KPMG

Net zero readiness spotlight : Cities

Insights towards progress

November 2022

Contents

01

Quick reader guide

Quick reader guide

The Net zero readiness spotlight: Cities report evaluates the status and progress of 50 cities in the reduction of greenhouse gas emissions across six sectors by assessing mitigation, adaptation, equitable climate action and city readiness to achieve net zero emissions by 2050. The report further evaluates the cities' readiness to leverage technology, climate finance, innovative partnerships and the circular economy, whilst striving to ensure equity and effective climate governance.

KPMG has selected 50 cities across emerging and advanced economies to evaluate the readiness and transition to net zero in five key sectors that drive and shape city economies. Just over half of these are capital cities and they include coastal, landlocked, and small island urban areas. Cities at various net zero implementation stages have been included. At the time of research, some cities may not have a net zero plan in place. For those cities the report considered local climate action plans, climate emergency plans, sectoral plans, and national climate plans.

The report applies a 'transboundary' approach whereby cities are defined as smaller scaled open systems embedded within larger-scaled infrastructure and trade networks. Cities are not viewed within their administrative boundaries, but from a local-to-global urban system lens.

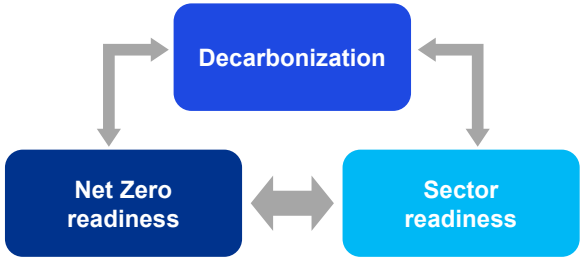
The Net zero readiness spotlight: Cities report uses the World Resources Institute definition of net zero. This involves the reducing greenhouse gas emissions caused by humans as close as possible to zero. Remaining emissions are balanced by an equivalent amount of carbon removal from the atmosphere effectively neutralizing humanity's future impact on the world's climate.

Net zero city:[1] Achieves an overall balance between urban CO2 emissions and removal of carbon from the atmosphere through various mitigation and adaptation actions.

Decarbonization: Refers to the process of reducing carbon intensity, thus lowering the amount of greenhouse gas emissions produced by the burning of fossil fuels.

Net zero readiness: The ability to operationalize the reduction of carbon emissions through social, economic, political, and technological systems.[2]

Sector readiness: The preparedness and ability to plan, mitigate and adapt end to end operations across the value chain to reduce reliance on carbon emitting sources.



How the Net zero readiness spotlight: Cities works

For each of the 50 cites, the report assesses 48 indicators that KPMG considers to be key drivers in transitioning to net zero. The indicators look at the progress and transition of cities to net zero through four lenses: decarbonization status, sector policies and preparedness, equity and city enablers.

The indicators are applied across five sectors that are not only high emitting but are critical for the functioning of a city's social, economic, political, and environmental ecosystem. These sectors include energy, mobility and connectivity, built environment, industry, waste and sanitation.

The indicators include mitigation and adaptation to capture balanced climate action towards decarbonization and net zero. Adaptation is often omitted, however this report recognizes its spatial benefits for cities' transition to net zero.

Sectors

Energy
This sector includes indicators related to electricity, e.g., generation, efficiency, etc.

Waste/Sanitation
This sector includes indicators related to waste treatment and its management processes

Connectivity & mobility
This sector includes indicators related to transportation, e.g., mode split, fuel type, etc.

Industry
This sector includes indicators related to type of industries, industrial emissions etc.

Built environment
This sector includes indicators related to buildings along with the type of cooking fuel and building heating mechanism among others

The report further analyses the decarbonization progress in cities through a set of dependent variables called transition drivers that impact the ability to deliver on net zero climate action. Different cities and sectors will likely require a mix of multiple drivers at different times and position in their net zero journeys.

Net zero transition drivers

01 **Technology**
Progress in allocating resources to R&D and the uptake of key technologies to key sectors in cities in order to net-zero.

02 **Climate finance**
Progress towards net-zero compatible finance and sustainable investments from private, public and nontraditional stakeholders

03 **Equity and inclusive climate action**
Action towards the reduction of vulnerable, energy poverty and ensuring the equitable distributive impact of inclusive climate action.

04 **Climate governance**
Progress towards new and inclusive governance models to enable, determine and contribute to tangible change to realize net zero

05 **Consumption and lifestyle changes**
Collective and individual behaviors in the way people move, live, eat work and consume across all sectors in order to contribute to the transition towards net-zero

The indicators are aligned to the sixth assessment report of the UN Intergovernmental Panel on Climate Change published in 2022, United for Smart Sustainable Cities (U4SCC), C40 Cities, CDP, UNHABITAT (United Nations Humans Settlement Program Global Urban Monitoring Framework and Organization for Economic Co-operation and Development (OECD), established urban level indicators. For each of the sectors, KPMG subject matter professionals have provided qualitative views on challenges, opportunities and key net zero trends.

Through this evaluation, KPMG has identified key insights and observations that are critical to overcoming challenges in cities' transition to net zero for accelerated climate action. Of utmost importance is the potential opportunities and benefits that cities can leverage as they transition to net zero. The results of the report have been categorized into two themes: sector scorecards and city net zero profiles. The sector analysis section discusses the position of cities in each sector against decarbonization progress. The sector scorecards classifies cities into pacesetters and followers and highlight the regional variations in climate action, which is an important starting point for advocating for climate finance, climate equity and a just transition towards net zero. The sector scorecards are also a consolidated snapshot of net zero activity across sectors and cities. The analysis captures critical elements of sectoral readiness and ability to accelerate to net zero.

The city net zero profiles showcase each city's unique journey including challenges, opportunities and useful commentary for the city and its peers.

Each city profile discusses the level to which transition drivers such as technology, climate finance, climate governance and equity have been considered as the city implements climate action. The profiles also feature a project, initiative or policy led or supported by that city in a particular sector.

As cities across the globe continue to implement climate action plans in the identified sectors it is likely that there will be changes to the city profiles and sector scorecards. KPMG intends to update this report regularly and share key insights on an ongoing basis.

More information of the results, methodology and sources used can be found in the Appendix.

The following abbreviations are use in the text: CO2 (carbon dioxide); GDP (gross domestic product); GHG (greenhouse gases); GW (gigawatt); MtCO2e (megatons of CO2 equivalent used to measure greenhouse gas emissions); and MW (megawatt) US dollar equivalents for local currencies are correct as of November 2022.

The main audiences for the Net zero readiness spotlight: Cites report are city leaders, mayors and officials. Others include those working in federal, national, state and provincial government public sectors, multilateral organizations, investors, financial institutions, the private sector and the public. It is likely to be of particular interest to anyone with an interest or responsibility in advancing the net zero agenda at the city level.

02

Foreword

Foreword

The COVID-19 pandemic shed a strong light on inequalities at the city level. The investment in economic recovery is an opportune moment for cities to put climate action, sustainable development, and equity at the core of policies and initiatives.

An intersectional approach to net zero is critical. The just transition must not be only about the energy transition but must aim to ensure that cities are positioned to provide the requisite social safety nets and a thriving economy that leaves no-one behind through concerted climate action towards net zero.

Cities account for more than 50 percent of the world's population, 80 percent of global GDP and more than 70 percent of annual carbon emissions.[3] It is anticipated that 70 percent of the world's population is expected to live in cities by 2050.[4] This will likely put pressure on and increase demand for energy infrastructure. The climate change crisis extends beyond city boundaries and national borders and requires the collective power of a global coalition.

Cities have greater capacity than they realize to move towards a low carbon future and arrive at net zero while helping to ensure prosperity and equity. They should leverage technology, budgets, green policies, capital programs, partnerships, and new governance models to influence emissions reductions. More than 700 cities across the globe have committed to cut their emissions by 50 percent by 2030 and arrive at net zero by 2050.[5] This commitment coupled with bold action is a step closer to meeting the Paris Climate Goals to keep global temperature rises below two1.5 degrees Celsius compared with pre-industrial levels.

Cities need to understand both current and future source of emissions, to put requisite actions and efforts in place to combat carbon intensity. The lack of standardization in the carbon accounting of cities and the lack of consensus on how to measure urban carbon emissions has an adverse effect on decarbonization. Striving to ensure data integration and interoperability can strengthen city initiatives and impacts towards net zero. KPMG in collaboration with United Cities has evaluated cities' readiness and progress towards net zero and provided insights into the opportunities and challenges. The results highlight the importance of balancing climate action to help ensure mitigation and adaptation for equitable and inclusive impact.

Research[6] shows that cities cannot achieve net zero by focusing on emissions reductions within their administrative boundaries alone. Cities must decarbonize key transboundary supply chains and use urban and regional landscapes to sequester carbon from the atmosphere. The Net zero readiness spotlight: Cities report considers the complex interplay between city infrastructure, behavior and sequencing of mitigation and adaptation action for cities to achieve net zero. It also considers the necessary transitions required in six interconnected systems of energy, mobility, built environment, industry, waste and sanitation and green infrastructure by leveraging on transition drivers.

A central finding of this report is the importance of developing city net zero policies and initiatives that can attract sustainable finance. Cities are conducive to innovation that can drive transformation through new ways of engagement, innovative business models and regulations to attract investment and get access to solutions in the market that can accelerate the transition to net zero.

Stephen C. Beatty
Global Head of Infrastructure and Head, Global Cities Center of Excellence, KPMG International

Stine Lise Hattestad Bratsberg
Partner, Head of Strategy and Transformation EMA , ESG Hub. KPMG in Norway

The report also emphasizes the intersectionality of net zero climate action. The intersection between culture, place, , race, class, and gender must be in the purview of cities and their leaders. The narrative around net zero particularly in cities has focused on siloed decarbonization efforts in high emitting sectors. If cities are to achieve net zero, climate action should consider the interconnectedness of sectors to develop complementary creative and innovative pathways to accelerate the net zero transition. The report reveals the critical role of climate governance in accelerating climate action towards net zero. The better-performing cities are leveraging tools such sustainable procurement, green budgets, innovative partnerships, and collaboration to decarbonize high emitting sectors.

Based on their design, urban makeup, geography and economic makeup, different cities will experience the effects of climate change differently. The model reveals that the five sectors are decarbonizing at different rates, highlighting regional differences, different policy and regulatory environments and varying city preparedness. Regional differences with respect to sectoral transition to net zero indicate that emerging cities require greater access to climate finance and in particular adaptation finance. Other key factors contributing to regional differences is the fact that developing cities still rely on fossil fuels for economic growth and development, although still emitting less than their counterparts in developed countries.

The objective for the Net zero readiness spotlight: Cities report is to highlight concrete opportunities and pathways for cities to accelerate climate action towards net zero and meet the sustainable development goals, as well as realize economic growth in an equitable manner. KPMG professionals are ready to walk this journey with cities and work with their leaders to help ensure that climate action is accelerated, equitable and opens door for economic growth and environmental prosperity.

03

City net zero results at a glance

City net zero results at a glance

Cities	Energy sector	Mobility & connectivity	Built environment	Industry	Waste & sanitation
Accra					
Addis Ababa					
Alexandria					
Amman					
Amsterdam					
Atlanta					
Barcelona					
Beijing					
Bermuda					
Bogota					
Budapest					
Buenos Aires					
Cairo					
Cape Town					
Chicago					
Dakar					
Dubai					
Hamburg					

Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, KPMG, 2022

Increasing order of transition readiness

City net zero results at a glance (continued)

Cities	Energy sector	Mobility & connectivity	Built environment	Industry	Waste & sanitation
Hong Kong (SAR), China					
Jeddah					
Kingston					
Kuala Lumpur					
Lagos					
Lisbon					
London					
Luanda					
Male					
Medellin					
Montevideo					
Montreal					
Mumbai					
Nairobi					
New Delhi					
New York					
Oslo					
Panama City					

Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, KPMG, 2022

Increasing order of transition readiness

City net zero results at a glance (continued)

Cities	Energy sector	Mobility & connectivity	Built environment	Industry	Waste & sanitation
Paris					
Port Morsbey					
Quebec City					
Rio De Janeiro					
Santiago					
Singapore					
Sydney					
Tel-Aviv Yafo					
Toronto					
Vancouver					
Vienna					
Warsaw					

Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, KPMG, 2022

Increasing order of transition readiness

04

Net zero and city prosperity

Net zero and city prosperity: Bridging the gap between investments and solutions

Cities are taking center stage in driving climate action. Transitioning to net zero helps cities to attract climate finance and solutions in the marketplace that can accelerate climate action. Good, creative, flexible, innovative policies and initiatives by cities can bridge the gap and accelerate the flow of readily available finance to cities.

The United Nations Intergovernmental Panel on Climate Change notes that approximately USD2.4 trillion is needed annually until 2035 to meet the Paris Climate Agreement goals.[7] But at present, cities are having a hard time accessing the right financial tools they need to reduce emissions.

The Climate Finance Leadership Alliance notes that to date, climate finance flows to cities amount to an estimated USD384 billion, falling short of the climate finance needed.[8] Private finance represents a tiny fraction of investments despite the availability and recent interest in working with cities.

The small number of investable ready and bankable projects is a significant barrier alongside restrictive legal mandates and regulatory barriers. There needs to be a paradigm shift in the climate finance ecosystem that creates multiple avenues for finance to flow quickly and directly to cities.

City leaders and their administrations need both a shift in approach and relevant tools to assist them in managing and adapting to climate risks to align municipal finance to net zero goals. Polices should be investable to attract capital towards high-emitting sectors.

Cities need to develop a steady pipeline of bankable projects that can attract finance. Through policy, markets, citizen engagement and participation, developing creditworthiness and blending finance, cities can also set up new mechanisms of financing net zero action and diversify the pool of climate financing options.

Research[9] shows that cities are conducive to innovation that can drive transformation through new ways of engagement, innovative business models and regulations to attract investment and get access to solutions in the market that can accelerate the transition to net zero. It is important to note that climate investment risks are city specific and arise due to several factors such political situations, currency, credit profile and the market.

Cities in emerging markets are experiencing rapid growth in their urban centers, putting pressure on economic, social, and environmental systems, yet they receive much smaller volumes of climate investment than their peers in developed markets. Strengthening climate action through the lens of net zero can yield numerous potential benefits including a city's attractiveness to climate investment. Investors are rapidly shifting their investment strategies and priorities towards achieving ESG targets and greening their portfolios. These sentiments must also be shared by their partners such as cities.

The city net zero profiles and the sector scorecard provides cites with a snapshot view of their journeys towards net zero in different sectors. This information can be useful to cities by enabling them to embrace an integrated systems thinking approach towards creating investment friendly policies and de-risking future projects to attract investments.

05

Operationalizing climate equity for net zero

Operationalizing climate equity for net zero

Net zero and addressing climate inequalities

Research[10] shows that it is unclear which policy measures are relevant for achieving net zero equitably, their implications and their implementation pathways. The UNFCCC under Article 3.1 identifies equity as a key element, anchored in the principle of Common But Differentiated Responsibilities and Respective Capacities. Studies[11] shows that approximately 10 percent of the global population generates more than 52 percent of global emissions. The report further notes that the poorest 50 percent of people in the world are responsible for just 7 percent of cumulative global emissions. Although these figures are representative of national data, they give an indication of what the numbers may look like at the city level considering that cities emit 75percent of the world's carbon dioxide.[12]

Additionally, climate change is linked to the challenges of poverty, socio-economic justice and creating a more inclusive and equitable world. The transition to net zero will likely see different cities and regions impacted in different ways. This report captures cities' efforts at aiming to ensure the transition to net zero is equitable and fair for all, by assessing equity indicators in each of the five sectors evaluated. The transition to net zero by cities should strive to ensure that institutions, processes, policies, and initiatives address the needs of marginalized and disenfranchised groups and are distributed in a fair manner.

KPMG finds that climate equity rests on the pillars of:

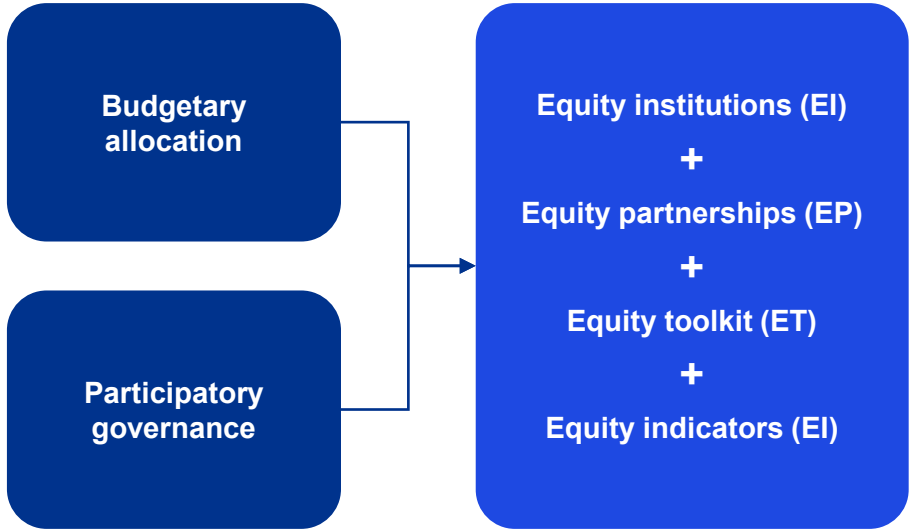
- Protection of vulnerable populations
- Ensuring sustainable development
- Raising climate ambition in countries with a larger responsibility for historical emissions.

What does climate equity look like in a city?

Cities are generally home to people of diverse backgrounds and cultures and a wide range of social and economic positions. Alongside this is the climatic, political, developmental, and locational shape of a city. Underlying concerns over equity are the interactions between a specific city's makeup and climate change. The question of who will be most impacted by the effects of climate change and how these impacts will be addressed is the pain point of achieving climate equity in cities.

The COVID-19 pandemic highlighted various systemic injustices which have led cities to focus on equitable economic recovery. City climate action plans across the world have incorporated tenets of justice, inclusivity, and equity; however, policy implementation, design and evaluation has been difficult to realize in some contexts.

Operationalizing equity in the context of net zero



EI: Equity institutions are the bodies within a city's administrative structure that have the mandate to administer, design and implement policies and strategic initiatives that address the impacts of climate change on identified marginalized and disenfranchised groups.

EP: Equity partnerships are derived from collaborating with activists, the private sector, community organizations and non-governmental organizations alongside groups that are outside formal city processes to develop climate equity interventions.

ET: An equity toolkit is a menu of policies, strategies, initiatives, and relevant instruments that simultaneously address urban planning and development processes, physical exposure by climate change impacts on a specific city and the social, economic and demographic characteristics of urban populations.

EI: Equity indicators are tools that cities can use to measure and track the effects of the equity toolkits, equity partnerships and equity institutions that proactively address impacts of climate change on various groups.

06

Key insights and observations

Key insights and observations

KPMG insights

Acting fast: Moving from net zero planning to action

Most cities across the world have put in place ambitious climate emergency and net zero climate action plans. This signifies the urgency in meeting the Paris Climate Agreement. However city-led action may be affected by lagging financial, policy and regulatory barriers.

Cities are already stretched with competing priorities and therefore must work collaboratively with key stakeholders to put in place the necessary infrastructures and incentives needed to make significant progress towards meeting net zero targets and goals.

Cities need to put in place robust and agile climate governance structures to ensure focused acceleration towards net zero. Coupled with this is the application of innovative and creative management structures to tackle operational challenges, aligning financing, procurement practices, supply chains and stakeholder management.

Cities can also take charge of educating, guiding, and encouraging behavior change, especially on consumption choices, waste management, recycling and mobility options among others.

Engaging citizens creates a sense of ownership and helps accelerate climate action because everyone is playing their part.

Catching up with the sustainable finance market

The financial resources required for a global transition to net zero cannot be financed by cities and national governments alone. The transformation required for meeting city net zero and climate action plans will likely need the unlocking of private capital to deploy climate solutions to facilitate the massive physical and economic transitions that are required.

Cities, particularly those that do not have the experience, need to be able to develop bankable and investable projects that are de-risked to attract private sector investors. Blended finance, where public capital is leveraged to improve risk-return profile and mobilize private investment towards green climate projects, is an available mechanism that should be utilized. Mitigation efforts need to be complemented by adaptation efforts to accelerate net zero action. Adaptation finance is therefore essential for cities to meet their net zero targets and goals.

Attracting climate finance requires a solid mix of bankable projects, high-quality data and political will to create an enabling environment for a diverse range of investors. Cities should aim to ensure that climate change considerations are embedded in strategic, spatial, budget, and capital investment planning.

The sustainable finance market is expanding to include ‘climate fintechs’. This new category of investors aims to catalyze decarbonization by combining finance, climate and technology. Cities need to be abreast of the growing and fast-paced sustainable finance market to position themselves to attract capital to accelerate climate action towards net zero. The market needs to be equally ready to work with cities as they transition to net zero.

Climate fintech is the intersection of climate, finance, and digital technology. These digital innovations, applications, and platforms serve as crucial financial intermediaries and mediums between all stakeholders pursuing decarbonization.[13]

Operationalizing equitable urban climate action

Cities by their very nature are host to diverse groups of people. The contrast between the rich and poor is strikingly visible in cities. The COVID-19 pandemic impacted city life as we know it. This not only shed light on the systemic injustices that face certain groups in society, revealing stark social and economic inequalities, but exacerbated it. Most cities have either updated or incorporated their climate action plans to focus on equity in several ways.

Cities should aim to ensure that climate equity is not only recognized but should be procedural in encouraging participation from disenfranchised groups and distributional in ensuring that climate action gains are redistributed effectively. Developing cities typically have a smaller carbon footprint compared with developed cities. Despite this, they face harsh climate impacts and tight city fiscal opportunities to adequately respond to equity concerns.

Climate action plans should not only reflect equity in their language but should put in place substantive policies to ensure tangible and equitable outcomes. The focus on structural problems should be at the core of policy development and implementation. Realizing climate equity and striving to ensure a just transition in cities may require out of the box solutions and thinking, innovative and 'unusual' collaborations and partnerships, to help ensure that marginalized and disadvantaged communities can not only benefit but also avoid further disenfranchisement.

Getting the data right and tracking city climate action

Cities directly feel the burden of climate change and are making efforts to cut down their greenhouse gas emissions while adapting to climate hazards and risks. Tracking urban climate action at the city level is challenging, particularly in developing cities. Cities need to be equipped with the right tools to assist them in setting goals, implementing their climate action plans, and tracking progress. The need to have common data points that are useful for planning and the financial resources to host data and information is critical.

Data is only one component. Cities need to be able to assess, monitor and evaluate the results of their mitigation and adaptation actions. Outcomes and impacts of climate action are at times difficult to track and monitor due to the lack of requisite mitigation and adaptation monitoring tools. This affects city efforts in determining the successes and challenges of their climate action plans, presenting barriers for accessing climate finance and leveraging public support.

Big data and artificial intelligence are critical for meeting cities' ambitious net zero goals. Cities should leverage big data by creating digital twins – virtual versions of the urban environments – using insights to help meet net zero goals. Artificial intelligence will likely be useful in accommodating the volume of environmental data produced, particularly in very large megacities.

To harness the power of data, city officials in charge of the environment and climate change need to work with other departments, but data that is needed to plan and implement net zero action is rarely shared across functional and technical offices. The interoperability of data and information needs strengthening at the city level to help ensure a well-organized transition to net zero.

Holding the right hands: Innovative partnerships and collaborations

The journey to Net zero cannot be walked alone. Cities need a diverse set of partners and collaborators to achieve emissions reduction in their respective jurisdictions. These include private sector organizations, national governments, communities, non-governmental organizations and other traditional partners. However, for accelerated action towards Net zero, cities need to be innovative and creative with their choice of partners and collaborators.

Cross-sector partnerships to inspire change and to explore new ideas will be critical in meeting city Net zero targets. In areas where cities lack experience, establishing partnerships can add value in many ways.

Traditionally cities have established partnerships based on economic and social needs, but developing and establishing partnerships with the aim of achieving Net zero is novel and cities will need to create an enabling environment for a diverse set of partners, groups, and individuals to effectively engage.

Cities should also focus on collaborating with their communities. Achieving Net zero at a neighborhood or community scale is as important as the top-down approaches that cities have in place. Policies, projects, and initiatives can be tested at the local level and used to trial innovative approaches as a way of mitigating risks, enhancing participation of citizens, and creating a sense of collaborative ownership in the transition to Net zero.

Accelerating net zero action by leveraging technology

The latest IPCC reports highlight the significance of negative emissions technologies (Nets) due to previous failures in global climate protection. All model calculations by climate scientists indicate that meeting the Paris climate goals to achieve net zero can only be met by incorporating Nets. Research shows that approximately 50 percent of the emissions the world needs to cut to achieve net zero could come from technology not yet invented.[14] Cities need to leverage research and development to help ensure that technologies in development match needs and realities on the ground.

It is key to note that deployment of technology can be costly and therefore the need to partner and collaborate with a diverse set of stakeholders is critical.

In this regard, cities need to work collectively and collaboratively with private sector partners to help ensure they can benefit from climate technologies including batteries and energy storage, building technologies, industrial process innovation, hydrogen, sustainable fuels, carbon removal and capture and nature-based solutions. These technologies can be applied in various high-emitting sectors to accelerate climate action towards net zero and increase cities' resilience toward climate hazards.

The COVID-19 pandemic accelerated the digital transformation in cities across the world. Due to lockdown policies that minimized face-to-face contact rapid uptake of technology was accelerated in almost all sectors. Digitizing cities and the role of smart cites can be an opportunity to integrate climate change. Climate smart cities are an opportunity to leverage innovative technology to accelerate action towards net zero and to enhance the efficiency of city operations and management. Carbon removal technologies are also essential in the transition to net zero.

Observations

- Attracting and retaining human capital to support cities in driving their ambitious climate action plans is a challenge both in developed and emerging cities.
- The success of climate action towards net zero is premised on striving to ensure that impacts are equitable, inclusive and leave no one behind.
- Leveraging the power of community engagement is critical for successful climate action towards net zero. Cities that provide effective avenues of participatory engagement and awareness can help raise and deepen citizen commitment and subscription to city-led projects and initiatives.
- Cities need to leverage research and technological advances through partnerships and collaboration to deepen innovation in the transition to net zero.
- Creative partnerships and collaborations are complementary to bold and ambitious climate action towards net zero.
- Multi level governance holds immense power in promoting climate action towards net zero. Vertical and horizontal coordination between different levels of government is critical for financing climate action in cities.
- Preserving the cultural essence of a city is important in the journey towards net zero. As cities move towards implementing their climate action plans the cultural fabric of the city should not be compromised.

07

Sectors: Opportunities, challenges and trends

Energy sector

Most cities have focused their efforts on decarbonizing the energy sector due to its position as the highest emitter. This is sometimes referred to as deep decarbonization. "Ambition to action" should be at the forefront of net zero strategies argues Mike Hayes, Climate Change and Decarbonization Leader and Global Head of Renewable Energy, KPMG International and a Partner, KPMG in Ireland.

Most cities lack control over the core decarbonization strategies in the energy sector such as removing unabated fossil fuels from the electricity grid as this sits at the national level. The interconnectedness of energy with other critical sectors in cities such as transport, building and industry, makes decarbonization a major priority in the energy sector. Mike Hayes urges cities to have measurable climate transition plans in place to attract sustainable finance and to develop viable commercial projects that can help transform the energy sector.

As renewable energy slowly becomes ubiquitous, increases in energy generation from clean sources should be matched by increased capacity in transmission and distribution networks. To sustain the economic and financial viability of such projects, transmission and distribution needs to be adequate. Both investors and lenders will likely be averse to funding clean electrification projects if they perceive risks such as congestion and curtailment of transmission and distribution networks.

Net zero acceleration

Cities need to differentiate between their corporate climate action plans – those that reflect the direct control they have over their own operations – and community climate action plans that consider the GHGs emitted within the geographic and administrative boundaries of the city.

Barriers to decarbonization

According to Saurabh Bansal, Managing Director, Infrastructure & Projects Advisory, KPMG in the US, access to capital and technology are some of the major barriers to decarbonization in the energy sector. Furthermore, he argues that the move towards net zero in the sector will likely be slow and this is predicated by city targets that are scheduled to be met between 2030 and 2050 as building and putting in place renewable portfolios will take time.

Some cities in advanced economies have access to capital through their state, regional, national, or federal governments in the form of stimulus packages or grants, while those in developing economies typically lack financial resources to implement large-scale climate actions in the energy sector. The cost of decarbonization and net zero solutions is greater than existing conventional choices in the market, mostly in emerging markets. This makes it difficult to invest in moving towards net zero and working to reduce the reliance on fossil fuels, especially in emerging and developing cities.

Mike Hayes notes that cities' abilities to attract climate finance will likely be increasingly dependent on them developing and putting in place decarbonization plans. He adds that capturing scope three emissions, indirectly generated by those in an organization's value chain, is challenging for cities, particularly those with heavy industrial activity. A successful energy transition is expected to require coordinated and effective collaboration between sectors, cities, and regions.

Leveraging digital technology

Scenario planning, digital technology and systems are central to decarbonization. Acquiring the right digital tools to manage demand and supply, provide user and network level insights and control a complex mix of energy sources can help strengthen a city's pathway to meeting their net zero targets.

Energy transition and climate equity

Leveraging clean electrification and technology to harmonize city energy systems is critical for achieving net zero. Cities need to think beyond individual projects and instead consider impact on the wider city ecosystem. The energy transition in cities is not only about doing away with fossil fuels but also striving to ensure a simultaneous equitable socio-economic transition. Through a range of policies and tools, cities can ensure that equity and inclusivity remains at the core of low carbon energy pathways.

Mike Hayes notes that energy security is back on the climate change agenda. Furthermore, aiming to ensure energy efficiency and management in cities is an opportunity to manage the transition to net zero to help achieve equitable outcomes.

Climate adaptation in the energy sector

Climate vulnerability is central to understanding effects on energy uses. Systemic impacts such as changes in mountain hydrology can affect the energy output of a hydropower system over a large geographical area.[15] Another example is localized impacts such as extreme weather events on energy infrastructure in coastal areas. Recent heat waves in cities around the world have presented significant challenges for the electricity generation sector, in particular an increased demand for cooling.

For cities in emerging and developing states, energy sector adaptation is important due to climate change effects such as reduced rainfall, sea level rises, and increased frequencies and severity of natural disasters that pose a threat to the transition to net zero. Bringing climate risk management into the mainstream of energy sector planning and operations is necessary as this also supports mitigation measures. To support adaptation efforts in the energy sector, there is need for knowledge to be transferred between sectors and cities to raise awareness that can support efforts to net zero pathways.

Climate governance and partnerships

Current and future technologies to accelerate the energy's sector transition to net zero must consider climate variability and changes. This requires cities to have requisite governance structures, partnerships and strong institutions that can link climate knowledge with action from a diverse set of key stakeholders.

Mobility and connectivity

Decarbonization of the transport sector is considered a catalyst for broader transformation in energy systems and cities. Transport emissions which include road, rail, air, and marine transportation are a growing source of greenhouse gas emissions globally. In 2019, 33 percent of GHG emissions from major cities were generated by transport[16] and they are also the primary source of air pollution.[17] Although emissions dropped during the pandemic, the return to 'normal' has reversed some of the gains made during this period. Road transport has the largest impact on emissions in the sector.

The transport sector requires new models, technologies, polices and sources of energy. Cities need to be prepared to attract sustainable finance for green transport options. Decisions regarding transport strategies and modal mix options – use of several types of transport – are unique to different cities and therefore decarbonization pathways will differ. Malini Bose, Associate Director, Future Mobility, KPMG in the UK notes that although the uptake of electric vehicles and modal mix are essential to a net zero city, transport infrastructure design, construction and operation is key. Limiting embodied carbon in vehicles and infrastructure is necessary for extensive decarbonization of the transport sector. Cities' emissions transition plans must highlight lifetime carbon-efficient gains such as aiming to maximize the life-span of assets, repurposing infrastructure and striving to minimize material use across the supply chain.

The decarbonization of the transport sector is dependent on the energy transition. Electricity and power suppliers serving transport networks from renewable energy sources will likely have a major impact on operational carbon.

The move from internal combustion engines to zero emission vehicles is key to helping reduce greenhouse gases. Cities are pursuing other forms of transport such as mass mode, intelligent rail, urban transit solutions and active transportation. Cities in Asia and Africa are taking the lead on micro mobility options such as electric bikes, scooters and tuk-tuks amongst others.

But Ben Foulser, Director, Infrastructure Advisory Group, KPMG in the UK, says that a stigma exists around micro mobility options, particularly in developed cities. He argues that despite mass decarbonization policies and initiatives across cities, buying vehicles driven by fossil fuels has become much cheaper, allowing a growing middle-class to own vehicles. He adds that city dwellers are now demanding products and services faster which means that freight traffic across cities will likely increase contributing to an increase in emissions. Malini Bose, Associate Director, Infrastructure Advisory Group, KPMG in the UK argues that the demand for transport needs be managed effectively by cities by offering cleaner alternatives and investing in diverse zero emission transport options.

Most cities have clear mitigation actions and efforts as they transition their transport sectors to net zero. However, Foulser argues that system-wide thinking and demand management are key adaptation measures that cities should consider. Initiatives including longer term land use planning and design of cities and towns that are commutable by walking and cycling are critical for the transition to net zero. Cities may also apply low emissions zones, congestion pricing and limited traffic zones.

Referencing the concept of the 15 minute city, Foulser notes that this could remove barriers to non-motorized mobility infrastructure and help increase the use of public transportation, promoting the expected public health benefits of low carbon policies.

Adding value in the transition to net zero

Critical to the decarbonization of the transport sector is the power of the circular economy, including old first-generation batteries being repurposed for new electric public transport vehicles. This addresses concerns around limited mineral resources that are required for producing batteries and other critical components.

Leaving no one behind: informal transport

In cities where the transport sector is largely informal, strengthening transport system resilience is important as it decarbonizes. Striving to ensure the recovery capacity and flexibility of these transport systems is critical whilst working to reduce emissions and protecting jobs of people in the transport sector to help ensure a just transition.

Net zero rail

Rail has a crucial role to play in the decarbonization of the transport sector. Electric and hydrogen trains are considered zero emissions at the point of use.

Built environment

The buildings sector accounts for over 38 percent of all energy related CO2 emissions when building construction industry emissions are included.[18] As a high-emitting sector, decarbonizing buildings is a major priority for cities. Analysis of variations in the built environment across cities and regions in this report shows a range of efforts towards mitigation and adaptation climate action in the sector.

With buildings accounting for approximately a third of energy related gas emissions globally, cities are in a position to drive decarbonization of their building stock as opposed to focusing on individual buildings. Cities can take advantage of a variety of energy efficient measures, using on and offsite renewable energy. Decarbonization solutions can largely depend on a building's heating and cooling demand, variable and limited capacities of renewable electricity supply, constrained grid, consumer preferences and costs. For example, recent heat waves across the globe have had a major impact on building performance and increased risk for occupants.

Early intervention and pro-active design

Sarah Varghese, Partner, Planning & Infrastructure Economics, KPMG Australia, says: "Early intervention and pro-active planning and design of not only buildings but precincts and cities is critical in our journey to net zero."

The pressure on developers, occupiers and real estate is intensifying as city governments set bold commitments to transition to net zero. Seizing the decarbonization opportunity in the ecosystem of buildings should involve early intervention across their full life cycle as well as related infrastructure, including design, materials manufacturing, construction, usage, and demolition. Typically, operations and use of buildings emit the most GHG emissions across the life cycle, followed by processing and raw materials.

Across the value chain of building professionals, architects, city planners and designers, many are engaging in climate proof proactive design at all scales. From eco-friendly interior finishes, net zero energy and various innovative strategies to help reduce and prevent physical damage to buildings in coastal cities, a range of mitigation and adaptation solutions can be leveraged.

Sarah Varghese argues that cities of the future including buildings, supporting infrastructure, parks and open spaces must aim for not just achieving net zero but moving towards net negative and aiming to reduce levels of GHGs in the atmosphere. She emphasizes the power of and need for collaboration between government and the private sector to co-create appropriate policies and successfully deliver carbon neutral cities on government-owned lands as a priority opportunity. Government needs to lead by example and spearhead the movement towards net zero cities.

Climate-proofing informal settlements

Cities that are host to informal settlements have traditionally received less policy attention in the climate change space, exacerbated by them contravening regulations and laws. Climate-related risks are amplified for inhabitants of informal settlements and hazard prone areas.

With mostly low and middle income cities hosting nearly one billion people in informal settlements,[19] the focus has shifted to 'risk reducing' infrastructure and services including safe affordable piped water, storm and surface drainage, electricity, and street lighting.

City governments and community initiatives that focus on upgrading and retrofitting informal settlements can enhance resilience to climate change risks. However, to design and implement effective upgrading initiatives there is great need for access to quality data to ensure targets and policies have positive distributive impacts.

Traditionally, most upgrading programs that have integrated environmental goals are complementary to the physical transformation of settlements. For cities to help ensure that their net zero goals are inclusive of vulnerable settlements, there needs to be accelerated action in funding and investing in sustainable upgrading initiatives. Cities also need to partner with communities to help ensure that initiatives are rooted in real needs and priorities.

Financing green cities

Greening the built environment is typically perceived as a costly endeavor. However, following COVID-19, cities are setting targets to improve the environmental performance of their cities. Evidence[20] demonstrates that investment in sustainable infrastructure can boost infrastructural productivity and lead to accumulated savings over time through lower maintenance costs and enhanced service provision.

Despite positive outcomes in the decarbonization of buildings across cities, the concept of the built environment remains largely overlooked. It interacts with the natural environment through its use of land, water and energy resources and the emissions produced. The interconnectedness of the built environment with industry, transport, health, planning, community, equity, and the economy puts pressure on the decarbonization pathways that cities develop, implement and monitor. The need for a holistic, systems thinking approach in this sector is critical for the transition to net zero.

Get your policy right, access your funds

Access to sustainable finance by cities is strengthened by the ability to develop policy efforts towards achieving climate objectives and mobilizing resources for climate action not only for buildings but for the entire city ecosystem.

Green infrastructure

Rising urbanization is intensifying densification and a demand for more building types. The demand for cooling and heating is likely to also increase. This means more energy is required leading to eventual production of emissions. Research also shows that urban environments can create microclimates that lead to temperatures increasing by as much as 10-15 degrees Celsius producing heat island effects.[21]

With rising heatwaves, floods and other climate risks, the concept of greening cities is becoming central to the net zero plans of cities. The recent heatwaves seen across Asia, Europe and North America have broken records according to the World Meteorological Organization, with the highest temperatures recorded in cities.

Financing nature-based solutions

Climate finance for nature-based solutions has been low. A report by the World Economic Forum[22] finds that nature-based climate adaptation projects receive less funding than mitigation projects from international climate finance. A study by the UN Environment Programme and the Global Commission on Adaptation estimates that approximately 1 percent of total climate finance goes to nature-based adaptation projects.[23]

Climate change events such as storms, recurrent heatwaves and droughts pose a risk to the ability of green spaces such as parks, green roofs, plant walls and other types of green infrastructure to lessen associated impacts. As cities continue to urbanize, the ability for urban forests to absorb carbon from the atmosphere is further compromised by land use strategies that favor densification and expanding the built environment. Stephen Beatty, Global Head of Infrastructure, Head, Global Cities Center of Excellence, KPMG International, notes that green spaces whether natural or artificial can help cities address climate impacts by enhancing ecosystems and supporting urban residents in building resilience.

Cities across the world have put in place policy measures to address afforestation and to revive extensive tree planting initiatives. Research shows that urban forests can mitigate against rising heat waves. One tree can absorb up to 150kg of CO2 per year in carbon sequestration.[24] The World Economic Forum places emphasis on small green spaces such as backyard gardens, green roofs, and parks as urban cooling strategies. Apart from acting as carbon sinks, urban forests can also increase the quality of city life by helping to reduce air pollution, protecting biodiversity, and acting to cool temperatures such as by providing shade.

Making green spaces accessible and inclusive

To help ensure that green spaces are accessible, physical barriers such as steps, lack of sanitation facilities and lack of parking should be avoided. A second set of barriers are psycho-social, which may include personal safety concerns and segregated design.

Inclusive greenspaces must be planned to accommodate all people striving to ensure that differences are not reinforced by using the space. Regardless of age, race, gender, ability and income, public green spaces should be enjoyed by all.

Through innovative and landscape design, cities can construct green spaces that promote safety and movement through texture, plant choice and barrier-free environment especially for disabled people.

The location of green spaces is especially important for lower income groups and for those that live in peri-urban areas, where access can be a challenge. The focus should be on access, park experience and usership.

It is critical to ensure that the design and maintenance of green spaces is done in a manner that allows maximum amount of carbon dioxide to be sequestered. Stephen Beatty says that green spaces need to be culturally and climate appropriate. For example, the city of Helsinki in Finland has experimented with biochar to enhance the sequestration capacity of urban green spaces.[25] Biochar is a charcoal-like substance produced by burning organic material from agricultural and forestry waste through a controlled process called pyrolysis. Use of biochar in one of Helsinki's public parks has resulted in significant amounts of carbon storage in the soil.

Technological innovation in green spaces

The carbon storage and sequestration potential of small green spaces such as yards and other artificial networks of ecological systems is still unknown. However, researchers find that positive impacts increase with upscaling[26] Enhancing the potential of residential small green spaces is a way to encourage residents to be part of a city's mitigation plan.

For cities that are limited in natural resources such as trees, grass and space, green landscaping is an innovative approach to creating carbon sinks. Through design and the use of digital technologies, cities can make decisions on where green landscape design is optimal.

Smart urban forests involve the use of tree monitors and 3D imagery to use forests in monitoring air pollution, tree hydration levels and even soil health as way to help improve maintenance and optimize sequestration capacity.

Industry

The process of decarbonizing the industrial sector is being challenged by high energy prices and energy supply chain disruptions.[27] In cities, competition for space and land use has often pushed industrial activities to the periphery. Research shows that many cities are adopting smart growth sprawl strategies that prioritize the conversion of industrial clusters into commercial and residential development.[28]

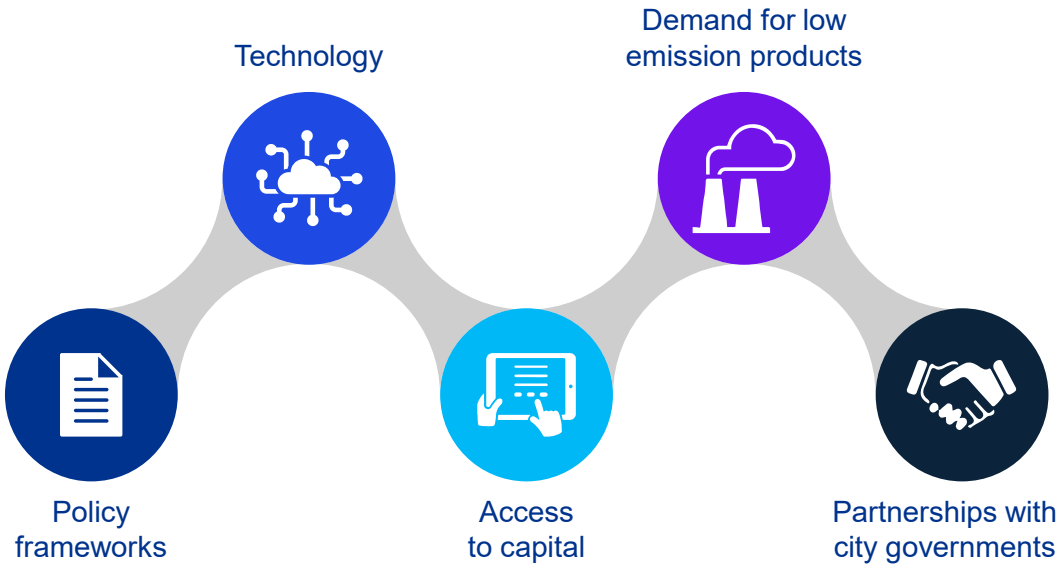
Nonetheless, some cities and their regions host industrial activities such as agriculture, manufacturing, mining, steel and cement production, oil, and gas amongst others. Efforts to transition to net zero will likely mean addressing a range of challenges such as waste, pollution, heating, and resource scarcity.

Achieving net zero requires a whole systems approach working across industry, city governance and policy structures, communities, researchers, and private sector to help ensure inclusive and sustainable pathways that can address the needs of urban areas. Research shows that adopting a place-based approach is critical for industrial decarbonization.[29]

What is an industrial city?

An industrial city is a zone or area that consists of a cluster of stand-alone industrial facilities, all operating simultaneously. It is usually located on the outskirts of a city, and is normally provided with good transportation access, including road and rail. Industrial cities offer integrated infrastructure for the various plants in one location, which would regulate the operation of all existing processes.[30]

Decarbonization of urban industrial hubs requires the following:



The role of technology is vital in the industrial transition to net zero. Digital infrastructure, artificial intelligence and machine learning can enhance decarbonization. There are a number of supply side technologies such as energy efficiency, carbon capture, electrification and zero carbon hydrogen that can accelerate the transition to net zero. Demand side approaches include reduced material waste, material efficient design and circular economy approaches such as recyclability and reusability.[31]

Opportunity for green jobs

As cities juggle multiple priorities concerning climate action, smart growth, and economic development, coordinating urban industrial development is critical for the generation of green jobs.

Urban areas are incubators for innovative technologies that can lead to creative solutions to accelerate net zero.

Waste and sanitation

Water management

Waste water is a significant problem for cities globally, leading to them addressing issues around water safety, supply, sanitation, waste water treatment and drainage.[32] One of the major causes of waste water in cities is poor and inadequate infrastructure. Alongside this is water governance and administrative arrangements at the city level. The management of water is better optimized in cities where there is shared management between several public and private actors. Several cities have demonstrated that management models with the intervention of the private sector have had a positive impact on the treatment of used water, ultimately limiting waste. Research further reveals that in city authorities where water management has been decentralized there are deficiencies when it comes to optimizing the water cycle.[33]

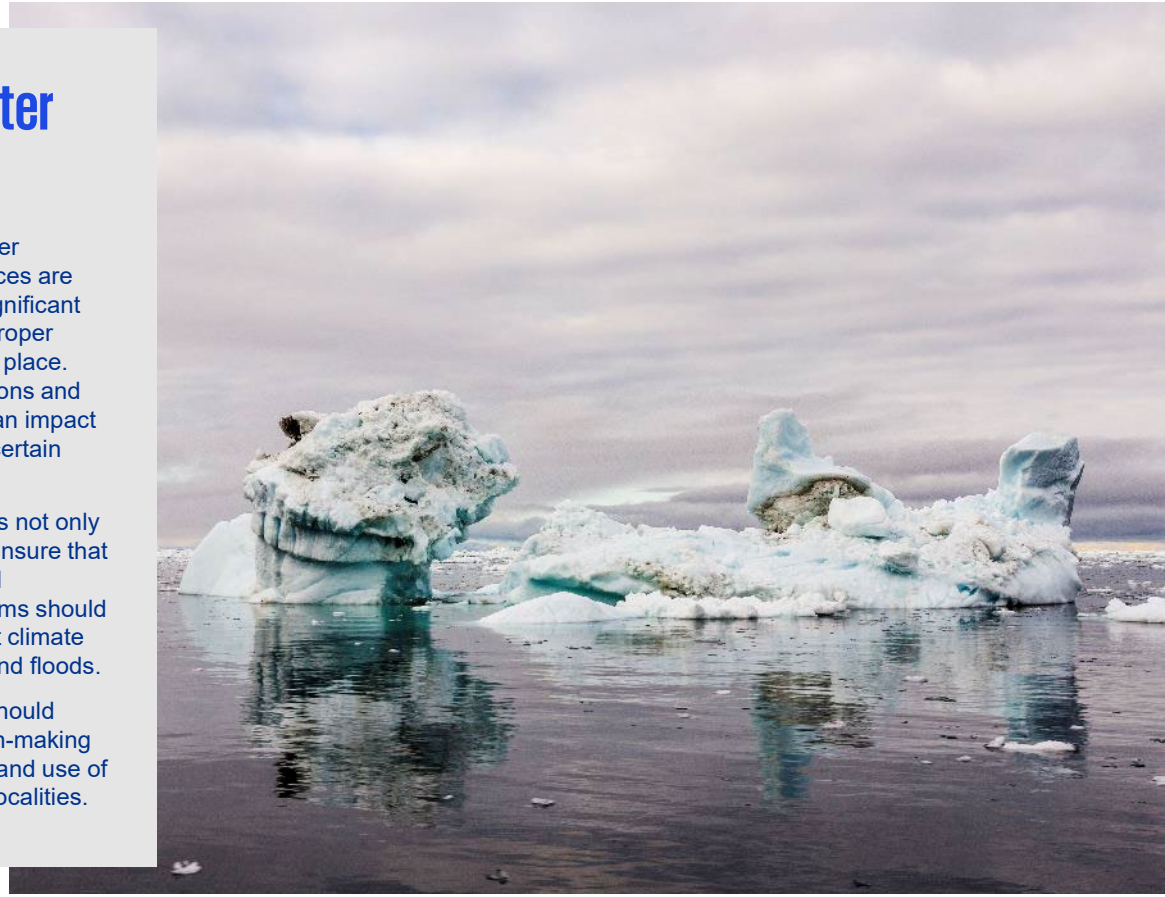
Eric Wolfe, Partner, Deal Advisory, Global Infrastructure Advisory, KPMG International and Partner, Deal Advisory , KPMG in Canada says that cities need to have requisite governance and management structures in place to help ensure everyone has adequate access to clean water. With increasing urbanization particularly in developing countries and deteriorating infrastructure, a water crisis is looming. In cities experiencing high water stress, conservation is not adequate to meet demand. Arriving at a sustainable net zero urban water balance requires collaboration between public and private stakeholders, innovative technologies and robust planning and design. Subsequently, there needs to be regulatory and policy tools to accommodate net zero water projects in cities.

Achieving water equity

Climate impacts on water infrastructure and services are expected to become significant in the coming years if proper policies are not put into place. Water systems, operations and their design may have an impact on access and use by certain groups in cities.

Critical in water equity is not only access, but striving to ensure that water is safe, clean and affordable. Water systems should also be resilient against climate risks such as drought and floods.

Communities in cities should have a voice in decision-making on water management and use of water systems in their localities.



Managing city waste

Cities produce 50 percent of global waste[34] and 3-5 percent of direct GHG emissions are a result of waste disposal.[35] The emissions are typically in the form of methane which is emitted when organic waste breaks down in open dumps or landfills where gas is not collected. Despite the data, waste and materials management has been at the margins of the decarbonization debate.

One of the major challenges in decarbonizing waste is the cost of diverting materials from landfills. Despite advances in sorting technology, the cost per ton remains expensive for most cities hampering effective reuse and recycling of materials. Eric Wolfe says that public-private models can be a way to mitigate issues around cost and innovative technology.

Mitigation strategies have focused on minimization of waste to landfill, reduction of CO2 from combustion facilities, recovering and recycling specific carbon intense materials, capturing landfill emissions and the optimization of transport logistics. Despite advances, one of the major pillars for driving the waste sector towards net zero is reducing consumption through materials management.

The circular economy is a system underpinned by a transition to renewable energy and materials based on eliminating waste and pollution, circulating products and materials at their highest value and regenerating nature. In a true circular economy, economic activity is decoupled from consumption of resources. A circular economy promotes the efficient use of natural resources and is key to achieving net zero from a climate adaptation point of view.

Eric Wolfe notes that adaptation is highly context specific, and cities should identify a range of options that are applicable and appropriate for their urban systems. The waste sector requires stakeholders across the supply chain to develop innovative decarbonization pathways starting with material design and behavior change that shapes how and what people consume. Arriving at net zero waste further requires technological innovation and advancement for cleaner and greener cities. He adds that an increase in cities engaging with extended producer responsibility with regards to responsible packaging can help reduce plastic waste, while public education and sensitization programs can be used by cities to encourage behavior change and consumption patterns.

Waste management: Electric and hydrogen refuse collection vehicles

Waste collection is a critical service. Zero emission refuse collection vehicles are an effective starting point for cities to showcase environmental leadership towards net zero in the waste sector. Innovative solutions such as hydrogen fuel cells can lessen environmental impact and hydrogen hubs can power not only refuse trucks but other commercial vehicles.

08

Sector scorecards

Sector scorecards: Analysis

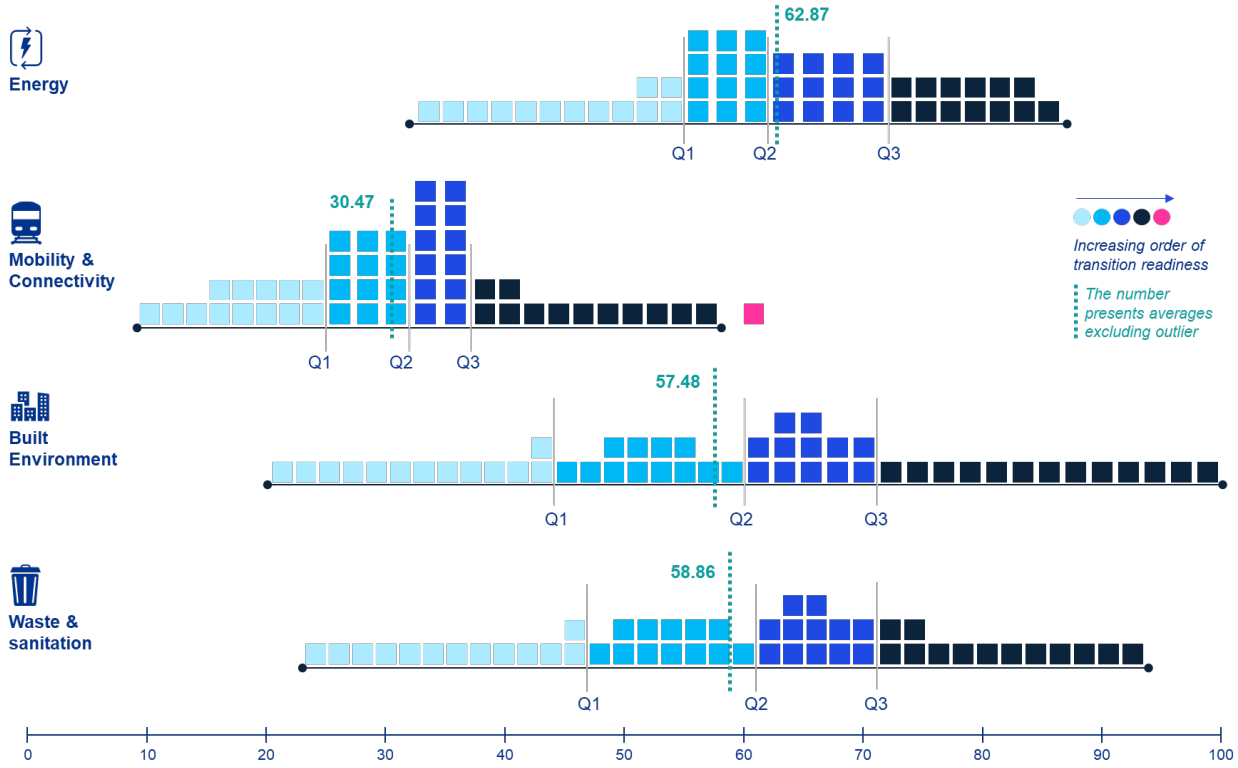
This section of the report assesses which sectors are performing and accelerating towards net zero in the 50 cities included in this report. Based on 48 indicators grouped under 'city enablers', decarbonization status "sector policies and preparedness' and climate equity', the analysis assesses the progress of cities in terms of climate action across the (energy, mobility, and connectivity, built environment and waste and sanitation sector).

The framework categorizes cities into two groups: Pacesetters, cities that score above average against the indicators in a sector, and Followers, cities that score below average in a sector.

*Industry does not feature in the sector scorecard analysis due to the data type collected and the scoring applied.

Averages of the sector

The below figures are the adjusted averages calculated for each sector against 48 indicators



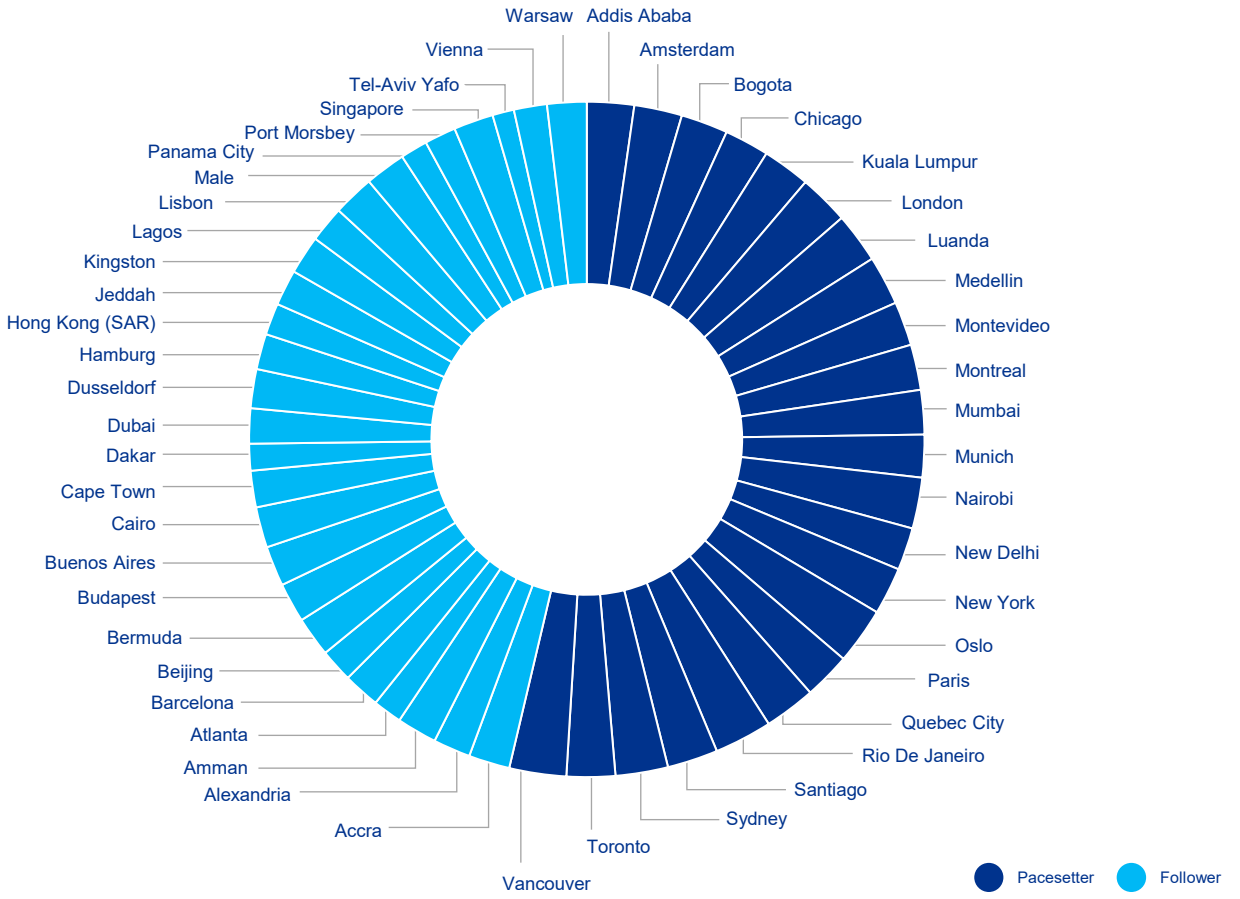
Energy sector

From a policy perspective, energy policies are usually designed at the national, federal, provincial, or state levels and most cities lack control over core energy decarbonization strategies such as ending use of unabated fossil fuels for electricity generation. Energy is one of the most regulated sectors. The integration of distributed energy resources and renewables is a major concern as well as the mismatch between regulations and the energy market.

In cities that are pacesetters there have been significant investments in solar, offshore wind and hydrogen. Long-term policies, coal phase-outs, market liberalization, reorientation of utilities and the adoption of new business models have transitioned the energy sector a step closer to net zero.

Furthermore, the interconnectedness of the energy sector with other high emitting sectors, makes moving this sector towards net zero both a challenge and an opportunity to simultaneously transition other sectors. Some developing cities feature as pacesetters, reinforcing the fact that they emit less than their developed counterparts as they consume less energy.

Despite the potential to use renewable energy in emerging and developing cities, the reliance on fossil fuels remains high as industrialization and development are key pillars for economic growth. The importation of diesel remains a prohibitory factor.



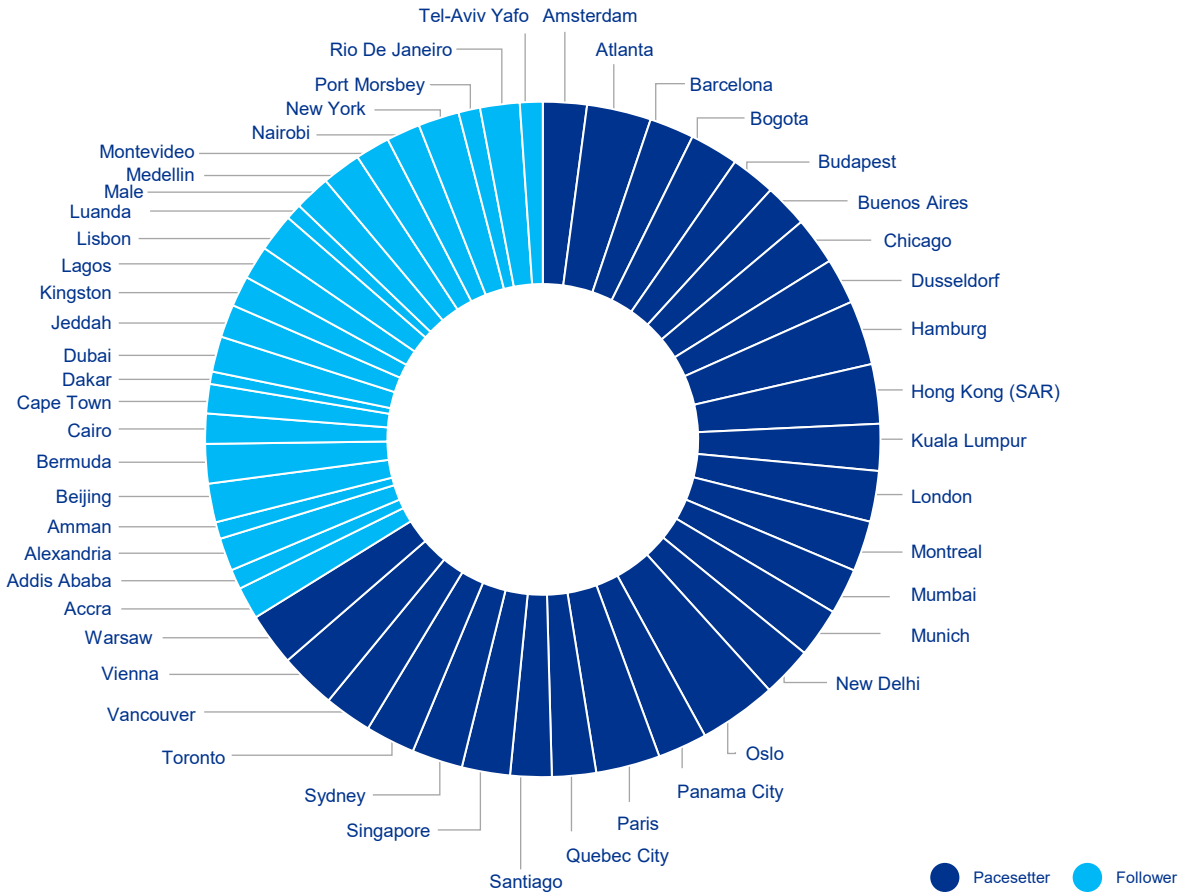
Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, (KPMG), 2022

Mobility and connectivity

One of the major challenges in decarbonizing the transport sector is the cost of acquiring electric vehicles and the availability of charging infrastructure, which can make polices and initiatives redundant. The location, visibility and accessibility of charging stations must be taken into consideration and a supportive renewable electric grid should be in place to accelerate the uptake of cleaner transport.

Cities in the pacesetter category have been able to leverage spatial planning tools, innovative city design not only to encourage uptake of electric public transport and vehicles, but also to support active transport such as walking and cycling. They have used innovative finance and investments to cover upfront costs of the transition to electric vehicles, electrify public transport fleet, diversify the modal mix and test micro mobility alongside digital solutions. Tax incentives for electric vehicles, removal of fuel subsides, and expansion of public transport infrastructure has positively influenced the transition to cleaner transport.

Some of the followers are megacities with very large populations, rampant urban sprawl and have in place public transport which is mostly informal or paratransit in nature, such as shared taxis. However, most of these cities are now in the initial stages of piloting electric public transport with a handful of buses on the roads albeit with limited charging infrastructure. Another limiting factor is that follower cities rely on counterproductive policies such as low-density suburban developments, fossil fuel subsidies and availability of cheap secondhand vehicles which negatively impact the decarbonization of the transport sector.



Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, (KPMG), 2022

Built environment

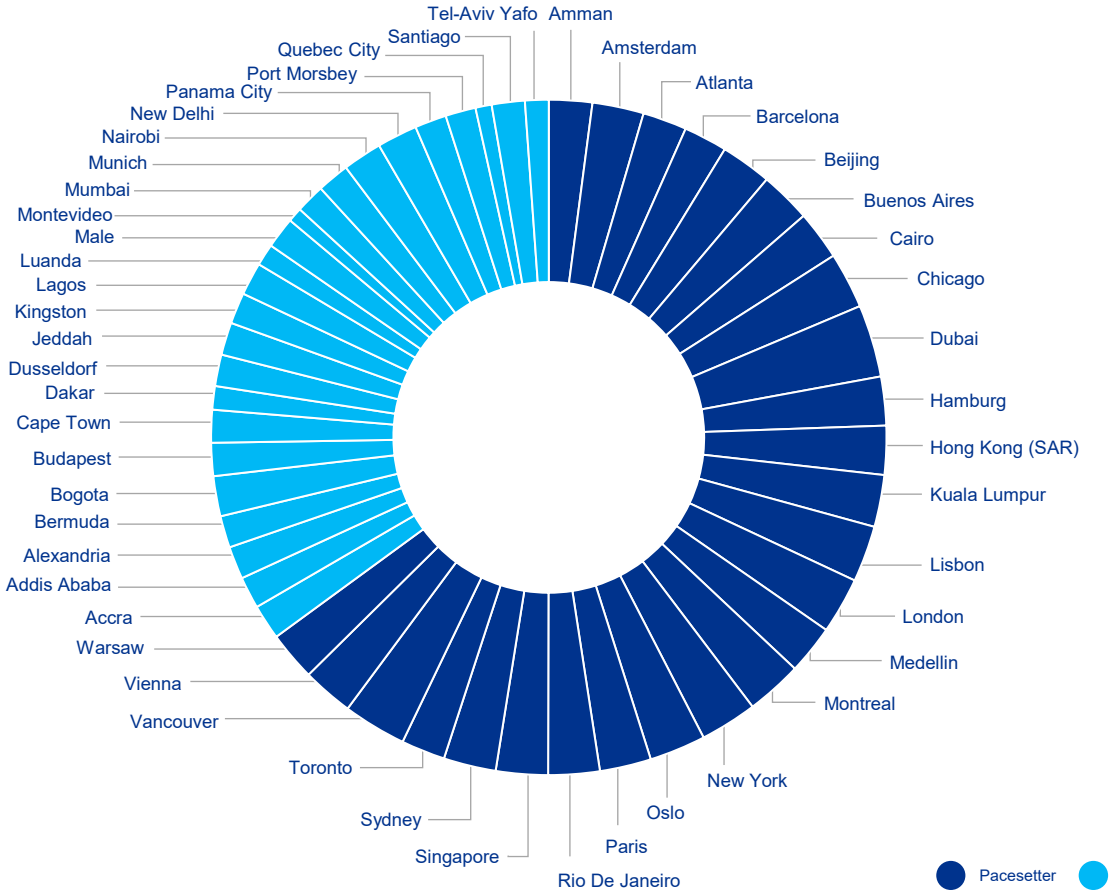
Buildings are one of the defining features of cities and as urbanization intensifies emissions are expected to continue to rise if the transition to Net zero is not accelerated. Buildings produce high levels of emissions, particularly from energy use for heating, cooling, and building operations. Seventy-five percent of global energy consumption occurs in cities and this is primarily attributed to the buildings sector.

Half of the 50 participating cities fall within the pacesetter category, signaling concerted efforts to help ensure energy efficiency in the use and operations of buildings in order to reduce emissions. Another indicator of success is the deployment of technology, digital solutions, and innovative design in the built environment sector. In cities where heating and cooling is a concern, innovative district cooling and heating, regulations such as green building codes, and the use of renewable energy has yielded positive results in the transition to net zero. There are also trends towards the enforcement of building energy regulations, the introduction of building codes that favor low carbon, and mandatory performance standards for existing and new buildings.

A major challenge in decarbonizing the built environment is that buildings are diverse in terms of their size, design, usage, and performance and vary across climatic zones. This requires climate, socio-economic and culturally appropriate decarbonization measures for both existing and new buildings. With the increasing challenges posed by rising temperatures that lead to heat waves, pacesetter cities are investing in green infrastructure and nature-based solutions. Green roofs, building retrofits and the uptake of renewable energy in particular solar energy are having positive impacts.

The challenges for cities that are followers vary depending on the city, but key concerns include rising population growth, demand for commercial and residential buildings, affordable energy and dependency on fossil fuels for heating, cooling and energy use.

Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, (KPMG), 2022

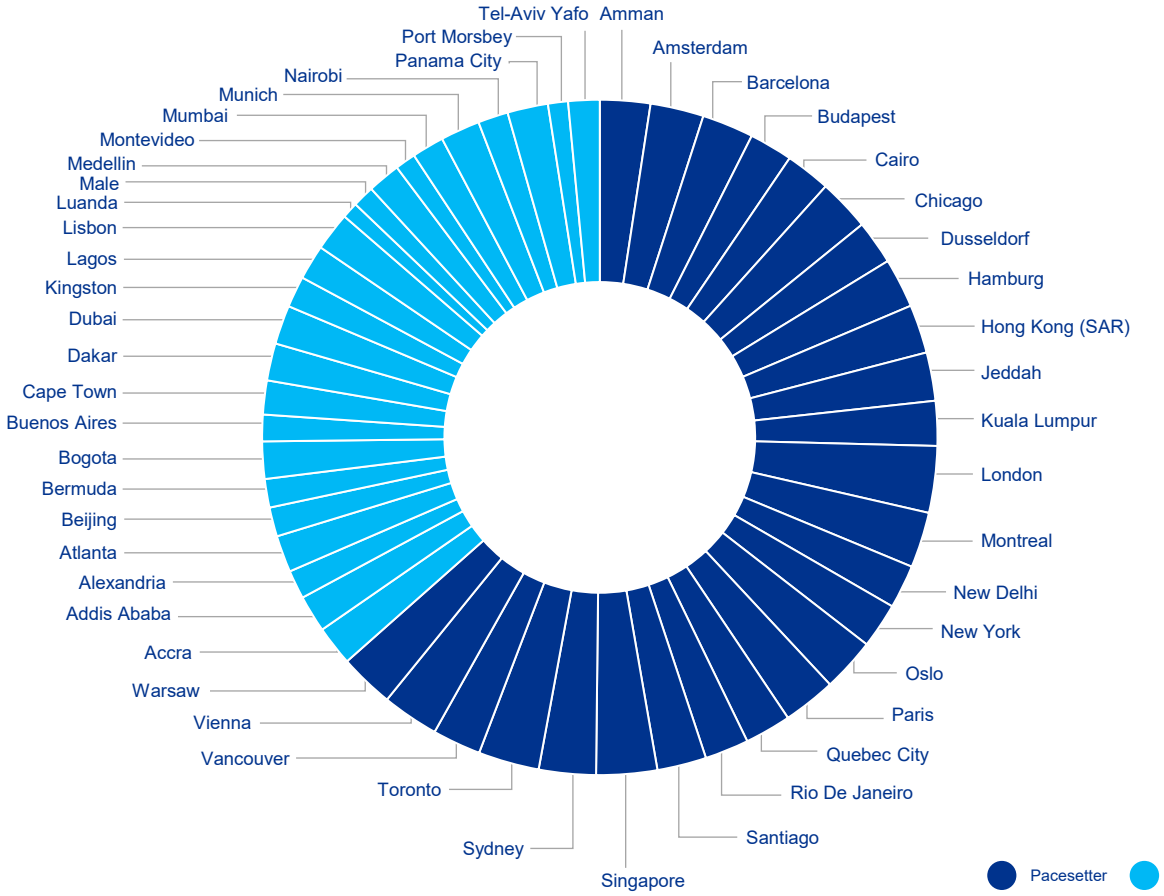


Waste and sanitation

The waste and sanitation sector typically generates fewer emissions than other sectors, but . remains a major contributor to greenhouse gases. As cities continue to grow, decarbonizing waste management processes such as transportation and incineration will be critical. Water management is energy intensive and with rising energy prices across the globe, progress towards net zero may be slow.

Pacesetter cities have been able move the sector towards net zero by decarbonizing activities in the supply chain rather than the sector in its entirety. Some cities have implemented waste-to-energy projects, developing a robust circular economy, decarbonizing waste water treatment facilities and deepening citizen and community engagement around zero waste.

Most of the followers are developing cities where the provision of waste, water and sanitation services are typically challenged by the cost of urban waste management. The World Bank finds that in low-income countries, waste is the single highest budget item comprising approximately 20 percent of a typical municipal budget.[36] Most of the cities, both pacesetters and followers, have set ambitious targets and goals for zero waste but more action is needed to achieve net zero.



Source: Net Zero Readiness Spotlight: Cities. Insights Towards Progress, (KPMG), 2022

09

City net zero profiles

Accra, Ghana

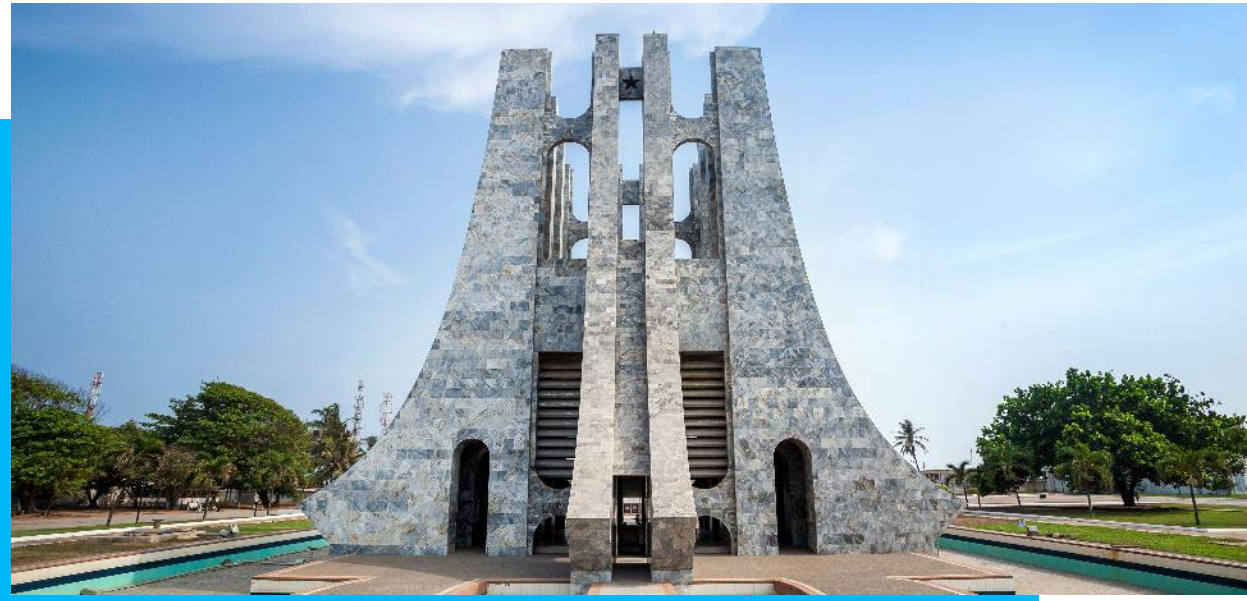
Accra's Climate Action Plan 2020-2025 aims to achieve carbon neutrality by 2050 and outlines measures to reduce greenhouse gas emissions by 73 percent. The Climate Action Plan puts emphasis on strengthening climate and urban governance whilst ensuring public participation and climate equity.[37] The climate action plan focuses decarbonization efforts in the solid waste and management sector, transportation and energy and buildings sectors.

The Government of Ghana has been at the forefront of SDG implementation and budgeting. These efforts are reflected in how the Accra Metropolitan Assembly develops their development plans leveraging on climate governance tools such as green budgeting, mainstreaming of SDG implementation with emissions reduction at the core of urban development and economic recovery.

The city is both a signatory and a key player in international city networks mobilizing for greater city action on emissions reductions.[38] Leveraging international donor finance and technical assistance the city is implementing The Greater Accra Resilient and Integrated Development Project (GARID), supported by the World Bank that aims to strengthen the resilience of critical urban infrastructure against climate hazard such as floods.

Urban sprawl, population growth coupled with public transport inefficiencies, has led to traffic congestion and an increase in air pollution. The Accra Metropolitan Assembly in collaboration with the national government are piloting electric buses with the objective of increasing the fleet of zero emission buses. The lack of charging infrastructure remains a significant challenge to increasing the uptake of electric vehicles.

In the waste and sanitation sector, the Accra Metropolitan Assembly has partnered with the United States Environmental Protection Agency under the Climate and Clean Air Coalition to develop and implement solid waste management strategies that potentially contribute to the reduction of short-lived climate pollutants and greenhouse gas emissions in the city.



Built environment: Energy efficiency revolving fund[39]

The Accra Metropolitan Assembly has set up an energy efficiency revolving fund as an incentive package to encourage developers to construct green buildings by offering rebates on property rates and building permits.

In tandem with the updating of the building code by the national government, adoption of the Ghana Net Metering alongside the uptake of green building programs, the city aims to drive down emission from the buildings sector. This is expected to lead to energy cost savings considering the demand for cooling throughout the year.

Addis Ababa, Ethiopia

The Addis Ababa city administration has been leading decarbonization efforts towards climate action. The city has seen an increase in population and economic growth that has put pressure on the city's energy system, transport network and an increase in waste.

Decarbonization of the transport sector has been at the forefront of climate action in Addis Ababa as the sector contributes to 47 percent of the cities total greenhouse gas emissions[40] The city launched Africa's first renewable energy-powered light-rail train network. The train is powered by Ethiopia's power grid, which is fueled almost exclusively by hydropower, geothermal, and wind power. Emissions reductions from the project are estimated to grow from 55,000 tons of CO_2 per year in 2015 to 170,000 tons CO_2 per year by 2030. The city is also advancing active transportation to encourage cycling and walking, diversifying the modal mix.

Through partnerships and collaboration with diverse stakeholders, the city of Addis Ababa has implemented a series of projects that tackle emission reductions in the city. For example, Addis Ababa has partnered with Climate and Clean Air Coalition and C40 cities to tackle air pollution mainly from the transport sector.

Urban sprawl and housing affordability concerns have led to a proliferation of shantytowns. The Addis Ababa City administration have taken the lead in advancing low – carbon building designs that will see the provision of energy efficient housing for low-income groups.

Addis Ababa's multisector approach to decarbonization of the energy, transportation, and waste sectors has accelerated climate action. It is the first city in the African continent to develop the waste to energy plant to ensure sustainable management of waste diverting waste from landfills.[41] To further address food waste, the city is a part of C40's Food Systems Network which supports citywide efforts to create and implement integrated food policies to reduce greenhouse gas emissions and increase resilience to deliver positive public health benefits outcomes and to establish a thriving circular economy.

Energy: Reppie waste-to-energy plant[42]

The Addis Ababa City Administration in partnership with Cambridge Industries has set up the Africa's first waste to energy plant. The plant uses municipal waste as fuel for power generation. It has a capacity to treat 1400 tonnes of waste on a daily basis to generate steam that drives two 25MW turbines. The two generators combined have the capacity to generate 185,000,00 kwh. The combustion process also sorts metal. The plant has cross – sectoral impact on waste and built environment sectors as the green energy produced from 80 percent waste is used to power 30 percent household electricity needs.

Alexandria, Egypt

Alexandria is Egypt's second largest city and is host to its main port. It is a member of ERBD Green Cities and as part of the program, will focus climate action on water, air quality and waste. The city has one of the oldest parks in the country that could play a role in the city's resilience and adaptation strategy. Rising population growth coupled with the city's proximity to the Mediterranean Sea is having an impact on critical infrastructure. Rising sea levels and increased rainfall have destroyed infrastructure particularly in low-income neighborhoods and important archaeological sites. To strengthen the resilience of the local authorities erected concrete barriers to break strong tides. The Egyptian government has also allocated funding for strengthening climate resilient infrastructure and other protective measure along the shoreline.

The City of Alexandria implemented a city development strategy for sustainable development to simultaneously address environmental degradation of Lake Mariout, local economic development, and participatory urban upgrading. Through this project a department for implementation and long-term development sustainability was established to coordinate and drive sustainable green development in the city. This signals the importance of strong climate governance structures for implementing and accelerating climate action

The city of Alexandria handles approximately 55 percent of imports and exports and there is need to for energy efficient transport.[43] A EUR250 million loan from the European Bank for Reconstruction and Development (EBRD) aims to finance a high-capacity electric metro system in Alexandria. This upgrade will improve air quality and reduce noise levels. The project aims to result in a modal shift from road transport contributing to significant greenhouse gas reductions.

Built environment: The Rise[44]

Under the presidential initiative 'Go Green', Alexandria inaugurated its first sustainable project. Specifically, the Rise sets standards for low energy use and carbon emissions and its impact on natural resources. The project provides for the harnessing of solar energy, wind energy and thermal cooling to reduce water use and treatment and provides green spaces. The objective is to have a holistic approach to decarbonizing the built environment considering the role of citizens, biodiversity, and climate.[45]

Amman, Jordan

The city of Amman faces great challenges, as Jordan is the second most water scarce country in the world. Largely a desert, the effects of climate change are increasing the city's vulnerability. The city has also experienced a sharp increase in population due to the Syrian civil war, which has increased demand for energy, water resources and service delivery. The city is host to most of Jordan's population and therefore accelerated climate action is critical.

The city of Amman has put in place a bold climate action plan that considers economic prosperity through ambitious emissions reduction and green growth policies. The Greater Amman Municipality has made significant strides in the water, waste, and sanitation sectors, considering the city's fragility. The waste sector is the second largest emitter of greenhouse gases, mainly methane from large amounts of organic waste[46].

Natural resource shortage coupled with irregular rainfall patterns, drought and rising temperatures in the summer months calls for resilient climate adaptation, innovative policy, the application of technology and partnerships to transition towards net zero.

The city places a specific emphasis on ensuring climate action benefits women in the city. Research[47] indicates that the impacts of climate change affect women in a significant way due to their roles as caregivers, domestic roles, and social norms. Urban heat waves are especially a concern for women who undertake household work while simultaneously providing cooling solutions. The Amman Green City Plan aims to empower women, by striving to ensure energy efficiency in buildings, sustainably providing cooling, and deeply engaging and involving women in the journey towards carbon neutrality.

As the city grows in numbers one of the major challenges will be to strive to ensure that climate action is inclusive and equitable. This is especially critical for the large refugee populations in the city and in the peri-urban areas. Alongside this is establishing a strong governance structure to ensure effective implementation towards net zero. Lastly, raising funds from municipal service to cater for climate action projects remains a challenge.

Waste and sanitation: Ghabawi Landfill Gas Capture and Power Generation Project[48]

Led by the Greater Amman Municipality this waste-to energy project main objective is to conduct power generation, gas combustion using landfill gas (LFG) and methane gas generated from the site. The Ghabawi Landfill gas will generate 4.8MW per hour by burning methane that will eventually cover the municipality's energy consumption. The power generated can power the landfill and the remainder will be directed to the national grid. This project hopes to reduce greenhouse gases emitted, optimize waste treatment, and reduce to the pressure on current energy systems. This project is funded by the European Bank for Reconstruction and Development.

Amsterdam, The Netherlands

The City of Amsterdam launched the Climate Neutral 2050 campaign to drive acceleration towards 95 percent reductions of emissions by 2050.[49] The city's approach to climate action towards net zero is inspired by technology, innovation and experimenting novel solutions to help maximize the most suitable decarbonization pathways. Decarbonization across the sectors has been guided by effective climate governance, planning and citizen engagement.

Top emitting sectors in Amsterdam are mainly from energy consumption, followed by buildings, transportation and from industry and port activity[50]. In addition to this, 63 percent[51] of emissions in the city are caused by products and materials consumed directly in the city, hence an emphasis on decarbonizing the waste sector and building a strong circular economy.

The city has adopted a monitor that tracks and evaluates progress in implementing a circular economy. This monitor is developed based on the doughnut model[52] developed by the economist Kate Raworth, that looks at both the use of materials but also the social fabric of the city. This intersectional approach is critical for developing equitable polices on climate action that benefit the socially and economically marginalized in the city.

Amsterdam's cutting-edge climate action policies have benefited from diverse and innovative funding mechanisms. For example, the Amsterdam Climate and Energy Fund[53] provides risk bearing financing such as loans, warranties, and other market competitive financing to projects that can contribute to decarbonization the city's energy sector.

Waste and sanitation: Amsterdam Circular

Amsterdam has put in place a strategy that gives direction for the next five years for the municipality, residents, and business in three areas of the city's circular economy. These are food and organic waste, consumer goods and the built environment. The city has specifically selected the three areas of focus due to the economic significance to the city and they impact on the environment. The city has put in place bold ambitions such as deploying spatial planning and innovation policy to advance and deepen the decarbonization of the waste sector by designating specific locations for the collection and reuse of waste.[54]

It has set targets that by 2022, 10 percent of the city's procurement will be circular;

by 2023, all of the city's invitations to tender in the built environment will be circular; by 2030, it will have 50 percent less new raw materials in Amsterdam; and by 2050, it will be a 100 percent circular city.

Atlanta, United States

The City of Atlanta launched its climate action plan in 2015.[55] Atlanta's approach to climate action puts an emphasis on community engagement. This commitment ensures that climate justice remains a pillar for accelerated climate action.

The State of Georgia has been at the forefront of emission reductions meeting the federal target of 50 percent by 2030. This has positively impacted the emissions profile of the city of Atlanta and its metropolitan areas. The state's highest emitting sectors are primarily transportation and energy. This is mirrored in the emission inventory of the City of Atlanta, which has implemented several bold measures to decarbonize the transport sector through the introduction of electric buses in vulnerable neighborhoods.

The City of Atlanta has also made significant progress in decarbonizing the buildings sector through leading by exampling. The Better Building's Challenge[56] was implemented in city owned building, schools, and commercial buildings – this led to a reduction in energy and water use by 20 percent.

The city has established a Mayor's Office of Sustainability and recently appointed a Chief Sustainability Officer. This shows the city's commitment to ensuring effective climate leadership is in place to drive climate action. This new appointment should see the updating of the current climate action plan, putting in place a sustainable procurement strategy and to leverage climate finance from federal sources particularly the recently passed climate legislation, the Inflation Reduction Act. The above traction towards decarbonization provides an opportunity for Atlanta to help ensure effective monitoring and evaluation processes are in place.

Mobility and connectivity: Atlanta's first electric buses

The Metropolitan Atlanta Rapid Transit Authority (MARTA) has launched the city's fleet of electric buses. With support from a consortium of partners such as the Federal Transit Administration, Siemens, New Flyer and the Center for Transport and the Environment, it introduced three electric buses in May 2022.

The electric buses will serve dense urban corridors. This strategic decision is to ensure underserved areas with vulnerable populations have access to transport services. The introduction of electric buses to MARTA's fleet hopes to reduce emission by approximately 935 ton of greenhouse gasses[57] as well as fine particle matter linked to several health issues.

Barcelona, Spain

Barcelona's transition to net zero is anchored on achieving successful economic recovery, growth, and diversification. The city's climate action plan has set an ambitious carbon neutrality goal by 2050. The city has focused efforts in emitting sectors – transport at 30 percent and buildings at 24 percent[58] – and has made significant impact. This traction is partly due to robust policies and impactful implementation of initiatives that tackle energy efficiency across the built environment, transport, and waste sectors.

A unique characteristic of Barcelona is its old housing stock. The average age of a building is 62 years old mainly located in vulnerable areas of the city, increasing exposure to climate hazards. Subsequently only 2 percent of the city's building stocks meets current energy efficiency requirements. Barcelona has put in place robust adaptation measures across to meet several sectoral net zero targets. To help reduce the energy consumed in cooling buildings during heat waves, the city is working together with homeowners and the private sector to retrofit commercial and residential home and increasing the use of renewable energy through solar power.

Alongside partnerships and collaboration, Barcelona is leveraging on technology to test their decarbonization plans and strategies through the application of digital twins. By applying this, the city aims to measure and track the impact and progress of their ambitious net zero climate action plan.

Recognizing the importance of climate equity, the city in conjunction with higher levels of government have put in place measures such as public transport subsidies to encourage ridership. The city has also put in place programs that educate lower income groups on how to save money for energy bills as well as subsidies to tackle the rising problem of energy poverty.

One of the major barriers to accelerated climate action is the tension between available climate finance and city administrative and management structures. Navigating the city's complex bureaucracy and creating an environment of trust between key stakeholders is critical for the scaling up of climate action and decarbonization.

Waste and sanitation: Zero Waste initiative

The city's Zero Waste[59] initiative aims to deepen implementation of an individualized system of collection and a waste fee linked to the volume of waste generation, to encourage city dwellers to sort their waste. The strategy is a multipronged approach that focuses on policy, citizen engagement and economic growth. The initiative of door-to-door collection of waste is supported by municipal led awareness raising amongst stakeholders complemented with incentives for waste and repair schemes, that can enrich the city's circular economy.

Specific targets include to reduce waste generation to less than 1.2kg per inhabitant per day; to reach recycling levels of 60 percent of municipal waste; and to reduce the polluted fraction of organic waste to below 8 percent.

Beijing, China

Climate action in Beijing is anchored on green economic growth, innovation, and the adoption of technologies to drive the city towards net zero. Beijing seeks to have 20 percent of its primary energy use generated from non-fossil fuels by the year 2030. Leading by example, municipal buildings are energy efficient and efforts towards decarbonizing government operations are underway. The city has powered its streetlights using solar energy.

Despite an efficient public transport system, the sector contributes significant emissions in the city. Beijing is taking a multi – pronged approach to decarbonization, by expanding transport infrastructure such as the subway to encourage ridership that has been affected by the COVID-19 pandemic. The city is promoting active transportation by launching bike sharing programs and incentivizing EV purchase through subsidy.[60, 61, 62]

Leveraging on partnerships and collaboration the city is discouraging car use through the establishment of the Green Traveler Platform, initiated by the Beijing Environmental Exchange, a corporate domestic and international environmental equity public trading platform. The platform brings together car networking companies, insurance companies, banks and other partners to promote a new integrated model in which public and private stakeholders work together to encourage a low-carbon society. The participants of the program receive a substantial financial incentive based on how much time was spent in driving.

The Beijing Chaoyang Circular Economy Industrial Park is a major industrialized waste treatment park. The park serves as a solid waste recycling center, a solid waste treatment research and development education center and a circular economy's industry development demonstration center. This innovative approach to decarbonizing the waste sector is a comprehensive project that deals with different types of waste such as organic, food and medical. The facility is also equipped with an electric vehicle charging park to fuel up to 400 vehicles that transport waste.

Built environment: Energy savings subsidy [63]

The Beijing Municipal Government and the Haidian District Government granted an energy saving endorsement and financial subsidy to the Microsoft Beijing campus rewarding the buildings performance. Johnson Controls partnered with Microsoft Beijing Campus for its ongoing retrofit and optimization of building operations, achieving 27.9 percent energy savings, and ensuring key equipment uptime to 98 percent.

The subsidy encourages developers, companies, and other key stake holders to implement energy efficiency in building operations aligning with the city's climate action plan that aims to arrive at net zero in the energy and built environment sectors.

Bogotá, Colombia

The city of Bogotá has an award-winning climate action plan that aims to achieve net zero status by 2050. The transport sector contributes 48 percent of greenhouse gas emissions, followed by the built environment at 20 percent. With a nonexistent railway system, the city is heavily dependent on an informal freight and trucking sector that has been a stumbling block for accelerating decarbonization of the transport sector. It is key to note that the informal freight cargo in Bogota is the oldest in Latin America.

Bogotá is the main transport artery connecting all parts of the country, and with no effective rail system, large volumes of freight cargo contribute to poor air quality which is a major public health concern. Due to the informal nature of the sector vehicle owners do not have the financial resources to upgrade or retrofit their vehicles. This leads to significant air pollution and traffic congestion. Despite these challenges, the transport sector in Bogota has seen rapid decarbonization. The city has adopted a wide range of mitigation and adaptation measures that aim to expand and improve public transport, walkability and cycling and using land use planning as way to ensure supporting infrastructure for cleaner non-motorized modes of transport.

In the energy sector, policy rests with the central government. Private sector companies whose main objective is to maximize profits have played a significant lobbying role that favor fossil fuel dependence. The municipality of Bogota therefore has limited leeway to advance climate action in the energy sector.

Unique to the city of Bogotá is the consumer preference for natural gas rather than electricity. New builds are designed and wired for natural gas rather than electricity as the former is a cheaper option, which end consumers are demanding. This trend is predicted to result in stranded assets in the long term as both oil and gas reserves are running out. The city does not have jurisdiction over building restrictions making the transition of the buildings sector to net zero challenging.

Mobility and connectivity: BiciCarga

Freight cargo mainly old trucks are responsible for around 40 percent of fine particulate pollution in Bogotá. The BiciCarga pilot project funded by the World Bank and coordinated by the Bogotá transport commissions aims to save 16 metric tons of particulate matter each day by switching trucks for electric cargo bikes.[64]

Another objective of the project was to solve bottlenecks of last mile distribution to facilitate the delivery of merchandise quickly and efficiently and streamline operational inefficiencies in distribution.

Budapest, Hungary

Adopted in 2021, the city of Budapest has put in place an ambitious sustainable energy and climate change action plan. The city has made significant investments moving the transport sector towards a low emitting sector. The city's action plan aims to reduce care use to 30 percent of all city traffic.[65] The city has a well-organized and expansive public transport system that is affordable. Through the Budapest card, passengers can travel without restrictions and for free within city boundaries via buses, trams, trolleys, subway and even boats. To further decarbonize the sector, the city has put in place measures and targets to increase active transportation and encourage cycling as means of moving around the city.

With an emphasis on public spaces, the city is leveraging on nature-based solutions to expand green areas. The city currently has 5m2 of green area per capita, which is significantly less than other European cities.[66] The city is implementing an initiative called 'pocket parks' in a bid to increase access to parks and green the city to reduce the urban heat island effect. Considering the architecture of the city's apartment buildings that have internal gardens covered with concrete - the city is removing the concrete and establishing green pocket parks to help improve the microclimate and water retention capacities. Through innovation and technology, the city can leverage on the river Danube to help decrease the urban heal island effect.

The establishment of community gardens in the city has also been a significant initiative part of the city's pathway to net zero. This unique approach actively engages citizens in co-partnering with the city to advance implementation of the climate action plan and deal with issues of food security amidst rising food costs. The city of Budapest has leveraged on spatial planning to advance both climate mitigation and adaptation initiatives. This approach allows the city to accelerate the decarbonization of multiple sectors such as transport, built environment and increasing resilience of critical urban infrastructures.

As the city of Budapest transitions to net zero, attracting climate finance remains a challenge. Funding mechanisms are not flexible enough to cater for more than one policy sector. The robust, integrated, and holistic climate action plans in place or Budapest require significant and innovative funding mechanisms to meet climate action targets. The city has also had a long history of social tension and segregation and therefore concerted efforts to address these concerns is of importance.

Mobility and connectivity: MOL Bubi Budapest bike sharing service[67]

With a decline in usage, the Budapest Transport Sector in partnership with the state oil company MOL, relaunched MOL Bubi, a bike sharing service. MOL Bubi has been given a facelift with new bikes and an upgraded rental system that is user-friendly, accompanied with a mobile application and website. The bikes are supplied locally by a Hungarian bike maker. To help ensure that the initiative is equitable and accessible to all, a security deposit system will be abolished, and a cheaper pricing system will be implemented. The system launched in April 2021, with a fleet of 1200 bikes. The city hopes to re-ignite the culture of cycling and active transportation to rapidly lower car dependency.

Buenos Aires, Argentina

The city of Buenos Aires has been at the forefront of setting very clear and ambitious emissions reduction goals through their Climate Action Plan 2050. The city has leveraged on quality data to inform their net zero pathway enabling effective monitoring and evaluation of impacts. The city's holistic approach to climate action is premised on four levers. The first is a prepared city that aims to increase the city's resilience through sustainable infrastructure and nature-based solutions, the second is close city that is walkable and accommodating to non- motorized transport. The third is an inclusive city where climate action leaves no one behind. Lastly, a low carbon city that leverages of innovative and technology to drive decarbonization across emitting sectors.

Unique to their Climate Action Plan 2050, is the intersectional understanding of the impacts of climate change not only across high emitting sectors but across the diverse urban makeup of the city residents and natural landscape. This integrated approach to climate mitigation and adaptation in the city is anchored on strong climate governance and collaboration across diverse stakeholders. The city has established a variety of participatory initiatives such as the Expert Advisory Council on Climate Change that brings together academics, scientists, and experts to assist the city government in the development or public policies on climate change. The city has also set up similar platforms to engage the private sector and the residents of Buenos Aires.

Despite the fact Argentina has some of the world's best solar and wind resources, increasing the city's uptakes for renewables need to be deepened.[68] For example, the transport sector which currently contributes 30 percent[69] of greenhouse gas emissions and has been difficult to decarbonize, could benefit from reliable and available renewable energy. The uptake of electric vehicles has been slow due to cost and lack of incentives. Secondly, the lack of convenient charging infrastructure has been prohibitory and most of the electricity in the city comes from nonrenewable sources. Despite this the city is promoting active transportation by offering low-cost bicycle rental options using mobile applications and designating bike paths to ensure safety and better access.

Built environment: Barrio 31

Buenos Aires has taken a unique approach to increasing the uptake of renewable energy. Considering the link between climate mitigation, equity, and social inclusion. The city has primarily focused on low-income neighborhoods, proving installation of solar water heater and panels in low-income homes.

In one of the largest informal settlements, locally know as Barrio 31, the city has embarked on transforming the neighborhood through clean energy. By installing rooftops with solar panels, Barrio 31 residents now have access to electricity and a steady supply of hot water. This does not only ensure that buildings are energy efficient, but also helps to ensure that target reduction emissions for the energy sector are met in an inclusive and equitable manner.[70]

Cairo, Egypt

The City of Cairo has over the last years been affected by extreme weather events such as flooding and rising temperatures. Climate action at the city level has become paramount. The Government of Egypt in 2022 launched the National Climate Change Strategy 2050 to guide the transition to a low carbon society. The government's climate plan is anchored on five pillars with emphasis on innovation and technology, attracting climate finance and achieving economic growth through low emissions development in strategic sectors.

Aware of its vulnerability the Cairo Governate is working together with the national government and other key stakeholders to strengthen its resilience. In the Greater Cairo area, the transport sector contributes approximately 26 percent of greenhouse gas emissions,[71] affecting the city's air quality. To encourage the uptake of public transport and cleaner transport such as electric vehicles, the national government enacted a fuel subsidy removal in 2014. Road expansions and infrastructure improvements in the Greater Cairo region have been implemented to ease traffic congestion. The city is also expanding and improving the mass transit network to encourage ridership.

The energy transition in Greater Cairo should be driven by increasing the uptake of renewable energy and putting in place measures to decarbonize the built environment sector. The Cairo Governate is leading by example as office buildings use solar power. The city has also benefited from small but impactful projects such as green roofs, urban gardening supported by non-government organizations. Green roofs are especially important in Greater Cairo, where the weather is hot and dry. The demand for cooling can be managed by increasing green spaces around the city.

With a growing population, waste management is a challenge. The City of Cairo has established a robust solid waste management plant to reduce emissions from the waste sector and is working on improving systems for solid waste management in partnership with private sector to benefit from innovative ideas and technological solutions. The city through the Cairo Cleanliness and Beautification Authority (CCBA)[72] brings together formal and informal waste collectors to raise awareness on the importance of emissions reductions in the sector.

Built environment: Greater Cairo Air Pollution Management and Climate Change project[73]

Funded by the World Bank the Greater Cairo Air Pollution Management and Climate Change Project objective is to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo. Key components of the project include reduction of air pollution and greenhouse gas, strengthening Cairo's resilience to air pollution, support the operationalization of solid waste management master plans in greater capacity building, and institutional strengthening.

Cape Town, South Africa

Cape Town's largest source of emissions are mainly from the built environment and transport sector emitting 42 percent and 31 percent respectively.[74] The city's Climate Change Strategy puts emphasis on strengthening data for evidence-based policies, leveraging climate finance to invest in net zero projects, private sector partnerships and effective monitoring and evaluation processes. The city has embarked on a major retrofitting of 60 percent of municipal buildings to drive the value of energy efficiency and to lead by example. Total electricity consumed in the city is by the residential sector and the heating of water is considered to a high energy user.[75] The city has been promoting the installation of solar water heaters in homes as part of the accredited solar water heater program.

The country has been experiencing an energy crisis that has resulted in load shedding across cities except for Cape Town. This is because the city has additional energy generation capacity via its Steenbras hydro-electric pumped storage scheme. The city is far ahead in terms of energy policy, readiness to transition to cleaner energy and only requires approval from National Government to procure energy from independent power producers. To further decarbonize the energy sector, Cape Town has launched a set of guidelines and associated tariffs for small scale embedded energy generators with a generation capacity of less than 1MVA. Guidelines and tariffs have been compiled for commercial, industrial, and residential generators and are applicable for both renewable energy generation and co-generation. Small scale generators will be permitted to connect to the grid and in so doing be able to both import energy from and export a limited amount of energy onto the city's grid, which they will be credited for.

The city's growing population coupled with limited land fill capacity has led to the establishment of a growing circular economy. The city has implemented several initiatives that aim to decarbonize the waste sector. For example, the collaboration between the city and a consortium of private sector companies under the Western Cape Industrial Symbiosis Programme aims to add value to waste materials linking business opportunities and resource efficiency. The projects also aims to reduce industrial and commercial waste produced by businesses.

Built environment: Cape Town ceiling retrofit project[76]

The city undertook retrofitting of several homes the city to address the demand for energy. The project involves the insulating of ceilings which would decrease the energy cost for residents and improve health complications caused by inappropriate insulation materials. Cape Town's cold climate makes its residents susceptible to tuberculosis and other illnesses, especially in low-income neighborhoods where housing often lacks the proper insulation further affecting indoor air quality. Through this project, the city has been able to address energy efficiency and public health concerns, illustrating the many ways that equitable climate action can be realized. Ultimately the initiative aims to realized reduced healthcare and energy costs, a reduction in emissions and improved quality of life for residents.

Chicago, United States

The city of Chicago has set bold ambitions to reduce carbon emissions by 62 percent by the year 2040. Chicago's climate action plan puts emphasis on equitable climate action and leverages on partnerships and innovative collaboration to transition to net zero. The city has put in place plans to advance environmental justice and aims to simultaneously strengthen economic prosperity and urban health.

Sources of emissions are from buildings at 69 percent, followed by transport at 24 percent and waste at 7 percent[77]. The city's governance structure helps to ensure effective collaboration with state and federal agencies to drive climate action at the city level. The need to put in place effective monitoring and evaluation measures is critical to the transition to net zero amidst rising temperatures, colder winters, and population growth.

Leveraging on partnerships, the city of Chicago in partnership with Exelon, has developed the world's largest municipal solar installation. The 40-acre site is host to a 10MW installation. In addition to this, Chicago is famous for its green roofs and is currently installing over seven million square feet across the city to decarbonize the built environment.

Particularly challenged by the fact that Chicago was built on a swamp, the rising water levels in Lake Michigan are causing damage to buildings and adversely impacting low-income neighborhoods. The city will require substantial investments towards climate adaptation to reduce loss and damage costs. In addition to this, is the need to leverage on new technologies that can accelerate the transition to net zero.

With a central focus on climate equity, the city has put in place a unique approach that links direct financial investments into inclusive climate action, engaging community leaders and financing projects that can help improve the livelihoods of historically marginalized groups and reduce the impact of climate change both at the macro and micro level.

Waste and sanitation: Chicago waste strategy[78]

Chicago has developed a robust strategy to divert waste from landfills, increase recycling, address environmental injustices, and create green jobs. The city of Chicago has taken a unique and intersectional approach to decarbonize the waste sector. The strategy considers that the transition to net zero must be just, fair and provide economic opportunities.

Furthermore, the city has developed this strategy in partnership with a specialized nonprofit organization dealing in municipal solid waste management planning and the University of Illinois at Chicago. The waste strategy will focus on the following waste sectors: residential waste reduction, organic and wasted food, specialty materials, construction and demolition debris, source reduction, reuse and repair, municipal management and data tracking, and industrial, commercial and institutional waste reduction.

Dakar, Senegal

The city of Dakar has developed the Local Climate and Energy Plan to guide climate action in the city. A unique element of the action plan is the emphasis on strengthening urban governance for a just energy transition. Climate action and the transition to net zero is not only about emissions reductions. Socio-economic development and economic growth are intricately linked to sustainable development. Biomass represents half of Senegalese energy consumption, while petroleum account for approximately 36 percent.[79]

Dakar has benefited from international climate finance mainly from international development and multilateral institutions. For example, as a member of the C40 Cities Finance Facility, Dakar will implement the landscaping redevelopment of the Zone de Captage storm water retentions basin. The project aims to reduce the city's vulnerability to flooding and improve public health conditions by preventing the discharge of waste water and household waste into the basin.

As a coastal city, Dakar faces challenges linked to sea level rise, rising temperatures and extreme weather events. As part of the Local Climate and Energy plan, the city has prioritized green infrastructure to increase the city' resilience amid climate change impacts. In partnership with the Food and Agricultural Organization, the city established an innovative and environmental friendly microgardens program[80] that uses local waste materials as growing substrates such as sand and coconut fiber to sustain food security.

Endowed with solar resources, Dakar has an opportunity to accelerate the energy transition. Initiated by private sector stakeholders, Dakar Future is a unique initiative linked to the famous Dakar rally. The project is a live lab of solar panels that will generate enough energy to power cars that take part in the rally. Based on the success of this project, the city can partner with investors and replicate the project to increase the uptake of solar power and decarbonize the energy sector.

Waste and sanitation: Solid waste generation data[81]

As part of the Climate and Clean Air Coalition, Dakar is leveraging the power of data to strengthen solid waste management and to reducing climate pollutant emissions from the waste sector. Eighty percent of the city waste stays in landfills and the city lacks recycling facilities. Data provides the city with information to plan towards suitable interventions that can help improve waste management across the city.

Dubai, United Arab Emirates

As the most populous city in the United Arab Emirates and with an average temperature exceeding 30C and up to 40C in the summer months, transition to net zero is critical. The country and all the emirate islands have leveraged the sunny climate to facilitate the rapid uptake of solar energy. The city is host to Mohammed Bin Rashid Al Maktoum solar park, the largest single site generator of solar energy with a capacity to produce 5GW by 2030. Dubai will also be host to a net zero urban technology and innovation hub. The hub will be an incubator for innovative ideas that aims to deepen sustainability in cities and will create 4000 jobs in green innovation.

With a robust real estate market, growing population and rising temperature, the city of Dubai needs to resolve the demand for cooling energy. Leading in deep decarbonization of the built environment sector, Dubai is ranked as the third amongst global cities with the greenest buildings in the world. Despite this ranking, residential segments are lagging. The Dubai Municipality has made it mandatory for all existing and new buildings to implement green building standards.

Dubai municipality is leveraging on cutting edge technology to accelerate the transition and progress to net zero. In partnership with the Mohammed Bin Rashid Space Centre, the city launched the region's first environmental nanometric satellite in 2021[82] to advance the development of solutions to address climate change through environmental forecasting.

Keeping up with a growing population will require Dubai municipality to deepen climate action across all sectors to maintain the momentum that has already been achieved. With a large migrant worker population, the city lacks a clear roadmap for equitable climate action. The distributive impacts must be spread amongst all city residents and citizens from all walks of life should play a role in decision making to ensure that no one is left behind in the transition to Net zero.

Dubai's sustainability and net zero ambitions have had a significant impact on its attractiveness as an investment location. Creating incentives for economic growth whilst moving the city towards net zero has been shaped by effective climate governance both at the national and local level. The city has leveraged on key partnerships and collaboration that boosts the city's magnetic capacity to attract investments.

Built environment: Dubai building code[83]

The code was developed by the city to unify building design across the municipality. The building code is easy to use and mandates minimum requirements to help ensure sustainable development of buildings, health, safety, welfare of people inside and around buildings and design techniques to reduce impact of the surrounding environment.

Built environment: Al Sa'fat Dubai green building system[84]

The city has crafted its own unique green building requirements which are mandatory requirements for all new buildings to meet certain performance rankings. The Al Sa'fat system enhances buildings users' safety and aims to ensure a more sustainable environment and spurs innovation, integration between green technology in building design that leads to improved performance, low energy consumption, efficiency of electrical and mechanical system and low carbon footprint through the life cycle of the building.

Dusseldorf, Germany

Endowed with green spaces and parks, Dusseldorf is considered a green city. The city has set targets to arrive at net zero by 2035. Dusseldorf is host to Europe's largest green façade, located in the downtown core. The building is covered with approximately 30,000 hornbeam plants. Designed in line with climate protection at the core, the building sets an example for developers to design and construct buildings that will have a positive impact on emissions reduction and energy performance.

The City of Dusseldorf provides financial support for green roofs, façades, inner courtyards, and urban gardens as well. This program is meant to strengthen the power of green infrastructure leveraging on nature to provide a cooling effect during hot summer months and to act as a buffer during periods of heavy rain.

In 2009, the city enforced a low emissions zone and only vehicles with an emissions sticker can access the zone. The city also has an extensive cycling network of around 700 kilometers and there are numerous bike rental systems in place. In 2022, the city launched the Cargo Bike Automat[85], that provides municipal employees the opportunity to rent a cargo bike at no cost, to deliver packages and travel around for city. This initiative is in line with the city's goal of driving down emissions to zero in the transport sector.

The City of Dusseldorf has put in place measures to decarbonize their operations through sustainable procurement. Decarbonizing municipal operations is a first step to taking ownership and responsibility of transition to net zero.

Mobility and connectivity: E-buses greening public transport[86]

Dusseldorf is deploying state of the art e-buses in its public transport fleet, the Rheinbahn. The city would like to see Rheinbahn as the first choice for mobility and turning around the transport sector with modern and intelligent solutions is a game changer in the transition to net zero mobility.

Hamburg, Germany

The City of Hamburg has updated its climate goals aiming to reduce emissions by 55 percent by 2030 and achieve net zero status by 2050. The Hamburg Parliament has passed a Climate Protection Act[87] and has enshrined the limitation of global warming in the constitution. In the transition to net zero, the city has identified four sectoral pathways to decarbonization with a focus on mobility transition, the economy, climate adaptation and heat transition and building efficiency.

Hamburg is a leader in district heating. The network can supply approximately 20 percent of households and there are plans in place to increase the capacity. The city is planning the construction of a 60MW waste water heat pump will supply heat to the port city in 2025 climate-friendly heat, avoiding 66,000 tonnes of carbon dioxide emissions.[88] Also, through the development of HafenCity, a new city development within Hamburg, a standard is being set for sustainable urban development. Unique to this development is the use of a steam turbine and fuel cell heating plant that emits less emissions compared to fossil fuel heat supply.

Hamburg is a historically green city. The Green Network Hamburg (Grünes Netz Hamburg) is a network of green open spaces that are connected to the city center. Designed over 100 years ago, the network is now supporting active transportation with bike lanes and increasing walkability. Also, a leader in green roofs, the city aims to ensure that 70 percent of all suitable rooftops are green. The Hamburg government has dedicated finances to increase green roof constriction for old and new buildings in the city.

With plans in place to arrive at net zero mobility, the City of Hamburg is committed to purchasing 100 percent electric vehicles and expanding the public transport fleet. Hamburg is one the most EV friendly cities due to the availability and accessibility of public charging stations. With a significant logistics industry, air pollution is a concern. Ships berthing at the port release pollutant emissions affecting air quality. Through Clean Air Plan for Hamburg, the city plans to expand on shore supply in the port of Hamburg which aims toreduce the pollution of nitrogen, sulphur oxides, and CO2 emissions.

Climate governance in the city of Hamburg is strong. Environmental criteria and considerations play a major role in the city's procurement strategy. The approach the city has taken has positive spillover effects to the private sector, spurring innovation and new business models that strengthen and accelerate climate action.

Mobility and connectivity: Zukunftstaxi[89]

An innovative partnership between the City of Hamburg, Hamburg's taxi association, the Hamburg Chamber of Commerce taxis and Hamburg Taxis, will implement emission free taxis. The project is supported and financed by a consortium of private sector partners. Apart from meeting the cities net zero targets in the transport sector, the project aims to engage taxi businesses as co-partners in the transition to net zero. The EV mobility sector is increasingly becoming competitive as customers align their consumption choices to sustainable initiatives.

Hamilton, Bermuda

As the capital city of a small island, the impacts of climate change can be severe and therefore the need to decarbonize and move towards net zero is critical. The approach to net zero adopted by Hamilton aligns with the island's wider strategy for economic growth. Most islands, including Bermuda, import diesel which makes electricity retail prices very high as compared to other parts of the world. In a bid to increase the share of renewable energy and reduce the cost of electricity especially for the most vulnerable in society, the island has embarked on leveraging solar energy to green power generation in accordance with its Integrated Resource Plan. The impact of this is expected to further ensure a spillover effect of decarbonization to other sectors particularly the transport sector.

As a small island, traffic congestion can be quite a challenge, particularly in Hamilton. By encouraging the use of electric vehicles on the roads, the island expects to benefit from reduced dependence on fossil fuels, reduced emissions and noise pollution, and improved air quality, particularly in the city of Hamilton. The Government of Bermuda has implemented policies that encourage decarbonization of the transport sector. For example, electric vehicles have been duty free since 2012, batteries since 2017, EV charging stations, parts, and related accessories since October 2018.[90] Most recently, the island introduced electric buses to its fleet.

In other sectors such as the built environment, the Corporation of Hamilton has embarked on using nature-based solutions to enhance the island's capacity to absorb greenhouse gas emissions and to help improve quality of life of the residents. A tree farm park has been established where young trees are being planted as way to manage tree mortality rates across the city.

Hamilton, Bermuda (continued)

Waste and sanitation: Greening Hamilton's waste water network [91]

The City of Hamilton has started several green initiatives to improve the performance of the Hamilton waste water network, with a goal to reduce pumping energy expenditures within the system. The current system is comprised of sixteen large waste water pumps, the energy costs of which can easily fall within the half a million-dollar range, per annum. An ideal reduction of 15 percent in energy consumption would result in average savings of approximately BMD75,000 per year. As an added benefit, reduction in energy consumption can further reduce maintenance costs and improve asset lifespans, a two-fold savings. Using a phased approach, the city has reduced the amount of 'inflow and infiltration' of both fresh and sea water into the waste water network. Sources of this water come from rain events, broken or damaged sewage lines, air conditioning condensate discharge lines, inappropriate roof drain connections and other sources. Fresh water and seawater, ideally, are handled by the city's street drain system and not the waste water network – a network that screens the inflow and removes solids before discharging it offshore.

Phase Two of this program included a full LED retrofit across the city as well as ongoing HVAC efficiency programs and solar installations. As HVAC systems make up roughly 30 percent of a building's energy consumption, this is a constant area to focus on.

The city has also installed solar panels on the roof of its pump station. The project encompassed 110 solar panels and generate approximately 35,000 watts of power for the pump station with an estimated annual electric cost saving of BMD18,000 per annum. Additionally, in 2019 the city installed a field of 210 solar panels on its roof at the works depot which has generated an approximate BMD40,000 reduction in the annual electric bill for the depot.

Hong Kong (SAR), China

Hong Kong (SAR), China's net zero Climate Action Plan 2050 aims to achieve net zero status by focusing on net zero electricity generation, green transport, waste reduction and energy savings and green buildings. This robust plan sets out a clear roadmap of decarbonizing high emitting sectors whilst putting an emphasis on public participation and community engagement. The city is also leveraging on technology, research and development and private sector collaboration and investments to drive net zero climate action.[92]

As an international finance center, Hong Kong (SAR), China's commercial spaces account for the highest consumption of electricity within the territory.[93] This, coupled with recent heat waves, has led to an increase in demand for cooling. In response to this the government continues to promote the installation of district cooling systems in new precincts to promote energy efficiency and conservation.

Hong Kong (SAR), China has a very efficient and accessible public transport system, used by approximately 10.6 million passengers daily.[94] With most people relying on public transport the city of Hong Kong (SAR), China aims to ensure that 100 percent of its fleet achieves zero emissions. The city further plans to collaborate with stakeholders in the transport sector to test out hydrogen fuel cell electric buses and heavy vehicles. In addition, the Hong Kong Special Administrative Region (SAR) Government has implemented an EV charging at Home Subsidy Scheme to ensure accessibility to charging infrastructure for electric vehicles.

Hong Kong (SAR), China is known to be a vertical city being highly densified. One of the challenges it faces is lack of space to develop multiple renewable energy power stations. It therefore relies on energy imported from Mainland China as well as being heavily dependent on natural gas for power generation. These challenges present an opportunity for the city to explore new technologies for carbon capture utilization and storage to advance decarbonizing efforts in the energy sector. Alongside this, new technologies are offering solutions to advance renewable energy despite limited land space.

Energy: Solar power station carbon reduction[95]

In collaboration with the Government of Hong Kong SAR, HK Electric built the city's largest commercial power systems with a generating capacity of 1MW. Using a new technology, the solar panels perform better under the city's high temperature making them more efficient and cost effective.

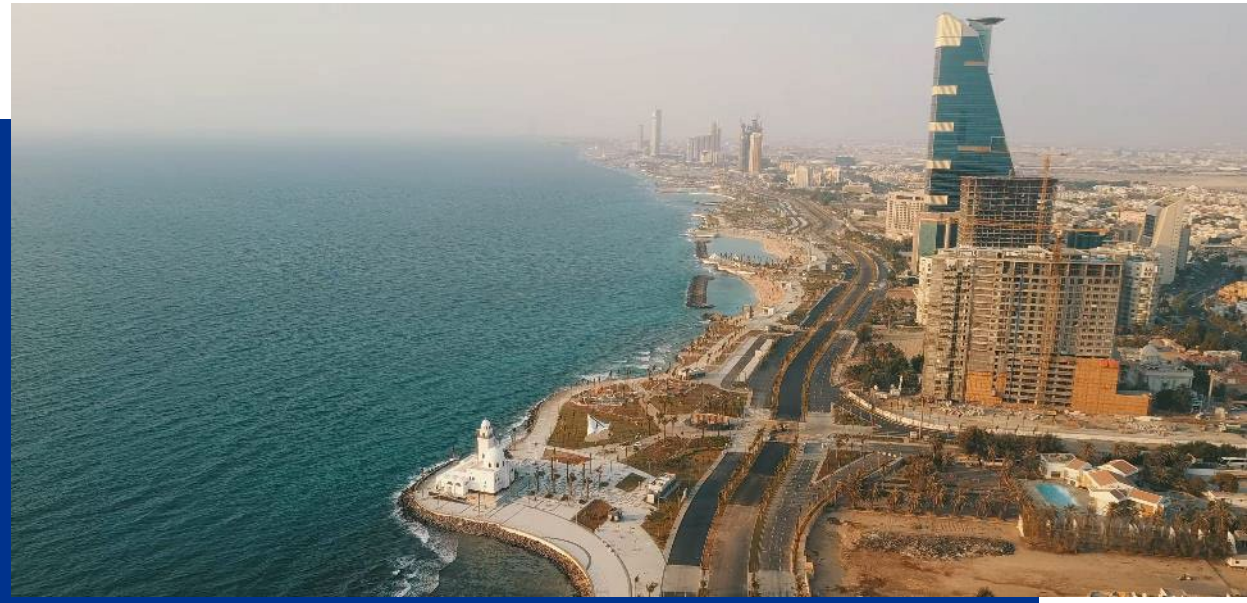
The solar power system is expected to generate 1,100,000 units of electricity annually. The power generated is fed directly to HK Electric's 380 V electrical system. This project is line with the city's climate action plan that aims to achieve net zero electricity by 2050. This project is expected to reduced carbon emissions by 915 tonnes annually. [96]

Jeddah, Saudi Arabia

Jeddah is recognized as a sustainable city with quality water and low pollution levels[97] However, as a coastal city, the impacts of climate change are increasing Jeddah's vulnerability. This means strengthening climate adaptation measures to protect critical urban infrastructure is essential to achieving net zero. The Kingdom of Saudi Arabia has pledged net zero greenhouse gas emissions by 2060.[98] Jeddah's pathway to net zero will be bolstered by effective multi-level governance.

The city has a vibrant industry mainly oil refining, food and beverage sector coupled with large productive factories. It has been observed that regional conditions such as aridity levels indicates that energy consumption and CO2 emissions are high.[99] Cheap fuel prices and water desalination plants are the major sources of GHG emissions in the city.[100] Potable water in the city of Jeddah is derived from water desalination plants that use high amounts of energy that emit high levels of CO2 emissions due to the burning of petroleum oil.[101] The national government however has put in place measures for zero carbon desalination through the Saudi Green Initiative. Alongside this is the "Circular Carbon Economy'[102] national program that aims to reduce greenhouse gas emissions in all sectors whilst ensuring socio- economic development. This initiative is anchored on the pillars of climate protection, socio-economic impact, and global leadership.

In partnership with the private sector, Jeddah was the first city in the Kingdom of Saudi Arabia to host an eco-friendly electric vehicle charging plant[103]. The plant also provides special bicycle parking, energy and water saving measures as well. Integrated in this charging plant is a recycling component that encourages waste reduction.



Waste and sanitation/energy sector: Shuaibah 3-expansion desalination plant[104]

As the largest desalination plant in the Kingdom of Saudi Arabia, the Saudi Water Partnership Company reconfigured the Shuaibah 3 plant to a green field reverse osmosis plant. This will reduce the reliance on fossil fuels to power the plant. With the application of cutting edge reverse osmosis technology, emissions emitted have reduced. Secondly, the plant produces approximately 250,000 cubic meters of water a day, serving the city of Jeddah and its environs particularly during peak periods.

Kingston, Jamaica

As a small island, the city of Kingston is vulnerable to climate hazards including sea level rise, hurricanes, and extreme weather events. The impact of natural disasters is likely to increase in intensity requiring investments towards climate mitigation and adaptation. Increasing storms across the Caribbean has impacted coastal infrastructure and marine biodiversity. The Municipal Corporation of Kingston in partnership with the Jamaica Social Investment Fund implemented the Port Royal Street Coastal Revetment Project to protect the shoreline. This development aims to prevent further erosion of the shoreline by wave action and safeguard it from storm surges.

The Government of Jamaica has implemented policies that aim to reduce emissions from the transport sector. The Motor Vehicle Import Policy[105] will provide for cheaper rates for imported electric vehicles making them accessible. Secondly, the city of Kingston through the Jamaica Urban Transit Company will introduce 50 electric buses, encouraging both ridership and increasing clean transport options.

The country depends on imported petroleum products which means that energy costs are high. Energy infrastructure is being modernized, power plants and distribution systems are becoming more energy efficient. These activities should increase the uptake or renewables such as solar, wind, biofuels by up to 20 percent by 2030. In a bid to ensure energy efficiency in multiple sectors, the Government of Jamaica has also embarked on decarbonization of the built environment. The Municipal Corporation of Kingston's buildings such as hospitals, schools will undergo major energy retrofits signaling city led action in the transition to net zero.

Energy sector: Solar panel loans[106]

The Development Bank of Jamaica and the National Housing Trust provide low interest loans to facilitate installation and retrofitting of solar water heating systems. The aim of the initiative is to increase energy efficiency in residential and commercial buildings. The loan is available to contributors who can provide a title for a residential property or who has at least enough funds in their Contribution Account at the NHT equal to the cost of the system, plus JMD20,000. The loan can be obtained at an interest rate of 3 percent over a maximum period of five years with a 5 percent service charge.[107]

Kuala Lumpur, Malaysia

Kuala Lumpur aims to achieve net zero status and increase its resilience against climate hazards by 2050. The Kuala Lumpur Climate Action Plan focuses on five strategies; mobility and infrastructure, waste management, green infrastructure, energy efficient, and climate resilient infrastructure. In addition to the net zero plan, Kuala Lumpur has also outlined a total of 245 low carbon programs under 10 strategic themes via the Low Carbon Society Blueprint 2030 across different sectors. These complementary activities aim to reduce emissions across high emitting sectors and subsequently accelerating the city's transition to net zero.

The transport sector is a major contributor to the city's emissions at 56 percent in 2017. The city records that 99.4 percent of emissions are from the on-road transport, thus leading to the city's commencement into deepening active transportation. To enhance connectivity in the city, Kuala Lumpur is constructing bicycle and pedestrian lanes to connect residential areas to the city center. This initiative is further strengthened through policy and guideline to lower motorized vehicle speed limits and create streets that are conducive for the uptake of active mobility. The city is also working towards expanding EV charging infrastructure to accommodate for the increasing appetite for EVs in the city.

The waste sector is also a major contributor to greenhouse gas emissions. The city's solid waste collection is outsourced via a concessionaire for a large part of the municipality with the exemption of private commercial areas and high-rise residential developments. Kuala Lumpur has partnered with the private sector to integrate waste management in the city through smart bins in selected public areas and a robust recycling system. By 2050, Kuala Lumpur targets a solid waste diversion of more than 50 percent from landfill disposal. To achieve this, the city will develop a waste masterplan for the management of solid waste, which will include waste reduction and recycling targets, strategies, and enforcement measures. The city also leverages public private partnerships to develop waste to energy plants to further divert municipal waste from landfills.

Aligned with the climate action plan, Kuala Lumpur also plans to increase the city's adoption of green infrastructure. As part of increasing resilience amid rising temperatures and increased rainfall, green infrastructure should be designed to protect the city from climate hazard and at the same time function as space for recreation and leisure. Initiatives such as imposing on developers to use at least 30 percent renewable energy components in projects (commercial or residential) and the installation of solar photovoltaic systems at municipal buildings are some of the measures Kuala Lumpur has implemented to help ensure carbon neutrality across the built environment sector. The city also plans to introduce policies to mandate reporting of energy usage of all buildings, following the proposed action on implementing mandatory building performance rating and benchmarking system to reduce energy consumption through targets setting based on building types.

Built environment: Sustainable towns in the heart of Kuala Lumpur

Kuala Lumpur is positioning itself as a leader in sustainable climate action. One of the best models for sustainable urban environment is Sunway City, an 800-acre development in Kuala Lumpur with a fully integrated green township. It has also been awarded the status of a low carbon city in 2016.

Sunway City is an example of a resource-efficient and low carbon city as envisioned in the Low Carbon Society Blueprint 2030. In collaboration with private stakeholders, the development can be used as a template for developing low carbon cities and showcasing new business and partnership model that other cities can adopt to advance their net zero plans.

Lagos, Nigeria

Lagos is the only city in Nigeria to develop a Climate Action Plan, covering 2020 to 2050.[108] The energy sector is the highest emitting sector at 55.1 percent, by waste at 25.3 percent and transport at 19.6 percent.[109] Recognizing the importance of balancing climate adaptation and mitigation, Lagos has put in place bold measures to reduce emissions in high emitting sectors and implement a resilient pathway towards climate action. In delivering the climate action plan, the Lagos State Government has established governance structures such as the State Climate Change Council, the Climate Change Secretariat, and the State Climate Change forum to coordinate the implementation of the city's transition to climate action.

Lagos is one of the largest coastal mega cites in the world. A growing population coupled with rising temperatures and increasing climate hazards such as floods and sea level rise, increase the city's vulnerability. Eko Atlantic City, a major project, was constructed with a 6.5km sea barrier aimed at protecting the city from sea level rise as well as mitigating against coastal erosion.

Road transport is the major mode of transport in the city. Traffic congestion and air pollution are increasing emissions and affecting air quality. The Lagos Metropolitan Transport Authority in partnership with Oando energy[110] solutions plan to deploy electric buses and contribute to the decarbonization of the transport sector. Additionally, the city is leveraging on its waterways to decongest the roads. Travelling by ferry will be an option for residents, broadening the modal mix of transport in the city.

The Lagos State Government has taken the lead in sensitizing key stakeholders including investors to speed up the adoption of renewable energy, particularly solar energy, which has the most potential. Through seminars and workshops, the state hopes to scale interest in the sector.

The city through international city networks is strengthening its capacity in several thematic areas such as building energy efficiency, clean air and urban flooding. Knowledge sharing and transfer is essential as the city implements its climate action plan. Lagos also has a vibrant start up ecosystem, that can be leveraged on to spur innovation and ideas for local solutions that can accelerate climate action.

Built environment: Building energy efficiency code[111]

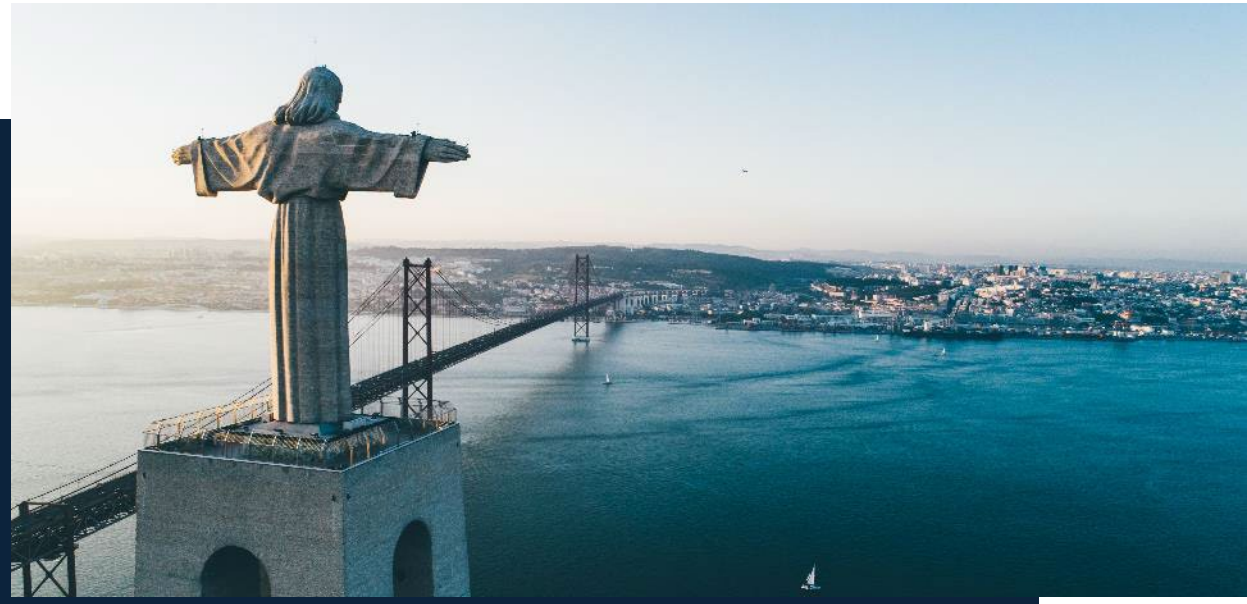
Buildings contribute up to 40 percent of emissions in the city,[112] making this a decarbonization priority. The Lagos State has partnered with the Nigerian Energy Support Program to adopt a Building Energy Efficiency code. The objective of this program is to advance energy efficiency projects in the building sector, train and capacitate relevant stakeholders on the code for effective implementation. The city sees this as a significant first step towards moving the built environment towards net zero, whilst strengthening socio-economic development in the city.

Lisbon, Portugal

Lisbon is considered a leader in climate action. The city's Sustainable Energy and Climate Action Plan boldly outlines mitigation and adaptation strategies for key priority areas such as spatial planning, water quality, transport, waste management, energy, and agriculture. Lisbon's pathway to net zero puts emphasis on effective climate governance, delivery capability, public participation, monitoring and increasing access to climate finance.

Host to one of the world's largest electric car charging networks, the city is successfully decarbonizing the transport sector. However, as more people choose to live outside of the city due to high housing prices, the dependency on cars remains. The COVID-19 lockdown period presented an opportunity to for Lisbon to accelerate the implementation of clean mobility. The city expanded walking areas to the addition of approximately 100 public spaces. To encourage cycling, more than 100km of new cycle paths are scheduled to be added on to the network with the aim of connecting homes and workplaces. The city is also expanding the electric fleet of buses and is encouraging micro-mobility through the responsible use of scooters. Leveraging on innovation and technology, Lisbon has adopted a Mobility Data Specification tool establishing a template so that dock less bike shares, e-scooters and other shared mobility providers are able to share data to inform public transport planning and management.

Rising temperatures are also affecting the city of Lisbon but the city is increasing resilience efforts. Lisbon's Life Lungs Project[113] is an innovative climate adaptation project that aims to increase resiliency in the city, mitigating against the effects of heat waves, water scarcity and other climate hazards. Life Lungs is an integrated project that promotes biodiversity, reduces energy consumption, and promotes citizen awareness and capacity building.



Built environment: Lisbon city council's building retrofit[114]

Built in the 19th century, the City Hall is both an iconic and historic building in Lisbon. The retrofit project is a successful template of how public service buildings can improve energy performance while still preserving their architectural and historic character.

Interventions included replacing heating systems, energy efficient lightings, procurement of renewable energy and leveraging technology for better energy management. The retrofit decreased the building's energy usage by 36 percent, decarbonizing the city government's operations.

A unique aspect of this project was the use of a 3D model simulation of the city hall building that helped to identify the most appropriate suite of retrofit solutions. The simulation allowed modelers to understand the interaction between weather, usage patterns, lightings systems and building materials.

London, United Kingdom

London aims to transition to net zero by 2030.[115] The city's net zero plan identifies the 'Accelerate Green' pathway as the preferred route for driving climate action. This pathway takes in account the urgency to act, ambitious goals and targets, social justice, and delivery capability. This pathway can only be effectively realized by establishing innovative partnerships with diverse stakeholders, accessing substantial climate finance and citizen engagement.

The council is prioritizing the built environment, transport, and energy sectors as it moves towards meeting bold net zero targets.[116] Residential buildings contribute a third of London's greenhouse gasses. Therefore, heating and insulation of homes, is a key priority for the city as most of the housing stock are not well insulated and rely on gas for heating. The city's Retrofit Accelerator program aims to create warm, affordable low carbon home by upgrading the old and energy inefficient housings.

The transport sector is a major contributor to greenhouse gas emissions. The council has implemented number of initiatives such as the zero emission bus fleet that has placed 550 electric buses on London's roads, the largest in Western Europe. Charging infrastructure in the city is accessible and available with over 7000 charge points. Walking and cycling has increased due to the introduction of the Streetpace program, low traffic neighborhoods and the addition of cycle lanes have also boosted active transportation. Other initiatives aimed at decarbonizing the transport sector include the introduction of hydrogen powered bus fleet under the 'Hydrogen London' program.

With increasing temperatures and heat waves exacerbated by the urban heat island effect, the London Environment Strategy aims to protect, increase, and improve green infrastructure. The Council is leveraging on the city's natural capital to mitigate against heat and aims to capitalize on the economic and environmental value of green infrastructure.

Energy sector: 'Be seen' energy monitoring guidance[117]

The guidance document explains how developers and owners of new major developments should monitor and report actual operational energy performance of buildings. It sets out what each responsible party needs to do to comply with the policy from the inception stage of a development to full occupancy. It provides information on the reporting templates applicants will need to use to report and explains how and when to report to the Greater London Authority. Applicants are required to provide accurate and verified estimates of each of the performance indicators of each reporting stage through the appropriate 'be seen' reporting template.

The objective of the monitoring guidance is to assist London to have an informed understanding of actual operational energy performance of buildings to achieve net carbon buildings across the city. This can help bridge the performance gap between design theory and actual energy use.

Luanda, Angola

Luanda is a coastal city with a growing population. With the rise of extreme weather events, the municipality is confronted with several challenges mainly, providing adequate water supply, sewerage infrastructures and reliable 'green' energy to a growing population. The city is extremely vulnerable to climate change. To strengthen climate action, the city requires reliable data to make informed decisions on climate investments. The Government of Angola recently approved the National Strategy on Climate Change 2022-2035. It is expected that cities including Luanda will be guided by this plan. However, with no documented climate action in place, the city is still addressing the challenges posed by climate change.

Luanda grapples with traffic congestion, air pollution and emissions from road transport. To resolve this, the city aims to rehabilitate its public transport system by creating and enabling environment for private sector to cash in on the lucrative e-mobility market. For example, T'Leva, an Angolan ride-sharing app, aims to include electric cars and motorbikes.

Luanda's public transport infrastructure is largely dominated by private shared taxis locally known as 'condongueiros'. The aging diesel fleet of taxis are non-compliant with international emission requirements. As a step towards decarbonization, the city government has deployed bus fleet in partnership with private sector to make the city more accessible in a bid towards decarbonizing the transport sector and inclusive economy. The government further plans to deploy 900 buses to help reduce the carbon emissions in the environment

Informal occupation of land in the city has led to the proliferation of informal settlements which exposes the vulnerable groups to climate hazards. To address this issue Luanda collaborated with UN-Habitat to prepare a framework through a holistic approach to support the territory and urban planning in the city.

Alongside city action, the national government is focused on preserving its environment through setting up financial programs and aligning with international protocols to conserve its natural ecosystem of green spaces and marine environment to adapt towards climate change events.

Energy sector: Solar power plant [118]

Funded by the United Nations Development program, the medical provincial warehouse in Luanda was fitted with solar power plant. The initiative 'Solar for Health' assists the world's hotspots with sustainable power for schools, small clinics, hospitals and medical warehouses. The local authorities received training on the plant's operations.

Malé, Maldives

The Maldives is considered to the be the most vulnerable country in the world. Eighty percent of the country's 1,190 islands are less than a meter above sea level, making them particularly vulnerable to rising sea levels.[119] Climate hazards such as flooding, coastline erosion is affecting critical urban infrastructure. Maldives have put in place climate adaptation measures such as coastal protection tools and community led resilience programs.

Given the size of the island, the Government of Maldives through the Ministry of Environment has been stewarding bold climate action in partnership with city councils including Malé. With the objective of arriving at net zero by 2030[120], the country is relying on international support to accelerated climate action. With a focus on early warning systems and strengthening emergency preparedness climate action is anchored on the national led urban development and resilience project with support from the city council of Malé.

The islands in the Maldives are geographically dispersed and the lack of land makes renewable projects such as installation of solar panels difficult. The island is approximately 98% water. The islands have relied on diesel generators for power supply, and this has not only contributed to higher carbon emissions, but high electricity prices that negatively impact low-income households. Alongside this is the difficulties around having a common power grid resulting in limited scale. The island has typically focused on adaptation due to its vulnerability to rising sea levels. The focus is now shifting to ramping up mitigation efforts. The Greater Malé region consists of artificial islands, and they are relatively elevated above sea level with robust coastal protection infrastructure. Secondly, popularly known for tourism the island has seen an increase in waste. Effective solid waste management is critical for retaining the islands place as a premium destination. With support from the Asian Development Bank, Greater Malé will establish a regional solid waste management system that will use waste to energy technology, recycling, and disposal infrastructure to reduce emissions and create a cleaner urban environment.

Energy sector/Industry: ASPIRE -De-risking solar projects to catalyze private investment in the Maldives

The ASPIRE[121] led by the World Bank in Maldives was set up to showcase and de risk solar projects to attract private investment towards decarbonizing the energy sector and support the city in their decarbonizing goals. The ASPIRE project has mobilized significant investments to install 6.5MW of solar power in the Maldives, lowering the cost of electricity and reducing importation of diesel.

The project showcases the areas in which projects can be de-risked: foreign exchange risk, high cost of solar PV, payment delays and termination of power purchase agreements.

Medellín, Colombia

The second largest and intermediary in Colombia, the city of Medellín is setting the bar when it comes to aggressive climate action. The city is host to the country's only metro system, numerous bike lanes and electric buses that traverse "green corridors".

Medellín has made significant strides in the built environment and energy sector stewarding natural based solutions to decarbonize high emitting sectors. Rising temperatures in Medellín has caused a demand in cooling, putting pressure on energy systems, and affecting the transition to net zero.

The award-winning initiative, the green corridors of Medellín, are an interconnected network of greenery across the city. The corridors connect existing green spaces, enhance urban biodiversity, significantly reduces the city's urban heat island, sequesters carbon dioxide, and reduces the average city's temperature by 2C degrees. These green corridors provide shade for workers, street vendors and people walking in the streets and serve as a natural cooling solution for rising heat waves. Through the green corridor, Medellín has showcased the benefits of how mitigation and adaptation sustainable transitions work in tandem to advance decarbonization and net zero.

The city's approach to climate governance is unique since 30 percent of Medellín is urban whilst 70 percent is rural. As the city implements its climate action, decarbonization polices will have to consider the urban and rural needs of the city.

As climate change continues to affect cities, Medellín is not immune to the struggles of attracting sustainable finance, however it stands as a model city for developing bankable projects that can attract large capital investment. The municipality is embarking on constructing a light rail system that will run on 100 percent electrical technology and reduce the amount of CO2 emissions in the transport sector.

The project financed by Bancocolombia,, Davivienda and Financiera de Desarrollo Nacional (FDN)[122] will expand the public transport system making it accessible and improving metropolitan connectivity, which is not only important for discouraging the use of vehicles but brings services closer to those who do not have access to personal vehicles.

Energy sector: Electric stairs in Comuna 13[123]

The municipality of Medellín has installed 56 solar panels for the operation of Comuna 13, a historically low-income neighborhood, that was once the most dangerous places in Colombia due to high homicide and drug crimes.

The project expects to lead to the reduction of electric energy costs for the escalator transport system and ultimately a reduction in the carbon footprint of the city. The solar panels will replace 21 percent of the electric energy used for the operation of the electric stairs.

The electric escalator further provides a clean alternative to commuters, providing services for approximately 25,000 people monthly. This initiative can not only ensure uptake of renewable energy but encourages active transportation that serves disadvantaged low income neighborhoods.

Montevideo, Uruguay

Over 90 percent of electricity consumption in Montevideo is from renewable energy (wind and hydro).[124] The city's largest source of emissions comes from the transport sector (52 percent).[125] The city recognizes market responsiveness to electric vehicles in private transport has been weak, due to higher acquisition costs as compared to internal combustion engine vehicles coupled with limited charging infrastructure. Underscoring the above challenges in moving the transport sector towards net zero is the national subsidy on fuel for public transport. This means that although there is significant share of residents using public transport due to cheap fairs, emissions are still high since a large part of the fleet is not green. However, the city is engaged in a mobility policy towards the transition to electric public transport, which started in 2015 with taxis and in 2020 with buses. The goal is to reach 100 percent of the fleet in 2040. Infrastructure investments have also been made in sustainable mobility. One of them has to do with the pacification of urban areas. The bike lanes in the city have increased by almost 250 percent in the last decade and cover the main branches of the city. Traffic lights have also incorporated signaling to the cyclist.

Decarbonizing the energy sector has been a major priority for both the city and national government. Energy policy has remained focused on renewables and the results are paying off. Despite major gains in moving towards a low carbon energy sector, the city has narrowed it efforts in changing energy consumption habits in residential homes. Although heating generated by air conditioning is not an issue due to the country's green electric matrix discussed above, in other cases heating is by liquefied petroleum or natural gas. Considering the interconnectedness of the built environment and energy sector, the city has put plans in place to implement and support the retrofitting of older buildings to improve their environmental performance.

A major pathway for the city's transition to net zero is the aim to increase forest cover by 50 percent in the city. With a carbon neutrality target pegged at 2040, the city aims to leverage on green spaces and nature-based solutions to increase the number of carbon sinks.

Montevideo remains a robust city government taking calculated climate action, but the lack of finance to invest into large sustainable infrastructure projects is an impediment to accelerated decarbonization. Donor funding from international finance institutions, multi-lateral development banks and other large non-governmental relations remains an available source for climate finance. However, the city requires diverse sources of finance from different investors and stakeholders to benefit from innovation, new technologies that can deepen decarbonization across sectors. At a national level, the Uruguayan government is working on an important milestone which is the first emission of a Sovereign Sustainability-Linked Bond[126] which includes SPT linked with the reduction of emissions per unit of real GDP and the increase of native forest area. A similar financing strategy might be followed by the city to achieve its net zero goals.

Energy sector: Solar energy for municipal buildings

The city is not only incorporating photovoltaic energy in municipal owned buildings – but are simultaneously learning how to implement the technology and leading by example by running energy efficient operations. This approach facilitates education, dissemination, and awareness of photovoltaic energy amongst residents to encourage uptake.

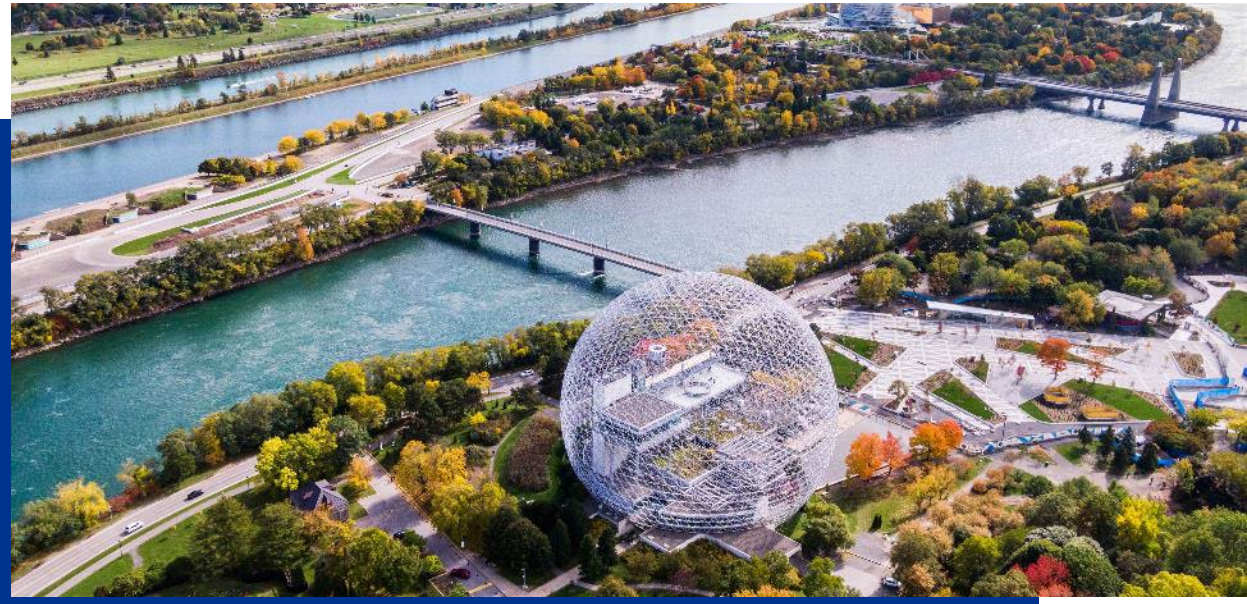
Montreal, Canada

The city of Montreal's 10-year climate action plan aims to achieve net zero by 2050. The action plan puts significant emphasis on an ecological transition to be adopted by all sectors. The city has also identified the importance of climate governance, putting in place measures that will consider environmental impacts across all decision making.

The city of Montreal benefits from a supportive provincial and federal government particularly with respect to accessing finance for sustainable investments. For example, cities in the province of Quebec including Montreal received funding for green infrastructure that will positively impact the local economy and create green jobs.[127] The power of inter-governmental partnerships and collaboration is a significant driver for decarbonization across emitting sectors in the city.

Through the city of Montreal's engagement in regional and global city networks, the city has developed a resilient strategy that aims to tackle issues of climate injustice and enhance inclusion in climate action. The city's unique intersectional approach to climate equity is underscored by four levers: social development, effective climate governance, economic development and improved access to municipal services and activities.

Road transportation contribute 30 percent of emissions and buildings 28 percent of emissions in the city.[128] The decarbonization progress in the energy sector is underscored by the need to reduce emissions in the built environment sector. The city particularly grapples with rising temperatures in the summer months leading to heat waves and higher demand for cooling. Storms, heavy rain, and floods also pose a threat to urban infrastructure and could potentially raise loss and damage costs.



Energy sector: Rénoclimat[129]

The city of Montreal benefits greatly from provincial led programs and initiatives, signaling the strong inter-governmental climate governance structure that is required for accelerated climate action. Rénoclimat is an energy efficiency program for residential homeowners that provides financial assistance to reduce energy efficiency by retrofitting homes. The program also provides free home energy evaluations and personalized advice on how to improve energy efficiency.

Under the Rénoclimat program, residents can channel financial assistance awarded to them to upgrading home insulation, installation and replacement of mechanical system doors and windows, all with the objective of maximizing the home's energy efficiency potential.

Mumbai, India

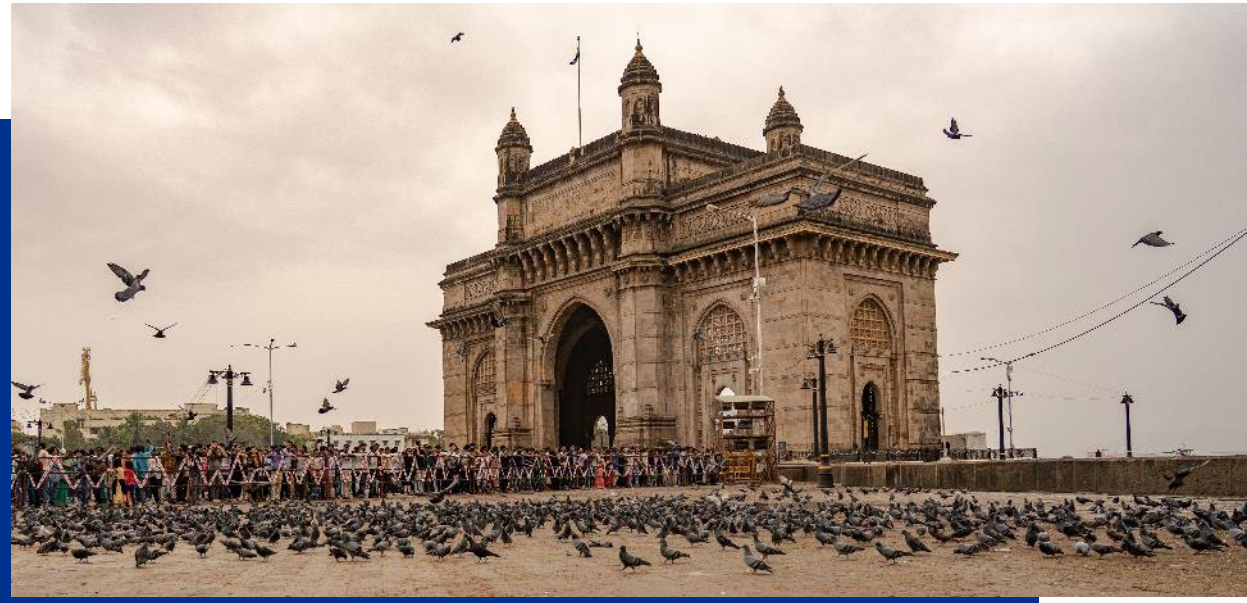
Mumbai is the first city in India to have its own Climate Action Plan aiming to transition to net zero by 2050. The plan emphasizes building the city's' resilience and will focus on the following thematic areas: zer -emission public transport, air quality, green infrastructure, decentralizes waste management, low carbon electricity, climate resilient infrastructure and urban flooding and water management.

Studies[130] show that that with the frequent occurrence of extreme weather events such as flooding and monsoons, the southern part of the city may be under water. Hence the importance the city is placing on resilience as a pathway to net zero. The city's climate action puts climate equity at the core by ensuring that the policy is inclusive and that outcomes from climate action are distributed equitably across citizens.

Majority of emissions in the city are from stationary energy at 72 percent followed by transport at 20 percent.[131] Energy use in residential and commercial buildings is high owing to the city's coal-based grid. Decarbonizing the electricity grid and transitioning to clean fuels is a major priority for the city. Through the solar rooftop program, the Government of India provides 40 percent subsidy to residential consumers and 20 percent to group housing societies and associations[132]. Cities such as Mumbai are taking advantage of this program that will see a decrease in household electricity bills. Remaining electricity will be purchased by the Maharashtra state of which Mumbai is the capital through a net metering arrangement

The Brihanmumbai Municipal Corporation (BMC) has launched a dedicated EV cell that aims to put in place 1,500 EV charging stations and ensuring at least 10 per cent of EV penetration into the city by 2025. This initiative is partnership with the World Resource Institute signaling the importance of collaboration in the transition to net zero.

The implementation of the city's action plan is supported by strong leadership and climate governance structures that the city has put in place. For example, the city is setting up a dedicated authority to midwife Mumbai's transition to net zero.



Mobility and connectivity: Decarbonizing the BMC's operations[133]

The Brihanmumbai Municipal Corporation is leading by example and decarbonizing its operations by acquiring electric vehicles to replace its current fleet of vehicles. Implemented in phases, the BMC will acquire, 32 dry waste vehicles, 12 E buses, 27 vehicles for official use and 12 E cleaning machine vehicles. Electric vehicles will also be bought to transport garbage. In addition to this, 85 charging stations will be put in place to ensure accessibility and availability.

Munich, Germany

Munich City Council declared a climate emergency and is accelerating climate action with the aim of getting to net zero by 2035.[134] The city's target is even more ambitious, 10 years ahead of Germany. The role of innovation and technology is paramount in Munich's transition to net zero.

The city's energy and buildings sector have been the highest emitters and therefore climate action has been centered around energy efficiency and low carbon buildings. A key lever for the city's ambitious transition to net zero is the decarbonization of its heating system. Moving away from fossil fuels and natural gas is essential. One of the measures the city is taking is exploring the use of geothermal power to heat over half a million homes. This could be a positive game changer for the city's ambitious net zero goals. Other steps include the integration of renewable energy in buildings through renovations and retrofits reducing dependence on fossil fuels or gas.

In early 2022, the City of Munich introduced its first set of solar buses. The city aims to ensure that pollution and emissions are reduced. Munich city has the most registered electric vehicles than the capital city Berlin. A total of approximately 36,000 battery powered electric vehicles and plug in hybrids, are found in the city.[135] Munich is also considered a short distance city that is walkable and cycle-friendly, with cycling accounting for 18 percent of all traffic.

Munich is famous for its waste management systems and to arrive at net zero by 2035, the city is putting concerted effort into achieving zero waste. Most of the city's waste is 70 percent recyclable. The city has put in place measures to establish a thriving circular economy. Munich's approach to decarbonizing the waste sector is in collaboration with diverse stakeholders and citizen engagement. Dialogue workshops and an online platform have strengthened public participation and citizen engagement. A Zero Waste Advisory Board has also been set up by the city to assist in the implementation of the city's zero waste concept.

Mobility and connectivity: E-scooters[136]

The Munich Transportation Authority (MVG) in partnership with TIER, a private company has introduced a rental system for e-scooters. Over 1500 e-scooters have been introduced as a transport option for the residents of Munich.

The e-scooters are available via the MVG and TIER applications ensuring that the user process is simple and efficient. This initiative has gained momentum as the Government of Germany approved the use of e-scooters on public roads.

Nairobi, Kenya

Nairobi's Climate Action Plan 2020-2050 is the main strategy driving decarbonization efforts with a focus on increasing the uptake of renewable energy, waste, and transport. The transport sector contributes the largest emissions at 45 percent followed by waste at 33 percent.[137]

Nairobi county is expanding its infrastructure to support dedicated bus corridors, construction and renovation of commuter rail stations making public transport accessible and affordable. Led by the Kenya Power and Electricity company, an E-mobility network infrastructure system comprising of EV charging infrastructure, billing and payment system and service management will be rolled out in partnership with the Nairobi County to test the potential of electric vehicles. The Government of Kenya has also put in place incentives such as lower import duty for electric cars and motorcycles and bicycles. Adaptation measures such as decongestion of streets to reduce air pollution and to encourage walkability and the use of non-motorized transports have been spearheaded by the county.

With a growing population, limited landfill capacity and growing e-waste, waste management is a challenge. The county's climate action plan aims to put in place measures, guidelines, and strategies for zero waste. The city government established several partnerships with key stakeholders to set a biogas project that address energy poverty, recycling, and waste management. The county of Nairobi in partnership with the business community, have also established the Kenya Extended Producer Responsibility Organization (KEPRO). This collaborative partnership of all stakeholders in the produced material value chain seeks to work with city to accelerate decarbonization of the waste sector.

Energy sector: Dandora dumpsite waste to energy [138]

Nairobi Metropolitan Services has partnered with KENGEN, a leading electricity power generation company to provide land for the upcoming Dandora to build a power plant that will harness energy from waste. The site will be a 45MW waste-fired thermal power plant.

New Delhi, India

New Delhi's State Action Plan on Climate Change 2021-2030 outlines bold climate action with an emphasis on addressing extreme weather events. The city recognizes the importance of both adaptation and mitigation measures in reducing the impacts of climate risks and hazards. Climate action in the city of New Delhi focuses on eight sectors, namely energy, transport, water, forest, health, agriculture, disaster management and urban development.

As a megacity, the demand for energy is high. The buildings sector account for nearly 50 percent of energy consumption the city[139]. The city has therefore put in place measures such as promoting the use of LED lighting in housing to reduce energy consumption. Leading by the example the Delhi Secretariat building is one of the first green buildings with a dedicated solar photo voltaic plant that meets the operational needs of the buildings. To increase the uptake of renewable energy, the city in collaboration with other agencies are implementing the Advance Clean Energy Deployment aims at enhancing energy security, improving access to energy, conserving energy, and promoting clean energy development.

The Government of India has also taken bold steps to promote renewable energy such as laying of new transmission lines and creating a new sub-station capacity for evacuation of renewable power and waivers for Inter State Transmission System (ISTS) charges for inter-state sale of solar and wind. The city receives mandates for renewable energy bulk purchase for power utilities to decarbonize the city's grid and reduce fossil fuel dependency. The city launched an ambitious 'Solar City Initiative' that aims to accelerate solar rooftop development by aggregating consumers and matching them with solar developers. The initiative has an educative component on the benefits of solar alongside financing options for consumers that participate.

The transport sector in New Delhi is a major source of greenhouse emissions contributing to air pollution. The city government in partnership with the Rocky Mountain Institute set up the urban mobility lab[140] initiative that aimed at translating the city's electric vehicle policy to action, transforming mobility in the city by implementing and scaling up clean transport. The city's aims to be the electrical capital of India.

Mobility and connectivity: Switch Delhi [141]

In 2021 the Delhi Government launched the Switch Delhi Campaign to raise awareness and inform the citizens on the benefits of electric vehicles through social media. The city recognizes the importance of implementing climate action by providing avenues for citizen engagement to encourage ownership and buy in. Switch Delhi is also an interactive one stop shop website providing a wide range of information on electric vehicles. The site also allows users to find charging stations and battery swapping stations. The site has an electric vehicle dashboard, that tracks the number of electric vehicles in the city.

The city further aims to launch the One Delhi mobile application that unifies all transport-related transactions such as paying for a bus ticket or locating an electric vehicle charging station in the city.

New York, United States

As a megacity, the City of New York (the City) has embarked on decarbonizing high emitting sectors such as buildings by 2030 through the new Carbon Challenge. Buildings contribute up to 66 percent[142] of the City's total carbon footprint. The City through the Local Law 97 implementation plan[143] has put in place policies and a series of initiatives that leverage multipronged pathways to decarbonize other high emitting sectors such as energy and transport. Local Law 97 is part of The Climate Mobilization Act passed by The New York City Council on April 18, 2019. This law aims to reduce New York City's carbon emissions 40% by 2030, and 80% by 2050. Reporting requirements for buildings over 25,000 square feet start in 2024.

Recent legislation and policy direction from the federal government, mainly through the Inflation Reduction Act, will see climate action in the City and the State of New York. Strengthened alignment and support by the federal government will likely hasten climate action implementation and strengthen the climate finance ecosystem. The City will likely have access to finances that will bolster their ambitious action plan.

The City Local Law 97 Implementation Action Plan' I has put in place measure ensure accountability on climate justice. These include the landmark Climate Leadership and Community Protection Act (CLCPA) makes specific provisions for historically disadvantaged communities to benefit from City-led climate action.

A major challenge for the City[144] will most likely be the lack of readily available human capital to midwife the ambitious Local Law 97 Implementation Action Plan. With high living costs in the City , most professionals are moving away from the City . This migration of talent may have an impact on the delivery capability of the City's ambitious climate action plan.

Energy sector: Clean energy program

The City has implemented an energy program that aims to achieve multiple objectives that will reduce emissions in the energy sector. Expanding distributed energy resources, solar PV, energy storage installations across the City's building stock is major initiative . These initiatives as indicated in the Local Law 97 Implementation Action Plan aim to position the City as an energy efficient city. These include solar panels on building rooftops, solar canopies in parking lots, garages, and wastewater treatment facilities, and back-up technology that will ensure battery storage that can supply electricity in the case of a power outage.

New York City takes climate equity and collaborative partnerships down to the educational level. Through the annual NYC Solar School Education Program, public school teachers are trained on operations and maintenance of solar projects across the City. Connecting solar installations on school buildings to curriculum allows teachers to use the project as a real-life example for students to learn about renewable energy and sustainability, and to encourage STEM learning.[145] This innovative approach of inculcating environmental responsibility, knowledge, and ownership in students is of critical importance in accelerating of actions between generations.

Oslo, Norway

Oslo, also known as Europe's green capital, is driving climate action towards net zero and aims to realize 95 percent reductions of direct greenhouse gas emissions by 2030 compared with 2009. With a vast supply of hydroelectricity, Oslo takes the lead in the transition to renewable energy. To achieve Oslo's net zero goals, effective climate governance is a key pillar. The city has a dedicated climate budget as tool for delivering climate action. Other tools for climate governance include a sustainable procurement strategy and land use planning. Communication, and cooperation, and collaboration both locally and internationally are key elements in climate governance. The city is leading by example, making sure that their procurement practices are in line with the climate goals and targets .

The City of Oslo is the poster child for net zero transport, with more than 31.2 % of all cars being electric. The country records that 78% of new car sales are electric vehicles, with great accessibility and availability of charging infrastructure. The country has put in place measures such as high tax on gas and diesel to discourage the use of internal combustion engine vehicles. Through land use planning and urban design, the city is promoting and upgrading infrastructure to increase active and zero-emission transportation. This includes a city toll ring, restrictive parking measures and investments in public transport and bike infrastructure. Building resilience against climate hazards such as urban floods, is a key priority for the city. Heavy rainfall is a challenge to the city's sewage system and causes damage to roads and buildings. In response to this, the city put in place a stormwater management strategy in place to prevent future damages that may arise with episodes of extreme weather. A cross-sectoral action plan ensures collaboration across land use, wastewater system and management of green spaces for a transformative approach to stormwater management with open and local solutions, such as raingardens and reopening of rivers. To become a climate resilient city, which is one of Oslo's five climate goals, Oslo has a holistic approach to climate change adaptation considering impacts of both heavier rainfall and increasing temperatures in planning and regulations.

In addition to become a net zero city, Oslo's natural environment will be managed in such a way that natural carbon storage in vegetation and soil are protected, and the greenhouse gas removal in forests and other vegetation increase by 2030. There are many synergies and common actions between carbon storage and climate adaptation in Oslo, especially in urban land use and forestry.

Decarbonization of the built environment is also at the core of Oslo's transition to net zero emissions. Municipally owned and operated buildings such as schools, nursing homes and sports halls are constructed with strict material requirements, in terms of sustainability and CO2 emissions. The city relies on electricity and district heating, the latter mainly produced from municipal waste incinerators and biomass fed cogeneration plants, in order to provide heating to commercial and residential buildings. The provided electricity mix in Norway has a very high share of renewable energy sources, with hydropower being the significantly largest contributor. Oslo has made a concerted effort to ensure public participation and engagement in the transition to net zero. The city has also leveraged on innovative partnerships and business models to accelerate climate action.

Oslo, Norway (continued)

Built environment : FutureBuilt programme

A joint initiative between six municipalities in the Oslo region, FutureBuilt is an urban development pilot project that aims to showcase the possibilities of climate neutral urban areas with high quality architecture.

From the project's offset in 2010 and up until today, almost 70 pilot projects have been realized through the program. FutureBuilt projects aim to reduce carbon emissions by at least 50% compared to current regulations and common practice. The reductions need to be in a combination of the building's material use, as well as in transportation and energy in the use phase.

Projects include:

- The National Museum, Oslo: The project has high environmental ambitions and is planned according to environmental goals in four key categories: greenhouse gas emissions, energy, material choice and technical building solutions.
- Kristian Augusts gate 13: A ground-breaking re-use project where a building from the 1950s has been upgraded in accordance with FutureBuilt's criteria for circular buildings.
- Ruseløkka skole: Ruseløkka school is a pilot project for the use of second generation concrete and for circular measures. The school has set high energy ambitions and aims to be a near net zero energy building. The building site at Ruseløkka was fossil free, including the transportation of surplus landfill.

Panama City, Panama

Panama is a largely urbanized country with approximately 50 percent of the country living in cities. With a dense population, waste and water management are major concerns for the city. The city is particularly sensitive to drops in rainfall, and this affects the management of water. Sewage is also a major concern as untreated sewage can damage mangroves and pollute the Panama Bay. This has grave implications for flora and fauna, as well as public health. The growth of the city over the last couple of years has further strained the city's water infrastructure. However, through national initiatives the city is making efforts to improve water security and build resilience in their physical infrastructures.

Panama City has a rain forest within the city and the country boasts 62 percent land cover of natural forest. This creates a large carbon sink that supports sequestration of emissions. The country of Panama is considered carbon negative as its forests absorb more carbon that the emissions emitted. The approach to climate action has been equitable and inclusive with specific attention to the indigenous population. Through partnerships with NGOs, academic institutions indigenous groups play a critical role in protecting forests. With support from the World Bank, a forest carbon monitoring campaign was implemented.[146] Indigenous technicians are trained through land use planning, forest tracking etc.

The city in partnership with the central government have focused their climate action efforts in driving sustainable transportation and transitioning to renewable energy. The city's metro system is undergoing expansion and will run on electricity thereby reducing the emissions. With the rising cost of fuel globally the city is working towards increasing uptake of renewable energy.

A major setback for climate action towards net zero in Panama City is the fact that city authority and power is retained at the central government. Increased climate governance at the city level would ensure that Panama City is resilient and can adapt to increasing climate hazards.

Industry: Panama Canal Authority

The Panama Canal Authority[147] has embarked on driving climate action through the deployment of sustainable maritime routes. The canal aims to be carbon neutral by 2030, primarily through the decarbonization of operations and encouraging customers to switch to cleaner fuels and the use of solar and hydraulic energy.

Leveraging on the importance of data, the Panama Canal Authority through a pilot program has acquired electric vehicles that will collect data to inform the migration of the canals existing fleet from fossil fuels to cleaner energy. Furthermore, through an Emissions Calculator shipping lines can measure GHG per route, which then provides critical data for the authority to analyses operations.

Paris, France

The City of Paris aims to transition to net zero by 2050. Plan Climat the main guiding document lays out targets to reduce local emissions by 100 percent.[148] Climate equity is central to the transition to net zero and the city is making concerted effort towards an inclusive and resilient transition.

Energy, built environment and the transport sectors are key priority areas for the city of Paris. By 2024, diesel powered mobility will be phased out and petrol-powered mobility by 2030. In addition to electrifying public transport, increasing the uptake of electric vehicles, and making available public charging infrastructure, the city is developing financial incentives and support measures for low carbon mobility. Active transportation is a key component of decarbonizing the transport sector. The city has implemented several self- service bike and electric vehicle sharing programs. Low emission zones within Greater Paris have been established to encourage the use of clean vehicles.

Rising temperatures across Europe particularly in the summer months has necessitated faster action to decarbonize the built environment. Paris is host to the world's largest eco-friendly underground cooling system. Currently at 89km, there are plans to lengthen the cooling pipes to by 163km extending cooling to the public sector which includes, hospitals, schools etc. The city is also accelerating the greening of its heating network and aims to renovate one million homes by 2050 to meet its net zero goals. In line with the city's inclusive climate action, the city has renovated social housing ensuring that they are energy efficient and reducing energy bills for low-income groups.

One of the city's busiest highways along the river Seine was converted to a pedestrian walkway. This pedestrianized riverbank caters to cyclists and has ample green space. The project is meant to strengthen the city's greening initiatives thereby tackling air pollution, encouraging active transportation, and improving the quality of life for people. The City of Paris has a complex multi-level governance architecture, with numerous layers of autonomous authority over regions in the greater Paris area. In line with Plan Climat, the city has an opportunity to strengthen climate governance and harmonize multiple climate actions for greater impact.

Waste and sanitation: Le Grand Paris Circulaire[149]

This is a city led collaborative digital platform which aims to become the gateway to the circular economy of the Greater Paris territory. Different groups can join as members and get access to free services and information. Members can get the latest circular economy news and identify opportunities, promote their business both locally and internationally. They can also establish partnerships with other members, access implementation tools and methodologies and benefit from feedback from other members.

The platform brings together key players in the circular economy sector spurring innovation, knowledge transfer, partnering with the city in a unique way to meet the city's targets of arriving at zero waste.

Port Moresby, Papua New Guinea

PNG aims to be carbon neutral by 2050. This is an ambitious commitment for a country that Is prone to natural disasters, tsunamis, and volcanic activity. The country is also endowed with vast renewable energy resources. Greenhouse gas emissions in the pacific nation of Papua New Guinea are mainly from the burning of fossil fuels for energy and industrial production of materials such as cement.

Despite two thirds of forest cover, the pacific island is experiencing deforestation and pollution from mining activity, all of which contribute to emissions and are affecting resilience. The city of Port Moresby is heavily built up and there is an increasing demand for coastal landfill developments which are depleting mangroves and reef ecosystems.[150] This is also increasing the risk and vulnerability of urban infrastructure across the city.

With urbanization as a recent phenomenon, most of the climate action in the city is aligned to the national government 2050 carbon neutrality goals. In partnership with the United Nations Development Program, the Government of Papua New Guinea is putting in place a national adaptation plan that will boost the countries resilience towards climate change and reduce vulnerability. A key expected outcome is the integration of the national climate change agenda into sub-national planning and budgeting. This is of importance considering the minimal role that the city of Port Moresby plays in driving climate action.

Waste and sanitation: Trash Tag-PNG[151]

The island faces a challenge with plastic waste and with limited recycling facilities. Therefore in 2018 the national government announced a total waste ban. Trash Tag-PNG is an awareness raising project that informs the public on issues of plastic pollution in the island. In collaboration with city parks and the municipality Trash Tag has found a way to engage citizens both directly and indirectly on the importance of waste management, recycling and has also brought to light the ills of plastic waste on the city's coasts and marine life.

Quebec City, Canada

Quebec City does not have a net zero action plan in place, however climate action is aligned to the 2030 Plan for a Green Economy document by the province of Quebec. It is the second largest city in the province of Quebec. Municipal led climate action in the city has not gained significant momentum compared to other provincial capitals across Canada. Gains in energy efficiency in Quebec City have been accelerated through provincial programs that provide financial assistance through four major programs. Electricity distribution and delivery for Quebec is undertaken at the provincial level. This signals the importance of multi-level governance in climate action and more so for territorial transition to net zero.

Quebec City was built around vehicles which inevitably encourages urban sprawl. The city remains fairly underserved with public transit facilities with exception of the downtown core. The city is not densified, and this is partly due to the increasing demand for detached homes and low-density neighborhoods in a bid to preserve the social fabric of neighborhoods. This has led to an increase in use of private vehicles and a lack of active transportation options due to the long distances. Despite these challenges, the downtown core of the city is also host to a well-maintained network of bike paths. Public transport is subsidized by the municipal government.

One major challenge affecting climate action and implementation is the disconnect between climate action and election gains. Informed and concerned citizens have over the last couple of years used their civic rights to demand more action from the municipality on climate action and particularly climate justice.

Energy sector: Decarbonizing buildings with steam

Québec City has led an innovative project that uses exhaust vapors from its incinerator to heat and air-condition a hospital. This reuse of the steam is enabling the Hôpital de l'Enfant-Jésus to reduce its annual greenhouse gas emissions by 10,000 tonnes of carbon dioxide equivalent, equivalent to the withdrawal of more than 2,900 light-duty vehicles from the roads. At the same time, the hospital is saving on energy costs.

Rio de Janeiro, Brazil

In a bid to restore the economy of Rio de Janeiro, the city has embarked on sustainable low carbon pathway that prioritizes both climate action and sustainable economic recovery aiming to be the green capital. Rio's has realized emissions reductions in the energy and waste/ sanitation sectors, considering the challenges of increasing waste in the city and higher demand for energy. Waste treatment in the city has been a major source of emissions.

Rio de Janeiro is host to a significant oil and gas industry which brings to the forefront tensions between fossil fuel dependence and decarbonization. None the less, with support from the World Bank, the city has developed legislation on active transportation, provisions for developing low emissions districts and more broadly a municipal climate action plan to guide decarbonization of the transport and energy sector.

The city of Rio has a significant presence of informal settlements with very little green spaces. This coupled with the lack of urban forests, vulnerability towards flooding, landslides, and urban heat island effects is concerning. Favela residents typically marginalized racial and low-income households are the most affected. The city has been working with local NGOs in several favelas to pilot the concept of green communities. Planting of trees has been a major part of greening communities with the objective of restoring biodiversity, increasing tree cover across the city to act as carbon sink and most importantly to improve the microclimate of the favelas.

One of the major challenges facing the city of Rio de Janeiro is political will and commitment at the federal level. The city has in many ways taken the lead in accelerating climate action through legislation, mega environmental projects and partnering with key stakeholders. However, limited support from the federal government on climate action strains the possibilities that lie in strong inter-governmental relationships to advance the city's net zero and greenhouse gas emissions goals.

Waste and sanitation/Energy sector: Ecoparque's pilot project [152]

Innovative technology and collaboration with diverse stakeholders have been critical in the reductions of emissions in the city. In partnership with the Federal University of Minas Gerais, the city is piloting a technology that will produce fertilizer and natural gas from waste. Funded by the Brazilian Development Bank, the biogas plant can generate energy for over 1,000 houses and even power 1,000 cars.

Santiago, Chile

Approximately 40 percent of the Chilean population lives in the metropolitan region of Santiago. Santiago is one of the most unequal cities in Latin America, with a wide gap between the rich and poor with particular emphasis on housing and gender inequality. Spatial segregation and social inequality pose a significant challenge to the realization of equitable climate action.

An increase in population has led to uncoordinated urban sprawl and has led to the proliferation of low-income housing that are susceptible to flooding, rising temperatures and squalid waste and sanitation conditions. Santiago's challenge with water has been long standing as the country recorded the driest decade in history. This has particularly impacted the metropolitan region of Santiago. Reduced rainfall coupled with a high demand for water across multiple economic sectors, has put stress on the regions aquifers. On the other hand, rising temperatures are melting rich glacial reserves is affecting the regions potable water. The metropolitan region of Santiago recognizes the urgent need to effectively, coordinate and midwife a strong resilient plan to adapt and reduce the cities vulnerability. Leveraging innovation and technology can accelerate effort towards net zero in multiple sectors.

The city has made significant strides in decarbonizing the transport sector. Santiago boasts the largest fleet of electing buses in Latin America. The city hopes to leverage on successful greening of their public transport to increase zero emission buses that can resolve poor air quality that is of concern particularly during the winter periods. 60 percent of the city's metro is powered from renewable production - wind and solar power.[153] The city remains a leading example of decarbonizing transport towards net zero.

Energy sector: Santiago bio-factory[154]

The city's three waste water plants have been turned into 'bio-factories' that convert waste water and sewer sludge into clean energy. The plants are zero waste, energy self-sufficient and aim to be carbon neutral by 2022.

The spillover effect from this bio-factory will also produce over 137,000 tonnes of biosolids that will be reused as fertilizer to grow food. The bio factories are anchored on a circular economy model that minimizes waste and pollution from waste water treatment processes. Waste water from urban and industrial environments consisting of sand is recycled for city construction projects.

City of Singapore

The City of Singapore's Climate Action Plan lays out strategies and targets to reduce GHG emissions by 2030. The city state aims to position itself a leader in green economic activities in industry, services, and finance capitalizing on the value proposition of a low carbon economy. The City of Singapore is host to a large logistics hub, a petrochemical industry, and a power generation industry. The city-state government has put in place a carbon tax to penalize polluting industries.

Considered one of the greenest cities in the world, the City of Singapore has taken lead towards decarbonizing the built environment leveraging on innovative solutions, architectural ingenuity, energy saving technologies, green roofs, and vertical gardens. The city has many high-rise buildings and is heavily densified, therefore the intentional approach to boost green infrastructure is necessary. The city is designed to cater for an integrated urban green walking network. 46.5 percent of land in the city state is covered in green space and a tree canopy of almost 30 percent.[155] The city's park connector network has been used as green mobility corridors supporting both walking and cycling.

Critical to the energy transition in the City of Singapore in the increase of renewable energy. Because of the limited land mass, the city-state imports natural gas from neighboring countries. Exploring low carbon technologies and such as the setting up of a hydrogen plant to drive its transition will be able to save up to 220,000 tons per year of CO2.

Seventy-five percent of the population uses mass transit due to the high costs associated with purchasing a private vehicle.[156] To increase the uptake of electric vehicles the city state has put in place tax incentives for consumers and grants to operators of electric vehicle infrastructure. The city aims to ensure 60,000 charging points in the city by 2030. The city is aiming to deepen decarbonization of the transport sector by running trials and testing the viability of autonomous vehicles.

Waste and sanitation: Recycle Right citizens' workgroup[157]

As part of the City of Singapore's Zero Waste Masterplan, the government has set up a recycle right citizens workgroup to co create solutions with the public on improving recycling in the home. The government opened a call for participation and selected a total of 48 citizens from diverse backgrounds. Over a period of 30 days, the selected citizens interact with waste and recycling experts to come up with key recommendations. The recommendations are submitted to the Ministry of Environment and Water Resources and developed into projects, one of which is developed and implemented. This innovative initiative puts public participation and citizen engagement at the core of climate action.

Sydney, Australia

The City of Sydney has a long and strong record of implementing climate action and has been implementing bold climate action informed by its Environmental Strategy 2021-2025.[158] In 2007 the city's operations were carbon neutral and in 2011, the city was the first local government in Australia certified as carbon neutral. In 2019, the City of Sydney declared a Climate Emergency reiterating the importance of accelerating climate action. Alongside is a complementary strategy, Sustainable Sydney 2030-2050, that aims to realize environmentally friendly concepts that will transform Sydney into a livable and sustainable city.

As the city continues to grow, Sydney is prioritizing waste and water management, improving energy efficiency in buildings through retrofits, and increasing the uptake of electric vehicles. In parallel, the Greater Sydney region is focusing on increasing the adoption of distributed energy resources and investing in infrastructure to accommodate the transition. Advocating for the acceleration of coal closures, electrifying public transport, and moving the built environment through net zero are also key priorities. The city has put in place regulations that will see development applications for new office buildings, hotels and shopping centers and major redevelopments of existing buildings complying with minimum energy ratings from January 2023 and achieve net zero energy use from 2026.

In the year 2020, the City of Sydney began using 100 percent renewables to meet its operational electricity needs. Another project, the Major Properties Efficiency Project (MPEP) targeting 14 of the city's highest energy and waste consuming sites through lighting upgrades, has been successful at delivering energy and water efficiency as well. In the transport sector the city is improving bike infrastructure and encouraging active transportation. The Cycling Strategy and Action Plan aims to increase ridership and provides free bicycle learning lessons to ensure that everyone can be part of the transition to zero emission transport.

With rising temperatures causing major heat waves the city is increasing accessibility to cool green public spaces. Alongside this is the expansion of canopy cover across the city. The transition to net zero in Sydney aims to leave no one behind. In this regard, the city has put in place the Equality Indicators framework to track, evaluate and act on ensuring equitable climate action.

Waste and sanitation: Food scraps recycling trial in apartment buildings[159]

This innovative project aims to turn food scraps generated from densified apartment buildings into energy. A total of 1016 houses and 141 inner-city apartment blocks take part in a City of Sydney food scraps recycling trial. Kitchen scraps from up to 12,000 homes are being diverted from landfill and turned into green energy and plant fertilizer. The trial began in 2019 and the city has collected and recycled more than 500 tonnes of food scraps.

Tel Aviv-Yafo, Israel

Tel Aviv-Yafo is considered a magnet city with people within and beyond Israel making the city their home. This surge in population coupled with post COVID-19 tourism puts pressure on the already highly densified metropolitan area. Urban sprawl has particularly been a major source of stress for the city, leading to an increase in car dependence, more waste and increasingly high demand for energy. The city issued a climate adaptation plan in 2020 outlining the likely impact of climate change on the city and has announced plans to issue its net zero plan later this year. Such plan is meant to outline specific steps and programs to be implemented to realize net zero status by 2050.

Due to the increasing number of high rise commercial and residential buildings, the city has invested heavily in its efforts into ensure that only energy efficient buildings are constructed. Leading by example, all public buildings use solar power and new builds of four stories or more are being required to be constructed based on highly stringent and detailed green / energy efficient standards.

Due to the density of buildings and the Middle East climate with no rain for 6 months per year, heat waves are common and affect the most vulnerable in society. The poor quality of housing in some neighborhoods exacerbates the effects of the heat amongst low-income groups. To address this challenge, the city has begun to install a wide range of shading facilities in these areas to reduce the impact of heat waves and in general to encourage more walking.

Transportation and mobility is also a focus areas of the city, which aims to reduce private and polluting transportation with the specific goal of reducing private vehicles by 30 percent by 2030[160] and to prioritize the pedestrians within a sustainable transportation pyramid. The city provides variety of solutions such as paving bicycle lanes, currently 165km with a stated goal to reach 300km by 2030, placing cooperative transportation such as bicycles and e-scooters throughout the city, and regulating parking preference for cooperative vehicles. A long-awaited light rail project is expected to be completed within the next two years.

There are two challenges that impact the city's transition to net zero. Tel Aviv-Yafo is a densely populated city with limited green spaces with continuing pressure based on building demand to reduce these spaces in favor of more construction, mostly towers. The second challenge is the availability of climate and infrastructure related finance at the municipal level as most funds and services are financed by Israel's national government

Waste and sanitation: Ecodrum[161]

The city of Tel Aviv-Yafo notes that the average waste produced per citizen is 2kg per day. This means that waste generated, coupled with a growing population will put pressure on landfills and contribute to an increase of greenhouse gas emissions in the waste sector. The city is leveraging on the power of strategic partnerships and collaboration to accelerate climate action in the sector.

Tel Aviv-Yafo's largest composter, an Ecodrum, aims to reduce methane gas and reduce the number of trips needed to transport waste to landfills. The partnership between the municipality of Tel Aviv-Yafo, a large supermarket chain Mega, an environmental non-governmental organization Tazlul and a private company called Eco City Green creates a platform for private companies and industry to turn their organic waste into compost. Wood chippings are provided by Tel Aviv-Yafo municipality. The linkage between, climate action, profit and public health is emphasized by the partners of the project.

Toronto, Canada

TransformTO is the main strategy informing net zero climate action in the city of Toronto. By 2030, the city aims to reduce emissions by 65 percent and arrive at net zero by 2040.[162] Toronto's approach to accelerating net zero is anchored on using new technologies and restructuring market and socio-economic systems towards a just transition. Through effective climate governance and partnerships, the city's 'ambition loop' leverages on critical relationships to advance climate action. The city has a wide range of initiative such as the net zero Existing Buildings Strategy, Green Wall Initiatives, BetterHomes TO and Home Energy Loans Programs, Active TO, all signaling the efforts towards arriving at net zero by 2040.

The City of Toronto has set up an innovate climate action fund supporting community led projects. This fund ensures that disadvantaged and marginalized communities are aware and engaged on climate action in the city. Through outreach and education, the fund supports climate action of community, grassroots groups, and leaders. The city has also put in place measures to ensure climate action addresses the needs of youth, isolated seniors, diverse linguistics communities and immigrants.

The Toronto Green Standard (TGS) is Toronto's sustainable design and performance requirements for new private and city-owned developments since 2010. Version 4 came into effect May 1, 2022 and includes three performance tiers for new planning applications. The TGS tier 3 Zero Emissions Buildings Framework, will result in greenhouse gas reductions of 30.6MtCO2e by 2050, achieving zero emissions buildings by 2028, and Transform TO's reduction target of net zero operational carbon by 2040. Version 4 introduces tracking of embodied emissions in building materials used in construction. The second city in Canada to acknowledge embodied carbon an integrate it. Embodied carbon reductions of construction materials is anticipated to step up with each new release of TGS, recognized as a critical area for reducing carbon footprint collectively for the built environment.[163]

The city is taking leadership on bold climate action by developing a model for urban decarbonization. Villiers Island is new climate positive development, where the city is testing several innovative solutions that will showcase sustainability, resilience, and net zero land use planning. Similarly, through a competition known as the deep retrofit challenge, the city aims to realize energy efficiency in existing buildings to help meet the ambitious goals of net zero emissions. This is of particular importance as buildings are the largest source of GHG emissions, approximately 57 percent of the city's total emissions mainly from the burning of natural gas for heating and hot water. Despite the ambitious action, Toronto faces several challenges centered around housing affordability and citizen engagement in net zero decision making.

Waste and sanitation: ReduceWasteTO program[164]

Holding the business community responsible and bringing them along the net zero journey by providing businesses with different methods they can take up to eliminate the use of single- use and takeaway items. These methods include choosing reusables and foam free options amongst others. The city is host to several small and medium businesses that daily provide their customers with singe use items.

The city currently manages approximately 900,000 tons of waste which is putting pressure on energy resource, capital, and clogging landfills. To move towards a circular economy, the city's long term development strategy is a road map that will improve waste management over the next 30-50 years.

Vancouver, Canada

The City of Vancouver has had a long history of climate action stemming back to the early 1990s. Dramatic changes in weather patterns, population increase, the COVID-19 pandemic led to the city of Vancouver has put in place a climate emergency action plan, 2020. The city's focus is to cut carbon pollution from transport sector (37 percent) and the buildings sector (57 percent).[165]

The City of Vancouver has over the last year experienced an increase in flooding, rainfall, wild smoke, and other extreme weather events. These events damage critical urban infrastructure, puts stress on plants and trees and displaces vulnerable population such as the homeless, indigenous populations and low-income groups. For this reason, municipal insurance is of particular importance as loss and damage is a concern. The Municipal Insurance Association of British Colombia's major objective is to support local governments across the provinces pre, during and post catastrophic losses and damages caused by Climate adaptation is essential to the transition to net zero. The City of Vancouver's Climate Adaptation Strategy puts emphasis on improved data, strong climate governance, strengthened capacity and knowledge and effective mainstreaming across departments. To effectively manage climate risks and hazards, the city is focusing on climate robust infrastructure, climate resilient buildings, heat mapping, increasing green spaces, coastal preparedness, and community engagement.

The COVID-19 pandemic saw a migration of people from the city center to the suburbs and this has led to an increase the use of personal vehicles. Despite this, the province of British Colombia has the highest uptake of electric vehicles in North America. The city has also put in place adaptation measures in the transport sector such as introducing parking levies and congestion pricing to discourage user of personal vehicles

Energy sector: CleanBC indigenous community heat pump

The provincial government of British Colombia offers free energy coaching services to support Indigenous communities wanting to take advantage of the CleanBC Indigenous Community Heat Pump incentive and related energy efficiency offers.[166] The fund which is accessible by all municipalities across the province including the City of Vancouver, caters for heat pump installations, fuel switching projects to cleaner energy where there is renewable electricity, covering capital and installation costs.

The city of Vancouver's energy supply is currently 31 percent renewable and with the renewable city strategy aims to accelerate renewable energy to 100 percent. The city notes that to meet this goal, plans, actions, and polices must be inclusive and equitable.

Vienna, Austria

Vienna, considered to be one of the most livable cities is implementing bold and innovative climate action. The city's Smart KLIMA City Wien[167] aims to transition the city to net zero by 2040. Vienna has the lowest CO2 emissions per capita compared to other cities in Austria even though it is densely populated and small. Vienna's transition to net zero places significant emphasis on climate governance, in particular political strategies, technological innovation, and social justice with a focus on low-income groups, the elderly and other vulnerable persons.

Despite the low emissions profile of the city, the energy, mobility, and buildings sectors are key priorities for decarbonization. District heating and cooling are major areas where the city is implementing innovative initiatives to advance to a net zero status. Referred to as the Vienna Model, the city uses waste heat from generating stations to feed into the district heating network which leads to energy savings and is an environmentally friendly process.

Rising temperatures in the summer months have spurred innovation and ingenuity to enhance energy efficient cooling. Vienna's heat islands are caused by pollution, concrete, asphalt and human activities, driving up the temperatures. The city has implemented mobile fog shower sprays that release a fine mist into the air to cool down people and are placed in the warmest public spots, mainly spaces that have large concrete cover. Residents can also use an application to locate the coolest spots in the city.

In the transport sector, the city is expanding its public transport network and exploring the role and potential of autonomous vehicles in the transition to net zero. The city is enhancing and improving active transportation. In 2022, the city's cycling network covers over 1660km of routes with more than 56,000 bicycle parking spaces. A bike sharing system has also been established to further encourage clean mobility.

In the energy sector, the city is researching the potential of blockchain technology to simplify the handling of energy transactions with a pilot project in the VIERTEL ZWEI[168] urban development area in Vienna's Leopoldstadt. A highly participatory pilot project, customers can test the viability of innovative energy tariffs, imagine new business models for solar power by incorporating blockchain technology.

Mobility and connectivity: Hydrogen bus and charging station[169]

As part of the city's transition to net zero mobility, the first hydrogen bus and charging station was launched. The partnership between the city owned energy supplier and the public transportation company is a joint effort in advancing deep decarbonization of the transport sector. The bus will be integrated into the city's public transport system and will be piloted to test the viability of the entire supply chain which includes storage, charging, pricing, and passenger and run efficiency. The city aims to introduce 10 additional hydrogen buses alongside a second charging station with the objective of becoming a central hub for green hydrogen.

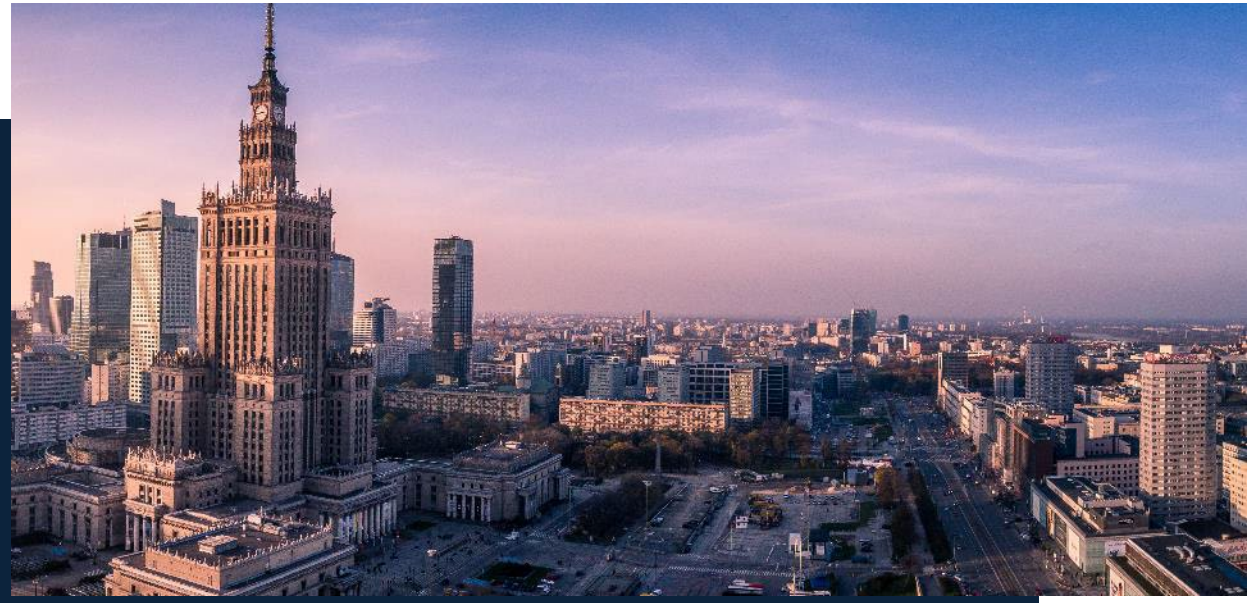
Warsaw, Poland

Warsaw's top emitters are mainly related to electricity generation, the heating and cooling of buildings and the transport sector.[170] Reducing energy consumption, heat lost in buildings and increasing the uptake of renewable energy are key priorities for the city. Warsaw's district heating was set up post Second World War and has one of the largest networks in Europe. The system has been upgraded and now provides efficient heating, reducing emissions from the built environment.

With the main source of green house gas emissions coming from the energy sector, due to the city's dependence on coal and gas, the city put in place the Sustainable Energy Action Plan for Warsaw 2020 and the Integrated Revitalization Program for the capital city of Warsaw. The city has focused on constructing and modernizing district heating networks to be energy efficient.

Sustainable mobility is a key priority for Warsaw. Plans to expand the public transport network to the suburban areas are in place. The city aims to have one third of buses in the city be electric or hybrid. The city's bike system is undergoing expansion as the city encourages and provides infrastructure for non-motorized transport. To discourage the use of cars within the core city, Warsaw has several park and ride car park systems in the outskirts near public transport hubs to encourage ridership, reducing emissions and air pollution from cars. Another initiative is a city led innovative retrofit of the Polczynska Park+Ride: Smart and Green Parking where investments have been made into the physical structures supporting transportation infrastructure, new buildings, and better energy efficiency.

Warsaw is the first city in Poland to join the European Bank for Reconstruction and Development (EBRD) Green Cities network, a flagship urban sustainability program, signaling the importance of regional partnership and collaboration towards net zero at the city level. The city is also part of C40's 'Private Building Efficiency Network' and 'Municipal Building Efficiency Network' strengthening city led efforts to reduce emissions from the buildings sector.[171]



Mobility and connectivity: Veturilo city bicycle system[172]

The Veturilo bike rental system is one of the largest in Europe. Cyclists have available over 300 stations and more than 4500 bicycles, plus several dozen stations and several hundred bikes funded by private partners. This system implemented by the city provides a user friendly website and mobile application that gives users choices for different types of bikes including electric bikes and bikes for children. The rental system is affordable with the first 20 minute free of charge.

10

Appendix

Appendix

Methodology

For this report, 50 cities have been assessed on 48 different indicators. For each city, the data for each indicator is normalized using the min-max method. This converts the variables to a range between zero and 100 by subtracting the minimum value, dividing by the range of the variable values, and multiplying by 100. If a lower number indicates greater progress towards a decarbonized future state, the result is then subtracted from 100. This means that for each indicator the top-ranked city receives 100 and the bottom city zero. Due to the challenge of data inconsistency at the city level missing values were adjusted with values from province/state or country level data. In the case of non-availability of such proxy values, an imputation of average of datasets for each indicator in the same income group were used as input for the index. Furthermore, where the average of same income group was not available for any specific indicator the value of nearest income group was considered.

The indicators are split into four groups: City enablers, decarbonization status, sector policies and preparedness and climate equity. The city preparedness score is calculated from three groups of unequal weights: decarbonization status, city policies and preparedness and equity. City ecosystem enablers is a standalone indicator group that signals city and sector readiness towards net zero.

Each city is further assessed on five sectors which make the greatest contributions to emissions. The five sectors are energy, mobility and connectivity, built environment, industry, and waste and sanitation. Each sector is assessed based on indicators from decarbonization status, city policies and preparedness and equity. These sector-specific scores are then weighted based on the sector's contribution to the country's emissions to provide an overall sector score. Due to inconsistent reporting of cities' emissions across sectors, the respective national emissions for each sector were used as weights to calculate the overall sector score.

The overall index score for each city is obtained by multiplying the city enablers score by the overall sector score and dividing this by 100.

Illustrative example: How the net zero transition score is calculated for Sydney

City preparedness score

90.28 | Contribution to city net zero (based on ten indicators):

This is the weighted average of 91.47 (Sydney comes under top 15 cities for lower GHG emission per capita of the 50 cities) — 100 percent weighting factor; 100 (it has presence of interim emission targets) — 33 percent weighting factor; 100 (it has presence of net zero target) — 33 percent weighting factor; 90 (Sydney's net zero target year is 2035) — 33 percent weighting factor; 100 (Sydney undertook a climate change risk and vulnerability assessment) — 100 percent weighting factor; 93.82 (Sydney's air quality is amongst the top 20 cities of the total 50 cities) — 50 percent weighting factor; 13.20 (Sydney's greenscape per capita is below average in comparison of other cities) — 50 percent weighting factor; 100 (Sydney has a governing body at city level for implementing and monitoring the net zero action plan) — 100 percent weighting factor; and 100 (Sydney has multiple climate funding options) — 100 percent weighting factor.

Sector score

Energy sector (based on 7 indicators): **79**, weighted based on 57 percent share

Mobility & connectivity (11 indicators): **38**, weighted based on 26 percent share

Built environment (5 indicators): **72**, weighted based on 4 percent share

Industry (5 indicators): **39**, weighted based on 10 percent share

Waste and sanitation (10 indicators): **80**, weighted based on 3 percent share

Weighted average of five sectors

The sector indicators are comprised of three groups paralleling three aspects of transition — decarbonization status, city policies and preparedness and equity.

The weight distribution among the scores for the three groups for the city is based on decarbonization progress of that city for those sectors.

If a city's decarbonization status is better than the median for that sector among cities, then decarbonization status, city policies and preparedness and equity receive 60 percent, 30 percent and 10 percent weights, respectively; otherwise, it will be 45 percent, 45 percent and 10 percent.

NZRI score

57.80

Limitations of the methodology

01

The selection of indicators utilized in the methodology were finalized subject to availability of data in a manner that is comparable across the cities. Some areas material to the urban sustainability effort excluded from this iteration of the index include:

- Emissions reduction progress, which maps change in emissions between selected years 2010 and 2020, was excluded due to unavailability of annual data at city level
- Experience with climate-linked finance instrument which captures the amount of investment per capita was excluded due to inconsistent data methodologies across cities
- Electricity system outage frequency was excluded to avoid penalizing developing cities for resource limitation
- Public transport network convenience was excluded as last mile connectivity in several cities is part of the informal economy and is not tracked in a reliable and consistent manner
- Number of new green jobs created was excluded since the cities are at different stages of transition and several cities do not yet track employment generation associated with a sustainable transition

02

Cities have different emissions accounting boundaries which are decided by the council or other bodies reporting emissions. These boundary definitions may not be consistent across cities and introduces ambiguity in utilizing emissions shares from various sectors as weights in the index. However, the emissions figures still provide an indicative view into the relative emissions shares of different sectors. Therefore, the country level percentage emissions shares of the sectors have been utilized to weight sector scores.

03

From an emissions inventory point of view, green spaces which are responsible for carbon removals are a component of agriculture, forestry and land use (AFOLU) sector. However, they have been modelled into city-wide indicators rather than as a separate sector since the AFOLU sector may have negative emissions in some cities, and it is not possible to assign negative weights in a weighted average-type index.

04

Data was gathered from secondary research. Where city level data is not available, a state/province level data has been sourced. Where neither city level data nor state/province level data is available an imputation method has been applied. Utilizing regional proxies or imputed data impacts accuracy, which can be improved through primary research in future iterations.

Indicators

City enablers

- **Amount of GHG emission in city per capita (1 weight)** The indicator captures the greenhouse gas emissions, measured in metric tons carbon dioxide equivalent per capita (MtCO2e/Capita) from the years ranging between 2014-2021. The figures are obtained from CDP reports of the cities and KPMG research.
- **Presence of interim emission targets – (1/3 weight, the other one third assigned to presence of net zero target and net zero target year since there is a high degree of statistical correlation amongst the three)** The cities have some interim targets to achieve net zero emissions which were set in place from the year 2015-2021 and are measured in two categories i.e. 0 and 1; 0 denoting the absence of interim emission target and 1 observing the presence of the target for the city. The presence of these interim emission targets is logged from the respective Climate Action plan of the cities and KPMG research.
- **Presence of net zero target (1/3 weight, the other one third assigned to the point above and net zero target year).** The cities have set a target year by which it would become carbon neutral economy wide. These targets are captured from the year 2015-2022 from the climate action plan of these cities and KPMG research, and are measured in three categories - 0 if the target is absent, 0.5 if the target is in policy or pledge and 1 if the target is in place by law.
- **Net zero target year (1/3 weight, the remaining one third of the point 2 and 3).** The target year in which the city will achieve net zero emissions. The target year is marked from the Climate action plan/Climate management plan of the cities and KPMG research from the year 2015-2022. The data is clubbed into 11 categories based on the target year it would achieve net zero emission. The categories are-

Categories	Net Zero Target Year
0	Later or No Targets
1	2075
2	2070
3	2065
4	2060
5	2055
6	2050
7	2045
8	2040
9	2035
10	2030

- **Climate change risk and vulnerability assessment undertaken for the city (1 weight, to understand how much the city is ready for climate change and any assessment is carried out for the same)** The figures are taken from the year 2014-2022 from the CDP report for the cities and KPMG research. It is measured in two categories i.e., 0 and 1; 0 denoting the absence of any climate change and vulnerability assessment undertaken by the city and 1 observing the climate and vulnerability assessment adopted.
- **Air quality (1/2 weight, the other half is assigned to Greenscape per capita)** Air Quality is defined by the presence of fine particulate matter, which is an air pollutant that reduces visibility and causes air to appear hazy when levels are elevated. The air quality figures are measured on a scale of particulate matter (PM 2.5) in microgram per cubic meter (µg/cu m) captured from the years ranging between 2013-2021, derived from World Health Organization (WHO) website and KPMG research.

City enablers (continued)

Greenscape per capita (1/2 weight, the other half of above point) The green space (square meter) per capita values for the cities are taken up from the website Hugsi.green which captures the data by applying the computer vision and deep learning techniques on satellite images. It uses the satellite image to acquire the data and machine learning techniques are applied to convert the digital images into a range of green space matrices. The value of greenscape is measured in square meter per capita (square meters/capita) for the cities ranging from the year 2018-2022.[173]

8. CCUS Capacity CCUS Capacity (as of now, this indicator is given zero weight) The indicator takes into account any carbon capture and storage projects implemented or planned by cities.

- **Is there a governing body at city level for implementing and monitoring the net zero action plan (1 weight)** The data sets are captured from 2016-2021 from CDP report of the cities and KPMG research. The indicator defines whether a governing body is present in the city for implementing and monitoring the Net zero Action Plan for the city. It is measured in two categories 0 and 1; 0 denoting the absence of the indicator i.e., the absence of a governing body to implement and monitor the Net zero Action Plan and 1 observing the presence of it.
- **Climate funding options (1 weight)** The climate funding option suggests the different types of funding available for various climate change initiatives. These funding includes Governmental (Public Funding), Public Private Partnership, Development finance (other multilateral funding agencies). This indicator is measured in three different categories 1, 2 and 3; 1 representing the climate funding from Public (Government) domain only, 2 denoting the funding from Public (Government) as well as through Public Private Partnerships and 3 represent the funding from Public (Government), Public Private Partnership as well as funding from other multilateral funding agencies. The values of the indicator are captured from CDP report of the cities and KPMG research from the years ranging between 2013-2021.

Energy sector

- **Percentage of electricity produced by low carbon sources (1 weight)** This indicator represents the percentage of electricity produced by low carbon sources like - Nuclear, Hydro, Bioenergy (Biomass and Biofuels), Wind, Geothermal, Solar (Photovoltaic and Thermal), Waste to energy (excluding biomass component) and other sources. The percentages for the cities are captured from years ranging between 2017-2022 from CDP report of the cities and KPMG research.
- **Electricity consumption (1 weight)** The figures show the electricity consumption of the cities in kilowatt-hour per capita per year (kWh/capita/year) from the year 2014-2022, obtained from CDP report of the cities, IEA website and KPMG research.
- **Target to achieve low carbon source (1 weight)** The indicator captures the achievable target of using low carbon sources for generating electricity in the defined target year. These values are derived from the year 2018-2022 from the CDP report of the cities and KPMG research. These target values are formulated (values are calculated by the formula – Achievable Target/ (Target Year – 2022)) and converted into numbers for normalization and standardization purposes. The greater the number, better is the condition of the city to achieve the desirable target and a negative value suggests that the target is already achieved by the city.
- **Smart electricity meters (1/2 weight, the other half is assigned to the other support mechanisms for renewable energy. Composite score for renewable energy incentives and support mechanisms (PTC, ITC, FiT, CfD)** The indicator captures the implementation of smart electricity meters in the city. The figures are captured from the year 2014-2021 from KPMG research and are further classified into three categories **0, 0.5** and **1**, where **0** signifies no work on smart metering, **0.5** denotes that smart metering is in proposal stage for the cities and 1 suggests that the implementation of smart electricity meters are already in progress.
- **Net metering (1 weight):** The indicator captures the mechanism that allows consumers to sell power back to the grid. The cities are given a score of 1 if such a mechanism is in place and 0 if not. The figures are captured from the year 2004-2022 from a thorough KPMG research.
- **Other support mechanisms for renewable energy. Composite score for renewable energy incentives and support mechanisms (PTC, ITC, FiT, CfD) (1/2 weight, the other half is assigned to smart electricity meter):** The cities are given a score of 1 if renewable energy incentives and support mechanisms are in place and 0 if not. The figures are derived from the year 2004-2022 from CDP, IRENA, and thorough KPMG research.
- **Access to electricity (1 weight)** The numbers represent the percentage of population with access to electricity in the entire city. The figures are captured for the year 2020 from World bank data and KPMG research.

Mobility and connectivity

- **Modal share/ridership: Public transport (metro, tram, buses, water navigation) / Modal share of sustainable modes (1 weight):** The indicator captures the percentage of people that use public transport as a means of commuting. The figures are captured from the year 2010-2022 from city transit website and a thorough KPMG research.
- **Percentage of electrical cars sold in previous year (1 weight)** The indicator represents the percentage of electric cars sold in comparison to the total number of cars sold in the previous year in the city. The figures are derived from 2019-2022 through KPMG research.
- **Charging infrastructure in the city (1/2 weight, the other half is assigned to electric vehicles in public transport since there is a high degree of statistical correlation amongst the two)** It is the total number of charging stations present per square kilometer in the city. The figures are obtained from the year 2021-2022 from CDP report of the cities and KPMG research.
- **Electric vehicles in public transport (percentage) (1/2 weight, the other half is assigned to charging infrastructure in the city since there is a high degree of statistical correlation amongst the two)** The figure represents the number of electric buses present in the city per square kilometer. The values are obtained from the year 2019-2022 from KPMG research and CDP reports of the cities.
- **Years of ban on sale of inter combustion engine (ICE) vehicles (1/3 weight, the other one third assigned to low carbon fuel mandates and average age of passenger cars presence of since there is a high degree of statistical correlation amongst the three)** The cities have proposed a ban on the sale of inter combustion engine (ICE) vehicles and have a plan to completely stop their use in the coming years. The indicator suggests a number, which signifies the complete ban on ICE. These numbers are obtained from KPMG research which are calculated in two different categories: Proposed ban and No Proposed ban. For cities that have proposed a ban, the number lies between 1 – 27 (Calculated as Year of ban – 2022) whereas for cities that have not proposed a ban the value is 28 (Taking the base year 2050).
- **Public transport network (1 weight)** The indicator captures the total length of transport network present for different modes of public transport in the city, in kilometer per hundred thousand inhabitants (km/100,000 inhabitants). The data sets are derived from the year 2010-2022 from City transit website and intensive KPMG research.
- **Low carbon fuel mandates (1/3 weight, the other 1/3 weight is assigned to ban on ICE engines and to the point below)** The indicator checks the presence of low carbon fuel mandates like usage of renewable energy sources (Solar, Wind, Hydro, etc.) hydrogen, blended biofuels such as ethanol, biodiesel, renewable biodiesel, and natural gas available in the cities. The figures are captured from the year 2014-2022 from a thorough KPMG research. The figures are classified in two categories **0** and **1**; **0** for no mandates available and **1** for availability of low carbon mandates for the cities.
- **Average age of passenger cars (1/3 weight, other 1/3 are assigned to 24 and 22)** The figure mentions the average age of passenger cars in years, captured from an in-depth KPMG research from the year 2014-2022. The values indicate the years after which the passenger cars should not be used.
- **Incentives for electric vehicles (1/2 weight, the other half is assigned to presence of legislation that regulates charging infrastructure operation, payments, and interoperability)** There are some incentives available for using or purchasing of electric vehicles in the city. The indicator is signifying the presence of such incentives for electric vehicles in the city, captured in two values 0 and 1; 0 denotes absence of incentives for electric vehicles and 1 denotes availability of incentives in the city.
- **Presence of legislation that regulates charging infrastructure operation, payments, and interoperability (1/2 weight, the other half is assigned to the above point)** There are certain policies/legislations that regulate the operations and payments of charging infrastructure in the cities. The indicator captures the presence of such legislations in the city and are represented in three categories; 0, 0.5 and 1. 0 denotes the absence of such a legislation, 0.5 indicates that it is proposed and 1 denotes the presence of it.
- **Public transport affordability (1 weight)** The figures capture the per capita monthly income divided by monthly bus pass price of the city, to estimate the public transport affordability. The smaller the number, the better is the condition of public transport affordability. The values are obtained from KPMG research.

Built environment

- **Gas consumption per capita (cooking and heating) (1 weight)** The figures capture the consumption of natural gas (Gross Domestic energy consumption per capita) per capita, measured in kilotons of oil equivalent per capita (ktoe per capita). The data is mapped at the country level for the indicator and the values for natural gas gross domestic energy consumption is considered as a forecasted value for 2022. The data set is obtained for the year 2022 from a website data tool (eiu.com).
- **Uptake of green building (1 weight)** The indicator is used to check the extent of green building area relative to the total area of the city. Apart from the LEED certification, no other green building certifications are taken into consideration for calculating the green building area. Moreover, only the buildings which have received the green building certification (and are not in the intermediate stages) so far are considered for the area calculations. The values are formulated for the purpose of standardization. The greater the value of the indicator better is the position of green buildings in the city. The information captured is till the year 2022, derived from the website Usgbc.org and KPMG research.
- **Green building rating mechanism adaptation policy/standards for public and private properties (1 weight)** The indicator captures the presence of green building rating mechanism and adaption of policy/standards for public and private properties in the city. It checks whether the city has adopted mandates for green buildings. The values are interpreted in two categories 0 and 1; 0 suggests the absence of such policies and standards, whereas 1 suggests the presence of policy/standards for public and private properties. The data points are taken up from the CDP report of the cities and KPMG research taken up from the year 2013-2022.
- **Retrofitting of existing buildings to adopt new source of heating and electrification: Retrofit and weatherization incentives and support mechanisms (1 weight)** The indicator is used to check if retrofitting of existing buildings are adopted to reduce the emission of the cities. The values are categorized as **0** and **1**; **0** stands for the city which has not opted for retrofitting of the existing buildings and **1** indicates that the city has opted for the retrofitting of existing buildings, to adopt new sources of heating and electrification. The values are marked up from CDP values of the cities and KPMG research considered from 2018 – 2021.
- **Presence of low carbon buildings in affordable housing (1 weight)** The indicator is used to check whether the cities are using low carbon sources in affordable housing buildings. The values of the indicator are categorized as **0** and **1**; **0** stands for the city which has not opted for the use of low carbon sources in affordable housing and **1** shows that the city has opted for low carbon sources for buildings in affordable housing. The values are taken up from the year 2017-2022, obtained from various KPMG sources.

Industry

- **Low carbon industrial cluster (1 weight)** The indicator identifies the existence of low carbon industrial cluster in the city. The values captured are categorized in two categories: 0 for absence of low carbon industrial cluster and 1 for the presence of low carbon industrial cluster in the city. The values are derived from the year 2013-2022, obtained from an extensive KPMG research.
- **Circular economy incentives (1 weight)** A circular economy entails markets that give incentives for reusing products, rather than scrapping them and then extracting new resources. In such an economy, all forms of waste such as clothes, scrap metal and obsolete electronics, are returned to the economy or used more efficiently. The indicator is used to check the presence of circular economy incentives in the city. The values are represented by 0 and 1, where 0 stands for absence of circular economy incentives and 1 represents that the city offers circular economy incentives.[174] The values are from 2009-2022 and obtained from thorough KPMG research.
- **Policies related to low carbon industrial zones and clean technology (1 weight)** Different policies related to low carbon industrial zones and clean technologies are adopted in cities. The value captured by the indicator are denoted by either 0 or 1, where 0 suggests the absence of the policies related to the low carbon industrial zones and clean technology and 1 represents the presence of these policies. The particulars are represented from the climate action plan of the respective cities and KPMG research obtained from the year 2009-2022.
- **Mandate for corporate sourcing of renewable energy (1 weight)** The indicator captures the mandates that are in place for corporate sourcing of renewable energy in the cities. The regulatory mandates for sourcing energy needs are considered from wind, solar, hydro and biomass for industries. The data sets are obtained from the year 2015-2021 from KPMG research and are represented in two ways; 0 showing the absence of mandates for corporate sourcing of renewable energy and 1 suggests the presence of mandates for corporate sourcing of renewable energy adopted by the city.
- **Minimum wages (USD PPP) (1 weight)** The indicator represents the minimum wage that is paid in the city. The values are captured in the domestic currency of the city and standardized based on USD PPP. The formula used is (Minimum wages (in domestic currency) / USD PPP) *8 to provide an overall comparison of the minimum wages paid in different cities. The figures are captured from KPMG research for the year 2019-2022.

Waste and sanitation

- **Volume of waste generated per person (1 weight)** The indicator captures the total amount of waste that is generated by a person in the city. It is measured in tons per capita per year. The values are obtained from KPMG research for the year 2007-2021.
- **Percentage of waste diverted from incineration and landfill (1 weight)** A large amount of waste generated is usually incinerated or sent to landfill for decomposition, giving rise to excess of air and land pollution. The cities have parted ways from using this conventional method in order to control pollution. The indicator captures percentage of waste material which is diverted from following the conventional practice of incineration and landfills. The figures are captured from the CDP report of the cities and KPMG research from the year 2012-2022.
- **Energy recovery from waste water (1/2 weight, the other half is assigned to water consumption)** The sewage sludge generated from waste water treatment can be reutilized to generate energy, for agricultural practices, for landfill and other different purposes. The information is obtained from 2013-2022 from KPMG research. The indicator captures these different purposes in three categories:

Categories	Different treatment/recovery for water treatment
0	No Treatment
1	Sewage sludge is used for landfill
2	Sewage sludge is used for agricultural manure
3	Sewage sludge is used for energy generation

Waste and sanitation (continued)

- **Water consumption (1/2 weight, the other half is assigned to energy recovery from waste water)** Water consumption is the portion of water use that is not returned to the original water source after being withdrawn. Consumption occurs when water is lost into the atmosphere through evaporation or incorporated into a product or plant (such as a corn stalk) and is no longer available for reuse. The figures capture the water consumption of an individual in the city measured in liter per capita per day (Liter/capita/day), drawn from KPMG research from the year 2009-2022.[175]
- **Targets for circular economy (1/3 weight, the remaining 2/3rd of the weights are aligned to two different indicators equally they are target for waste treatment and target for food waste)** As indicator number 35 captures the cities using the principle of circular economy, this indicator is used to represent the targets that are present for circular economy, if any. The information is represented in numbers 0 and 1, where 0 shows that the targets for circular economy are not available and 1 suggests the availability of targets in the cities. The values for the indicator are obtained from KPMG research for the year 2017 – 2022.
- **Targets for waste treatment (1/3 weight, the remaining 2/3rd of the weights are aligned to two different indicators equally they are target for circular economy and target for food waste)** This indicator is used to represent the targets that are present for treatment of waste, if any. The information is represented in numbers 0 and 1, where 0 shows that the targets for treatment of waste are not available and 1 suggests that the targets are in place for the cities. The values for the indicator are obtained from KPMG research for the year 2016 – 2022.
- **Targets for food waste (1/3 weight, the remaining 2/3rd of the weights are aligned to two different indicators equally they are target for waste treatment and target for circular economy)** This indicator is used to represent the targets that are present for the cities for food waste, if any. The information is represented in numbers 0 and 1, where 0 shows that the targets for food waste are not in place for the cities and 1 suggests the targets are set for the cities. The values are obtained from KPMG research for the year 2013 – 2022.
- **Smart water meters (1/2 weight)** This indicator indicates the implementation of smart water meters in the cities. This indicator is represented in three different categories of numbers: 0 represents no implementation in the city, 0.5 represents that the smart water meters are in proposal stage and will be shortly implemented and 1 represents that the implementation has already been started. The indicator values are captured from 2018-2021 through KPMG research.
- **Waste water treatment (1/2 weight)** The indicator represents the percentage of waste water which is being treated in the city relative to the total amount of waste water produced by in the city. The indicator is expressed in percentage. The units used to measure the waste water produced and treated are 10^9m3/year. The value is formulated (Waste water treated/Waste water generated * 100) to standardize the data for the purpose of comparison. The data is derived from the year 2008-2022 through KPMG research.
- **Water accessibility (1 weight)** The indicator defines the percentage of population with water accessibility in the city. It is expressed in percentage and is captured from CDP report of the cities and through KPMG research for the year 2016-2022.

A	City enablers
1	Amount of GHG emission in city per capita
2	Presence of Interim Emission Targets
3	Presence of Net zero Target
4	Net zero Target year
5	Climate change risk and vulnerability assessment undertaken for the city
6	Air quality
7	Greenspace per capita
8	CCUS capacity
9	Is there a governing body at city level for implementing and monitoring the Net zero Action Plan
10	Climate funding options
B	**Energy Sector**
i	**Decarbonization status**
11	Percentage of electricity produced by low carbon sources
12	Electricity consumption
ii	**Sector Policies and Preparedness**
13	Target to achieve low carbon source
14	Smart Electricity Meters
15	Net metering
16	Other support mechanisms for renewable energy Composite score for renewable energy incentives and support mechanisms (PTC, ITC, FiT, CfD)
iii	**Equity**
17	Access to Electricity

C	Mobility & Connectivity
i	**Decarbonization status**
18	Modal share/Ridership: Public transport (Metro, tram, buses, water navigation)/Modal share of sustainable modes
19	Percentage of electrical cars sold in previous year
20	Charging infrastructure in the city
21	Electric vehicles in public transport
ii	**Sector Policies and Preparedness**
22	Years of ban on sale of inter combustion engine (ICE) vehicles
23	Public Transport Network
24	Low carbon fuel mandates
25	Average age of passenger cars
26	Incentives for electric vehicles
27	Presence of legislation that regulates charging infrastructure operation, payments and interoperability
iii	**Equity**
28	Public transport affordability
D	**Built Environment**
i	**Decarbonization status**
29	Gas consumption per capita (cooking and heating)
30	Uptake of green building
iii	**Sector Policies and Preparedness**
31	Green building rating mechanism adaptation policy/standards for public and private properties
32	Retrofitting of existing buildings to adopt new source of heating and electrification: Retrofit and weatherization incentives and support mechanisms

iii	**Equity**
33	Presence of low carbon buildings in affordable housing
E	**Industry**
i	**Decarbonization status**
34	Low carbon industrial cluster
ii	**Sector Policies and Preparedness**
35	Circular economy incentives
36	Policies related to low carbon industrial zones and clean technology
37	Mandate for corporate sourcing of renewable energy
iii	**Equity**
38	Minimum wages (USD PPP)
F	**Waste & Sanitation**
i	**Decarbonization status**
39	Volume of waste generated per person
40	Percentage of waste diverted from incineration and landfill
41	Energy recovery from waste water
42	Water Consumption
ii	**Sector Policies and Preparedness**
43	Targets for circular economy
44	Targets for waste treatment
45	Targets for food waste
46	Smart Water Meters
47	Waste water Treatment
iii	**Equity**
48	Water Accessibility

11

About KPMG

About KPMG

About GLOBAL ESG

GLOBAL ESG provides insights about mitigating risks and grasping opportunities, to help drive positive, sustainable change for KPMG firms' clients, people and society at large. It is the platform which supports and empowers KPMG professionals as they assist clients in fulfilling their purpose, achieving their ESG goals, and supporting the world's attainment of the UN Sustainable Development Goals. It helps KPMG firms' clients across ESG & Sustainability, Economic & Social Development, Sustainable Finance, Climate Change & Decarbonization, and Measurement, Assurance & Reporting. For more information, visit Environmental, Social and Governance – KPMG Global (home.kpmg)

About global infrastructure advisory

Global Infrastructure Advisory professionals help public and private sector organizations involved in infrastructure to deliver the outcomes you are seeking, whether for society or for your business, or both, as efficiently as effectively as possible. KPMG professionals aim to help solve some of the world's biggest challenges. For more information, visit Infrastructure - KPMG Global (home.kpmg)

About the global center of excellence for cities and local governments

The Global Center of Excellence for Cities and Local Governments brings together subject matter advisors and industry professionals from throughout the world to share leading practices, knowledge, and experience. The mission is to advise and support the sustainable development of cities and the effective provision of municipal services.

Acknowledgements

Sponsoring partners

Steven C Beatty
Head, Global Infrastructure
Head, Global Center of Excellence for Cities and Local Governments
KPMG International

Stine Lise Hattestad Bratsberg
Partner, Head of Strategy and Transformation EMA ESG Hub
KPMG in Norway

Project team

Fernando Faria
Latin America Head of Infrastructure
KPMG International

Shefali Ahlawat
Data & Research Lead
KPMG Global Services, India

Jane Lumumba
Manager, Global Sectors, Government
KPMG International

Lily Ainapure
Senior Marketing Manager, Infrastructure
KPMG in Canada

Omar Raza
Sector Executive
Global Center of Excellence for Cities and Local Governments
KPMG International

With Thanks To:
Kari Eik
Executive Director
United Cities

12

KPMG contacts

KPMG contacts

Accra, Ghana
Evans Asare
Associate Director
easare@kpmg.com
KPMG in Ghana

Cairo and Alexandria, Egypt
Fares Amer
Partner, Audit
famer@kpmg.com
KPMG in Egypt

Hong Kong (SAR), China
Axel Kurschat
Director, Deal Advisory
axel.kurschat@kpmg.com
KPMG China

Munich, Germany
Reiner Klinz
Consulting – Public Sector
rklinz@kpmg.com
KPMG in Germany

Lisbon, Portugal
Fernando Faria
Latin America Head of Infrastructure
ffaria@kpmg.com
KPMG International

Nairobi, Kenya and Addis Ababa, Ethiopia
James Woodward
Partner, Deal Advisory
jameswoodward1@kpmg.co.ke
KPMG East Africa

Beijing, China
Stone Shen
Partner
stone.shen@kpmg.com
KPMG China

Sydney, Australia
Elizabeth Watts
Partner, Enterprise
ewatts@kpmg.com.au
KPMG Australia

Hamburg, Germany
Olaf Buske
EU Lead Partner
obuske@kpmg.com
KPMG in Germany

Barcelona, Spain
Jordi Oliver Hernandez-Nieto
Partner, FS Consulting
jordioliver@kpmg.es
KPMG in Spain

Lagos, Nigeria and Dakar, Senegal
Dimeji Salaudeen
Partner & Head, Infrastructure, Government & Healthcare
dimeji.salaudeen@ng.kpmg.com
KPMG in Nigeria

Mumbai and New Delhi, India
Anvesha Thakker
Global Co-Lead Climate Change & Decarbonization: Partner & Lead, Renewable
anveshathakker@kpmg.com
KPMG in India

London, United Kingdom
Anna Purchas
London Office Senior Partner
anna.purchas@kpmg.co.uk
KPMG in UK

Dusseldorf, Germany
Jurgen Storms
Senior Manager
jstorms@kpmg.com
KPMG in Germany

Budapest, Hungary
Agnes Rako
Partner, Advisory
agnes.rako@kpmg.hu
KPMG in Hungary

Capetown, South Africa
Ron Stuart
Partner, Digital Consulting
ron.stuart@kpmg.co.za
KPMG in South Africa

Kuala Lumpur, Malaysia
Abhishek Kumar
Executive Director
abhishekkumar30@kpmg.com.my
KPMG in Malaysia

Oslo, Norway
Stine Lise Hattestad Bratsberg
Partner and Head of strategy and transformation EMA ESG Hub
stine.hattestad.bratsberg@kpmg.no
KPMG in Norway

Vienna, Austria
Erich Thewanger
Partner
ethewanger@kpmg.at
KPMG in Austria

Amsterdam, The Netherlands
Wilco Leenslag
Senior Manager, Strategy, and Innovation
leenslag.wilco@kpmg.nl
KPMG in The Netherlands

Luanda, Angola
Fernando Mascarenhas
Partner, Advisory
femascarenhas@kpmg.com
KPMG in Angola

Singapore
Sharad Somani
Partner, Infrastructure Advisory
sharadsomani@kpmg.com.sg
KPMG in Singapore

Paris, France
Ismail Hamoumi
Senior Consultant Advisory
ihamoumi@kpmg.fr
KPMG in France

Warsaw, Poland
Justyna Wysocka-Golec
Director, Energy
jwysocka-golec@kpmg.pl
KPMG in Poland

Rio de Janeiro, Brazil
Luis Claudio
Partner in Charge of KPMG Rio de Janeiro Office
lcaraujo@kpmg.com.br
KPMG in Brazil

Medellín, Colombia
David Villalba
Vice President, Infrastructure Projects
dvillalba@kpmg.com
KPMG in Colombia

Buenos Aires, Argentina
Maria Begue
Manager
mbegue@kpmg.com.ar
KPMG in Argentina

Bogotá, Colombia
David Villalba
Vice President, Infrastructure Projects
dvillalba@kpmg.com
KPMG in Colombia

Montevideo, Uruguay
Magdalena Perutti
Partner
magdalenaperutti@kpmg.com
KPMG in Uruguay

Panama City, Panama
Jose Felix Magana
Partner, Advisory
josemagana@kpmg.com
KPMG in Panama

Santiago, Chile
Santiago Barba
Partner, Advisory
santiagobarba@kpmg.com
KPMG in Chile

Amman, Jordan
Mohammad Abudalo
Senior Director, Advisory
mabudalo@kpmg.com
KPMG in Jordan

Tel Aviv-Yafo, Israel
Hillel Schuster
Principal, Advisory
hillelschuster@kpmg.com
KPMG in Israel

Jeddah, Saudi Arabia
Fadi Alshihabi
Senior Director, Advisory
falshihabi@kpmg.com
KPMG in Saudi Arabia

Dubai, United Arab Emirates
Fadi Alshihabi
Senior Director, Advisory
falshihabi@kpmg.com
KPMG in Saudi Arabia

New York, United States
Todd Francesconi
Managing Director, Accounting Relationships
tjfrancesconi@kpmg.com
KPMG in USA

Atlanta, United States
Vonetta Daniels
Director, Advisory
vdaniels@kpmg.com
KPMG in USA

Chicago, United States
Linda Imonti
Office Managing Partner, Principal Advisory
limonti@kpmg.com
KPMG in USA

Vancouver, Canada
Chris Sainsbury
Partner, Global Infrastructure Advisory
christophersainsbury@kpmg.ca
KPMG in Canada

Quebec City and Montreal, Canada
Mathieu Bouchard
Senior Manager
mathieubouchard@kpmg.ca
KPMG in Canada

Toronto, Canada
Eric Wolfe
Global Infrastructure Advisory and Partner, Deal Advisory
ewolfe@kpmg.ca
KPMG International and KPMG in Canada.

Hamilton, Bermuda
Steve Woodward
Managing Director, Audit
stevewoodward@kpmg.bm
KPMG in Bermuda

Kingston, Jamaica
Raymond Campbell
Principal/Partner, Advisory
raymondcampbell@kpmg.com.jm
KPMG in Jamaica

Malé, Maldives
Mohamed Mihad
Partner, Advisory
mohamedmihad@kpmg.com
KPMG in Maldives

Port Moresby, Papa New Guinea

13

Sources

Sources

1. Seto, K. C., Churkina, G., Hsu, A., Keller, M., Newman, P. W., Qin, B., & Ramaswami, A. (2021). From low-to net-zero carbon cities: The next global agenda. Annual Review of Environment and Resources, 46(1), 377-415.
2. Fankhauser, S., Smith, S.M., Allen, M. et al. The meaning of Net zero and how to get it right. Nat. Clim. Chang. 12, 15–21 (2022)
3. Empowering Cities for a Net zero Future Unlocking resilient, smart, sustainable urban energy systems. International Energy Agency (2021) https://iea.blob.core.windows.net/assets
4. Building Sustainable Communities Blog. World Bank October 6th 2022 https://www.worldbank.org/en/topic/urbandevelopment/overview
5. 700+ cities in 53 countries now committed to halve emissions by 2030 and reach net zero by 2050. April 16th 2021 https://www.c40.org/news/cities-committed-race-to-zero/
6. Seto, K. C., Churkina, G., Hsu, A., Keller, M., Newman, P. W., Qin, B., & Ramaswami, A. (2021). From low-to net-zero carbon cities: The next global agenda. Annual Review of Environment and Resources, 46(1), 377-415.
7. Biennial Assessment and Overview of Climate Finance Flows. UNFCCC https://unfccc.int/topics/climate-finance/resources/biennial-assessment-and-overview-of-climate-finance-flows
8. Banking on cities: How to boost private investment in green urban infrastructure? Aug 11th 2022 https://citiesclimatefinance.org/news-and-events/banking-on-cities-how-to-boost-private-investment-in-green-urban-infrastructure/
9. Close, J. (2022). The Financed City. The Climate City, 376-390.
10. Lenzi, D., Jakob, M., Honegger, M., Droege, S., Heyward, J. C., & Kruger, T. (2021). Equity implications of Net zero visions. Climatic change, 169(3), 1-15.
11. Confronting Carbon Inequality. OXFAM. September 21st 2021. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621052/mb-confronting-carbon-inequality-210920-en.pdf
12. The Future of Urban Consumption in a 1.5C World by C40 Cities , ARUP and the University of Leeds. https://www.arup.com/perspectives/publications/research/section/the-future-of-urban-consumption-in-a-1-5c-world
13. Net zero by 2050: A Roadmap for the Global Energy Sector (2021) International Energy Agency. https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
14. Vergara, W., A. Deeb, I. Leino, A. Kitoh, M. Escobar (2011). Assessment of the impacts of climate change on mountain hydrology: development of a methodology through a case study in Peru. World Bank Studies, Washington, DC, USA.
15. Creating transportation systems that work for people and our planet. C40 Cities https://www.c40.org/networks/public-transit-network/
16. Transport sector CO2 emissions by mode in the Sustainable Development Scenario, 2000-2030, International Energy Agency, January 5th 2022 https://www.iea.org/data-and-statistics/charts/transport-sector-co2-emissions-by-mode-in-the-sustainable-development-scenario-2000-2030
17. 2020 Global Status Report for Buildings and Constructions: Towards a Zero Emissions and Efficient and Resilient Buildings and Construction Sector. UNEP and The Global Alliance for Buildings and Constructions. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf
18. Strategies for Improving Informal Settlements: Issue 2 (2019): University of Buffalo, Global Health Equity https://www.buffalo.edu/content/www/globalhealthequity/Resources/policy-briefs/issue-2--strategies-for-improving-informal-settlements/_jcr_content/par/download/file.res/02_Final_Policy%20Brief_Smith_NCL.pdf
19. Delivering on Sustainable Infrastructure for better Development and Climate. Amar. B et al Friday, December 23, 2016, Brookings Institute https://www.brookings.edu/wp-content/uploads/2016/12/global_122316_delivering-on-sustainable-infrastructure.pdf
20. Sharmin, Tania & Steemers, Koen & Matzarakis, Andreas. (2017). Microclimatic modelling in assessing the impact of urban geometry on urban thermal environment. Sustainable Cities and Society. 34. 10.1016/j.scs.2017.07.006.
21. What are Nature Based Solutions and How Can We Finance Them ? February 10, 2022 World Economic Forum https://www.weforum.org/agenda/2022/02/nature-based-solutions-finance-ecosystems
22. Adaptation Gap Report 2020 Fifth Edition. UNEP, UNEP DTU Partnership, World Adaptation Science Programme (WASP) https://www.unep.org/resources/adaptation-gap-report-
23. FAO 2022 Benefits of Urban Trees https://www.fao.org/3/c0024e/C0024E.pdf#:~:text=A%20tree%20can%20absorb%20up%20to%20150%20kg,with%20trees%2C%20can%20increase%20property%20values%20by%2020%25.
24. Helsinki Region Environmental Services Authority (2021) Report on the carbon storages and sinks in the Helsinki Metropolitan Region. Final report. (Selvitys pääkaupunkiseudun hiilinieluista ja varastoista. Loppuraportti). https://julkaisu.hsy.fi/selvitys-paakaupunkiseudun-hiilinieluista-ja–varastoista.pdf
25. Ariluoma M et al. (2021) Carbon sequestration and storage potential of urban green in residential yards: A case study from Helsinki. Urban Forestry & Urban Greening 57: 126939
26. World Economic Forum's Net-Zero Industry Tracker 2022 highlights the key challenges for industries August 2nd 2022 https://www.sme10x.com/10x-industry/world-economic-forums-net-zero-industry-tracker-2022-highlights-the-key-challenges-for-industries#:~:text=The%
27. World Economic Forum's Net-Zero Industry Tracker 2022 highlights the key challenges for industries August 2nd 2022 https://www.sme10x.com/10x-industry/world-economic-forums-net-zero-industry-tracker-2022-highlights-the-key-challenges-for-industries#:~:text=The%20Net-Zero%20Industry%20Tracker%202022%20highlights%20the%20need,to%20limit%20global%20warming%20to%201.5C%20by%202050.
28. Leigh. N and Hoelzel.N (2012) Smart Growths Blind Side. Journal of the American Planning Association Vol. 78 (1) pp.87-103
29. Devine-Wright, P. (2022). Decarbonisation of industrial clusters: A place-based research agenda. Energy Research & Social Science, 91, 102725.
30. S. Alnouri et al (2014) Synthesis and Design of Interplant Water Networks using Direct Recycling Techniques within Industrial Cities. Computer Aided Chemical Engineering Vol.33 pp.73-78
31. Rissman. J et al (2020) Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070. Applied Energy
32. Koop, S. H. A. and Van Leeuwen, C. J., 2016. The challenges of water, waste and climate change in cities. Environment, Development and Sustainability, DOI 10.1007/s10668-016-9760-4

Sources (continued)

33. Cosgrove, W. J., and D. P. Loucks(2015), Water management: Current and future challenges and research directions,Water Resour. Res.,51,
34. William. J (2019) Circular Cities. Urban Studies Vol.56 (3) pp. 2746-2762
35. Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Urban Development;. Washington, DC: World Bank.
36. “Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Urban Development;. Washington, DC: World Bank. World Bank. https://openknowledge.worldbank.org/handle/10986/30317
37. Accra outdoors Climate Action Plan; outlines measures to reduce greenhouse gas emissions. October 22, 2020 https://ama.gov.gh/news-details.php?n=Mjk4OTI2NW85MG4yM25zNXI0cjU2cXM2MHIzcXFzOTNvcG5uNDhzMA==
38. Cities100: Addis Ababa - Sub-Saharan Africa’s First Light-Rail Train . November 2016 https://www.c40.org/case-studies/cities100-addis-ababa-sub-saharan-africa-s-first-light-rail-train
39. AMA introduces incentive package to motivate developers to construct green buildings. August 31st 2020. Accra Metropolitan Assembly. https://www.ama.gov.gh/news-details.php?n=NzRwMG42bzRxMTRwc3I3N25xNHEzbjBzOTEzNTdvMDJzMDAyODU5MA==
40. Cities100: Addis Ababa - Sub-Saharan Africa’s First Light-Rail Train . November 2016 https://www.c40.org/case-studies/cities100-addis-ababa-sub-saharan-africa-s-first-light-rail-train/
41. Reppie in Addis Ababa, Ethiopia: The first waste-to-energy facility on the African continent https://ramboll.com/projects/re/reppie-in-addis-ababa-ethiopia-first-waste-to-energy-facility-african-continent
42. Waste-to-energy to transform Ethiopia’s energy outlook By Babalwa Bungane Nov 28, 2017 https://www.esi-africa.com/renewable-energy/reppie-waste-to-energy-plant-ethiopias/
43. Summary of EGEDK (Alexandria Port) https://www.seabaycargo.com/seaport/detail/Alexandria-New_Egypt_EGEDK.html
44. First international environmentally friendly sustainable project planned in Alexandria by Al-Masry Al-Youm. August 24th 2022. https://egyptindependent.com/first-international-environmentally-friendly-sustainable-project-planned-in-alexandria/#:~:text=On%20Thursday%2C%20Alexandria%20is%20witnessing%20the%20inauguration%20of,give%20global%20attention%20to%20sustainable%20environmentally%20friendly%20projects.
45. First international environmentally friendly sustainable project planned in Alexandria by Al-Masry Al-Youm. August 24th 2022. https://egyptindependent.com/first-international-environmentally-friendly-sustainable-project-planned-in-alexandria/#:~:text=On%20Thursday%2C%20Alexandria%20is%20witnessing%20the%20inauguration%20of,give%20global%20attention%20to%20sustainable%20environmentally%20friendly%20projects.
46. The Amman Climate Action Plan. A Vision for 2050 Amman. 2019 Greater Amman Municipality. https://www.ammancity.gov.jo/site_doc/climate.pdf
47. Devonald, M., Jones, N., & Yadete, W. (2020). The first thing that I fear for my future is lack of rain and drought’: Climate change and its impacts on adolescent capabilities in low-and middle-income countries. Gender and Adolescence: Global Evidence: London, UK.
48. Electricty generation project inaugurated at Ghabawi landfill by the Jordan Times . July 2nd 2019. https://jordantimes.com/news/local/electricity-generation-project-inaugurated-ghabawi-landfill
49. Policy: Sustainability and energy. City of Amsterdam https://www.amsterdam.nl/en/policy/sustainability/
50. Amsterdam’s goal is to achieve a 55% reduction in emissions by 2030, and a 95% reduction of emissions by 2050. https://carbonneutralcities.org/cities/amsterdam/
51. Towards a Circular Economy in Amsterdam https://journey.circleeconomy.com/circularamsterdam#156340
52. What on Earth is the Doughnut? By Kate Raworth https://www.kateraworth.com/doughnut/
53. Amsterdam Climate And Energy Fund. https://www.e3partners.nl/en/funds/amsterdam-climate-and-energy-fund/
54. Amsterdam Circular 2020-2025 Strategy https://assets.amsterdam.nl/publish/pages/867635/amsterdam-circular-2020-2025_strategy.pdf
55. City of Atlanta Climate Action Plan July 23 2015 https://ccwgsmartcities.lbl.gov/sites/all/files/action-plans/atlanta-climate-action-plan-07-23-2015.pdf
56. Atlanta Better Buildings Challenge. 2017 Top Performers https://www.atlantabbc.com/2017-top-performers-all/
57. MARTA announces launch of electric buses. April 25th 2022 https://www.masstransitmag.com/bus/vehicles/hybrid-hydrogen-electric-vehicles/press-release/21265341/metropolitan-atlanta-rapid-transit-authority-marta-marta-announces-launch-of-electric-buses
58. This Is Not A Drill. Climate Emergency Declaration 15th January 2020. Barcelona. Ajuntament de Barcelona. https://www.barcelona.cat/emergenciaclimatica/sites/default/files/2020-07/Climate_Emergency_Declaration_en.pdf
59. Ecology. Urban Planning, Infrastructures and Mobility https://ajuntament.barcelona.cat/ecologiaurbana/en/zero-waste/zero-waste-strategy
60. Beijing unveils new EV subsidy program to boost sales after pandemic by Technode Feed June 27th 2022 https://technode.com/2022/06/27/beijing-unveils-new-ev-subsidy-program-to-boost-sales-after-pandemic/
61. Liu, Z., Jia, X., & Cheng, W. (2012). Solving the last mile problem: Ensure the success of public bicycle system in Beijing. Procedia-Social and Behavioral Sciences, 43, 73-78.
62. Beijing unveils new EV subsidy program to boost sales after pandemic by Technode Feed June 27th 2022 https://technode.com/2022/06/27/beijing-unveils-new-ev-subsidy-program-to-boost-sales-after-pandemic
63. Johnson Controls AI-enhanced OpenBlue platform cuts the Microsoft Beijing Campus energy footprint. August 20th 2022 https://www.missioncriticalmagazine.com/articles/94227-johnson-controls-ai-enhanced-openblue-platform-cuts-the-microsoft-beijing-campus-energy-footprint
64. BiciCarga ¿Qué es? https://www.movilidadbogota.gov.co/web/galeria/
65. New climate strategy for Budapest – car use to be reduced to 30% of all traffic by Gabor Wagner April 6th 2021 https://welovebudapest.com/en/article/2021/4/6/budapest-new-climate-strategy-for-budapest-car-use-reduced

Sources (continued)

66. Budapest - NBS for climate resilience and pollution control. https://oppla.eu/budapest-nbs-climate-resilience-and-pollution-control
67. MOL Bubi reloaded! https://molbubi.hu/en/
68. Argentina May be the Hottest Renewable Energy Market You Haven't Hear of ? Can It Spur a Global Boom, October 15th 2019, Silvio Maracci .Forbes https://www.forbes.com/sites/energyinnovation/2019/10/15/argentina-may-be-the-hottest-renewable-energy-market-you-havent-heard-of-can-it-spur-a-global-boom/?sh=7ce82271eeb2
69. Climate Action Plan 2050. City of Buenos Aires. Executive Summary . April 2021 https://www.buenosaires.gob.ar/sites/gcaba/files/pac_resumen_ejecutivo_eng_0.pdf
70. Solar Energy Provides Hope for Poor Neighbourhoods in Buenos Aires. February 19th 2019 . https://cpnn-world.org/new/?p=15185
71. Alaa Abbass R, Kumar P, El-Gendy A. Emissions Control Scenarios for Transport in Greater Cairo. Toxics. 2021 Nov 1;9(11):285.
72. Cairo Cleaning and Beautification Authority. Official Portal of Cairo Governate . http://www.cairo.gov.eg/en/Pages/AuthoritesDetails.aspx?AuID=4
73. Egypt - Greater Cairo Air Pollution Management and Climate Change Project (English). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/788691601776867710/Egypt-Greater-Cairo-Air-Pollution-Management-and-Climate-Change-Project
74. City of Capetown Climate Change Action Plan (2021) https://resource.capetown.gov.za/documentcentre/Documents/City strategies, plans and frameworks/CCT_Climate_Change_Action_Plan.pdf
75. Cities100: Cape Town - Building Trust in Solar Water Heating. October 2015 https://www.c40.org/case-studies/cities100-cape-town-building-trust-in-solar-water-heating
76. Ceiling Retrofitting Programme: Cape Town, South Africa. ERBD Green Cities Policy Tool. https://www.ebrdgreencities.com/policy-tool/ceiling-retrofitting-programme-cape-town-south-africa/
77. 2022 CAP. Chicago Climate Action Plan. https://www.chicago.gov/content/dam/city/sites/climate-action-plan/documents/Chicago-CAP-071822.pdf
78. 2021 Waste Strategy. City of Chicago https://www.chicago.gov/city/en/progs/env/2021-waste-strategy.html
79. Green Growth Pathways in Senegal. https://gggi.org/project/green-growth-pathways-in-senegal/
80. Dakar: creating micro-gardens using recycled materials. By FAO, ESta, Municipality of Dakar (2018) https://www.fao.org/urban-food-actions/resources/resources-detail/en/c/1147049/)
81. Scaling up waste action. Dakar, Senegal. https://www.ccacoalition.org/en/partners/dakar-senegal
82. Dubai Municipality and MBRSC to launch region's first environmental nanometric satellite on March 20. Gulfnews . March 11th 2021 https://www.utias-sfl.net/?p=3556
83. Dubai Building Code (DBC). Government of Dubai. https://www.dm.gov.ae/municipality-business/planning-and-construction/dubai-building-code-2/
84. Al Sa'fat – Dubai Green Building System. Government of Dubai. https://www.dm.gov.ae/municipality-business/al-safat-dubai-green-building-system/
85. DÜSSELDORF LAUNCHES NEW "CARGO BIKE AUTOMAT" April 6th 2022 https://mayorsofeurope.eu/news/dusseldorf-launches-new-cargo-bike-automat/
86. Rheinbahn. https://www.rheinbahn.de/
87. Hamburg's new climate plan and new climate protection law. December 5th 2019. https://sdg21.eu/en/blog-2/new-climate-plan-and-new-climate-protection-law-for-hamburg
88. Hamburg to power district heating with 60-MW wastewater heat pump by Anna Ivanova September 3rd 2022. https://renewablesnow.com/news/hamburg-to-power-district-heating-with-60-mw-wastewater-heat-pump-799005/
89. Zukunftstaxi. https://www.hamburg.com/zukunftstaxi
90. Viscide.L et al (2020) Electrified Islands: The Road to E-Mobility in the Caribbean. Inter- American Dialogue, Inter – American Development Bank
91. Green Initiatives For City's Wastewater Treatment by City of Hamilton. November 10th 2020 https://www.cityofhamilton.bm/news_detail_T9_R128.php
92. Chapter 4 Decarbonisation Strategies, Targets and Actions, Hong Kong's Climate Climate Action Plan 2050. October 2021. https://www.climateready.gov.hk/files/pdf/CAP2050_booklet_en.pdf
93. Chapter 4 Decarbonisation Strategies, Targets and Actions, Hong Kong's Climate Climate Action Plan 2050. October 2021. https://www.climateready.gov.hk/files/pdf/CAP2050_booklet_en.pdf
94. Hong Kong: The Facts. Transport https://www.td.gov.hk/en/home/index.html
95. Solar Power System. https://www.hkelectric.com/en/our-operations/solar-power-system
96. Solar Power System. https://www.hkelectric.com/en/our-operations/solar-power-system
97. 'Jeddah region's most environmentally sustainable city' Saudi Gazzette. February 10th 2015. https://english.alarabiya.net/News/middle-east/2015/02/10/-Jeddah-region-s-most-environmentally-sustainable-city-#:~:text=The%20Bride%20of%20the%20Red%20Sea%20is%20the,natural%20and%20build%20asset%20design%20and%20consultancy%20firm.
98. A Sustainable Saudi Vision. https://www.vision2030.gov.sa/v2030/a-sustainable-saudi-vision/
99. Aljoufie, M., & Tiwari, A. (2015). Climate change adaptions for urban water infrastructure in Jeddah, Kingdom of Saudi Arabia. Journal of Sustainable Development, 8(3), 52.
100. Aljoufie, M., & Tiwari, A. (2015). Climate change adaptions for urban water infrastructure in Jeddah, Kingdom of Saudi Arabia. Journal of Sustainable Development, 8(3), 52.
101. Abaza, M., Mesleh, R., Mansour, A., & Aggoune, E. H. M. (2013, December). Spatial diversity and multi hop in FSO communication over turbulence channels. In 2nd symposium on wireless sensor and cellular networks (WSCN'13), Jeddah, Saudi Arabia (pp. 13-16).
102. Circular Carbon Economy National Program https://www.cce.org.sa/
103. Jeddah hosts first eco-friendly electric vehicle charging plant in Saudi Arabia Maryam al-Jaber, Al Arabiya English. October 31st 2018. https://english.alarabiya.net/business/technology/2018/10/31/Jeddah-hosts-first-eco-friendly-electric-vehicle-charging-plant-in-Saudi-Arabia

Sources (continued)

104. Shuaibah III Expansion II desalination plant was inaugurated in Saudi Arabia. Fisia italimpianti July 25th 2019 https://www.fisiait.com/en/media/news-press-releases/news/shuaibah-iii-expansion-ii-desalination-plant-was-inaugurated-in-saudi-arabia.html
105. Import duty reduced, licence fee removed for electric vehicles. The Bleaner July 20th 2022 https://jamaica-gleaner.com/article/news/20220720/import-duty-reduced-licence-fee-removed-electric-vehicles#:~:text=The%20import%20duty%20on%20electric%20vehicles%20has%20been,vehicle%20licence%20fees%20over%20the%20next%20five%20years
106. Solar Panel Loan. National Housing Trust. https://nht.gov.jm/loans/need-a-loan/solar-panel https://nht.gov.jm/loans/need-a-loan/solar-panel
107. Solar Energy Ideal Option for Many Jamaicans by Latonya Linton. March 30th 2012 https://jis.gov.jm/solar-energy-ideal-option-for-many-jamaicans/
108. Lagos Climate Action Plan. Second Five Year Plan 2020- 2050 . Lagos State Government, Ministry of Environment and Water Resources. https://moelagos.gov.ng/wp-content/uploads/2021/09/C40-Lagos_Indesign-Document-Full-Report-Revert-2_Update-2.pdf
109. Lagos Climate Action Plan. Second Five Year Plan 2020- 2050 . Lagos State Government, Ministry of Environment and Water Resources. https://moelagos.gov.ng/wp-content/uploads/2021/09/C40-Lagos_Indesign-Document-Full-Report-Revert-2_Update-2.pdf
110. Oando partners Lagos on mass transit by Bertram Nwannekanma. June 7th 2022. https://guardian.ng/news/oando-partners-lagos-on-mass-transit/
111. Lagos' Building Code and Regulation by Rasak Musbau. July 4th 2018. https://lagosstate.gov.ng/blog/2018/07/04/lagos-building-code-and-regulation/
112. Buildings account for 40% of greenhouse emissions' by Pia Lee-Brago. January 3rd 2019 https://www.philstar.com/business/science-and-environment/2019/01/03/1881751/buildings-account-40-greenhouse-emissions
113. Life Lungs. https://life-lungs.lisboa.pt/en/
114. Retrofit cuts energy use by 36 percent at Lisbon's City Hall by Sarah Wray. June 23rd 2020 https://cities-today.com/retrofit-cuts-energy-use-by-36-percent-at-lisbons-city-hall/
115. Analysis of a Net Zero 2030 Target for Greater London. Final Report for Greater London Authority. January 18th 2022 https://www.london.gov.uk/sites/default/files/nz2030_element_energy_final.pdf
116. London's consumption based greenhouse gas emissions 2001-2018. Greater London Authority . https://data.london.gov.uk/dataset/london-s-consumption-based-greenhouse-gas-emissions-2001-2018 -2018 - Londo
117. Be seen' energy monitoring guidance. London Assembly https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/london-plan-guidance/be-seen-energy-monitoring-guidance
118. Solar Power plant in Luanda, Angola. JGH Solar. https://jgh-group.com/project/solar-power-plant-in-luanda-angola/
119. There's no higher ground for us': Maldives' environment minister says country risks disappearing by Karen Gilchrist. May 18th 2021 CNBC https://www.cnbc.com/2021/05/19/maldives-calls-for-urgent-action-to-end-climate-change-sea-level-rise.html
120. President Solih States That Maldives Can Reach Net Zero Emissions by 2030 With International Support. December 20th 2020 https://visitmaldives.com/en/news/president-solih-states-that-maldives-can-reach-net-zero-emissions-by-2030-with-international-support#:~:text=During%20the%20United%20Nations%20Climate%20Ambition%20Summit%20held,emissions%20as%20early%20as%202030%20with%20international%20aid
121. The ASPIRE Project: De-risking solar projects to catalyze private investment in the Maldives. March 31st 2022https://www.worldbank.org/en/results/2021/03/31/derisking-solar-projects-to-catalyze-private-investment-in-maldives
122. Tres entidades nacionales y el Metro de Medellín firman contrato para la financiación del Metro de la 80. April 1. 2022. Alcadia de Medellin. https://www.medellin.gov.co/es/sala-de-prensa/noticias/tres-entidades-nacionales-y-el-metro-de-medellin-firman-contrato-para-la-financiacion-del-metro-de-la-80/
123. Electric Stairs of the 13. Medellin Tips https://medellin.tips/en/electric-stairs-of-the-13/
124. Over 90% of Uruguay's electricity from clean energy by Joe Mellor. April 12th 2015 https://www.thelondoneconomic.com/news/over90ofuruguayselectricityfromcleanenergy-21735/
125. Hacia una Movilidad Eficiente y Sostenible en Uruguay. Moves. https://moves.gub.uy/
126. Uruguay's Sovereign Sustainability-Linked Bond Framework Second-Party Opinion (2022) https://mstar-sustops-cdn-mainwebsite-s3.s3.amazonaws.com/docs/default-source/spos/uruguay-s-sovereign-sustainability-linked-bond-second-party-opinion.pdf?sfvrsn=ce3626a2_1
127. New funding for green infrastructure projects in Quebec. Government of Canada. January 14th 2019 https://www.canada.ca/en/office-infrastructure/news/2019/01/new-funding-for-green-infrastructure-projects-in-quebec.html
128. Climate Plan 2021-2030. Montreal 2030. https://portailm4s.s3.montreal.ca/pdf/climate_plan_2020_2030_vdm.pdf
129. Rénoclimat. Quebec. https://transitionenergetique.gouv.qc.ca/en/residential/programs/renoclimat
130. Khatri, S., Kokane, P., Kumar, V., & Pawar, S. (2022). Prediction of waterlogged zones under heavy rainfall conditions using machine learning and GIS tools: a case study of Mumbai. GeoJournal, 1-15.
131. Climate Action Plan 2022 . Towards a Climate Resilient Mumbai. Summary for Policymakers. https://drive.google.com/file/d/1KRgfTrpm6fMpo1h2b-Ydlh4TRdXRmWyG/view
132. Maharashtra: Subsidy for residential users to opt for rooftop solar power. September 1st 2021. https://content.magicbricks.com/property-news/other-cities/maharashtra-subsidy-for-residential-users-to-opt-for-rooftop-solar-power/123918.html#:~:text=The%20Union%20government%20is%20providing%20a%2040%25%20subsidy,Maharashtra%20State%20Electricity%20Distribution%20Company%20Ltd%20(MSEDCL)%20said.
133. Mumbai gets India's first EV charging station powered by food waste by Express News Service. May 10th 2022. https://indianexpress.com/article/cities/mumbai/countrys-first-organic-waste-powered-ev-charging-station-inaugurated-in-mumbai-7908869/
134. Munich Net Zero. Global Community Shapers Munich. https://globalshapersmunich.org/munich-net-zero

Sources (continued)

135. Munich to buy 40 electric buses. First 4 come from Ebusco. October 18th 2018. https://www.sustainable-bus.com/news/munich-to-buy-40-electric-bus-first-order-from-ebusco/
136. E-Scooter Sharing Has Arrived in Munich! Here's How to Use It. https://boredinmunich.com/e-scooter-sharing-has-arrived-in-munich-heres-how-to-use-it/
137. Nairobi City Climate Action 2021. Daily Nation. October 29th 2021. https://cdn.nation.co.ke/downloads/Nairobi-City-Climate-Action-2021.pdf
138. Environment Energy Water and sanitation. Nairobi City County. https://nairobi.go.ke/environment-energy-water-and-sanitation/
139. Domestic Efficient Lighting Program (DELP). Government of NCT in Delhi. http://www.web.delhi.gov.in/wps/wcm/connect/doit_eerem/EEREM/Home/Initiatives+Achievements/
140. Urban Mobility Lab: A Gathering of EV Innovators across Government and Industry. Government of NCT in Delhi https://ddc.delhi.gov.in/our-work/6/urban-mobility-lab
141. Switch Delhi - Find a charging station near to Making Delhi the EV capital of India . Switch Delhi. https://ev.delhi.gov.in/u
142. Local Law 97 Implementation Action Plan. New York City. NYC Local Law 97 Compliance – Local Law 97 Compliance Services (nyll97.com)
143. Local Law 97 Implementation Action Plan. New York City. NYC Local Law 97 Compliance – Local Law 97 Compliance Services (nyll97.com)
144. What Is the True Cost of Living in New York City? By Nick Wallace. April 6th 2022 https://smartasset.com/mortgage/what-is-the-cost-of-living-in-new-york-city
145. NYC Solar Schools Education Program 2022-2023 https://thegreendesignlab.org/nyc-solar-schools-education/

City of Oslo . https://www.oslo.kommune.no/english/

146. Panama. https://www.forestcarbonpartnership.org/country/panama https://www.forestcarbonpartnership.org/country/panama
147. Panama Canal Authority Launches Decarbonization Plan, Targets 2030 Carbon Neutrality by Tom. June 22, 2021 https://panamaadvisoryinternationalgroup.com/blog/news-from-panama/panama-canal-authority-launches-decarbonization-plan-targets-2030-carbon-neutrality/#:~:text=The%20Panama%20Canal%20Authority%20announced%20April%2026%20it,with%20the%20goal%20of%20becoming%20carbon-neutral%20by%202030
148. Le Plan Climat Air Energie : une stratégie globale pour le climat à Paris by Agence Parisienne du Climat. January 23rd 2019. https://www.apc-paris.com/Plan-climat
149. Grand Paris Circulaire. https://www.grandpariscirculaire.org/
150. Kiele, R., Miria, G., & Joel, E. (2022). Vulnerability and Risk Assessment of the Port Moresby (Papua New Guinea) Coastline—A Case Study. In Planning Climate Smart and Wise Cities (pp. 165-190). Springer, Cham
151. Trash Tag Challenge: Plastics a Major Issue by Lillian Keneqa. March 31st 2019. https://emtv.com.pg/plastic-is-an-issue/
152. Pilot biogas system installed in Rio de Janeiro, Brazil by Erin Voegele . January 11th 2019. https://biomassmagazine.com/articles/15872/pilot-biogas-system-installed-in-rio-de-janeiro-brazil
153. Santiago Biofactory | Chile . UNFCCC https://unfccc.int/climate-action/un-global-climate-action-awards/planetary-health/santiago-biofactory-chile
154. Singapore a City in a Garden – A model for creating an integrated urban green walking network . October 2020. https://naturalwalkingcities.com/singapore-a-city-in-a-garden-a-model-for-creating-an-integrated-urban-green-walking-network/#:~:text=1%20Park%20Connector%20Network%20and%20green%20walking%20corridors%3A,is%20then%20incorporated%20into%20walking%20networks.%20More%20items
155. Singapore a City in a Garden – A model for creating an integrated urban green walking network . October 2020. https://naturalwalkingcities.com/singapore-a-city-in-a-garden-a-model-for-creating-an-integrated-urban-green-walking-network/#:~:text=1%20Park%20Connector%20Network%20and%20green%20walking%20corridors%3A,is%20then%20incorporated%20into%20walking%20networks.%20More%20items
156. Public Transport Utilisation - Average Daily Public Transport Ridership. https://data.gov.sg/dataset/public-transport-utilisation-average-public-transport-ridership
157. How can we improve household recycling? Recycle Right Citizens' Workgroup. https://www.towardszerowaste.gov.sg/citizens_workgroup/
158. Environmental strategy 2021-2025 . City of Sydney. July 27th 2021 https://www.cityofsydney.nsw.gov.au/strategies-action-plans/environmental-strategy
159. Food scraps recycling trial . City of Sydney. https://www.cityofsydney.nsw.gov.au/environmental-support-funding/food-scraps-recycling-trial
160. Tel Aviv Yafo . Climate Adaptation Plan 2020. https://www.tel-aviv.gov.il/en/Documents/Climate%20Adaptation%20Action%20Plan.pdf
161. Giant compost machine christened in Tel Aviv. Jerusalem Post. October 23rd 2011. https://www.jpost.com/israel-news/giant-compost-machine-christened-in-tel-aviv-682858
162. TransformTO . City of Toronto. https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/
163. Toronto Green Standard . City of Toronto. https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/
164. City of Toronto launches waste reduction program for businesses . June 13th 2022 https://www.toronto.ca/news/city-of-toronto-launches-waste-reduction-program-for-businesses/#:~:text=Today%2C%20the%20City%20of%20Toronto%20is%20taking%20a,the%20City%E2%80%99s%20Single-Use%20and%20Takeaway%20Items%20Reduction%20Strategy.
165. Climate Emergency. Action Summary Plan 2020- 2050. City of Vancouver. https://vancouver.ca/files/cov/climate-emergency-action-plan-summary.pdf
166. CleanBC Indigenous Community Heat Pump Incentive . Clean BC Better Homes. https://betterhomesbc.ca/rebates/icec-offer/
167. Smart Climate City Strategy Vienna –Our way to becoming a model climate city . Vienna https://smartcity.wien.gv.at/en/strategy/#:~:text=The%20Smart%20Climate%20City%20Strategy%20Vienna%20is%20the,way%20to%20becoming%20a%20model%20climate%20city%20tangible.
168. Viertel Zwei. https://www.viertel-zwei.at/en/home

Sources (continued)

169. Vienna Opens First Hydrogen Station with Promise to Become Austria's Central Hydrogen Hub . Hydrogen Central . December 13th 2021. https://hydrogen-central.com/vienna-first-hydrogen-station-austris-central-hydrogen-hub/
170. Warsaw 2030 Strategy.https://um.warszawa.pl/documents/56602/38746844/%23Warsaw2030+Strategy.pdf/8845940c-99df-aca4-1a03-524adafe4f63?t=1639549741334
171. Warsaw. https://www.c40.org/cities/warsaw
172. Warsaw Public Bike . Veturilo. https://veturilo.waw.pl/en/
173. Quantifying the greenness of global cities. https://www.hugsi.green/
174. Circular Economy. UNCTAD https://unctad.org/topic/trade-and-environment/circular-economy
175. What's the Difference Between Water Use and Water Consumption? By Paul Reig. March 12th 2013.https://www.wri.org/insights/whats-difference-between-water-use-and-water-consumption#:~:text=%E2%80%9CWater%20consumption%E2%80%9D%20is%20the%20portion,no%20longer%20available%20for%20reuse

kpmg.com/socialmedia

Document Classification: KPMG Public