

# CIRCULAR CITIES

IMPACTS ON DECARBONIZATION AND BEYOND

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PRELIMINARY STUDY

With the scientific contribution of





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# Introduction

Cities generate around 70% of global carbon emissions, account for over 60% of resource use<sup>1</sup> and produce 50% of global waste<sup>2</sup>. Considering that by 2050 about two thirds of the world's population will live in cities<sup>3</sup>, they will play a key role in addressing the effects of climate change.

Building on a history of joint research in the field of the circular economy, climate change and cities, Arup, Enel and the Enel Foundation have collaborated on a research project with Bocconi University in Milan (Italy), Universidad de los Andes in Bogota (Colombia) and University of Genoa (Italy) to evaluate the impact of adopting circular economy principles on cities in terms of emissions (including consumption based emissions), quality of life, and resilience.

To prove these hypotheses and to provide relevant evidence-based recommendations to city leaders, we have used qualitative as well as quantitative modeling methods to assess the potential scale of impact of interventions in three focus sectors: Built Environment, Mobility and Energy Systems. The project also contextualizes these interventions in four cities - Bogota, Genoa, Glasgow, and Milan.



The research is structured in two parts. The first involves qualitative research focusing on the key interventions per sector as well as city-based case studies. The second features a quantitative assessment of the decarbonization impact of each intervention and their prioritization. It also contextualizes the interventions for each focus city. This report, which is being launched at Pre-COP26 Milan, presents the key evidence from the research. Further research outcomes will be presented during COP26 in Glasgow in order to provide useful guidance for city leaders and policymakers.

<sup>&</sup>lt;sup>1</sup> https://www.un.org/sustainabledevelopment/cities/

<sup>&</sup>lt;sup>2</sup> https://www.oecd.org/cfe/regionaldevelopment/circular-economy-cities.htm

<sup>&</sup>lt;sup>3</sup> https://www.worldbank.org/en/topic/urbandevelopment/overview



# The role of cities in a circular economy

Cities must play a key role in accelerating the transition from a linear to a circular economic model. Cities have always been crucial economic growth engines, and as such they are major contributors to climate change. UN Habitat estimates that cities today consume about 78% of global energy and account for more than 60% of global carbon dioxide (CO<sub>2</sub>) emissions. With a projected additional 2.5 billion people moving to cities by 2050, these numbers are critical<sup>4</sup>. At the same time, however, cities have always been spaces for innovation, new thinking and action. As such, they need to be the focus of immediate and direct climate action.

The established linear economic model geared to continuous growth has long been regarded as an immutable principle at the basis of the prosperity of our society. It has indeed created material abundance for many, but at the same time its dramatic negative effects on natural systems and the environment are evident. Linear logic has brought our climate and Earth's natural systems to severe tipping points: once crossed, they will lead to irreversible and highly unpredictable domino effects.

The latest IPCC report indicates that the average global temperature has risen more rapidly since the 1970s than over the previous 2000 years<sup>5</sup>. Scientists are concerned that temperatures as well as extreme weather events are increasing at an even faster speed than previously assumed, so that cities are shifting their focus to climate adaptation strategies.

<sup>&</sup>lt;sup>4</sup> https://www.un.org/en/climatechange/climate-solutions/cities-pollution

<sup>&</sup>lt;sup>5</sup> https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC\_AR6\_WGI\_Full\_Report.pdf

The 2020s therefore are a critical decade for the future of our planet. At COP21 in 2015, commitments were made within the Paris Agreement as a global framework to stop climate change and set the goal to limit global warming to well below 2, and preferably to 1.5 degrees Celsius above pre-industrial levels. The urgency for climate action has gained notable momentum, which is fundamental as climate stabilization requires a strong, rapid, and sustained reduction in emissions<sup>6</sup>. Social movements such as Fridays for Future have given a significant further impetus and urgency to critical reflection on the vulnerability of our existence on planet Earth, and to the question of how to conceive a more resilient and sustainable future.

The journey to net zero goes beyond decarbonization measures: it requires a holistic systems transformation. A crucial step is the shift from the entrenched linear economic model based on a take-make-waste principle to circularity. The Ellen MacArthur Foundation (EMF) estimates that transitioning to a circular economy would contribute to the 45% decrease in GHGs needed to achieve net zero.<sup>7</sup> According to the EMF, a circular economy requires a redefinition of growth, the decoupling of economic activities from the consumption of finite resources, and the generation of economic, natural, and social capital in an even way.<sup>8</sup>



- <sup>7</sup> Completing The Picture How The Circular Economy Tackles Climate Change E: Macarthur Foundation 2019 https://emf.thirdlight.com/link/2j2gtyion7ia-n3q5ey/@/preview/1
- <sup>8</sup> https://www.ellenmacarthurfoundation.org/circular-economy/concept

<sup>&</sup>lt;sup>6</sup> https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/



# Focus of the study

This study focuses on the cities of Bogota, Genoa, Glasgow and Milan across three sectors: Mobility, Built Environment, and Energy Systems.

The aims of the study are:

- **1**. To provide evidence that cities must adopt circular economy principles if they are to unlock their full potential to mitigate GHG emissions.
- To understand which specific decarbonization and circular economy-related interventions, and their related scale, public and private stakeholders should prioritize and act on.
- **3.** To understand the wider benefits that result from systemic circular change in terms of resilience and quality of life.
- **4**. To identify the critical success factors, levers and actions that enable public and private stakeholders to accelerate urgently needed change across sectors.
- 5. To provide evidence-based recommendations to city leaders and main decision-makers.

Relevant studies have shown that adopting material efficiency strategies can help reduce life cycle emissions in G7 countries by 40% in the housing sector and by up to 40% in the mobility sector<sup>9</sup>.

Regardless of the sector, this data implies that identifying and implementing high-impact interventions requires a systematic view of the entirety of all value and supply chains.

# Four global cities in focus

Four cities have been chosen to provide evidence-based demonstrations of how circular economy principles can unlock ecological, economic and social potential. Both Milan (a C40 city) and Glasgow, which are hosting pre-COP and COP26, have set ambitious circular economy agendas. Genoa has undertaken a substantial urban redesign process that is partly based on circular economy principles, while Bogota (also a C40 city) is a pioneer in South America.

- <sup>10</sup> https://bogota.gov.co/mi-ciudad/ambiente/abece-del-plan-de-accion-climatica
- <sup>11</sup> http://www.comune.genova.it/content/secap
- <sup>12</sup> https://carbonneutralcities.org/cities/glasgow/
- <sup>13</sup> https://www.covenantofmayors.eu/about/covenant-community/signatories.html
- <sup>14</sup> https://climate-adapt.eea.europa.eu/eu-adaptation-policy/covenant-of-mayors

#### BOGOTA

Bogota is a frontrunner city in South America, setting ambitious climate targets and a 30-year roadmap to reach them. Under its 2020-2050 Climate Action Plan (PAC 2020-2050) developed by the Mayor's Office, Bogota aims to reduce its GHG emissions by 15% by 2024 and by up to 50% by 2030, achieving carbon neutrality by 2050.<sup>10</sup>

### GLASGOW

In 2019, the city of Glasgow announced that it set a target to become carbon neutral by 2030. This implies reducing GHG emissions by 37% as of 2018 compared to 2006. At the same time, the city set an economic growth target of up to 21% compared to 2010.<sup>12</sup>

## GENOA

In line with European 2030 objectives, the Municipality of Genoa has implemented a Sustainable Energy and Climate Action Plan (SECAP) to reduce GHG emissions by 40%, inject a 32% share of renewables into its energy mix, and improve its energy efficiency by at least 32.5%.<sup>11</sup>

## MILAN

In order to accelerate its urban decarbonization process, Milan in 2017 joined the C40 Deadline 2020 program, pledging to become a carbon neutral city by 2050. It also joined the EU Covenant of Mayors in 2008<sup>13</sup> and in 2019, pledging to accelerate the transformation needed to achieve the EU 40% GHG reduction targets by 2030 and to adopt climate change adaptation strategies.<sup>14</sup>

# Focus sector definitions

This study focuses on three major sectors, which were chosen because of the dominant impact of their global emissions in the aggregate, and because they are implicitly linked, both in terms of their current emissions and of the solutions required to decarbonize them and cities in general.<sup>15</sup> An overview of the boundaries, in simple terms, is set out below:

### MOBILITY

The mobility sector analysis looks at emissions from the manufacture, maintenance and disposal of vehicles (Scope 3), and direct emissions from the operation of vehicles (Scope 1) in each of the four cities.



**BUILT ENVIRONMENT** 

The built environment sector analysis considers emissions related to the construction of buildings, transportation and other physical infrastructure (Scope 3), and the direct (Scope 1) emissions from the operation of that infrastructure and from any associated supply chains (e.g. the production and distribution of natural gas consumed in the city).

#### **ENERGY SYSTEMS**

The energy system sector analysis focuses on electricity consumption (Scope 2) emissions associated with the operation of each city, including buildings, infrastructure and electric vehicles. This is because shifting to renewable energy coupled with electrification is the strongest lever to achieve sustainable development.<sup>15</sup> The study also considers supply chain emissions associated with the production and distribution of the electricity consumed in each city, and the manufacture (Scope 3) of products that generate, distribute and run on electricity, such as lighting, highway signaling equipment and household appliances.

<sup>15</sup> European Commission Impact Assessment accompanying the communication on the 2030 Climate Target Plan (September 2020)

For the purpose of this study Scope 1, Scope 2 and Scope 3 are defined as follows:

SCOPE 1: GHG emissions from sources located within the city boundary

SCOPE 2: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary SCOPE 3: All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

# Unlocking zero emissions with circular interventions

This study was carried out in two phases in collaboration with three global universities. The first part consists of qualitative research based on semi-structured interviews with stakeholders from the private and public sectors, NGOs and city leaders. The purpose of the interviews was to inform elements of the study related to key interventions per sector as well as city-based case studies.

The second part of the study comprises a quantitative analysis focused on a consumption-based calculation for Scope 1 and 2 emissions as well as an Input-Output Analysis (IOA) for Scope 3 supply chain emissions. Please refer to the appendix for a more detailed description.

In looking at the three focus sectors – Mobility, Built Environment and Energy Systems – we find significant opportunities to reduce consumption-based emissions and unlock wider benefits, such as increasing quality of life for residents and increasing cities' resilience.

An extensive literature review as well as stakeholder interviews were carried out for each city in order to understand its ongoing initiatives, programs and interventions in terms of decarbonization. The following set of interventions are based on circular economy principles and are designed to unlock additional decarbonization effects or even create additional value by focusing on the nexus of the three sectors, which cannot be separated from one other.





Mobility is a key component of urban life and economy, and it generates relevant pressures including air and noise pollution and GHG emissions. Rethinking mobility from a decarbonized and circular perspective implies a reflection on the overall impacts of different mobility options along their entire value chain, as well as finding new models that overcome the traditional dependence on individual car ownership and fossil fuels. The COVID-19 crisis has also shown the potential of remote/flexible work models and their impacts on mobility patterns.

In coherence with these goals eight main interventions have been identified.

INTERVENTION	SUMMARY
Modal shift	Switching from individual car use to sustainable modes including walking, cycling, micro-mobility, public transportation.
Fleet renovation	It implies renovating the private/public vehicle fleet by substituting existing vehicles with more efficient ones.
Electrification of transport	Switching from traditional fossil fuels to electricity and green hydrogen.
Vehicle sharing and pooling	It implies that fewer vehicles are required to provide the same mobility services.
Circular design in vehicle manufacturing	Using low carbon, recycled and renewable (e.g. bio-based) materials in the manufacturing of vehicles; designing vehicles in order to maximize disassembly and the recovery rate (with particular focus on batteries), as well as using less material by optimizing vehicle design.
Recover, reuse, repurpose of materials	Promoting the recovery of vehicle parts/components.
Extend material life	Extending the average lifespan of vehicles, by designing them in a more efficient way and in order to be more durable (production-side)/enhancing their maintenance and repair (consumer-side).
Promote flexible work models	It implies reducing the mobility needs and optimizing commuting times for workers through remote-working or flexible-working models.



The built environment sector considers emissions associated with the construction of physical infrastructure within city boundaries. This includes buildings and transportation infrastructure, as well as their operation and supply chain emissions. Five key interventions have been identified and are consistent with key literature sources such as the recent UNIRP report focusing on material efficiency strategies.<sup>16</sup> In line with the European 9R Framework the interventions have been prioritized according to their scale of impact on GHG emissions.

The following table summarizes these key interventions and indicates their chief contributions.

INTERVENTION	SUMMARY
Enhance building use and occupancy	Fewer buildings, products and components are required to provide the same services to citizens. New circular business models like space sharing, spaces for rent, peer-to-peer lodging, smaller and more efficiently designed residential units and increased household sizes (co-housing) can achieve a reduction of new buildings.
Switch materials	Switch from traditional carbon-intensive materials to renewable and/or low-carbon materials such as timber or low-carbon concrete. This also implies a switch from virgin to secondary materials and from toxic to healthy materials.
Use materials efficiently	Using less material by design and improve fabrication yields, e.g. by reducing materials scrap.
Recover, reuse, repurpose materials	Replacing production of spare parts or primary products. For example, steel parts like beams could be reused (based on available performance data).
Extend life of materials and components	Increasing repairs and enhancing secondary markets through better design. The lifetime of a building can be extended by designing it for adaptability, flexibility and durability to accommodate constant change.

		INTERVENTION	SUMMARY
	Every Systems	Decarbonized and electrified city	Transition to a decarbonized and electrified cities is key for decreasing global greenhouse gas emissions. This intervention has several side benefits like enhancing energy access, boosting economic productivity, increasing comfort and health for citizens and resilience to climate change. Replacing fossil fuel-powered devices (furnaces, heating systems, generators and other equipment) with electric ones and generating electricity from renewables are the key actions. As regards the specific case of the City of Genoa and all the port cities, it is necessary to extend the electrification process to this infrastructure and in particular to the ships in port which produce electricity through their thermal engines: cold-ironing allows ships to be connected to the electricity grid reducing appreciably their emissions.
The electricity of CO <sub>2</sub> emiss efficiency and are identified: and digitalizin	The electricity generation and distribution sector is crucial for the reduction of $CO_2$ emissions. These involve systems of production, management, efficiency and reduction of energy waste. The following areas for intervention are identified: reducing energy waste, transitioning to renewable sources	Home automation - technology for buildings	Home automation can significantly reduce the energy needs of any building, especially in terms of heating, cooling, and lighting. The continuous and real-time control of some parameters (temperature, consumption, etc.) allows for fast detection of anomalies and helps avoid unnecessary waste and disruption and related costs.
	and digitalizing services. The following table summarizes key interventions.	Installation of micro-cogeneration and micro-trigeneration plants by private individuals	Micro-cogenerative and micro-trigenerative systems increase the overall efficiency of an energy conversion system and save primary energy based on the same supply, containing CO <sub>2</sub> emissions. Local energy production means no heat and electricity distribution and fewer voltage drops on final lines.

Digitalization of	This intervention takes into account several others sub-interventions that		
	As a result, sewage heat recovery systems are an excellent low-carbon source for cities to use to supply a district heating system		
from wastewater	is a source of energy that can be utilized to heat structures		
Heat recovery	Wastewater from houses and offices, particularly hot wastewater,		

Digitalization ofI his intervention takes into account several others sub-interventions thatservices - smart citiesare related to digitalization: smart grids, smart work and smart travel.

# Cities must act now

While the identified interventions provide useful guidance, cities must take on a significant role in stimulating and facilitating them. This goes beyond committing to strategies and roadmaps, to setting ambitious targets with clear interventions to reach them. Given the gravity of the current situation as reemphasized by the latest IPPC report mentioned above, it is of the utmost urgency for all stakeholders to act on climate change. Thus, cities must lead and stimulate multi-stakeholder collaborations across sectors to create demand that the private sector can act on.

The following chapter summarizes selected case studies and best practices in the four focus cities, and references the identified interventions accordingly.





## BOGOTA

Colombia's National Circular Economy Strategy prioritizes six lines of action: flow of industrial materials and mass consumption products; flow of packaging and packaging materials; biomass flows; energy sources and flows; water flow, and construction material flows. Based on its economic metabolism, Bogota is focusing on three fields: the energy transition, waste management, and expanded public transportation as part of its effort to achieve the city's sustainability and climate action goals and contribute to those of the country as a whole.

CASE STUDY	SUMMARY
Connecta 26	The master plan for Connecta 26 comprises a mixed-use business center with a new waste recycling and recollecting methodology for an efficient resource management system, reducing waste sent to landfill in Bogota by 70%. The plan includes an energy efficiency system to save resources and satisfy 100% of the energy demand through non-conventional renewable sources, and an efficient water use and savings program to reduce water consumption by 5%.
Energy transition to renewable sources	This intervention intends to achieve 100% renewable electricity for Bogota. Currently, the city draws 80% of its electricity from hydro and 20% from coal. This intervention looks at replacing the coal portion with renewables.
Construction and demolition waste management	Bogota is a growing city and with this comes construction and demolition (C&D) waste. This intervention aims to close the materials loop for C&D waste flow by achieving capacity of 70,000 tons/year, reducing dependency on landfills and displacing virgin raw materials in construction.



## GENOA

A permanent circular economy forum named LiguriaCircular<sup>17</sup> was established in the municipality of Genoa in 2014. Its aim is to promote and manage circular economy initiatives in the Ligurian territory. The first area of interest for Genoa is the significant reduction of food waste and the associated effects on land, water and energy use. The second area of interest is to accelerate the adoption of resource efficient buildings by following circular economy principles.

## CASE STUDY SUMMARY

University of Genoa climate neutral strategy	The University of Genoa assumed a strong commitment against climate change, pledging to be climate-neutral by 2030, joining the United Nations global campaign Race To Zero for Universities and Colleges. It accounts and validate since 2014 its carbon footprint and realizing a plan to achieve both interim and longer-term pledges. The plan includes actions to reduce Scope 1 and Scope 2 emissions, such as energy efficiency and renewable energy, and Scope 3 emissions by promoting sustainable mobility actions, thus becoming a living lab for the City of Genoa.
PRINCE project	Although it is often overlooked, citizen engagement is a fundamental pillar of circularity. The PRINCE project uses discounts and vouchers to reward the virtuous behaviour of residents who choose sustainable means of transportation. The PRINCE app allows them to see how much CO <sub>2</sub> they save by making those choices. The project involves several city stakeholders such as the municipality, the university and the local public transit company.
FORCE initiative	Leveraging innovation to implement the circular economy is a fundamental step. This project has 22 partners at the European level and follows a circular logic to close the loop on four material flows: plastic, wood, WEEE, and organic waste. It develops eco-innovative and participatory solutions. In particular, it intends to include resources in the economic process, which can become new products or raw materials that can be reinserted into the technological as well as the biological cycle.



#### **GLASGOW**

Circular Glasgow, an initiative of the Glasgow Chamber of Commerce, accelerates the transition from linear to circular businesses by adopting circular innovations, technologies and business models. In collaboration with Zero Waste Scotland, Glasgow is pioneering circular solutions that benefit the climate agenda and the city's resilience by future-proofing business value chains and thus the life of people in the city.<sup>18</sup>

**SUMMARY** 

### CASE STUDY

## University of Glasgow net zero carbon strategy

The University of Glasgow has developed a net zero carbon strategy to inform the university's ongoing consultations in response to the climate emergency and sets out guidelines on how to meet its carbon targets. The strategy considers actions to improve and retrofit the campus to reduce energy demand and the likely scale of investment that will be needed. It also identifies the contribution that low carbon energy systems could make to reducing emissions.

Clyde Waterfront Innovation Campus Clyde Waterfront Innovation Campus will be a high-tech innovation facility built on vacant and derelict land in Govan. Academic and industrial assets will stimulate economic growth, particularly in the life sciences and continuing education sectors, thanks to its proximity to a hospital and other high value added industries.



#### MILAN

Milan is known as a frontrunner in the circular economy field. It has joined several high-impact networks in recent years, including Reflow,<sup>19</sup> the CE100 Network and the C40 Clean Construction Forum. It has also put several strategies in place, such as the Sustainable Energy Action Plan, the Sustainable Urban Mobility Plan, the Resilience Strategy and the Milano Plastic Free initiative as a testament to its commitment to cutting GHG emissions and accelerating the shift from a linear to a circular economy.

**SUMMARY** 

## CASE STUDY

### MIND - Milano Innovation District

As innovation plays a central role in the transition to a circular economy, MIND can be considered a flagship project. It is the future center of innovation, knowledge and enterprise for sustainable development that will reuse the area that hosted Milan Expo 2015. Enel X provides solutions to reduce consumption-based emissions by focusing on renewable energy generation, smart energy storage and distribution as well as the seamless integration of mobility vehicles into the grid.

Porta Romana Scalo Urban renewal through recovering and enhancing existing assets is an important example of the circular approach. Milan's Porta Romana industrial district will undergo a major urban-scale transformation. The project celebrates the industrial legacy of the site, reusing large infrastructure parts and combining this with contemporary, ecologically-minded programs. The scheme will reclaim a large railway yard and introduce a new green park and connective tissue linking the area to the city center. Several circular interventions unlock decarbonization benefits and improve quality of life in the city.

# Wider benefits of circular interventions

quality, cost savings, increased accessibility etc.

It is an imperative for cities to prioritize interventions not only in relation to their expected GHG reduction potential but also to additional benefits in terms of their overall financial, social, natural and economic value. City authorities must therefore be able to identify and monitor the socio economic benefits deriving from the reduction of GHG emissions and the ones related to citizen health and wellbeing conditions, such as improved air

Quality of life

The way cities are built and organized and how they deliver services have a great impact on quality of life: for example, in terms of ease of access to essential services and the availability of dedicated services for vulnerable citizens. A city's built environment, mobility and energy systems also affect citizen spending, use of time, and health.

This research demonstrates that interventions can achieve multiple benefits: for instance, Bogota significantly reduced its GHG emissions from public transportation by switching to electric mobility and car sharing schemes. Individual motorized transportation was already declining and will be reduced further, and public space formerly used for parking will be repurposed. Thus mobility becomes safer, cheaper and more accessible, especially for children and the elderly. As well, the creation of local jobs related to new and greener services is unlocking wider economic value for the city and the region.

# Resilience

Resilience is and will continue to be one of the greatest challenges. While cities are particularly vulnerable to large-scale potential damage due to their concentration of people and assets, they are also the best equipped to reduce this exposure on a structural level.

Case studies from the four cities prove that the principles of the circular economy can also unlock positive effects in terms of socio-ecological resilience and the capacity of urban ecosystems to withstand shocks and retain their original and stable state of self-organization.<sup>20</sup>

For instance, implementing renewable or closed loop material principles can shorten the supply chain and foster local supply, thereby improving resilience to external shocks. Adopting nature-based solutions and greener city ecosystems can mitigate the both effects of extreme weather events, improve air quality and reduce noise pollution.

Glasgow has launched several social and resilience initiatives that are based on circular economy principles. These include building stakeholder knowledge, skills and know-how on circular businesses and design, broadening stakeholder participation across the value chain, and providing access to tools and relevant networks.

<sup>20</sup> Gunderson, L. H. (2000). Ecological resilience: In theory and application. Annual Review of Ecology and Systematics. Vol 31, pp.425–439

# What needs to happen now?

Implementing the circular economy requires redesign under many aspects, and governance plays a central role. Approaches that were effective with linear models are inadequate in the new context. The analyses and interviews performed offer some insights into the implementation of initiatives in the four focus cities:

- **Provide a citywide vision:** this plays a relevant role in the short- to mid-term as it allows all stakeholders to plan and engage, while providing an integrated vision of all sectors.
- Circular economy strategies as part of overall city planning: cities often adopt separate strategies for decarbonization, resilience, the circular economy, etc. However these have overlapping areas, and synergies could be achieved by integrating them. This concerns not only the integration of the strategies themselves, but also that of the relevant departments. The circular economy is a strategic approach that should inform city strategy as a whole.
- Engage stakeholders proactively: the circular economy concept works top down and also bottom up. The municipality should provide an overall framework and implement key interventions, but without the proactive participation of citizens, NGOs and businesses the results will be limited.
- Key role of value chain networks: implementing the circular economy requires an in-depth redesign of key value chains. This cannot be achieved if the players act in isolation. In this respect municipalities can play a fundamental role in supporting collaboration at every step of each value chain.
- Targets and metrics focus: the circular economy is an economic model. As such it is quantitative, and should be measured constantly in both physical (energy, materials, assets, products, etc) and money terms. Therefore it is important to associate overall targets and specific initiatives to quantitative targets, and to measure performance on an ongoing basis.



Qualitative and semi-structured interviews with local institutions, private sector companies and NGOs were conducted in each of the four cities, and participating universities performed local policy analyses. The aim was to understand enablers, barriers and key success factors to leverage decarbonization and circular economy interventions in the local context. Four key success factors were identified across all the focus cities, regardless of the specific socio-economic and cultural context:

- 1. Active strategies now
- 2. Prioritize high-impact circular interventions within and across sectors
- 3. Involve a broad set of stakeholders
- 4. Stimulate new business models and cross-industry innovation

All areas will require constant, consistent and pragmatic regulatory and fiscal frameworks to accelerate the shift from traditional to circular production and consumption patterns.

# Active strategies now

A clear vision and the ability to define ambitious commitments and targets are the fundamental starting points for a city's transition to a circular economy approach. However, the time to act is now: city leaders must identify practical and feasible interventions and solutions and create an agile environment for all stakeholders involved, reduce roadblocks and other barriers to implementation, and make massive investments in terms of money as well as people.

**Glasgow**, for example, has set a target to become carbon neutral by 2030 and to achieve circularity by 2045, in line with Scotland's commitment to achieve net zero emissions by 2045. The city's recently published Circular Economy Route Map for Glasgow 2020–2030 sets out a framework of circular guiding principles and outlines actions in five areas: Built Environment, Food, Textiles, Energy, and Plastics. It also identifies 30 specific actions with associated targets, action groups and deadlines.

Moreover, both **Glasgow** and **Genoa** joined over 50 signatories to the European Circular Cities Declaration<sup>21</sup>, aimed at accelerating the transition from a linear to a circular economy in the EU. Dedicated plans have been developed and adopted in all focus cities. Within the Air and Climate Plan adopted in 2020<sup>22</sup>, for example, **Milan** has indicated a specific target and clear interventions to promote the circular economy model, such as the adoption of a circular economy action program. **Genoa** in 2021 designed its path to circularity, resilience and adaptation to climate change through its Genoa Lighthouse City Strategy and its Genoa 2050 Action Plan, in order to achieve European 2030 and 2050 targets.

A relevant commitment has been taken by the municipality of **Bogotà** with the presentation of the Climate Action Plan - PAC 2020-2050, a roadmap for the next 30 years that will allow the city to meet the goals of mitigation and adaptation to climate change. Reducing greenhouse gas emissions (GHG) by 15% by 2024 and up to 50% by 2030, also obtaining carbon neutrality in 2050 and increasing resilience to present and future changes in the climate are the challenges of this purpose.

# Prioritize high-impact circular interventions within and across sectors

Sector selection is a key tool in strategy development as it determines the focus of analysis. Circular opportunities, risks and barriers can differ greatly per sector; within an integrated vision of the city coupled with a synergic approach, a sector-specific approach is a key success factor across countries.

For this study, three high-impact sectors were chosen because of their role in the city and the national economy as well as their circularity potential, i.e. material and energy intensity, volume of waste generated or share of landfilled waste. However it is important to identify and leverage interventions across sectors with resulting multi-sector gains, as circular innovation cannot happen in isolation. Cities can thus act as role models for regions and countries and collaborate with further relevant infrastructure hubs such as ports and airports to extend their influence beyond their own boundaries.

# Involve a broad set of stakeholders

Strategies and plans that are developed in a top-down way often remain in the abstract for the stakeholders needed to implement them. As many global best practices show, a broad set of stakeholders that includes private sector businesses as well as finance, industry and environment policymakers are necessary to successfully implement national, municipal and city-wide circular economy strategies<sup>23</sup>. However the involvement of citizens is also an imperative: all interventions must be inclusive, because many of them rely on behavioral change.

<sup>21</sup> https://circularcitiesdeclaration.eu/

<sup>&</sup>lt;sup>22</sup> At the current date, the Air and Climate Plan has not been definitively approved yet by the Municipality of Milan.

<sup>&</sup>lt;sup>23</sup> EMF Policy Maker Toolkit, p. 41

#### AMSTERDAM\*

The success of Amsterdam is based on an effective collaboration between civil society, companies,<sup>24</sup> universities, and the government. The city boldly involved societal stakeholders at every step of the process. Because creating trust in relevant stakeholder groups is a key success factor, Amsterdam decided to collaborate with Cambridge Institute for Sustainability Leadership Professor Kate Raworth to use her Doughnut economy model,<sup>25</sup> which balances essential human needs with planetary boundaries.

\* Best practices, not part of the research.

## 24....

- <sup>24</sup> Cramer, J., 2020, Implementing the circular economy in the Amsterdam Metropolitan Area: The interplay between market actors mediated by transition brokers, Business Strategy and The Environment published by ERP Environment and John Wiley & Sons Lt, 2020;29: pp. 2857–2870.
- <sup>25</sup> https://doughnuteconomics.org/about-doughnut-economics
- <sup>26</sup> https://relondon.gov.uk

# LONDON\*

The British capital has launched ReLondon,<sup>26</sup> a partnership between the Mayor of London and the city boroughs to improve waste and resource management and transform the city into a leading low-carbon circular economy. ReLondon stimulates collaboration between the national government, cities, local authorities and the private sector.

#### BOGOTA

In Bogota, key actions included open debates and knowledge exchange activities in order to foster citizen trust and develop new ideas and proposals on how to make the city greener and promote behaviors that reduce emisssions and mitigate the effects of climate change. In 2020 the Secretary of Environment led a variety of participative and educational activities, engaging over 20,000 people through local environmental commissions and actions that focused on the transformation of conflict zones in the city.

## GENOA

Genoa is making significant efforts to engage micro-enterprises in establishing regenerative processes and making a wider contribution to the transition. Local stakeholder interviews confirm that involving a broad stakeholder set is the key to raising people's awareness, overcoming bureaucratic obstacles and modifying consumption and production patterns. Projects that encourage responsible consumption and promote and incentivize recycling are often the first steps in this engagement.

# Stimulate new business models and cross-industry innovation

Besides the social and environmental benefits, cities must also focus on the economic benefits of high-impact interventions. As major consumers, cities can for instance use their purchasing power to choose environmentally friendly goods, services and projects and make a significant contribution to sustainable consumption and production.<sup>27</sup> Green public procurement is an instrument that could play a key role in the transition to a circular economy.

In 2017, the Scottish government won a Circulars Public Sector award for placing the circular economy at the center of its economy strategy. Hosted by the annual World Economic Forum, the Circulars Awards highlight circular achievements in a number of categories.<sup>28</sup> Two years later Circular Glasgow, a Glasgow Chamber of Commerce initiative, was selected as a Public Sector finalist. To date, Circular Glasgow has engaged over 650 businesses through its activities<sup>29</sup> with a clear focus on circular business models that local businesses can adopt. These can be summarized as follows:<sup>30</sup>

- 1. Think digital increase efficiency at the design, manufacturing and distribution stages to cut down energy consumption
- Rethink materials to cut down waste focus on the supply chain to reduce raw material consumption and increase the use of secondary materials and cross-industry material flows
- 3. Improve design to enhance and retain material value goods that are designed for durability, or to be easily repurposed at their end of life mean less consumption of resources, reduced waste and increased economic gains
- 4. Retain ownership to gain steady income during and after the sales and operation phases – goods and products create constant value along their entire life cycle, increasing customer loyalty

The Bogota Sustainable Business Network (RedES-CAR)<sup>31</sup> program fosters a shift to eco-sustainable production practices. There are currently 590 participants and 190 projects aimed at efficient uses of energy, water, raw materials and waste in value chains, generating economic and environmental benefits for companies. RedES-CAR works on three specific areas with companies from different economic sectors: production chains, industrial symbiosis and complete water management. Within these are 28 anchor organizations that replicate the model with their suppliers, which increases the impact. This study is carried out by the Chamber of Commerce with technical advice from the University of Los Andes and the Regional Autonomous Corporation of Cundinamarca (CAR).

The Bogota administration has concretely committed to making urban transportation more sustainable and inclusive. Starting in 2019, in collaboration with Enel X, the city launched the Transmilenio public transit electrification project, which involves building two electro-terminals to charge electric buses in addition to four existing electrified terminals. Subsequently, it will expand the public fleet to 401 e-buses.

Genoa is leveraging electrification and digitization to improve its competitiveness and sustainability. Examples include the introduction of a separate collection and management service for land and ship waste produced in the port area, the use of alternative energy sources, and the introduction of a cold ironing system to provide shoreside electrical power to vessels at berth while their main and auxiliary engines are switched off. In terms of transportation, the city is developing bike lanes, electric mobility and car sharing while leveraging city analytics to systematically improve overall mobility. Along with Enel X it has the first data analytics project in Italy: it analyzes passenger flows between city subway stations to estimate routes taken and carries out macro analyses of presences and mobility flows at the city level, taking into consideration the census areas of the city.

- <sup>29</sup> https://www.circularglasgow.com/businessgreenawards
- <sup>30</sup> https://ceaccelerator.zerowastescotland.org.uk/circular-guide/business-models/
- <sup>31</sup> http://www.redescar.org/

<sup>&</sup>lt;sup>27</sup> Green Procurement, https://ec.europa.eu/environment/gpp/index\_en.htm

<sup>&</sup>lt;sup>28</sup> https://thecirculars.org/awards-program

Open data is a valuable resource – if properly published, collected and processed – to monitor indicators that allow administrations to implement a circular economy transition, by supporting existing tools and policies and introducing new ones. In this context, Enel X with academic partners developed the Circular City Index<sup>32</sup> – a score, fully based on Open Data at national level, to support municipalities transition and that already been implemented for all Italian cities and soon extended to other countries. The Index systematizes urban "circular variables" on four main areas (digitalization, climate and resources, sustainable transport and mobility, waste and materials) to foster the digital, energy and ecological transition of cities highlighting strengths and weaknesses of cities to be addressed. As first results, for example, Milan and Genoa show the highest overall scores for circularity among Italian cities with more than 500,000 inhabitants: Milan is ranked 279° (over 7904 municipalities) with a score of 0.64 (over 1 as maximun) while Genoa is ranked 352° with a score of 0.63.

Moreover, by using data analytics and by addressing an work of open data discovery, collection and processing – unique in the smart city sector , Enel X is developing the digital solution "15 minutes index" in order to support cities in promoting urban planning by proximity and sustainability transition knowing the geographical distribution of services (e.g., transport, hospitals, schools, etc.) easily reachable on foot by citizens, to understand which areas are underserved compared to the population density and to redesign the urban territory through the first pragmatic & scientifically validated tool to build the "15 Minutes City".

Among the different solutions identified under its Air and Climate Plan to mitigate climate change, Milan has chosen a nature based solutions (NBS) approach to increase its adaptive capacity. NBS involves natural processes, such as expanding tree cover in the city to absorb CO<sub>2</sub> emissions, decrease the heat island effect by 2°C, increase the permeability of soils and decrease hydrogeological risk.

A relevant example from Milan is the recovery of public spaces such as streets and squares for recreational and social uses in the context of COVID-19. Its Piazze Aperte (Open Squares) and Strade Aperte (Open Streets) program has adopted tactical urbanism solutions.<sup>33</sup> Within the context of the COVID-19 pandemic the use of roads and public spaces had to be redefined to support the widespread use of bicycles, scooters and other forms of micro- and light mobility that ensure social distancing. During the summer of 2020, 35 km of new bike lanes were introduced, extending the existing bike lane system to over 100 km by April 2021. Within the perimeter of the Strade Aperte project, in May 2020 the Municipality of Milan issued regulations allowing more than 2,400 restaurants and cafés to recover outdoor spaces to make up for the indoor space they sacrificed under social distancing measures.



32 https://www.enelx.com/it/it/istituzioni/sostenibilita/circular-city-index

<sup>&</sup>lt;sup>33</sup> involvement of the inhabitants in the processes of urban regeneration on a neighborhood scale using short-term, low-cost and scalable spatial and political interventions



# Next steps

The vision for a circular city within the focus sectors will be contextualized for each city, outlining the key challenges and opportunities each city faces in their transition to circularity. This will be supported by quantitative modelling which will estimate the potential scale of impact of the priority circular interventions for each city. That will represent a useful knowledge for policymakers and public and private stakeholders to drive the change.

# Appendix - Methodology

# Phase 1

Based on a literature review and a semi-structured stakeholder interview process, interventions have been identified that focus on three sectors: mobility, the built environment, and energy systems. Interventions for each city were identified based on the following questions:

- 1. Can the city generate additional benefits in terms of decarbonization as well as other dimensions, e.g. quality of life, by implementing the interventions they have already planned?
- 2. What additional decarbonization interventions can the city implement beyond those already planned, and what benefits would be generated by implementing these interventions using circular economy principles?

The impact of these interventions is being analyzed using both quantitative and qualitative methods to assess their potential benefits to the environment, quality of life, and city resilience. An ambitious but realistic target for the level of implementation of each intervention by 2030 will be defined for each city, exploring how different urban contexts lead to variations in outcome and should therefore guide the prioritization of interventions.

Local stakeholder and expert consultations will be used to contextualize the interventions within the socio-economic fabric of each city and to understand the enabling factors for their successful implementation. This includes new business or governance models and required actions for public and private sector stakeholders.

# Phase 2

Quantitative analysis will be performed using consumption-based city GHG footprints for 2017, calculated using a hybrid modeling approach. The analytical process will combine bottom-up reported and measured data for Scope 1 and 2 emissions with top-down estimates based on Input-Output Analysis (IOA) for Scope 3 supply chain emissions. A consumption-based perspective was chosen to ensure results reflect the GHG emissions that occur as a result of the demand for goods and services driven by activities within city boundaries, as opposed to just emissions from sources within the city. This allows cities to understand the potential contribution of their interventions to global decarbonization efforts.

Interventions shall be quantified in the model, exploring how policies can impact:

- Consumption reducing demand or switching demand to low-carbon alternatives
- Emissions intensity producing the same resources at a lower level of emissions