urbanization: Can the 2030 Agenda be delivered without it? *Environment and Urbanization*. **28**(1) 13–34.

Mahendra, A., Seto, K.C., 2019. *Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South*. World Resources Institute, Washington, DC.

440 Coady, D., Parry, I., Le, N.-P., Shang, B., 2019. *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund, Washington, DC. Available at: *https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509*

Partners

The Coalition partners listed endorse the general thrust of the arguments, findings and recommendations made in this report.*

Managing partners

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CITIES ARE ENGINES OF GROWTH, INNOVATION AND PROSPERITY. THIS REPORT SHOWS HOW THE RIGHT INVESTMENTS CAN BUILD SUSTAINABLE AND LIVEABLE CITIES AND COMMUNITIES THAT WILL HELP US ACHIEVE THE SUSTAINABLE DEVELOPMENT GOALS AND THE OBJECTIVES OF THE PARIS AGREEMENT. IT IS POSSIBLE AND REALISTIC TO REALIZE NET-ZERO URBAN EMISSIONS BY 2050. BUT TO GET THERE, WE WILL NEED THE FULL ENGAGEMENT OF CITY GOVERNMENTS COMBINED WITH NATIONAL ACTION AND SUPPORT.

ANTÓNIO GUTERRES
SECRETARY-GENERAL OF THE UNITED NATIONS

COALITION FOR URBAN TRANSITIONS
C/O WORLD RESOURCES INSTITUTE
10 G ST NE, SUITE 800
WASHINGTON DC, 20002, USA

C40 CITIES CLIMATE LEADERSHIP GROUP
3 QUEEN VICTORIA STREET
LONDON, EC4N 4TQ
UNITED KINGDOM

WRI ROSS CENTER FOR SUSTAINABLE CITIES
WORLD RESOURCES INSTITUTE
10 G ST NE, SUITE 800
WASHINGTON DC, 20002, USA

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