D1.1 Monitoring tool of CLIMABOROUGH project

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Executive Summary

Introduction

The present deliverable is the first planned for WP1 Urban Planning and Climate Neutrality Evaluation and aims at defining a common framework of KPIs to measure the project impacts and to guide urban planning strategies towards Climate Neutrality. In this respect it provides a work-in-progress update on the development of the Urban Planning Framework for Climate Neutrality within the CLIMABOROUGH project. It acknowledges the need to test and finalize the framework in collaboration with cities, considering various aspects such as the final set of Key Performance Indicators (KPIs), the climate action approach, and the organizational structure for implementing climate neutrality plans.

The draft concept of the framework has identified a theoretical gap that requires further exploration and operational reflections. A planning concept for climate neutrality must address the dual time dimensions of responsiveness to fast-changing climate phenomena and the long-term perspective necessary for complex urban systems. Key questions arise regarding how to embed these time dimensions within the framework and what organizational requirements, normative procedures, and regulatory settings are needed to ensure such responsiveness. The answers to these questions will influence the refinement of the draft framework.

About the document

The document is divided into seven chapters, each addressing specific aspects related to urban planning and the transition to climate neutrality.

Chapter 1 provides an introduction to urban planning and its role in addressing the climate challenge. It explores the concept of transitioning to climate neutrality and the mission of urban planning in this context. It also highlights the need to move beyond the "think global and act local" approach and acknowledges the greater uncertainty surrounding climate issues.

Chapter 2 focuses on climate services for urban planning, delving into the definitions, actors, and landscape of international and intergovernmental institutions involved in providing climate services. It emphasizes the importance of these services in enabling informed decisions for urban planning.

Chapter 3 presents the state of the art of Climaborough Cities, starting with an assessment based on Net Zero Cities Applications. It explores urban plans and ambition, sectorial policies and targets, budget assessment, and governance mechanisms related to climate neutrality.

Chapter 4 examines advanced urban plans as case studies. It analyzes three specific cases: Valencia Urban Strategy 2030, New Amsterdam Climate (including the roadmap and vision for Amsterdam Climate Neutral 2050), and San Francisco's Climate Action Plan 2021. It explores the key elements of climate neutrality and urban planning in these cases and draws lessons from their experiences.

Chapter 5 focuses on and discusses the scope and approach of the CLIMABOROUGH Urban Planning Framework. It introduces the Urban Planning Framework for Climate Neutrality (UPF4CN) and emphasizes the importance of planning under climate hazard pressure and urgency.

Chapter 6 explores the Climate Neutrality strategic assessment. It discusses the monitoring of climate urban factors and proposes a framework for designing Key Performance Indicators (KPIs) for the Climate Neutrality Strategic Assessment. It also explores assessing cities' capacity to achieve climate neutrality using the capital approach.

Finally, **Chapter 7 provides concluding remarks.** It presents preliminary results and raises additional questions based on the work carried out so far. It outlines the steps forward for the project, including data mapping and KPI development, utilizing a dashboard scenario for the Climate Neutrality Strategic Assessment, and engaging in discussions and exploration of topics such as "responsive planning" and "planning in a hurry."

1. Urban planning and its role in the transition to climate neutrality

1.1 Planning in the climate challenge

It is widely shared that urban planning needs to take climate changes into consideration in the development, design and re-development of urban areas all over the world. The climate crisis is now here, evident, disruptive and finds all completely unprepared. However, it was announced several decades ago (see the Intergovernmental Panel on Climate Change reports since the early 1990s). “It is time to suggest a research and policy paradigm to craft better urban planning systems in response to climate change,” wrote Blakely in 2007; the capacity is still weak to set urban (planning) actions

having a wide systemic perspective in dealing with climate changes, and this is mainly due to the scarce knowledge about 1) the increasing hazards climate changes are exposing cities to and 2) the impacts, individual impacts, that cities could achieve to create on climate. Still, it is clear that urban planning can (still) play a crucial strategic role; this is clear even though urban planning has been and still is, in the middle of the tension between mitigation and adaptation (Howard, 2009), which reduces the ability of urban planning to set effective tools, convergent models (theoretical and non), aligned normative frameworks. It is shared nowadays that mitigation and adaptation are both crucial and should be combined in any spatial strategy, aware that we have not done enough for mitigation when it could have been more impactful and beneficial.

Clearly, urban planning has been, and still is, under pressure and has been required to set a strategic priority on the ecological dimension in competition with the strong interest of economic growth with its land-use growing demand (Davoudi et al., 2009). The tension between mitigation and adaptation is still challenging the development of a responsive planning framework although the early debate is nowadays weaker in relevance as it clearly appears that any adaptation capacity will be challenged by the speed of climate change and the rise of extreme events. Planning for mitigation (global perspective) is functional to adaptation (local perspective). Vice versa, planning for adaptation gives value to any mitigation action.

The European initiative for climate neutrality is an answer to the global climate challenge in the direction of mitigation. It clearly looks at spatial planning in urban contexts as playing a pivotal role in the transition to climate neutrality by providing a strategic framework to address the challenges of climate change at the local, national, regional and global levels.

Urban planning towards climate neutrality is a multi-scalar, participatory and adaptive process, taking into account the local context, stakeholder preferences and future scenarios of climate change and urban development. According to several recent studies, urban planning towards climate neutrality can be observed in four themes: (a) the legitimization of cities as climate actors in a fragmented climate governance landscape, which explores how cities have emerged as key players in addressing climate change, despite the lack of a coherent global framework for climate action (Shabb and McCormick, 2023); (b) the evolution of climate urbanism as a paradigm for urban planning towards climate neutrality, which discusses the principles, frameworks and models of climate urbanism while also critiques the limitations, challenges and trade-offs of climate urbanism, such as its techno-centricity, market-dependency, social inequality and ecological footprint (Wu et al., 2023); (c) the assessment of carbon emissions and sinks in urban areas and the identification of mitigation and adaptation strategies in urban areas across different dimensions, such as spatial layout, density, land use, mobility patterns and energy efficiency (Jooste et al., 2019); and (d) the implementation of carbon-neutral urban projects and policies and the evaluation of their outcomes and impacts for example, through a systematic review of the latest social science literature on carbon neutrality (Zhang et al., 2021).

As highlighted by the European Commission on the "Climate-Neutral and Smart Cities[1], EU Mission, urban planning is considered one of the critical factors in achieving climate neutrality, which means

[1] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

balancing greenhouse gas emissions and removals within a specific period and area. The EU Mission Climate-Neutral and Smart Cities aims to deliver 100 cities that are carbon-free and innovative by 2030 and to enable all European cities to follow their example by 2050. While the EU proposed mission primarily emphasizes mitigation, **it is crucial to integrate adaptation and resilience measures into urban planning and development strategies to ensure that cities are prepared for the current and future challenges posed by climate change.**

The mission appears inspired by the approach of "mission-oriented innovation policy", as proposed by Mariana Mazzucato (2018); this approach suggests that policy should identify and articulate concrete problems that can mobilise various sectors and actors to find solutions that are transformative, inclusive and sustainable (Mazzucato, 2017). Mazzucato argues that a mission-oriented policy is an instrument to reframe the way to tackle grand societal challenges, such as climate change, by setting ambitious goals, enabling bottom-up experimentation and learning, and fostering cross-sectoral and cross-disciplinary collaboration.

Mission-oriented policy in the context of climate neutrality and urban planning entails setting clear targets and aligning policy measures to foster sustainable urban development, reduce greenhouse gas emissions, and enhance energy efficiency. It involves integrating climate considerations into urban planning processes, and, in the meantime, it promotes the adoption of innovative technologies while addressing social inclusion and quality of life in urban areas[2]. By embracing mission-oriented policy, policymakers can drive investment and research towards solutions that enable cities to become climate-neutral. For instance, this can include funding initiatives for green infrastructure, supporting the development of smart grids and energy-efficient buildings, promoting sustainable mobility options, and developing climate services[3]. The policy orientation encourages collaboration among different stakeholders, such as government entities, businesses, academia, and communities, to work together towards common climate goals. Furthermore, **mission-oriented policy recognises the interconnectedness between climate change, urban planning, and policy. It emphasises the need for coordinated and integrated approaches to tackle climate challenges in urban areas**. This includes fostering multi-level governance frameworks, enhancing public participation, and aligning policies across different sectors to ensure a holistic and effective response to climate change.

The mission-oriented policy also represents a conceptual reference within the framework of spatial planning first because it is a composed framework itself, made of different actions, tools and measures moving from the design of spatial transformations to guiding policies; second because it suggests as essential the relevance of a strong, shared, systemic commitment and alignment among a large set of actions, their scopes and visions. Due to the urgency of climate actions many countries, regions, and cities are activating strategies, policies and measures within a governance complexity that is also relying on a polycentric landscape of climate actions. The large diversity of actions and actors clearly calls for both horizontal (connection of peer cities and regions through networks of transnational climate governance) and vertical (linking and coordinating policies between different levels of government) alignments (Hsu et al., 2017, see also Cheng et al. 2021) as well as for the coordination of top-down and bottom-up initiatives (Chan et al., 2016) to reinforce and synergise

2 https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/mission-climate-neutral-and-smart-cities-info-kit-cities-now-available-2021-10-29_en

3 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

each other.

This coordination/alignment/systemic perspective, embedded in the concept of mission oriented policy, is perfectly coherent with the shared understanding that mitigation and adaptation should work together and provide comprehensive responses, complement each other, avoid counterproductive impacts and effects (Laukkonen et al., 2009; Hamin and Gurran, 2009; Sharifi, 2021). In this respect the present deliverable will primarily focus on Climate Neutrality as per the consistency with the project perspective but the operational effort that will follow will try to deal with both dimensions.

1.2 Transition to climate neutrality

The transition to climate neutrality is a complex and multifaceted process. It refers to the process of transforming socio-economical and technical systems to achieve net-zero greenhouse gas emissions by balancing sources and sinks. The multi-level perspective on sustainability transitions by Geels explains how transitions occur through the interplay of dynamics at three levels: niches, regimes and landscapes[4]. His multi-level perspective on sustainability transitions (Geels 2002, 2011) offers a valuable framework for understanding and advancing the climate neutrality transition. As outlined by Geels (2011: 25), "*Transitions towards sustainability have some special characteristics that make them different, in certain respects, from many (though not all) historical transitions. First, sustainability transitions are goal-oriented or 'purposive'* (Smith et al., 2005; quoted in Geels, 2011) *in the sense of addressing persistent environmental problems, whereas many historical transitions were 'emergent'* [...]" this happens because, "*sustainability is an ambiguous and contested concept, [and] there will be disagreement and debate about the directionality of sustainability transitions (Stirling, 2009)*. Second, "*most 'sustainable' solutions do not offer obvious user benefits (because sustainability is a collective good), and often score lower on price/performance dimensions than established technologies. It is therefore unlikely that environmental innovations will be able to replace existing systems without changes in economic frame conditions (e.g., taxes, subsidies, regulatory frameworks). These changes will require changes in policies, which entails politics and power struggles, because vested interests will try to resist such changes*." Third, "*the empirical domains where sustainability transitions are most needed, such as transport, energy and agri-food* [...] *are characterized by* [...] *incumbent firms* [having] *strong positions vis-a-vis pioneers that often first develop environmental innovations*. As a consequence the sociotechnical model of transition can be adopted in a prescriptive manner being aware that it is a descriptive model and we need to learn how to make it a tool for intended transformations.

As outlined by Geels, niches are the protected spaces where radical innovations emerge and are tested. It consists of small-scale experiments, initiatives, and alternative practices that challenge the prevailing regime. Niches often operate at the fringes of the mainstream and serve as incubators for novel solutions. The regime level represents the dominant set of rules, norms, and practices that shape the current system. They can exert significant influence and control over technological, social, and economic systems. However, regimes are not static and can evolve and adapt over time. They may respond to pressures from niches or external factors, leading to transformative changes or gradual adjustments within the existing system. The landscape level represents the broad socio-technical, economic, and cultural context in which niches and regimes operate. It encompasses

[4] https://www.brookings.edu/research/accelerating-the-low-carbon-transition/

macro-level trends, external factors, and global influences that shape the conditions for sustainability transitions (Figure 1).

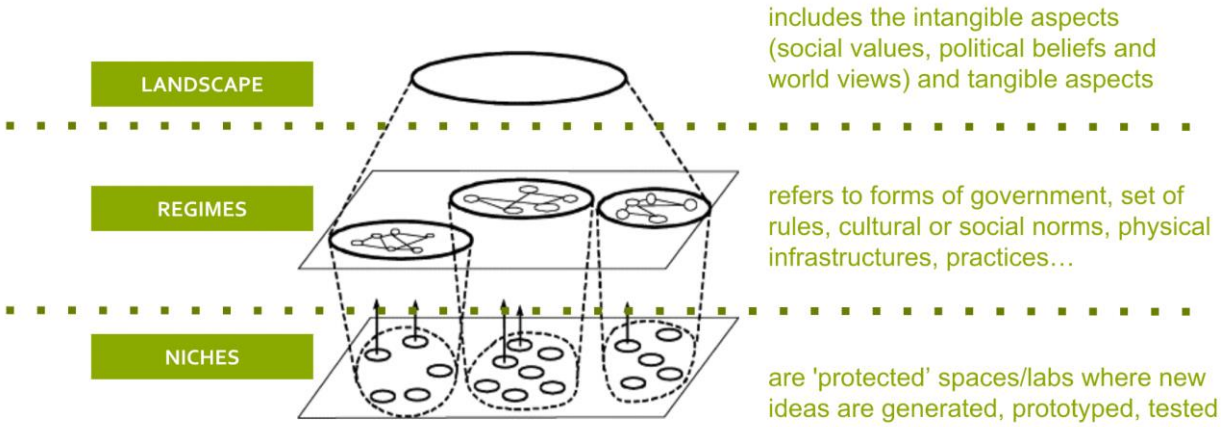

Figure 1: Multi-level technological transitions (Geels, 2002)

To contribute to the climate neutrality transition, transformative changes are required across various sectors and systems, including energy, transportation, industry, and buildings. Applying Geels' multi-level perspective and aligning it with the role of urban planning in the CLIMABOROUGH project, we can essentially examine the transition to climate neutrality through the lens of niches, regimes, and landscapes, as presented in the following section.

1.3 Urban planning and the climate neutrality mission

Urban planning is a crucial 'intentional' factor in the transition to climate neutrality, and refers to the balance between greenhouse gas emissions and greenhouse gas removals in urban areas. Urban areas account for a significant proportion of global greenhouse gas emissions, making up approximately 70% of total emissions. As such, urban planning plays an essential role in ensuring that cities and towns transition towards carbon neutrality and contribute to the global effort to mitigate climate change (UNEP 2017)[5]. Urban planning involves designing, developing, and managing the built environment of urban areas. This includes land use planning, transportation planning, infrastructure development, and the provision of essential services such as water, energy, and waste management. In the context of climate neutrality, urban planning is essential for reducing greenhouse gas emissions, promoting sustainable development, and adapting to the effects of climate change.

Urban planning also plays a critical role in adapting to the effects of climate change, which are already being felt in many urban areas around the world. By planning for climate resilience, urban areas can prepare for the impacts of extreme weather events, such as floods and heat waves, and reduce the risks to urban populations. This includes designing infrastructure and buildings that can withstand extreme weather events, ensuring that essential services such as water and energy are protected, and promoting green infrastructure that can mitigate the effects of extreme weather events. In addition, **urban planning has to be transformed in its current approach to spatial design and the spreading of human activities to break the siloed urban knowledge and innovation that slow down and, in some cases, impede the transition of European Cities towards a new**

5 UN Environment Programme. (2017). The Emissions Gap Report 2017. Nairobi, Kenya: United Nations Environment Programme. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf?sequence=1&isAllowed=y

ecological, sustainable and digital order.

By applying Geels' multi-level perspective urban planning clearly refers to the regime level (see Figure 2) and could represent a contributive driver of the purposive and intentional nature of the sustainability transition. It includes the entire set of tools, measures, and actions that cities may provide to the climate neutrality mission: strategic plans, land use plans, sectoral plans, norms, policies, urban regeneration plans, and any other transformative action within a complex multi sectoral and multi level governance.

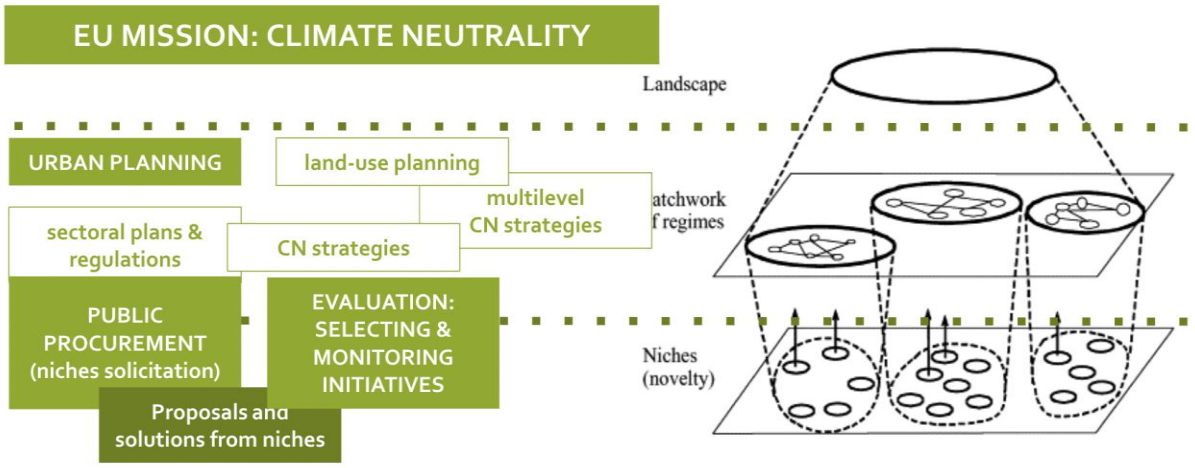

Figure 2: Planning in the sociotechnical model

Within the framework of such a composite urban planning landscape CLIMABOROUGH does not only aim at proposing a model specifically targeting climate neutrality, it also aims at experimenting the role of innovative public procurement as an administrative strategic tool to feed planning with specific transformative actions coherent with the transformative orientation of its climate strategy. Within the Geels' model the innovative public procurement represents the manner through which the climate neutrality mission (acted within the regime) could effectively solicit the niches to propose/produce ideas, solutions, tools, devices coherent with the chosen perspective.

1.4 "Think global and act local" is not enough: a greater uncertainty

The slogan "think globally, act locally" is commonly used to emphasize the importance of considering and targeting global issues while taking action at the local level within the awareness that actions, the most important ones are those materially transforming the "local". This slogan encourages individuals, communities, and organisations to recognise the interconnectedness of the world and the impact of their local actions on the broader global context. It is a commitment to personal change, it deliberates changes to reduce inconsistencies that exist between what we know (awareness about global issues) and what we do (local actions). This principle for many years has been widely linked to urban planning as the town planner and social activist Patrick Geddes (1915) popularised this concept and emphasised the importance of considering the global perspective while taking practical actions at the local level to address societal and environmental challenges, to be active contributors to the globe.

By incorporating the principle of thinking global and acting local, urban planners have been imagining to address global challenges such as resources sustainability, social justice, climate changes mitigation, equity and inclusivity. However, this principle seems to need to be better specified when the climate challenge is involved. As cities are recognized as both the source of climate change issues and the key to finding solutions to address the climate crisis (Panagiotopoulou et al., 2023), the number of cities committing to climate related actions towards both mitigation and adaptation is growing and there is no real capacity to understand, forecast, preview how the growing and intensifying simultaneous actions can affect the "climatescape" (the climate dimension of the Geels' landscape) in a fractal vision of the sociotechnical model where cities could be seen as niches and regimes as the global level of coordinated policies, actions and rules driving and aligning the responses to the climate challenge (figure 3).

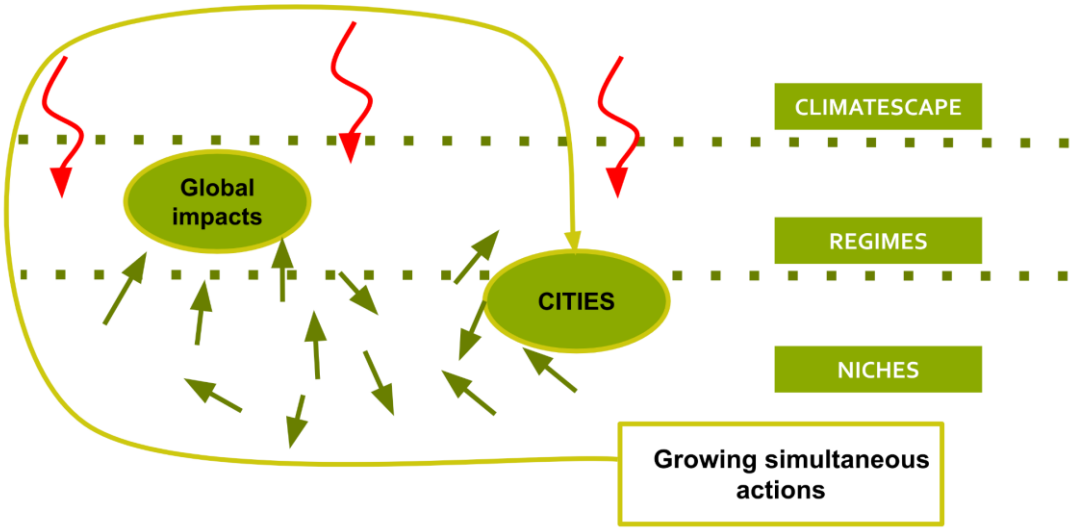

Figure 3: The stress of the climatescape

While the slogan "think global, act local" encourages individuals and communities to consider global issues and potential global impacts of local actions, also a motto like "monitor global and refine local" is becoming relevant; it suggests that we need to know more the global; it suggests that the global needs to be observed, monitored, measured constantly, continuously and that we need to know more about the interdependencies about local and global to tune and refine local actions (Lyons and Mandaville, 2010; Tarantola, 2013). Especially in the context of climate challenges, the "uncertainty of the local towards the global" needs to be taken into account and explored to improve the capacity of cities to contribute to the global and to be better prepared for the stresses that the global produces on the local.

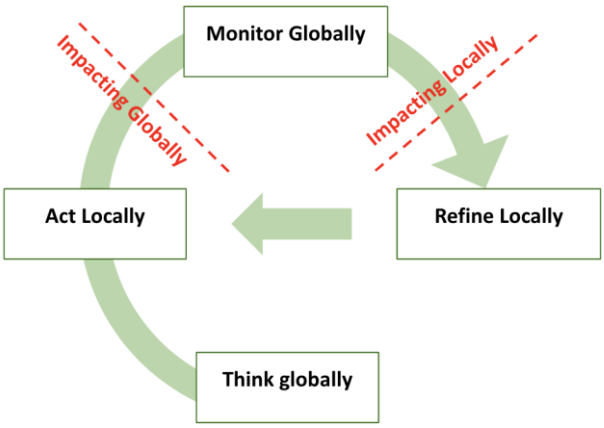

Figure 4: Global-Local responsiveness

Monitoring and enhancing global effectiveness in addressing climate challenges requires a comprehensive grasp of local conditions and the potential of local actions, which can be further refined in response to global changes. This involves analysing the specific challenges and opportunities within a local context, such as identifying local sources of greenhouse gas emissions, vulnerabilities to climate impacts, available resources for mitigation and adaptation, current trends, governance structure, etc.

In addition, exploring the global impacts and effectiveness of local actions implies the capacity to continuously refine local plans, a sort of responsive ability for responsive actions and plans. Such a responsiveness cannot privilege only mitigation or adaptation, rather, it should be an aware hybridization of both perspectives taking into account co-benefits and synergies between the measures (Sharifi, 2021) of the two.

2. Climate services for urban planning: concepts and perspectives

2.1 Climate services: definitions and actors

"Climate services" is a broad term that generally refers to the provision of climate information as a support to individuals and organisations in making climate-smart decisions[6]; it includes various products, such as projections, trends, economic analysis and tools for climate mitigation and adaptation[7], enabling informed decisions in various sectors such as agriculture, water resources, energy, health, transportation, and disaster risk reduction (Eltazarov et al. 2021).

Climate services have emerged as a distinct investigation field in recent years only (Soares & Buontempo, 2019), as a relevant and important bibliometric study by Larosa & Mysiak (2019) demonstrates: the paper explores the time evolution of this research topic. It reveals that the first publication ever mentioning the keyword "climate services" dates back to 1974. However, the number of international scientific contributions did not exceed 20 publications/year until 2015 (see Figure 5).

The World Climate Conference in 2009 and the launching of the Global Framework for Climate Services in 2012 have driven a significant increase in climate services-related publications worldwide. Still, it is from 2014 and 2019 that the interest in this theme grows up to reach 40 published papers/per year.

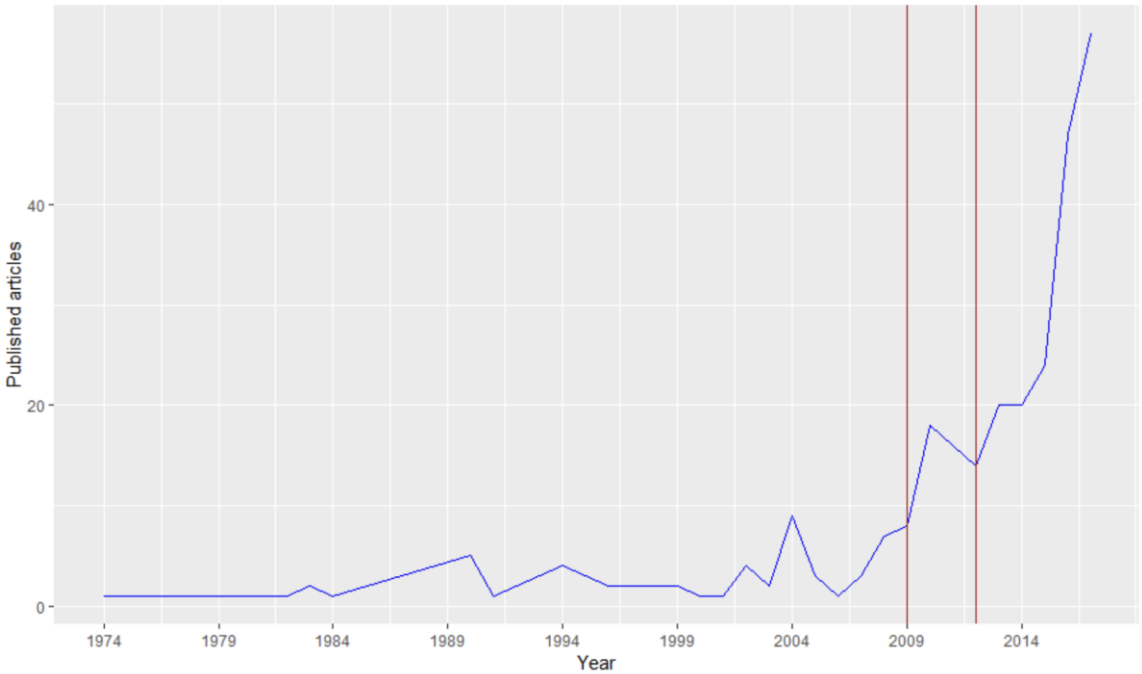

Figure 5: Scientific production on climate services from 1974 to 2019 (Larosa et al., 2019)

Recent years have seen a sharp, constant increase in institutions' and policymakers´ attention to climate services, hand in hand with the growth in losses due to the impacts of climate change on various sectors every year. The United States of America recognized that **up to one-third of its gross**

6 https://gfcs.wmo.int/what-are-climate-services

7 https://www.sciencedirect.com/journal/climate-services

domestic product depends on accurate weather and climate information (Brasseur et al., 2016). The UK's Meteorological Office[8] realized that its expertise in weather forecasting and services should be strengthened hence allocated massive funds to implement this intention in order to advise public and private sectors on climate-related issues.

This increased attention is being translated into international initiatives (international conferences and workshops), into the diffusion of policy briefs such as the European research and innovation roadmap for climate services in 2015 and the new EU Adaptation strategy in 2021. Furthermore, numerous knowledge platforms and initiatives were launched to foster the application of climate information into effective adaptation and mitigation actions: Copernicus Climate Change Services (C3S), which aims at providing open-source climate information; Climate-ADAPT, presented as "a climate knowledge intelligent portal"; innovation communities like Climate-KIC, supported by the European Institute of Innovation and Technology (EIT); and many others. Despite recent advancements, the relative immaturity of this research field still implies a lack of sedimented and shared definitions, which still constitutes an issue for studies on climate services.

Current definitions of climate services are: "climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement along with an effective access mechanism and must respond to user needs"[9]. According to the National Research Council, climate services are the "timely production and delivery of useful climate data and knowledge to decision makers"[10]. The Joint Programme Initiative (JPI-Climate) defines climate services as "user-driven development and provision of knowledge for understanding the climate, climate change and its impacts, as well as guidance in its use to researchers and decision makers in policy and business" (Brasseur et al., 2016).

The European Commission identifies in climate services the "transformation of climate-related data and other relevant information, into customized products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessments), counselling on best practices, development and evaluation of solution, and other services in relation to climate that may be of use for society at large" (EC, 2018). It introduces the possibility to integrate climate-related information with other relevant information from different sources (Brasseur et al., 2016).

In the urban context, they are seen as "highly spatially resolved information on an urban scale of weather and climate […] that supports the decision-making processes required for the provisions of the general urban services" (WMO, 2016).

Kathleen (2018) broadly conceptualizes the developments of climate services as "climate knowledge systems", stressing the importance of the three-phases transformation from data to usable information to knowledge.

These services should be designed to bridge the gap between the data and tools used by researchers and the needs of end users and stakeholders who are making decisions or taking actions related to the impacts of climate change (Swart et al., 2021).

8 https://www.metoffice.gov.uk/
9 https://gfcs.wmo.int/about-gfcs
10 https://www.cnr.it/en/about-us

Other studies have defined Climate Services as services that provide decision-makers with actionable information to reduce climate-related risks and losses. They differ from climate information in that they are tailored to address the needs of specific user contexts and can include a range of activities, such as the development of tailored products, the delivery of training and the provision of advice (Giordano et al., 2020).

For the purpose of this study, it proved extremely useful interpreting a definition provided by the CTCN (Climate Technology Centre and Network)[11] that identifies climate technologies, in which the emerging idea of a new, innovative set of climate services is well represented by the following adapted definition: "any service, equipment, techniques, practical knowledge and skills that can be used to increase climate resilience of human system". Here the main aim is to turn scientific information into operationally available information and services that would help society to better cope with climate variability and change.
However, the portfolio of already available climate services remains often limited to past climate indicators (i.e. temperature, precipitation indexes) deduced from observations and data analyses.

Climate services focus primarily on providing climate raw data, but they should also include climate impacts. Some examples of what climate services include are:

- medium and long-term weather forecasts;
- climate predictions and projections;
- global, national, regional and local climate models;
- future climate scenarios and climate trends;
- impacts, vulnerability and risk assessments;
- storm tide level forecast and warning;
- road freezing warning;
- heat index;
- pluvial flooding forecast and warning;
- forest fire index;
- climate data management services;
- re-analyisis of processed climate data;
- advisory services, including decision-making support tools;
- publications;
- capacity building, training;

and many other services that "may be useful for the society at large" (https://www.ctc-n.org/).

Climate services are categorized and distinguished in different typologies according to the point of view of different authors and sources: typologies vary per portal, report and purpose of the study (EC, 2015). This complex of available classification systems, that are often inconsistent and overlapping, makes it difficult to understand what exactly is intended by "climate services" and to identify gaps in the present offer.

Against this background and given the advancements in studies devoted to climate services, the development of an agreed and shared taxonomy of climate services is needed to provide a better overview of already available climate services and indications of where to find them (Climateurope, 2018). This typology of climate services should respond to users´needs mainly; from users point of view, it would be recommendable to adopt a differentiation of services by intended use and/or sector

11 https://www.ctc-n.org/

of application (i.e. specific applications in energy, agriculture, health, disaster risk reduction, urban planning, etc.).

Other currently available typologies are: i) by level of background knowledge of the designated user; ii) by data sources; iii) by time horizon; iv) by level of processing of data; v) by purpose of use.

About different roles in climate services market, the World Meteorological Organization (henceforth WMO)[12] – one of the reference institutions for climate services at the global level – claims that users are a heterogeneous mix of stakeholders at the national, sub-national and community levels.

Generally speaking, climate services users are those who can benefit from the production, translation, transfer and use of climate information and knowledge for decision-making and action. Different users can derive different benefits from using climate services. According to the categorization of the main roles in the climate services market proposed by the WMO, not all users are end-users. Stakeholders are distinguished in the following three categories:

- **End-users**: the ultimate beneficiaries of climate services, who use them to inform their decisions and actions related to climate variability and change. They can be individuals, households, communities, businesses or organisations that operate at different scales and sectors, such as agriculture, health, water, energy, disaster risk management and urban planning;
- **Intermediaries**: these are the subjects whose role is facilitating the climate information transfer and the delivery of climate services to end-users. They can be public or private entities that provide technical assistance, advisory services, training, education or advocacy on climate-related issues. They can also be researchers, consultants, journalists or civil society organisations that synthesise, translate or disseminate climate information and knowledge to different audiences[13];
- **Providers**: the role of climate services provider corresponds to those entities producing and supplying climate information and products, such as observations, forecasts, projections, scenarios, assessments and analyses. Providers can be national or international institutions with the scientific expertise and infrastructure to generate and manage climate data and knowledge or specialised agencies and networks that offer tailored or customised climate information products to specific users and for specific sectoral applications.

Climate services stakeholders can also be classified into different categories based on their needs, capacities and interests. In an assessment of market demand for climate services and users' needs, Tart et al. (2020) categorise the users as economic, administrative, political and scientific stakeholders across different sectors and disciplines. According To Máñez et al.(2021), the interaction and the collaboration among different categories of climate services stakeholders are essential for the co-production and co-design of climate services that are relevant, credible, legitimate and salient for decision making and action.

12 https://public.wmo.int/en

13 https://www.wfp.org/climate-serviceshttps://public.wmo.int/en/bulletin/what-do-we-mean-climate-services

2.2 The Climate services landscape: international and intergovernmental institutions

According to the assessment by Schleussner et al. (2016), the difference between the global impact of 1.5 °C and 2 °C warming would be significant, which requires the early adoption of mechanisms and services which are able to support and facilitate climate-smart decision-making. By customising climate data to the particular requirements of various sectors, climate services facilitate the integration and application of such data, thereby supporting climate change adaptation and sustainable development (Williams et al. 2020). Climate services can be used for various applications, from designing adaptation strategies to informing policy decisions. They provide access to data, models, and tools that help users understand and manage the risk of climate change. They can also provide access to decision support systems, forecasting tools, and other services that help users and stakeholders take action, particularly supporting decision-making under uncertainty (Hewitt et al. 2012).

They are designed to provide "actionable information" and knowledge to help decision-makers and communities cope with the impacts of climate change. The practical application of climate services has been demonstrated in various sectors and regions worldwide, from agriculture and water management to disaster risk reduction and public health. There are some examples of how climate information can support decision-making and adaptation in different sectors and regions. They demonstrate the benefits and challenges of providing and using climate services for various purposes and user groups. Climate services providers could be divided into three groups (a) related to the national weather services; (b) depending on universities or research centers and (c) private sector providers. There is a big landscape of providers in Europe as presented by ClimateAdapt[14].

2.3 Climate services for urban planning: enabling informed decisions

As a premise to this sub-section, a further reflection shall be made on the convergence of the terms "urban planning" and "urban adaptation planning", "climate change adaptation planning" or similar expressions.

The in-depth literature review on climate services for urban planning at the basis of the present contribution included white papers and reports released by the most authoritative institutions and organization in this field, proceedings of conferences of international relevance and highly cited and recently published studies. By browsing numerous heterogeneous sources, it emerged that the expressions "urban planning" and "adaptation planning" and equivalents are often used synonymously. This apparently trivial observation draws attention to, instead, the ultimate planning goal: sustainable development.

As advocated by the United Nations, the link between climate change and sustainability is indisputable: climate change action and sustainable development promotion are "two mutually reinforcing sides of the same coin", which implies that climate change is the ultimate sustainable development issue (UN General Assembly, 2015).

It can therefore be said that urban planning processes essentially are, in the present scenario, urban climate adaptation and mitigation - hence, climate neutrality - planning process. For these two main

14 https://climate-adapt.eea.europa.eu/en/network/organisations/index_html

options to respond to climate change, measures shall be identified and implemented at the urban and territorial planning level, by designing and applying:

1. **Mitigation strategies**: the aim of these strategies is to limit GHG emissions and/or to capture them. An example of mitigation strategy through urban planning is designing urban configurations that aim at limiting CO2 emissions connected with transportations, by promoting compact settlements.
2. **Adaptation strategies**: the aim of these strategies is to cope with the (unavoidable in the short and medium terms) consequences of climate change, which means to reduce urban vulnerability, to reduce climate hazards' impacts at the local scale. An example of adaptation strategy through urban planning is increasing streets shading with tree-lines to reduce the impacts of urban heat island effect.

Perrin et al. (2016) reported that many studies (Marshall et al., 2004; Lobell et al., 2008; Davin et al., 2014; and many others) demonstrated that regional meteorology and climatology had demonstrated over the past that changes in land-uses and/or in land cover had substantial impacts on i) mean regional/local climate; ii) magnitude and duration of extreme events; c) air quality and therefore human's and ecosystems' health.

Such studies supported the hypothesis that urban planning measures may have significant beneficial effects on both CO2 emissions reduction (mitigation) and climate change impacts (adaptation).

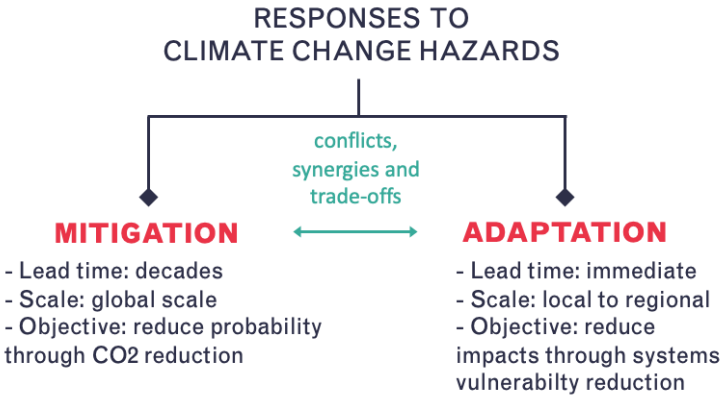

Figure 6: Two options to respond to climate change: mitigation and adaptation

Shalaby et al. (2017) support these statements observing that "urban planning has the potential to become a key factor in developing and implementing adaptive responses in urban systems".

As claimed by Reveco-Umaña (2023), "providing usable climate information to city planners and decision makers is considered a pre-requisite to develop robust urban adaptation strategies".

This statement outlines the inseparable connection between urban planning and climate resilience, in which climate services play a vital role by directing the choices in matters of planning at the local (city) scale.

An extensive study conducted within the EU Horizon 2020 funded MARCO (MArket Research for a Climate Services Observatory) project[15], provides a systemic and extensive analysis (371 providers analysed) of EU-based climate service providers. The final output is a systematic database that currently provides information on i) categorization of services providers; ii) categorization of the provided services; iii) categorization of services users (to whom these services are provided); iv) identification of targeted sectors (to which sectors the services are targeted); v) and on which geographic markets the services will be made available. The study revealed that the sector "urban/spatial planning" is included in the top-4 target sectors (water, energy, agriculture and urban/spatial planning) and that the 75,5% of the provided climate services end-users is the category of "public decision makers/politicians" (Cortekar et al., 2020). In fact, as well outlined in the Horizon 2020 funded EU-MAC (European Market for Climate Services) project[16] proposal, and more in particular in the section on urban planning, "urban planning is one of the most well-known user segments in climate services markets, and "urban planners and managers need a plethora of climate services"[17].

The Horizon 2020 funded project PUCS (Pan-European Urban Climate Service)[18] is an important experience in the field of climate services co-production and provision at the urban scale. It had as main output the establishment of Climate-fit.city[19], a new subject relying on a multidisciplinary team which provides urban climate services designed for responding to the specific needs of six sectors: mobility, energy, cultural heritage, emergency planning, health and urban planning. The set of services and tools aimed at supporting urban planning processes (hence, informing urban planners) constitute "the intelligence behind climate-resilient and low-carbon strategies" (Lefebre, 2022) and were developed by combining the a urban climate model UrbClim (De Ridder et al., 2015) and an interactive web-based GIS map tool. The final product is an interactive "urban planning scenario modelling tool" which allows end-users to create their own scenarios and simulate the expected impacts on climate resilience. The different maps on climate different hazards are then tailored to the needs of different sectors. Examples are maps on heat wave days, cooling/heating degree days, tropical nights, urban heat island intensities, temperature statistics, etc. The simulated scenarios are provided on cells of 100 m.

Data and information on climate parameters on the past, the present and the future are interpolated to obtain projections. Information on the past (historical, reference simulations) are elaborated on the basis of meteorological data provided by the Copernicus Climate Change Service (C3S)[20]. The climate model is based on land cover data extracted from the Copernicus Data Store (CDS) and combined with urban datasets (air temperature, humidity, wind speed, etc.): cities have to enter all their relevant and available data into the map: the more the provided data are and the more detailed, the more reliable will be the developed scenarios.

The developed services are the following:

1. Active mobility service;

15 https://cordis.europa.eu/project/id/730272/de
16 https://cordis.europa.eu/project/id/730500
17 https://eu-macs.eu/urban-planning/
18 https://cordis.europa.eu/project/id/730004
19 https://climate-fit.city/about-climate-fit/
20 https://climate.copernicus.eu/

2. Bike citizens analytics platform;
3. Building energy service;
4. Zoo management;
5. Urban spatial planning (focused on heat stress);
6. Heat-health service;
7. Emergency planning service;
8. Socio-economic impact service.

Climate-fit.city actually demonstrated that a "climate-wise" urban planning enables a reduction of Co2 emissions in cities and enhances cities resilience both to climate extremes and medium-long term changes in climate parameters, but such complex planning requires highly advanced climate services or multi-dimensional ones, providing information on vulnerability and adaptive capacity as well.

Any urban planning processes aiming at climate neutrality can be considered as characterized by three main phases: 1) understanding risks; 2) planning the interventions; 3) monitoring and evaluating the effectiveness [of the implemented interventions] (Giordano et al., 2020). The Horizon 2020 project EU-MACS[21](European Market for Climate Services) revealed how the segment of urban planning often overlooks the integration of climate services into its processes and identified the lack of monitoring tools for the evaluation of the implemented actions effectiveness (hence, phase number 3) as the main reason behind this under-utilisation.

CLIMABOROUGH intends to fill this gap by providing a robust climate neutrality indicator-based assessment framework to be applied in the evaluation of implemented actions.

Furthermore, the case-study elaboration carried out on Helsinki within EU-MACS project led to the identification of some main barriers to climate information integration into urban planning processes and collaborative planning for climate resilience: i) ambiguity in problem understanding; ii) difficulties detecting information gaps and needs; iii) lack of connections between different involved subject and between their available resources.

Climate services, hence, play a vital role in urban planning by providing accurate and localized climate data, projections, and risk assessments and support sustainable urban planning by advancing knowledge on how to mitigate climate change by reducing emission and at the same time how to adapt cities to climate change impacts, fostering urban resilience as well as by supporting planning to envision and quantify the contribution to climate neutrality of local actions.

As mentioned above, from the point of view of climate services, urban planning's primary goal is to create sustainable, functional and resilient urban environments. Climate information related to different aspects and availability from different sources is taken into consideration for different uses. Some examples follow:

- **Land Use Planning**: Climate-conscious land use planning considering factors like compact development, mixed land uses, and preserving natural areas to reduce energy consumption

21 https://eu-macs.eu/urban-planning/

and promote sustainable transportation options. In here climate services involve determining how land can be allocated for different uses such as residential, commercial, industrial, and green spaces taking into consideration different climate scenarios and risks;

- **Transportation Planning**: Urban planners focus on designing integrated networks that prioritize public transit, cycling infrastructure, and pedestrian-friendly environments to minimize reliance on private vehicles and reduce GHG emissions;
- **Green Infrastructure**: By the design and incorporation of green spaces, urban forests, parks, and permeable surfaces that helps mitigate the urban heat island effect, enhance biodiversity, and reduce stormwater runoff. Additionally by the planning of the integration of green infrastructure into city designs to improve air quality, regulate temperature, and provide recreational spaces;
- **Energy Efficiency and Renewable Energy**: by distilling climate information for considering passive solar design, green building codes, and district energy systems.

3. State of the art of Climaborough Cities

3.1 An assessment starting from the Net Zero Cities Applications

The Net Zero Cities (NZC) application called for expressions of interest from cities committing to achieve climate neutrality by 2030. Cities were required to provide information on their current situation, ongoing initiatives, and future plans in relation to climate neutrality. As outlined in its implementation plan, the Mission adopts a cross-sectoral and demand-led approach, seeking to create synergies with existing initiatives and tailor its activities to the specific needs of cities.
The Climaborough assessment aims to create a comprehensive analytical table that reflects the current state of the Climaborough leader cities' (CB Cities) progress towards achieving climate neutrality (Table 1).

Table 1: Climaborough leader cities and the Net Zero Cities programme. All the leader cities applied for expression of interest; 6 out of 8 were selected to be part of the 100 Climate-Neutral and Smart Cities by 2030

Leader cities:	**NZC**	**Leader cities:**	**NZC**
1 Turin (Italy)	Y	5 Grenoble-Alpes[22] (France)	Y
2 Athens (Greece)	Y	6 Sofia (Bulgaria)	Y
3 Ioannina (Greece)	Y	7 Cascais (Portugal)	X
4 Differdange (Luxembourg)	Y	8 Maribor (Slovenia)	X

The assessment examines the eight CLIMABAROUGH cities across four main sections:

- Plans and Ambitions,
- Sectorial Policies,
- Budget Assessment, and
- Governance.

The section on Urban Plans and Ambitions analyzes the existing climate targets and city plans, such as Urban Development Strategies or Green Infrastructures. It also includes the ambitions expressed by cities in their NZC application. The second section, Sectorial Policies and Targets, focuses on three key sectors where cities implement actions and policies: Energy, Transport, and Waste/Wastewater/Circularity. Within these sectors, cities are compared based on a checklist of relevant areas covered by current policies and the types of policies being implemented. The Budget Assessment section assesses the estimated capital requirements for financing climate-neutral actions and identifies the potential sources of investment considered to support them. Lastly, the Governance section explores various aspects such as the legal powers of cities to act in different

22 The partner of CLIMABOROUGH and NZC city is Grenoble-Alpes Métropole, the urban agglomeration of the City of Grenoble (which is a separate local authority).

areas, data collection and reporting, data monitoring, and partnerships established by cities to advance their climate policy agenda. The Governance section also encompasses research and innovation projects in which cities are involved.

3.2 Urban plans and ambition

The *Urban Plans and Ambition* section provides an overview of the current state of urban planning efforts towards achieving climate neutrality. It is divided into five subsections: Existing Reduction Targets, Residual Emissions, Existing Climate Urban Plans, Ambitions: Sectors and Policy Addressed, and Ambitions: Future Projects.

When examining *Existing Reduction Targets*, a diverse range of scenarios emerges in terms of the base year considered for emissions reduction and the percentage of reduction targeted. Turin, for instance, has officially adopted a target of at least 40% reduction by 2030 based on the year 1991, and it has already been achieved. In contrast, cities like Ioannina and Athens have recently set ambitious reduction targets for 2030, aiming for 40% and 61% respectively (with base years of 2019 and 2018). Table 2 provides an overview of the reduction targets set by the CLIMABAROUGH cities, without direct comparison, as the sectors considered and methodologies used vary. All cities, except for Differdange, have committed to the Covenant of Mayors, with Differdange being the only city yet to officially adopt a greenhouse gas (GHG) emissions reduction target.

Regarding *Residual Emissions*, most cities acknowledge that achieving absolute-zero emissions will be challenging, and they anticipate having more than 10% residual GHG emissions (except Ioannina, which plans for even greater reductions). These residual emissions are primarily expected to arise from the Transport sector (Athens and Cascais), as well as Agriculture and other soil-related issues (Ioannina and Maribor). Additionally, a minor portion of residual emissions is attributed to the Energy Generation and Industrial Production sectors.

Table 2: CLIMABOROUGHB cities existing reduction targets in terms of reduction percentage and residual emissions

	Reduction percentage	**Base year**	**Target year**	**time span (y)**	**% Reduction/ year**	**Residual emissions**
Ioannina	40%	2019	2030	11	3,64	0-10 %
Athens	61%	2018	2030	12	5,08	Over 20%
Grenoble-Alpes	50%	2005	2030	25	2,00	
Turin	40%	1991	2030	39	1,03	To be determined within the Mission

Maribor	20%	2018	2031	13	1,54	11-20 %
Sofia	40%	2007	2030	23	1,74	
Cascais	97%	2015	2050	35	2,77	Over 20%
Differdange	Planned					

We conducted a further analysis of the *climate urban plans* that cities had already developed prior to their application to the NZC program. All cities have a Sustainable Energy and Climate Action Plan (or Sustainable Energy Action Plan), and many also have additional plans that include greenhouse gas (GHG) emissions reduction targets (Figure 7). For example, Ioannina, Grenoble-Alpes, Turin, and Sofia have Sustainable Urban Mobility Plans in addition to their broader plans. Other cross-sectoral plans include Sustainable Urban Development Strategies (Athens and Differdange), a Green Infrastructure and Forest Plan (Turin), a Waste/Wastewater Management Plan (Grenoble-Alpes), a Municipal Program of Environmental Protection (Maribor), and an Air Quality Plan (Sofia).

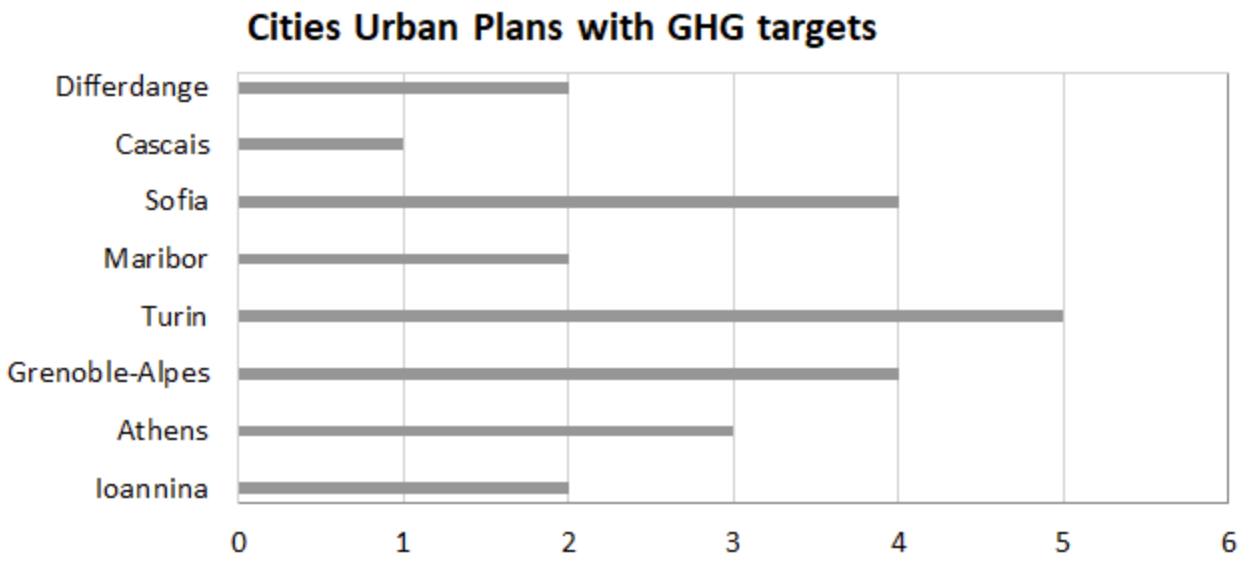

Figure 7: Number of cities urban plans including GHG reduction targets

Finally, we compared municipalities based on their *Ambition* for climate neutrality. After describing their vision for achieving climate neutrality by 2030, cities outlined a list of areas to address in order to reduce greenhouse gas emissions, as well as the policy instruments planned to support the necessary actions. In the stationary energy sector, all CLIMABAROUGH cities address areas such as Building Electrification, On-site and Nearby Renewable Energy Generation, Behavioral Changes, and Energy Efficiency in Public Lighting. Regarding the transport sector, the main spheres of focus include Cleaner/Efficient Vehicles, Accessibility of Public Transport, Modal Shift to Walking &

Cycling, and Park and Ride Facilities. In the waste sector, key areas of concern are Municipal Waste Prevention, Food Waste Prevention, Waste Separation, Wastewater Reuse, and the promotion of Circular Economy business models that encourage the reuse, repair, and/or recycling of products. Lastly, all CLIMABAROUGH cities also address Transversal Areas such as Urban Heat Island Effect Mitigation and Digitalization and Smart City Solutions.

These actions are intended to be supported by a variety of policy instruments across different planning sectors, with a shared emphasis on awareness raising and training. In the stationary energy sector, all CLIMABAROUGH cities have plans to promote renewable energy generation and improve energy management as means to achieve climate neutrality. Similarly, within the transport sector, all cities aim to implement regulations for sustainable urban mobility planning.

3.3 Sectorial policies and targets

Within the NCZ application, urban policies are described within three sectors that play a significant role in achieving climate neutrality: Energy, Transport, and Waste/Wastewater. Cities outline the current areas being addressed and the policies being applied in these sectors, providing a comprehensive overview of the progress towards sector objectives.

In the *Energy sector*, all cities are focused on approaches such as Nearly Zero Energy Buildings (NZEBs) and energy renovation/retrofitting of existing buildings (below NZEB level). Street lighting is another common area of action, along with efforts to mitigate the urban heat island effect. Maribor and Ioannina are leading the way in this sector, with current areas of focus ranging from the integration of renewable energy systems into buildings to the generation of on-site and nearby renewable energy (electricity, heat/cold). Citizen and renewable energy communities are also relevant areas being addressed (Table 03).

In terms of the policies currently being applied, there is one common point among CLIMABAROUGH cities: the implementation of technical measures. This includes actions such as smart metering and the provision of energy-efficient products and services. Among the CLIMABAROUGH cities, Grenoble-Alpes appears to be the most advanced, as they are currently implementing various types of policies proposed by the questionnaire. These range from regulatory actions such as building codes/standards, minimum energy performance standards, and public procurement rules to the enhancement of infrastructure measures such as power plant upgrades, increasing renewable energy capacity, and implementing smart grids.

Cities also provided other important information related to the energy sector. Regarding the building categories targeted by their plans, while all cities address residential and institutional buildings, only a few include social housing, commercial, industrial, and historical buildings in their plans (Maribor, Cascais, Differdange). The percentage of energy consumed from Renewable Energy Sources (RES) varies widely among the cities, ranging from 40% to 59% in Turin to below 20% in Maribor, Sofia, and Cascais. Grenoble-Alpes stands out with over 80% of energy generated from RES.

Table 3: Areas currently addressed by cities energy policy. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Nearly Zero Energy Buildings (NZEBs)	■	■	■	■	■	■		■
Positive Energy Buildings	■			■				
Nearly Zero Energy Buildings (NZEBs)	■	■	■		■	■		
Energy renovation/retrofit of existing buildings	■	■	■	■	■	■		■
Building electrification	■	■	■		■		■	■
Energy efficient electrical appliances					■		■	■
Integrating RES systems into the building	■	■		■	■	■		
Building Automation and Control Systems	■			■				■
Nearly Zero / Positive Energy Districts		■	■		■			
Digitalisation and smart city solutions	■	■		■	■	■	■	
Local heat/cold storage			■		■			
Street lighting	■	■	■	■	■	■	■	■
Citizen and renewable energy communities	■	■	■		■	■	■	■
On-site and nearby renewable energy generation	■		■		■	■	■	■
Local (off-site) renewable energy generation	■	■	■		■	■	■	■
District heating/cooling			■	■	■			■
Demand response						■		■
Virtual power plants					■	■		
Urban heat island effect mitigation	■	■	■	■	■	■	■	■
Mixed-use development and sprawl containment	■		■				■	■
Urban regeneration	■		■		■	■	■	■
Behavioural changes	■	■	■		■	■	■	■

Table 04 provides a comprehensive overview of the current policies in the *Transport sector*, giving a general picture of their progress. Firstly, it is evident that all cities have implemented measures to promote the use of efficient (electric) vehicles and have established park and ride facilities. Additionally, the enhancement of micro mobility, which includes self-service schemes for lightweight vehicles like bikes or scooters, is a common focus among all cities. Except for Athens, all cities also address the theme of improving the accessibility of public transport and the development of multi-modal hubs that integrate different transport modes. The promotion of modal shift towards walking and cycling is also recognized as an important area, with all cities except Turin actively implementing related policies. On the other hand, eco-driving, which emphasizes driving behavior and style to reduce fuel emissions, appears to be the least addressed area in terms of policy measures.

In terms of the policies currently being applied, all cities prioritize infrastructure measures, such as the creation of cycling lanes and the installation of recharging stations for electric cars. Planning solutions, such as Sustainable Urban Mobility Plans (SUMP) or integrated land use and transport planning, are also widely adopted. Cities also place importance on providing information and raising awareness among citizens, and technical measures are implemented, such as the use of smart cards for public transport.

Table 4: Areas currently addressed by cities transport policies. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Cleaner/efficient vehicles	■	■	■	■	■	■	■	■
Clean buses	■	■	■	■	■	■	■	■
Electric vehicles (incl.	■	■	■	■	■	■	■	■
Investment in metros and		■	■	■		■		
Accessibility of public transport	■		■	■	■	■	■	■
Modal shift to walking & cycling,	■	■	■		■	■	■	■
Car sharing			■		■	■	■	
Ride-sharing/car-pooling	■		■			■	■	
Park and ride facilities	■	■	■	■	■	■	■	■
Multi-modal hubs/integration	■		■	■	■	■	■	■
Micromobility	■	■	■	■	■	■	■	■
Mobility as a Service (MaaS)			■	■	■	■	■	■
Improvement of logistics and			■	■	■	■		■
Road network optimisation	■		■		■	■	■	
Mixed use development and	■		■				■	■
Digitalisation and smart city	■	■		■	■	■	■	
Eco-driving (driving behaviour	■	■				■		

The *Waste/Wastewater sector* aims to reduce municipal waste production and protect water resources through actions focused on the collection, treatment, and reuse of wastewater. Table 05 illustrates that all cities address the management of biodegradable waste and the prevention of litter in public spaces and/or marine areas. Municipal waste prevention, including food waste, and the promotion of sustainable buildings are also significant areas addressed by current city policies. Among the cities, Cascais is the most advanced in terms of waste/wastewater sector policies, covering all the areas mentioned in the NZC questionnaire.

Infrastructure measures, such as reprocessors, recycling centers, and waste-to-energy facilities, are commonly implemented policies in the waste/wastewater sector. Information and awareness-raising initiatives, including litter prevention campaigns and recycling campaigns, are also widespread. Additionally, voluntary measures involving stakeholders are powerful tools for incentivizing sustainable practices. Regulatory actions, however, are less frequently applied, with only six out of the eight CLIMABAROUGH cities implementing such measures.

Table 5: Areas currently addressed by cities waste/wastewater management policy. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Use of recycled and recyclable, renewable materials	■	■	■		■	■	■	
Management of biodegradable waste	■	■	■	■	■	■	■	■
Municipal waste prevention	■	■	■		■	■	■	■
Food waste prevention	■	■	■	■		■	■	■
Redirecting food surplus and food scraps	■		■	■			■	■
Litter prevention in public spaces and/or marine litter prevention	■	■	■	■	■	■	■	■
Industrial symbiosis between local businesses	■		■		■		■	
Sustainable buildings	■	■	■	■		■	■	■
Circular economy business models	■	■	■	■	■		■	
Efficient thermal treatment/ landfill management			■	■	■	■	■	■
Efficient waste /landfill gas to energy / fuel			■	■	■		■	■
Wastewater reuse	■			■	■	■	■	■
Stormwater management	■		■		■	■	■	■

3.4 Budget assessment

The budget assessment reveals that cities, in general, have a limited estimation of the capital requirements for financing climate-neutral actions. Among the CLIMABAROUGH cities, only Grenoble-Alpes and Maribor provide rough estimates, ranging from €300,000,000 (Grenoble-Alpes) to €959,000,000 (Maribor). Grenoble-Alpes indicates that 55% of the funding will be from their own funds, 40% from regional, national, and EU funds and financing, and 5% from private funding. Conversely, Maribor presents a different distribution, with 44% from private investments, 35% from regional, national, EU funds, and 15% from the city's budget, with the remaining coming from "other" sources.

Regarding investment strategies for the current climate action plan(s), the responses vary. Ioannina, Turin, Maribor, and Cascais mention their experience in financing specific projects, while Athens, Sofia, and Differdange are in the early stages of estimating investment needs. Grenoble-Alpes has multiple investment strategies at the sectoral level. Financing and investment readiness also refer to past investment initiatives and projects involving citizens, private capital investors, and technology/service providers. Some CLIMABAROUGH cities have developed relatively small projects with a few stakeholders (Athens, Grenoble-Alpes, Cascais), while others have undertaken larger projects with complex financial structures and multiple stakeholders (Differdange, Sofia). Turin and Ioannina have received assistance from the regional/national government in this regard.

Only a few cities have assessed the potential of capital markets as a source of climate funding and investment from local, regional, national, and international sources. These cities have taken steps towards establishing an investor community. For example, Grenoble-Alpes, Turin, and Cascais have gained experience in using financial products in combination with national/EU grants and subsidies. Turin has attracted private sponsorships and collaborated on urban commons through collaboration pacts for new landscaping and tree planting. Cascais has engaged with stakeholders in grant applications to develop pilot projects within the municipality and has also collaborated with private

stakeholders to support technology and innovation development. Grenoble-Alpes has utilized an approach primarily based on investments directly carried out by the Métropole, involving third-party investors for photovoltaic/solar systems and leveraging subsidies to individuals/companies for the conversion of wood heating systems and vehicles.

Most CLIMABOROUGH cities have actively worked with established investment/finance partners to create an investor-ready pipeline of projects contributing to climate neutrality. In many cases, this has involved the use of innovative financing instruments. For example, Turin is exploring options for implementing crowdfunding schemes, energy performance contracting, and social impact bonds.

3.5 Governance

Governance plays a critical role in enabling cities to achieve their climate neutrality goals. It encompasses various aspects such as legal powers, data collection and reporting tools or structures, monitoring mechanisms, collaboration through partnerships, and the development of research and innovation projects.

Having *legal powers* in specific fields is crucial for cities to overcome barriers and drive transformative change towards climate ambitions. Table 06 illustrates the analysis of the NZC application, highlighting common areas where all eight CLIMABAROUGH cities possess legal power to act, including Buildings & Construction, Transport, Green spaces / Green infrastructure, and Environment. Sectors typically associated with the private sector, such as Industrial emissions, do not fall within the sphere of policy decisions for cities. Agricultural emissions, is only within the scope of Sofia's legal powers. Urban land use and air quality are areas where all cities, except Athens, assert their legal power to act. Other planning fields where cities report having legal power include Economic development, Waste/wastewater management, Water Resource Management, and Disaster risk.

Having the legal authority to act in these areas empowers cities to implement effective policies and measures to address climate change and work towards achieving climate neutrality. It provides a foundation for cities to lead and drive sustainable transformations within their jurisdictions.

Table 6: Planning fields in which cities have legal powers to act/make policy decisions. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Buildings & Construction	■	■	■	■	■	■	■	■
Economic development	■		■		■	■	■	■
Energy demand in buildings			■	■		■	■	■
Energy supply			■		■	■		■
Transport	■	■	■	■	■	■	■	■
Public Health		■			■	■	■	
Waste/wastewater management	■		■		■	■	■	■
Industrial emissions						■		
Agricultural emissions								
Urban land use	■	■	■	■	■	■	■	■
Green spaces / Green infrastructure	■	■	■	■	■	■	■	■
Water Resource Management	■	■	■		■	■		■
Air quality	■		■	■	■	■	■	■
Environment	■	■	■	■	■	■	■	■
Disaster risk	■	■			■	■	■	■
Finance & Investment		■			■	■	■	■

Data collection and reporting are essential for cities to track their progress, evaluate the effectiveness of their policies, and make informed decisions. The CLIMABOROUGH cities provided information on their data collection and reporting practices, with variations among them.

Regarding monitoring and evaluation systems for existing plans, Athens, Grenoble-Alpes, Turin, and Cascais reported conducting annual monitoring, evaluation, and updates of their climate change policies. Differdange carries out monitoring annually but evaluates and updates its policies every three years (at least). Maribor does not have any monitoring or evaluation system in place and updates its policies every five years (at least). Ioannina conducts monitoring at least every three years and evaluates and updates its policies at least every five years. Sofia's data on monitoring and reporting is not available in this section.

Table 07 provides an overview of the sectors covered by data collection and reporting. The common areas where data is collected and reported by all CLIMABAROUGH cities are Street lighting (in the Energy sector), Public transport (in the Transport sector), and Public services (in the Waste sector), except for Cascais. In the Energy sector, most cities report on Renewable energy generation, Residential buildings, and District heating/cooling. Passenger cars (vehicle kilometers traveled or similar) and Private homes/households are covered in the reports related to the Transport sector and Waste/wastewater sector, respectively.

By collecting and reporting data in these sectors, cities gain valuable insights into their energy consumption, transportation patterns, waste management, and other relevant areas. This information helps them assess their progress, identify areas for improvement, and make data-driven decisions to advance their climate neutrality goals.

Table 7: Areas and sectors where data are regularly collected by cities. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Eneregy								
Residential buildings	■	■	■		■		■	
Commercial buildings and facilities	■		■		■		■	
Institutional buildings and facilities	■	■	■	■	■		■	■
Industrial buildings and facilities	■		■		■		■	■
Street lighting	■	■	■	■	■		■	■
Renewable energy generation	■	■	■		■		■	■
Non-renewable energy generation					■			■
Co-generation			■		■			■
Energy production from waste/wastewater	■		■	■				■
Local heat/cold storage								
Transport								
Passenger cars (vehicle km traveled or similar)	■	■	■	■	■			■
Public transport (mode share)	■	■	■	■	■		■	■
Urban freight and logistics (vehicle km traveled or similar)								
Cycling (mode share)			■		■			■
Walking (mode share)			■					
Micromobility (mode share)	■	■	■	■	■	■	■	■
Real-time transport data	■	■	■	■	■	■	■	■
New transport technologies							■	
Waste/Waste water								
Private homes/households		■	■	■	■			■
Public services (i.e. schools, hospitals, municipal buildings)	■	■	■	■	■			■
Businesses/industry		■	■	■	■			

The involvement of various stakeholders is crucial for the successful formulation and implementation of climate change mitigation and greenhouse gas (GHG) emissions reduction policies in cities. Table 08 illustrates the main stakeholders currently involved according to the information provided in the NZC questionnaire.

The figure shows that all CLIMABOROUGH cities recognize the importance of involving the National government in their climate agendas. This is understandable as national governments play a significant role in setting policies, providing resources, and creating enabling frameworks for local climate action. Academia/Research & Innovation (R&I) institutions, Citizens, NGOs and associations, and the Youth & Education sector are also widely recognized as important stakeholders in the formulation and implementation of climate policies by all CLIMABAROUGH cities. These stakeholders contribute valuable expertise, knowledge, and community engagement, which are essential for driving sustainable solutions and behavioral changes.

Interestingly, the involvement of Regional government and Neighboring local/regional government varies among the CLIMABOROUGH cities. While some cities actively engage with their regional counterparts, others may have more limited collaboration in this aspect. The private sector and utilities are highly involved in the cities' climate agendas, which reflects the importance of business and industry in driving innovation, investment, and technological advancements towards climate neutrality.

In summary, the engagement of a diverse range of stakeholders, including national governments, academia, citizens, NGOs, the private sector, and utilities, is crucial for cities to effectively tackle climate change and achieve their emission reduction targets. Collaborative efforts and partnerships with these stakeholders can bring together a wide array of resources, expertise, and perspectives to drive meaningful change at the local level.

Table 8: stakeholders currently involved by CLIMABAROUGH cities in formulating and implementing climate change mitigation/Greenhouse Gas (GHG) emissions reduction policies. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
National government	■	■	■	■	■	■	■	■
Regional government	■		■	■	■			■
Neighbouring local/regional government	■		■	■	■			■
Academia / Research & Innovation (R&I) institutions	■	■	■	■	■	■	■	■
Private sector	■	■	■	■	■	■		■
Citizens	■	■	■	■	■	■	■	■
Vulnerable groups		■		■				■
Financial institutions	■	■	■	■				■
Trade unions		■		■				■
NGOs and associations	■	■	■	■	■	■	■	■
Utilities	■	■	■	■	■	■		■
Citizen and renewable energy communities	■	■	■			■	■	■
Youth & education sector	■	■	■	■	■	■	■	■

Support from stakeholders is crucial for cities in formulating and implementing the climate agenda. Cities receive support in policy formulation, capacity building, financial assistance, project opportunities, and dissemination/outreach. This collaboration ensures alignment with broader strategies, enhances knowledge and skills, provides funding for projects, and helps raise public awareness. Table 09 shows the support received by CLIMABOROUGHcities, to advance their climate policy development and implementation.

Table 9: Areas of support currently received by CLIMABAROUGH cities. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of support received	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Policy and regulation formulation	■	■	■	■	■	■		■
Capacity building	■		■	■	■	■	■	■
Financial advisory services and resource Mobilization	■					■		■
Access to tools and skills	■		■		■	■		■
Coordination	■		■		■	■		■
Technical and strategic assistance	■		■		■	■		■
Financial support and opportunities for projects' development	■	■	■	■	■			■
Assistance in dissemination, outreach, awareness raising initiatives	■	■	■		■	■		■
Regular and systemic reporting	■				■		■	■

On the other hand, Table 10 illustrates the areas where cities require more support. The main support needed by cities includes assistance in policy and regulation formulation, financial advisory services and resource mobilization, as well as financial support and opportunities for project development and implementation. Collaborating with regional and national governments, research institutions, financial entities, and private sector partners is crucial to meet these support needs and advance cities' climate agenda effectively.

Table 10: Areas of support needed by CLIMABAROUGH cities. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of support needed	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Policy and regulation formulation	■	■	■	■	■	■		
Capacity building								
Financial advisory services and resource mobilisation	■			■			■	■
Access to tools and skills		■						■
Coordination					■	■		
Technical and strategic assistance		■				■	■	
Financial support and opportunities for projects'development			■	■	■		■	
Assistance in dissemination, outreach, awareness raising initiatives			■					
Regular and systemic reporting	■							■

Table 11 highlights the partnerships between CLIMABOROUGH cities and the private sector in driving climate neutrality. The main areas of collaboration include public-private partnerships for climate-neutral infrastructure and services, climate neutrality in business operations and value chain improvement, and the promotion of start-ups and green job creation. These partnerships facilitate the implementation of innovative solutions, leverage private sector resources and expertise, and contribute to the overall goal of achieving climate neutrality by 2030. Research and innovation also play a vital role in these collaborations, driving technological advancements and supporting the development of sustainable solutions.

Table 11: Cities collaboration with the private sector to advance its climate policy agenda. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Private sector provides financial & insurance services in the transition to climate neutrality	■							■
Public Private Partnerships for climate neutral infrastructure and services	■	■	■	■	■			■
Crowdfunding from companies and SMEs in climate neutral infrastructure and services								
Climate neutrality in business operation and improving value chains	■	■	■		■	■		
Promoting start-ups and green jobs creation	■	■	■			■		■
Establishment of net-zero goals								
Research & Innovation, new technologies	■		■			■		■

Citizen engagement is a key aspect in achieving their climate neutrality goals. Table 12 illustrates the various activities implemented by CLIMABAROUGH cities to involve citizens in the process. These activities include informative practices and awareness-raising events, deliberative practices for evaluating options and co-creating plans and actions, and educational activities and programs. Ad-hoc co-creation engagement practices, participatory budgeting to prioritize actions, and participatory urban planning are also utilized to actively involve citizens in decision-making processes. These initiatives aim to empower citizens, gather diverse perspectives, and ensure that climate actions reflect the needs and aspirations of the community.

Table 12: Citizen engagement activities put in place by cities. Abbreviations: IOA (Ioannina), ATH (Athens), GAM (Grenoble-Alpes), TORO (Turin), MARI (Maribor), SOFIA (Sofia), CASCA (Cascais), DIFF (Differdange)

Areas of current policy address	IOA	ATH	GAM	TOR	MARI	SOFIA	CASCA	DIFF
Deliberative practices to judge options or co-create plans and/or actions	■	■	■	■	■	■		■
Informative practices and awareness-raising events	■	■	■	■	■	■	■	■
Participatory budgeting to prioritise actions		■	■		■		■	■
Participatory urban planning			■	■	■			■
Ad-hoc co-creation engagement practices	■		■	■	■	■		■
Educational activities and programmes	■	■	■	■	■	■	■	■

4. Learning from advanced urban plans

4.1 Three cases under the lens

In this Chapter we analyze the climate strategies developed by three different cities (2 European and 1 out of Europe). The scope is to highlight the large quantity of approaches to climate strategy that cities are adopting whatever is normative/methodological/policy framework they are following.

One of them, Valencia, has been selected among the 100 European cities committed to achieve climate neutrality by 2030. In April 2022, Valencia was chosen by the European Commission as one of the 100 European cities where it will focus its efforts to accelerate the necessary transformation and turn València into a hub of European innovation in the necessary climate, economic and social transition. In the same way, and in line with the proposal for multi-level governance, the Generalitat Valenciana has recently secured the selection of the Valencian Community as one of the European regions where the mission for adaptation to climate change will be deployed. In line with the innovation mission proposed by the European Commission to achieve 100 smart and climate-neutral European cities by 2030 with the help of (and on behalf of) the citizens, Valencia City Council anticipated its first major consensus on València's missions in 2021 by approving, in a plenary session and once again with a large majority, the first of its missions: the Valencia 2030 Climate Mission.

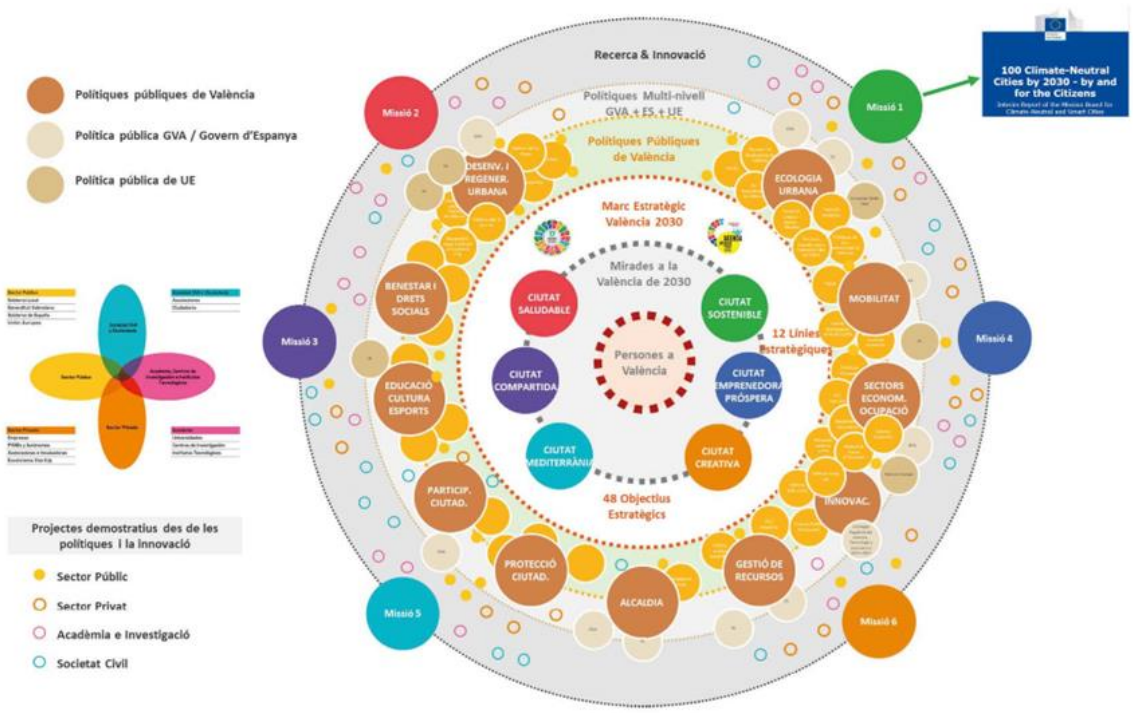

Figure 8: Strategic Framework of the city of Valencia. Source: València 2030 Urban Strategy. Local Action Plan. Available at: https://estrategiaurbanavlc2030.es/en/

The other two cases, namely Amsterdam and San Francisco, have been selected from the Carbon Neutral Cities Alliance catalogue[23]. The Carbon Neutral Cities Alliance (CNCA) is a collaboration of leading global cities working to achieve carbon neutrality in the next 10-20 years – the most aggressive GHG reduction targets undertaken anywhere by any city. It includes several global tier 1 cities: Adelaide, Amsterdam, Boulder (Colorado, USA), Copenhagen, Glasgow, Helsinki, London, Melbourne, Minneapolis, New York, Oslo, Portland, Rio de Janeiro, San Francisco, Seattle, Stockholm, Sydney, Toronto, Vancouver, Washington DC, Yokohama. After a preliminary view of the synthesis, Amsterdam and San Francisco resulted to be two interesting cases of study, on top of Valencia. Even though we initially included the city of Copenhagen, we decided not to deepen its strategy in the final draft. In fact, although there is a climate-neutral plan by 2025 (which was designed in 2017, far

23 https://carbonneutralcities.org

before the introduction of the EU Climate Neutrality Mission), it does not work within the framework of an Urban Planning action for the climate-neutrality mission. Therefore we opted for Amsterdam, which made a similar decision to Valencia while designing a new plan right after her admission to the EU Climate Mission. Finally, San Francisco represents an out-of-box case of study that serves to see how global capitals are facing climate neutrality in absence of a major guideline policy framework (the EU mission).

The City of Amsterdam aims to have the city's CO2 emissions decreased by 55% in 2030 and by 95% in 2050 compared to 1990 (used as a reference year). The city will move over to 100% sustainably generated energy. In 2040, Amsterdam will no longer use natural gas and aim for all traffic to be emission-free as early as 2030. The municipal organization will also be climate neutral by 2030. Amsterdam decided to implement its Roadmap to Climate Neutrality 2050 through a Green Infrastructure spatial plan, and implement Nature Based Solutions as part of the Structure Spatial Vision by 2040. Interestingly, the vision is included in the Strategy on Spatial Planning and the Environment (Omgevingsvisie). In the Zoning Plan (Omgevingsplan), details on Nature-Based Solutions application are included as part of the ordinary regulatory framework for urban planning.

San Francisco's climate neutrality strategy is attractive from many points of view: it is an extra EU case which does not act within the framework of the Climate Neutrality Mission. It includes a dedicated section on Transportation, and Land Uses and, finally, it has been designed to foster the social equity of a fair transition by co-designing the solutions through participation.

4.2 Valencia Urban Strategy 2030

The objective of the València 2030 Climate Mission is to transform Valencia into a city that is climate-neutral by 2030. This mission is aligned with the larger European goal of achieving 100 climate-neutral cities by 2030. Valencia aims to contribute to the European Union's target of reducing climate emissions by 55% by 2030 and achieving climate neutrality by 2050.

What makes València's proposal unique in the context of mission-driven innovation is that it has been developed based on the Valencia 2030 Urban Strategy itself. This strategy merges political action with innovation, ensuring that the city's efforts are directed towards the success of the climate mission. The strategy encompasses ten strategic objectives that guide urban policies while considering the specific circumstances of each locality:

- Land-use planning and rational land use, conservation, and protection.
- Promoting social cohesion and striving for equity.
- Avoiding urban sprawl and revitalizing the existing city.
- Promoting and supporting the urban economy.
- Preventing and mitigating the effects of climate change while enhancing resilience.
- Ensuring access to housing.
- Sustainable resource management and fostering a circular economy.
- Leading and promoting digital innovation.
- Encouraging proximity and sustainable mobility.
- Enhancing intervention tools and governance.

To support the overall Strategy, six documents have been created:

- **Diagnosis**: Provides an assessment of the current situation.
- **Strategic Framework**: Outlines the key principles and direction for action.
- **Action Plan**: Specifies the steps and initiatives to be implemented.
- **Governance Model**: Defines the structure and processes for decision-making and coordination.
- **Monitoring and Evaluation System**: Establishes mechanisms to track progress and assess outcomes.
- **Graphic Documentation**: Provides visual representations to aid in understanding and communication.

Through the Valencia 2030 Climate Mission and the comprehensive Strategy, the city aims to actively contribute to the European mission while addressing local challenges and leveraging innovation for a sustainable and climate-neutral future.

The Strategic Diagnosis Valencia has implemented provides a comprehensive summary of the information gathered throughout the process described in the text above. It is structured into two main sections:

- The first chapter focuses on the challenges identified for the city in 2020, which served as the foundation for the 2021 Strategic Framework.
- The second chapter presents data and details related to the 12 strategic lines outlined in the revised 2022 Strategic Framework.

The Strategic Diagnosis document consolidates all the essential information crucial to developing the Action Plan for the Valencia 2030 Urban Strategy. It is organized around Challenges, with each Challenge comprising the following components:

- **Description**: A concise overview of each Challenge.
- **Linked themes**: A list of sub-themes associated with each Challenge, derived from the city's strategies.
- **Fit with the local agenda**: The extent to which each Challenge is mentioned in the analyzed strategies (Government Plan, Covid-19 Framework Agreement, València 2030 Missions, and Special Plan for Urban Quality Guidelines).
- **Starting point**: The strengths and weaknesses associated with each Challenge, based on the strategies and indicators developed for València.
- **Observations**: Insights provided by area managers in the City Council during interviews regarding the identified challenges.

The Diagnosis also incorporates the strengths, weaknesses, opportunities, and threats identified by workshop participants and interviewees, aligning them with the 12 Strategic Lines. Each Strategic Line is further analyzed within the context of the Strategic Framework 2022, including its description, alignment with the Sustainable Development Goals (SDGs) and the Special Urban Agenda (SUA), descriptive data and indicators, analysis of the 25 plans and strategies mentioned above, as well as a SWOT analysis of the consultation process.

SL1 - Climate resilience, land use and city rewilding
SL2 - Fair and inclusive energy transition
SL3 - Sustainable, Inclusive and Efficient Urban and Metropolitan Mobility
SL4 - Sustainable and local food
SL5 - Inclusive and local city
SL6 - Urban regeneration based on social cohesion, accessibility and sustainability
SL7 - Accessible and sustainable housing
SL8 - Associative fabric and intergenerational and intercultural citizen networks
SL9 - Well-being, education and health, at all stages of life
SL10 - Inclusive and sustainable economic development
SL11 - Innovation, culture and sustainable tourism
SL12 - Urban and Metropolitan Governance

The twelve strategic Lines are further empowered by six visions to support the Strategy: Healthy city, Sustainable city, Shared city, Prosperous and enterprising city, Creative city, Mediterranean city. Visions are transformed into projects by using the recovery funds for transformation actions also aiming at attracting private capitals.

In Table 13 below, the synthesis of the most significant initiatives related to the strategy.

Table 13: Key initiatives of the Valencia strategy

Strategic Framework	The Strategic Framework of València serves as the guiding document for the development of the València 2030 Urban Strategy. It consists of city visions, strategic lines, and objectives, with a particular emphasis on innovation missions. These missions are defined in strategic policies, programs, and projects that aim to foster dialogue and involve various stakeholders within the city. To facilitate this dialogue, the València 2030 Urban Forum took place in May 2022, attracting over 1,500 participants and featuring 55 influential speakers from diverse fields. Their contributions greatly enhanced the content of the strategy. While the Strategic Framework primarily focuses on the city itself, it is crucial to adopt a metropolitan perspective during its development. This approach ensures the incorporation of essential elements at the appropriate scale and facilitates the integration of the city with its surrounding territorial environment. Moreover, the entire process must address significant challenges stemming from the climate emergency and increasing social inequality. Additionally, it should prioritize the promotion of human rights as a guiding principle for sustainable, inclusive, innovative, and intelligent economic development. By advancing the transformation of the city across various dimensions, these objectives can be achieved.
Implementation through Demo Projects	An essential element of this strategic framework is the role of demonstration projects, which allow the practical coordination of solutions to the challenges identified and demonstrate the way forward for the fulfillment of the strategic objectives. These transformative projects are driven from both the public and private spheres and are an essential part of the city's strategic framework because they make the process dynamic through a planning- and action-based approach.
Action Plan	The Local Action Plan of València outlines the complete set of actions for implementing the València 2030 Urban Strategy. It encompasses programs, lines of action, and projects that directly align with the strategic lines and objectives established in the València Strategic Framework. This framework not only defines the Urban Agenda for the city but also ensures its alignment with mission-oriented innovation policies, specifically through the València 2030 Climate Mission. The Local Action Plan serves as a dynamic portfolio of actions and opportunities that will be regularly updated through the governance system. It remains open to incorporating new opportunities that may arise for the city in the future.

	Budget estimates have been included for the programs based on the projects outlined within each Line of Action. These estimates were made as of September 2022 and may be subject to modifications during the operational implementation by the respective Government Departments. It is important to note that the budget estimate is not exhaustive, and some Lines of Action have not been included due to a lack of specific details and available information.
Governance Model	The València 2030 Urban Strategy is a strategic document that does not have a regulatory nature. However, by embracing the principles of Open Government, which emphasize transparency, participation, and collaboration among various government and civil society actors, it holds significant potential for transformative social, economic, and environmental sustainability. The Spanish Urban Agenda aims to move away from compartmentalized approaches and promote cross-cutting solutions at all levels. This can only be achieved through a strong political commitment that initiates an open and participatory process both internally and externally. To truly bring about transformation, the Urban Agenda must be led by the mayor's office and co-led by various government bodies, as well as actively involve the social, business, trade union, entrepreneurial, and academic sectors. Robust and effective public participation is also essential.
City Social Council	The City Social Council serves as the highest consultative and participatory body in València. It plays a crucial role in the development of the València 2030 Urban Strategy. The council comprises representatives from a wide range of institutions, organizations, and entities within the city. It includes members from government bodies, public institutions, civil society organizations, and the private sector. Each member represents their respective institution, organization, or entity. The City Social Council will establish an Urban Strategy Commission, which will drive and promote the strategy. The commission will have a diverse composition and will work closely with the Steering Committee, validating all work, schedules, agendas, and topics related to the city strategy.
Council of Representatives	Upon designation by the Local Government Board and proposal from the mayor's office, a Council of Representatives may be formed. It will consist of individuals with personal prestige and credibility, providing an external perspective on institutional and organizational frameworks. The council will include prominent figures from various sectors such as culture, art, science, business, academia, sports, and civic engagement. Its composition should be diverse and gender-balanced, contributing ideas and content for shaping the desired future of València.
Urban Strategy Coordination Committee	The Strategy Coordination Committee comprises individuals appointed by the Local Government Board in relation to urban strategies, the urban agenda, or strategic initiatives. It receives support from coordinators representing different government areas. The committee is responsible for overall coordination, proposing working group compositions, establishing timelines, making operational decisions, organizing schedules and agendas, and ensuring effective management and coordination of the plan's implementation. It operates with administrative support from a management office.
Thematic Roundtables and Working Groups	The city strategy is structured around strategic challenges with a cross-cutting nature. Thematic roundtables or working groups can be established for each challenge to facilitate debate, dialogue, and public participation. These groups should be designed to address the concerns, suggestions, demands, and expectations of citizens in a comprehensive manner. They will have a mixed composition, following the quintuple helix approach, involving actors from the public administration, private sector, civil society, academia, research, and media. These groups aim to foster cross-sectoral collaboration and incorporate a holistic approach to address city issues. Typically, these groups consist of a directorate, secretariat, and both permanent and temporary members based on the topics being addressed. Gender perspective and other specific perspectives, such as those of the elderly or children and adolescents, will be considered during their work.
València 2030 Urban Forum	The València 2030 Urban Forum is a biennial event that serves as a continuation of the reports produced to monitor the València 2030 Urban Strategy. Its purpose is to provide an ongoing space for public debate and participation on relevant issues.
Citizens' Climate Assembly	As part of the València 2030 Climate Mission, an experimental citizens' assembly will be created to analyze, deliberate, and propose actions and solutions for addressing the climate emergency in the city. This assembly will consist of approximately 100 randomly selected individuals aged 16 and above. Participants will receive training from experts to develop a comprehensive understanding of the city's

	situation. Based on this knowledge, they will generate proposals for the city council and other stakeholders. The selection process for the assembly will ensure a stratified representation in terms of gender, age, origin, neighborhood, and other factors.
Demonstration Projects	Demonstration projects offer opportunities for different actors to learn and collaborate effectively in real-life situations, addressing key concerns. These projects prioritize implementation without extensive funding efforts. They are particularly suitable for participatory design and helpful in identifying obstacles, institutional issues, management challenges, and other aspects critical for subsequent expansion. Urban Living Labs concept can be employed in demonstration projects, facilitating participatory and collective learning processes to develop and test innovative solutions for climate change and urban sustainability challenges. These projects also contribute to the governance mechanisms necessary to foster collaboration among stakeholders and scale up the proposed solutions.
Battery of Indicators	This is a single document that outlines a set of indicators for evaluating the objectives outlined in the València Strategic Framework within the València 2030 Urban Strategy. The indicators have been filtered based on three criteria. First, they must be applicable at the city level according to the methodology of the Joint Research Centre (JRC) of the European Commission. Second, they should align with the specific objectives of the Spanish Urban Agenda, as defined by the Spanish Ministry of Transport, Mobility, and Urban Agenda. Lastly, the indicators must be in line with the goals established by València City Council in their document on the strategic axes, lines, and objectives. The indicators are divided into two categories. Effort indicators focus on measuring the progress of project implementation, such as budget expenditure or resource utilization. Result/impact indicators, on the other hand, assess the achievement of objectives, such as unemployment rate, Gini Index, CO2 emissions, and indicators related to the measurement of citizens' quality of life. Both types of indicators are necessary to evaluate the impact and effectiveness of the strategies and actions undertaken.

4.3 New Amsterdam Climate

The climate initiative in Amsterdam includes a Roadmap towards Amsterdam neutrality by 2050, the Amsterdam vision 2050, and an implementation plan.

4.3.1 Roadmap. Amsterdam Climate Neutral 2050

The Amsterdam roadmap document begins by assessing current greenhouse gas emissions in Amsterdam, exploring their historical context and providing insights into future projections. The strategical roadmap document outlines the challenge ahead and the impact of the measures. It manages the transition by utilizing a Climate Budget and describes an approach that is based on four transition paths: (1) Built Environment, (2) Mobility, (3) Electricity, and (4) Harbour & Industry.

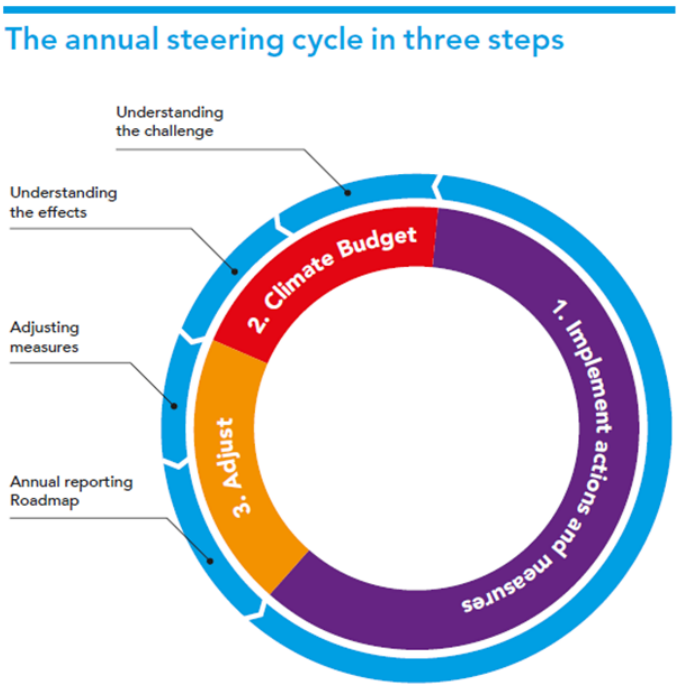

Figure 9: Annual Steering Cycle. Source: New Amsterdam Climate. Roadmap. Amsterdam Climate Neutral 2050. Available at: https://www.amsterdam.nl/en/policy/sustainability/policy-climate-neutrality/

The term "energy transition" is frequently used in the roadmap. It refers to the shift from a world reliant on fossil fuels to one that exclusively relies on renewable energy from perpetually available sources. This transition necessitates a comprehensive societal transformation that will affect the economy and daily lives.

The document starts with the assessment of greenhouse gas emissions at the present level, providing insights into the past, present, and future emissions in Amsterdam. Chapter 1 of the strategic roadmap document presents a vision of the energy transition in Amsterdam, outlining the essential elements of the strategy to shift from fossil fuels to renewable energy. Chapter 2 takes a systematic approach with the Climate Budget, offering a quantitative analysis that provides insights into the proposed measures and their effects. Chapter 3 focuses on four transition paths: Built Environment, Electricity, Mobility, and Harbour & Industry. Each path comprises multiple pillars, totaling sixteen, which detail the actions planned to reduce carbon emissions. In Chapter 4, the pillars encompass measures that may not directly result in lower carbon emissions but are vital for the energy transition in Amsterdam. These include collaboration, climate justice, innovation, space and energy infrastructure, financing, and regulations.

To make a substantial contribution towards achieving the Paris climate targets, the goal is to reduce CO2 emissions in Amsterdam by 55% in 2030 and 95% in 2050 compared to the reference year of 1990. The aim is to phase out natural gas by 2040 and eliminate all carbon emissions from transportation by 2030. The municipality also strives to become a climate-neutral organization by 2030. By 2030, the use of new raw materials will be halved, and the objective is to establish a 100% circular economy by 2050. The transition involves phasing out fossil fuels such as oil, natural gas, and coal in favor of 100% sustainably-generated energy. Additionally, the city will focus on becoming "climate adaptive" by effectively addressing the inevitable consequences of climate change.

The roadmap emphasizes the following points:

1. The energy transition necessitates a societal transformation.
2. Climate justice is a guiding principle.
3. Collaboration is encouraged.
4. The municipality takes the lead.
5. Responsible practices are upheld as a capital city.
6. In a broader context, the roadmap includes a chapter titled "The Spatial Vision and the Spatial Plan."

The transition paths identified in the roadmap include:

- The built environment (transition to gas-free, energy-efficient buildings, and climate-neutral urban growth).
- Mobility (aiming for emissions-free Amsterdam by 2030).
- Electricity.
- Harbour and Industry.

4.3.2 The Amsterdam vision 2050

The Spatial Vision outlines Amsterdam's image for 2050, focusing on a green and livable city for people, plants, and animals. It serves as a guide for the future, drawing input from the Amsterdam Climate Neutral Roadmap, the Regional Energy Strategy, and the Transitievisie Warmte. The Spatial Plan offers opportunities for facilitating or regulating activities that contribute to the energy transition.

The Climate Budget serves as the quantitative aspect of the roadmap. This chapter provides insights into the emissions attributed to Amsterdam, amounting to 5,000 kt of CO2 annually. It offers a comprehensive understanding of the figures and quantitative effects of the planned actions and measures across all transition paths and portfolios. Taking into account autonomous developments, the specific actions and measures outlined in the roadmap are expected to result in a 48% reduction in CO2 emissions in Amsterdam by 2030. The calculated range falls between -21% and -55%, indicating that a 55% reduction is attainable. The Climate Budget will be regularly updated to gain a deeper understanding of the challenges ahead and the impact of planned actions and measures. Progress will be assessed through annual reporting on the roadmap. The concept of climate justice acknowledges that the consequences of the transition from fossil fuels to renewable energy may affect different residents and neighborhoods unequally. The guiding principle for the Municipality of Amsterdam is to prioritize climate justice.

The vision outlines how this vision can be achieved. It considers various aspects such as green infrastructure, mobility, sustainable energy systems, affordable housing, and social safety in a comprehensive manner. It discusses the significance of green infrastructure for urban life, emphasizing four main reasons: health, social well-being, climate adaptation, and nature. These reasons emerged as the most important topics based on conversations with professionals, community organizations, institutions, and residents in Amsterdam. Also it establishes the guiding principles to realize the green city by 2050. Projects will adhere to these principles in terms of policies, maintenance planning, resource allocation, and collaboration with residents, community organizations, businesses, and institutions.

As per the green infrastructure it concentrates efforts on connecting and enhancing green areas within the city to improve both a resilient green structure and more resilient areas. This structure encompasses a diverse range of vegetation and green infrastructure, including flowers, trees, quiet areas, busy centers, ecological zones, and green playgrounds.

Figure 10: The Green City. Source: Amsterdam Green Infrastructure Vision 2050. A liveable city for people, plants, and animals. Available at: https://www.amsterdam.nl/en/policy/sustainability/policy-climate-neutrality/

The elements of the green city include:

- Green buildings (featuring green facades, roofs, courtyards, and gardens)
- Community green spaces (found in streets, squares, along waterways, and neighborhood parks)
- Park areas (encompassing city parks, sports parks, and allotments)
- The landscape surrounding the city, including designated "green gems"
- Greenways and "green-blue connections" (such as green streets, waterfront areas, and green corridors)

Accessibility is an important aspect, with the goal of having a park-like public space within a 10-minute walking distance from homes and a large green area on the outskirts of the city reachable within 15 minutes of cycling. The integration of multifunctionality and biodiversity into urban planning, construction, and management is emphasized.

The vision establishes the link between guiding principles and ambitions for 2050. It aims to create a robust green infrastructure that extends from individual buildings in the city to the surrounding metropolitan landscape. Each type of green element is discussed in terms of the envisioned green structure and the necessary actions to be taken. These directions for action will be further developed and detailed in the forthcoming green infrastructure implementation program. Chapter 3 serves as

the core of the green infrastructure strategy, illustrating the use of nature-based solutions (NBS) such as green and blue connections through Green Buildings, Green Neighborhoods, Park areas, and the landscape surrounding the city. A map is provided to demonstrate the development of green and green-blue connections in the future, showcasing how these connections interconnect and link neighborhoods with larger green areas in the city. Examples include green high streets, walking and cycling routes, tree-lined avenues, green waterfronts, and green quay walls.

Green Buildings are presented as opportunities to incorporate rooftop gardens or living roofs alongside solar panels, terraces, or spaces for activities. Green neighborhoods emphasize the importance of permeable and green street and public spaces, even in narrow streets. Park areas encompass various public city parks, forests, and green spaces, including non-fully public areas like allotments, school gardens, cemeteries, and sports parks. Distribution of these areas throughout the city is crucial, and while the City manages park areas, volunteers can contribute to their maintenance. The landscape surrounding the city seeks to transform the crests of green gems into landscape parks, designed in accordance with their green character. Examples include Brettenzone, Tuinen van West, Waterland, Diemerscheg, Amstelscheg, or Amsterdamse Bos.

Finally the vision addresses the requirements for realizing the green infrastructure vision in terms of organizational structure, finance, knowledge, communication, collaboration, research, and evaluation.

4.3.3 The implementation plan

The implementation plan:

- provides each of the 7 city districts with a map illustrating opportunities to add or improve green infrastructure. Projects aligning with the vision's goals will be prioritized based on available budgets for construction and management.
- Updating current standards for green space in new urban developments to align with the Green Infrastructure Vision's objectives.
- Updating the Main Green Structure, a component of the Structure Vision 2040, to be included in the Strategy on Spatial Planning and the Environment (Omgevingsvisie). More detailed information about the Main Green Structure will be incorporated into the Zoning Plan (Omgevingsplan).

The creation, design, and management of green spaces are funded through various sources, including the general city budget, land development tax, urban mobility fund, and occasional funds.

4.4 San Francisco’s Climate Action Plan 2021

4.4.1 The Vision

The 2021 San Francisco Climate Action Plan (CAP) has been developed through a collaborative effort involving the San Francisco Department of the Environment and various individuals and institutions. The plan aims to achieve a net-zero emissions citywide by 2040 while promoting racial, social, and

economic equity. The plan focuses on several sectors, and the key objectives are summarized as follows:

- **Buildings**: By 2021, all new buildings will be required to have zero onsite fossil fuel emissions. By 2035, the same requirement will extend to large existing commercial buildings, and by 2040, all buildings must achieve zero onsite fossil fuel emissions.
- **Clean Energy**: By 2025, San Francisco aims to provide 100% renewable electricity, followed by supplying 100% renewable energy by 2040.
- **Zero Waste**: By 2030, the plan aims to reduce solid waste generation by at least 15% and decrease the disposal of solid waste through incineration or landfill by at least 50% compared to 2015 levels.
- **Transportation**: The goal is to increase low-carbon trips to at least 80% of all trips by 2030. Additionally, the plan aims to have at least 25% of all registered private vehicles as electric vehicles (EVs) by 2030, eventually transitioning to 100% EVs for all private vehicles by 2040.
- **Roots**: The plan focuses on sequestering carbon through ecosystem restoration, including efforts to increase the urban tree canopy, green infrastructure, and compost application.
- **Housing**: San Francisco aims to construct a minimum of 5,000 new housing units per year with maximum affordability, ensuring that not less than 30% of these units are affordable. Emphasis is also placed on retaining and rehabilitating existing housing.

Each sector is supported by a list of strategies, summarized as follows:

- **Energy Supply**: Strategies include supplying 100% renewable electricity, investing in local renewable energy and energy resilience projects, developing a reliable and flexible grid, and enhancing workforce capacity for clean energy resources.
- **Building Operation**: Strategies focus on eliminating fossil fuel use in both new and existing buildings, tailoring solutions based on building ownership, systems, and use types, expanding the decarbonization workforce, and transitioning to low-global warming potential refrigerants.
- **Transportation and Land Use**: Strategies include building a fast and reliable transit system, creating a connected active transportation network, developing pricing and financing schemes that reflect carbon costs and efficiency, efficient parking management, promoting job growth and housing along transit corridors, increasing density and land use diversity, and accelerating the adoption of zero-emissions vehicles (ZEVs).
- **Housing**: Strategies involve supporting BIPOC families through housing and stabilization programs, serving vulnerable populations and underserved communities through the preservation and rehabilitation of existing housing and new development, advancing zoning and implementation improvements, and expanding subsidized housing production for low-, moderate-, and middle-income households.
- **Responsible Production and Conduction**: Strategies include achieving carbon balance across buildings and infrastructure, reducing the carbon footprint of the food system, promoting reduction, reuse, repair, and recovery of goods and materials, and leading emissions reduction efforts in the aviation sector.
- **Healthy Ecosystems**: Strategies focus on collaboration for nature-based climate solutions, increasing community participation and incorporating Indigenous science and Traditional Ecological Knowledge, restoring and enhancing parks and natural lands, optimizing urban forest management, maximizing trees throughout the public realm, integrating local

biodiversity into the built environment, and conducting carbon sequestration farming pilot projects and research.

Figure 11: San Francisco's Climate Action Plan 2021. Available at: https://www.sfclimateplan.org/

The plan sets the current emissions profile as the baseline and establishes reduction targets. These targets also estimate potential health benefits resulting from emissions reductions. It is the result of a multi-year process developed by the San Francisco Department of the Environment with support and collaboration from many individuals and institutions.

The transportation and land use aspects play a crucial role in addressing climate change in San Francisco. With transportation accounting for nearly 50% of the city's total emissions, it is essential to transform the transportation system and reduce reliance on cars. The goal is to establish efficient and equitable connections through transit, walking, and biking, while steadily transitioning all remaining vehicles to zero emissions.

To achieve the target of net-zero emissions by 2040, transportation and land use policies are of utmost importance. Significant investments are required to reduce emissions from transportation and pave the way for a healthier, cleaner, and more equitable future. The key actions include improving transit services, expanding bicycle lanes and pedestrian-friendly spaces, increasing housing density and development near destinations, and implementing pricing and parking management programs aligned with climate goals. In terms of land use, San Francisco, being a city built before automobiles became popular, possesses denser development patterns suitable for pedestrian and transit travel. However, with the rise of cars, the focus shifted towards accommodating them, often at the expense of pedestrians. In recent years, San Francisco has taken steps to reverse this trend by removing parking requirements and revising density controls to allow for denser housing reminiscent of the city's older construction style. Nevertheless, there is still more room for improvement in coordinating transportation and land use in San Francisco.

4.5 Climate Neutrality and Urban Planning in the three cases

4.5.1. Key elements

This chapter explores the integration of climate neutrality and climate justice principles into urban planning processes. Cities worldwide are recognizing the urgent need to address climate change and its associated challenges. By adopting strategic planning documents and implementing transformation projects, cities like Valencia, Amsterdam, and San Francisco are taking proactive steps towards mitigating climate impacts, adapting to changes, and promoting a fair and just transition.

Valencia is adopting a typical strategic planning document which then uses single transformation projects to make the transition; Amsterdam is the only case where the Plan has a normative approach (Green Infrastructure) where Green actions are delivered by the local zone regulation (ordinary planning). San Francisco pays particular attention to social justice while reducing inequalities.

Integrating climate neutrality and climate justice into urban planning requires a comprehensive and multidimensional approach. By assessing baselines, setting targets, integrating sectors, adopting urban strategies, spatializing actions, and promoting inclusivity, cities can navigate the path towards a sustainable and resilient future. Through effective planning, cities worldwide are driving the transition towards a climate-neutral society that upholds principles of justice, equity, and community well-being.

Assessing the Baseline and Setting Targets. Strategies for climate neutrality and climate justice are developed based on a comprehensive assessment of the current emission profile. Climate services and climate budget tools help evaluate the baseline and define specific targets for emissions reduction. These assessments consider both statistical data and spatial analysis to identify vulnerable areas most susceptible to climate change impacts, emphasizing multi-risk areas that require prioritized interventions.

Coupled Integration of Sectors. Effective climate planning involves a coupled integration of multiple sectors such as mobility, energy, urban planning, environment, and waste management. Strategies encompass actions targeting buildings, neighborhoods, energy systems, transportation networks, and ecosystems. This holistic approach ensures that climate mitigation and adaptation efforts are synchronized across different sectors, maximizing their effectiveness.

Urban Strategies for Climate Neutrality. Cities that integrate climate neutrality into their planning processes develop specific urban strategies dedicated to achieving this mission. By adopting normative approaches like the Green Infrastructure Plan in Amsterdam, cities establish regulatory frameworks that facilitate the delivery of green actions. These strategies provide guidance for implementing climate-neutral measures in the zoning plan, ensuring their incorporation at a local level.

Adaptation through Green Infrastructure. Adaptive urban planning is increasingly embracing the concept of green infrastructure to enhance resilience and promote climate adaptation. Green infrastructure solutions, such as the development of green spaces, sustainable water management systems, and biodiversity conservation, are key components of climate adaptation strategies. These approaches enable cities to enhance their capacity to withstand and recover from climate-related challenges.

Spatializing Nature-based Solutions (NbS) and Actions. To transition from strategic planning to regulatory frameworks, spatializing nature-based solutions and actions is crucial. By incorporating maps and spatial analysis, cities can identify suitable locations for implementing NbS and effectively guide their implementation. This spatial approach facilitates the integration of climate actions into the fabric of the city, ensuring their alignment with local conditions and needs.

Implementation Plans and Job Potential Estimation. Concrete and effective climate plans go beyond theoretical strategies and estimate the budget required for implementation. By providing a clear roadmap for action, cities can allocate resources effectively and ensure the realization of climate goals. Additionally, these plans consider the potential for job creation and economic opportunities associated with the implementation of climate actions, emphasizing the co-benefits that arise from sustainable practices.

Participative and Inclusive Transition. A fair and just transition is a fundamental principle underlying climate planning. Engaging communities, fostering collaboration, and embracing co-design processes contribute to a participative and inclusive transition. By involving diverse stakeholders and integrating their perspectives, cities ensure that climate actions address social equity concerns and meet the needs of all community members.

4.5.2. Lessons Learnt

The integration of climate neutrality and climate justice into urban planning offers valuable lessons for cities seeking to address climate change effectively and equitably. The following lessons can be derived from the discussed aspects of assessing the baseline, coupled integration of sectors, urban strategies, adaptation through green infrastructure, spatializing nature-based solutions, implementation plans, and participative and inclusive transition. Comparing. The comparison of these cases with the assessment of Climaborough cities starting from the Net Zero Cities Applications offers some valuable considerations that can be pointed out as the gaps that we can identify between our cases and the best-selected practices.

1. **Comprehensive assessment and target-setting:** NZC cities are generally far away from conducting a comprehensive assessment of the current emission profile and vulnerability allowing the cities to set specific targets for emissions reduction and prioritize interventions in multi-risk areas. This data-driven approach provides a solid foundation for informed decision-making and effective climate action.
2. **Holistic approach through sector integration:** NZC goals are too sectorial and scarcely integrated while the Integration of multiple sectors, such as mobility, energy, urban planning, environment, and waste management, ensures that climate neutrality efforts are coordinated and mutually reinforcing. This holistic approach maximizes the effectiveness of strategies and actions, leading to comprehensive and integrated solutions.
3. **Normative urban strategies:** NZC cities does not includes any specific evaluation in understanding if specific urban strategies dedicated to achieving climate neutrality are based on regulatory frameworks that facilitate the delivery of green actions. Normative approaches, like the Green Infrastructure Plan in Amsterdam, provide guidance for incorporating climate-neutral measures into local zoning plans, ensuring their implementation at a grassroots leve**l.**

4. **Embracing green infrastructure for adaptation:** Even though mentioned in just some cases (Turin), Green infrastructure, including green spaces, sustainable water management systems, and biodiversity conservation, plays a vital role in enhancing urban resilience and promoting climate adaptation. Green Infrastructure approach is considered an asset in all the advanced cases. By integrating nature-based solutions into urban planning, cities can enhance their capacity to withstand and recover from climate-related challenges.
5. **Spatial analysis for effective implementation:** The incorporation of spatial analysis and mapping tools helps cities identify suitable locations for implementing nature-based solutions and climate actions. NCS application does not investigate the spatialization of solutions. Working with spatial assessment can align cities with local conditions and needs, ensuring their integration into the urban fabric and regulatory frameworks.
6. **Concrete implementation plans and co-benefits:** Concrete climate plans that estimate implementation budgets and job potential are crucial for effective action. Such plans provide a clear roadmap for allocating resources and realizing climate goals. Additionally, they recognize the co-benefits of sustainable practices, including job creation and economic opportunities, which contribute to the overall success and acceptance of climate actions.
7. **Participative and inclusive decision-making:** Engaging communities, fostering collaboration, and embracing co-design processes are vital for a fair and just transition. By involving diverse stakeholders and integrating their perspectives, cities ensure that climate actions address social equity concerns and meet the needs of all community members. This participative approach strengthens the legitimacy and effectiveness of climate planning and implementation.

5. CLIMABOROUGH: cities towards climate neutrality

5.1 Scope and approach of the CLIMABOROUGH Urban Planning Framework

In the CLIMABOROUGH project, we take for granted that the cities are informed. At a certain level, referring to climate monitoring agencies, the hypothesis we have considered while developing the CLIMABOROUGH urban planning framework for climate neutrality is that those agencies may be in the position of providing cities with climate fact sheets. That means that the cities may be informed in a quite relevant manner concerning their specificities about what scenarios they will be challenged by in the future.

Meanwhile, cities and, in general, urban systems contribute to transformations of those factors that (may) impact climate. Those factors have already generated an impact on factors themselves, and this is the reason why the climate is exercising pressure. Therefore, considering the changes all around the world and the climate agencies that are collecting and monitoring evidence about climate factors such as temperature, precipitation, snowing, and flooding enable us to project some trends within the perspective of some hypotheses about the achievements of our effort to deal with climate change. We can imagine what we will have in front of us, an optimistic and improved or worse scenario.

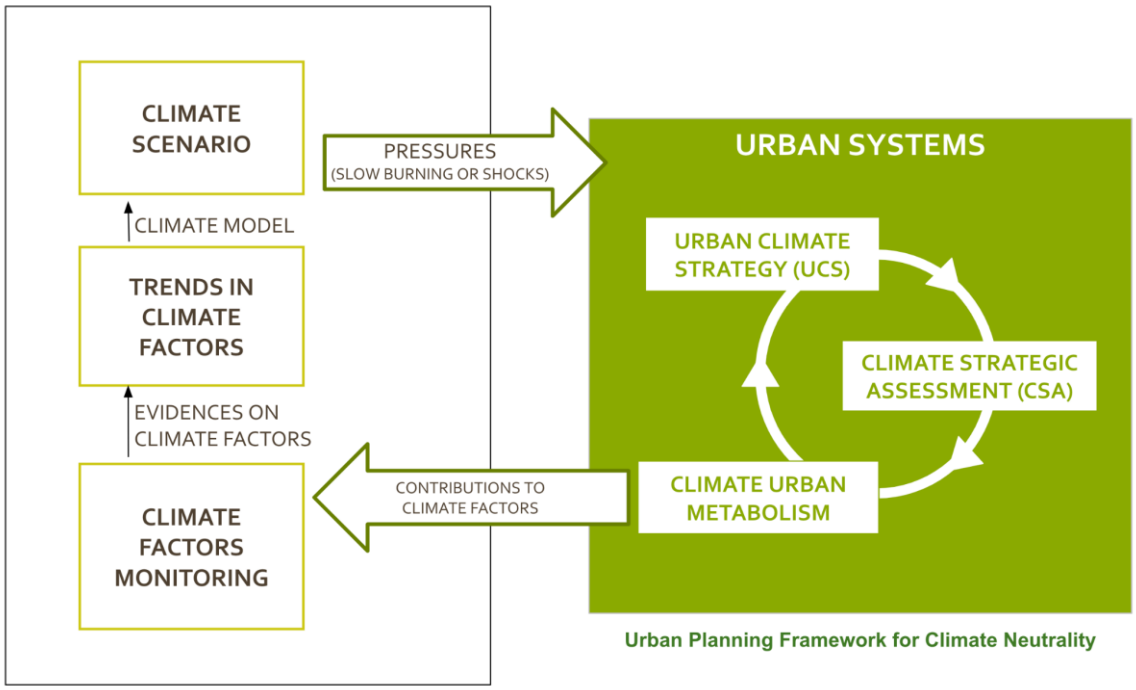

Figure 12: The CLIMABOROUGH Urban Planning Framework for Climate Neutrality relation with climate pressures and urban factors

Furthermore, both the evidence of climate factors and the trends of these factors, thanks to the operation of the climate model, allow the creation of climate scenarios that cities may face. Climate scenario, trends are all factsheets that cities may refer to while planning their actions in response to climate change, and in particular for climate neutrality, which is the primary objective of the CLIMABOROUGH Urban Planning Framework.

It is important to acknowledge that a single city alone cannot significantly impact climate factors. However, when cities collectively contribute their efforts and take meaningful actions, it is possible to influence climate factors and alter their trends. This is in the hands of climate modellers and climate analysts, and climate monitoring relevant for cities seems to understand what kind of pressures they will have to deal with, but also to be in front of those facts to understand what can be done at the local level.

In the CLIMABOROUGH urban planning framework, urban systems consider elements related to urban climate strategies, climate strategic assessment and climate urban metabolisms (figure 8 above). Questions to be answered are: how does the city work in relation to the production or functions affecting the climate factors? How can the city develop an urban climate strategy, which can be different even in the approach in which it is conceived and managed, as we have seen in the previous chapters (see chapter 1, 2 and 4). Out of these strategies, how may a city run an assessment? In the CLIMABOROUGH Urban Planning Framework for climate neutrality, the assessment could be a self-assessment activity that cities should run, considering their data collection activities as well. Obviously, here we imagine that the cities are so committed to having a climate-related data collection strategy, not only the strategy for the climate itself but also for citizens needed to develop a data strategy for climate-related issues. The following section examines in detail the urban planning framework for climate neutrality.

5.2 The Urban Planning Framework for Climate Neutrality (UPF4CN)

Conceptually, the CLIMABOROUGH Urban Planning Framework for Climate Neutrality consists of three blocks. Before elaborating on these three blocks, we need to consider that one side of this framework is related to the urban climate metabolism, and the other is focused on formulating the urban climate strategy (UCS), as we need to understand how the city can effectively respond to the requirements set by the climate urban metabolism. It is essential to understand the different aspects of urban climate strategy, first, whether the actions that are planned to be implemented by the cities are or are not impactful on the climate urban metabolism. Additionally, regular monitoring of climate urban factors of the climate urban metabolism is necessary to evaluate the ongoing effectiveness of these actions over time (Figure 13 below).

In the first block of the CLIMABOROUGH Urban Planning Framework, the climate urban metabolism of the city has been conceived as a system that, from one side, produces pollutants contributing to the worsening of climate factors and, on the other side, able to contribute to the absorption of those pollutants. We have labeled the first sub-block "system capacity" in relation to the urban emission budget by the urban system. At the same time, we labeled the second sub-block "ecosystem capacity" referring to those functions that the city can perform in relation to carbon sequestration, carbon storage and, in general, pollutants reduction. The block called "ecosystem capacity" is inspired by, and also considers some, Ecosystem Services (ES) (Costanza et al., 1997) relevant for urban planning strategies.

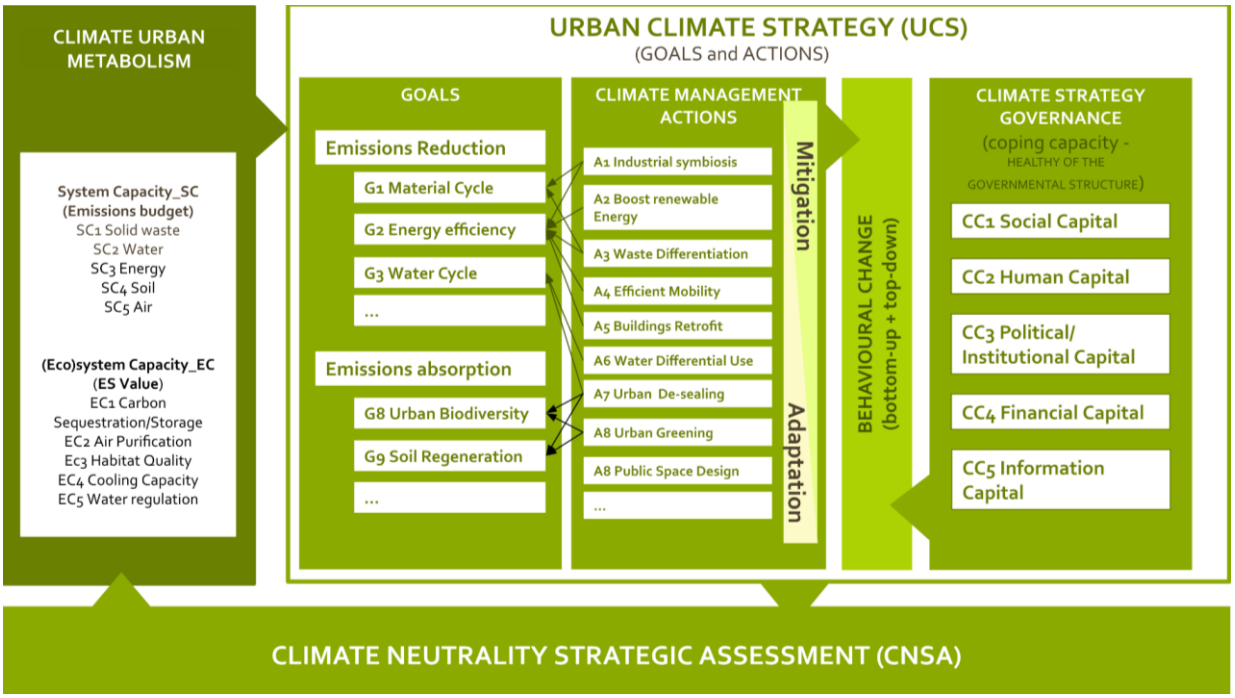

Figure 13: The CLIMABOROUGH Urban Planning Framework

Included in the first sub-block "system capacity" are the emissions: for example the solid waste that is released into the environment, the emissions producing water pollution, the excessive non efficient use of the water so consuming the water systems of specific urban areas, the production of pollutants related to energy production and consumption, the pollution of the soil as well as its consumption and the emissions in the air. As per the ecosystem capacity in relation to absorption capacity, we consider the mechanisms of carbon sequestration and storage, air purification, the

improvement of habitat quality, the cooling capacity and the water regulation functions (Arcidiacono et al., 2015; Ronchi et al., 2020; Salata et al., 2017, 2021). These are all related and inspired by ecosystem services, which are strong references as per the absorption capacity.

Considering the conditions of the climate urban metabolism, in the second block of the framework cities have general goals in front of them, which are related to two general perspectives: the first of emissions reduction and the second of emissions absorption. Emissions reduction entails minimizing pollutant inputs into the urban systems and addressing issues such as material cycles, energy efficiency, water management, air pollution, and more. On the other hand, emissions absorption involves actions pertaining to urban biodiversity, soil regeneration, and similar broad goals.

To achieve these goals, cities may develop a comprehensive range of actions, each with varying relevance and roles in targeting the desired outcomes. These actions are collectively referred to as climate management actions, meaning they are all together improving or acting as mitigation mechanisms but also as adaptation. This is crucial because, in the CLIMABAROUGH Urban Planning Framework for Climate Neutrality, we consider relevant the idea that climate neutrality should be achieved without reducing, eventually augmenting the adaptation and resilience capacity of the cities in front of climate extreme events. Thus, both mitigation and adaptation perspectives are vital, as they contribute to the transformation of climate urban metabolism factors.

Consequently, these actions are integrated into the urban climate strategy, which encompasses diverse elements such as policies, immediate measures, land use plans, service plans, and legislation related to transformations in various aspects. Examples include enhancing access to renewable energy, implementing waste management strategies, establishing efficient transportation systems, promoting building retrofitting, and adopting responsible water usage practices. It is essential to recognize that climate neutrality cannot be attained through a single solution but requires a complex system of measures, policies, regulations, actions, financing, and more. These actions span a spectrum from transforming practices within the urban context to infrastructural changes. They aim to alter behaviors by leveraging infrastructural developments or by providing incentives, gamification strategies, and accessibility transformations linked to specific infrastructures or benefits. The ultimate goal is to effect behavioral changes that align with climate objectives and drive progress towards climate neutrality.

The strategy for achieving climate neutrality is a complex process that varies significantly from one city to another, as explained in sections 3 and 4. The question of "how" cities approach and manage this strategy is highly relevant. We refer to this approach as climate strategy governance, which forms the third block of the framework. Climate strategy governance encompasses the city's capacity to cope with the challenges associated with climate change. To assess a city's coping capacity we investigate the health, the fitness of a city's governmental structures and processes, looking at them through the lens of "capitals". The term capitals refers to "the assets, capabilities, properties or other valuables which collectively will represent the good functioning" (Máñez et al., 2014) of a governance model. The maintenance or the enlargement of capitals might contribute to the maintenance or the improvement of the capability of a city to tackle environmental hazards.

We adopted a differentiation into five capitals – which we have extensively described in Section 6.3 – specifically designed and tailored on the objectives of the CLIMABOROUGH project.

1) **Social capital**: it focuses on relationships between multiple stakeholders, shared norms and values that qualify a certain society. It contributes much to the capacity of local governments

to implement effective climate measures and achieve climate neutrality, as well as on the well-being level of citizens

2) **Human capital**: it commonly refers to individual skills and competences. In the case of local governments, the human capital results from the sum of employees' and collaborators' skills and competences.
3) **Political/institutional capital**: political capital has as its focus in the governmental processes and procedures performed by political and administrative figures, which write and apply laws, strategies and plans and implement policies. The term "institution" here refers to "the rules and customs of a special group of similar interest" (Máñez et al., 2014), whereas the common interest is achieving climate neutrality. It is closely related to the principle of "institutional fitness".
4) **Financial capital**: it refers to the most common meaning of the term "capital", tangible resources and all types of wealth (funds, substitutions, compensations etc.) that are provided to local governments by banking industries, private businesses or by means of public funding programs at the international, European, national or regional scale;
5) **Information capital**: it is closely linked to information management, tools and procedures and it is indeed seen as one of the pillars of climate neutrality strategies. An optimal exploitation and interpolation of the available climate and non-climate information enables informed decisions in complex anthropic systems.

These five capitals were selected as a framework to "breakdown" climate neutrality governance in the pilot cities of the Climaborough project.

In order to evaluate the effectiveness of this conceptual framework, it is necessary to assess the alignment between climate actions, climate strategy, and governance. The key objective is to determine whether the actions that a city has set within the strategies are able to achieve change in the desired directions in both system capacity factors and ecosystem capacity factors. Additionally, evaluating whether the city possesses the coping capacity to achieve these goals is important. Considering the role of the effectiveness of the actions is different from the goal of assessing the coping capacity, meaning that the former may also be used for regular adjustments and re-tuning the action framework more frequently. In contrast, the latter, the coping capacity, is more concerned with changing the overall approach and management strategies to ensure the smooth operation of this complex process.

5.3 Planning under the climate hazard pressure and urgency

The Urban planning framework for climate neutrality, developed under the CLIMABOROUGH project, considers the basic awareness that cities are increasingly informed about the relevant pressures that climate change is putting on their environment, their daily lives and their urban systems. In CLIMABOROUGH, we imagined that cities are developing actions and initiatives and putting their policies and measures which, to some extent, intend to make cities better respond to such pressures. But to what extent can we determine our goals, and what does it mean to plan under time constraints? And what does planning in a hurry actually mean? These questions pose complex challenges. First of all, our understanding and ability to measure the impact of each action on climate factors is limited. We lack knowledge about synergies and uncertainties in natural systems, making it difficult to establish key performance indicators (KPIs) for setting appropriate targets and assessing progress.

Moreover, we face significant uncertainty when it comes to forecasting and assessing urban systems and their reactions to climate change. Our understanding of natural systems and their intricate details is lacking, which undermines the accuracy of our predictions. Moreover, **many cities do not base their achievement thresholds on scientific foundations or data-driven decision-making processes.** While cities are actually making efforts, their focus tends to be on meeting feasible targets rather than addressing the actual needs of the urban environment and its contribution to climate change. This means cities are doing what they can achieve in the fastest manner possible. They are increasingly recognizing the urgency of taking climate action at the urban level. However, different cities adopt varying approaches to tackle the issue. Some rely on available funds for climate change adaptation and mitigation, which allows them to implement measures quickly. Nevertheless, it remains unclear to what extent this sense of urgency and hurry has become a standard model within urban planning frameworks for achieving climate neutrality.

In CLIMABOROUGH we aim to explore two key aspects: feasibility within urban systems and the inclusion of emergency planning or urgent measures. The notion that faster action yields better results needs to be examined not only within the theoretical framework of urban planning but also at the operational level when cities possess the necessary resources but lack efficient procedures to respond promptly to climate change emergencies.

6. Climate Neutrality strategic assessment

6.1 Monitoring Climate Urban factors

In the CLIMABAROUGH Urban Planning Framework for Climate Neutrality, the climate-neutrality strategic assessment is related to what the cities will be able to do also, thanks to the use of the dashboard described in Deliverable 2.1. In relation to this and to the core elements that the climate strategic assessment takes into account, we have conceived three different families of KPIs that the climate neutrality strategic assessment is taking into adopting to perform the assessment itself (See figure 14).

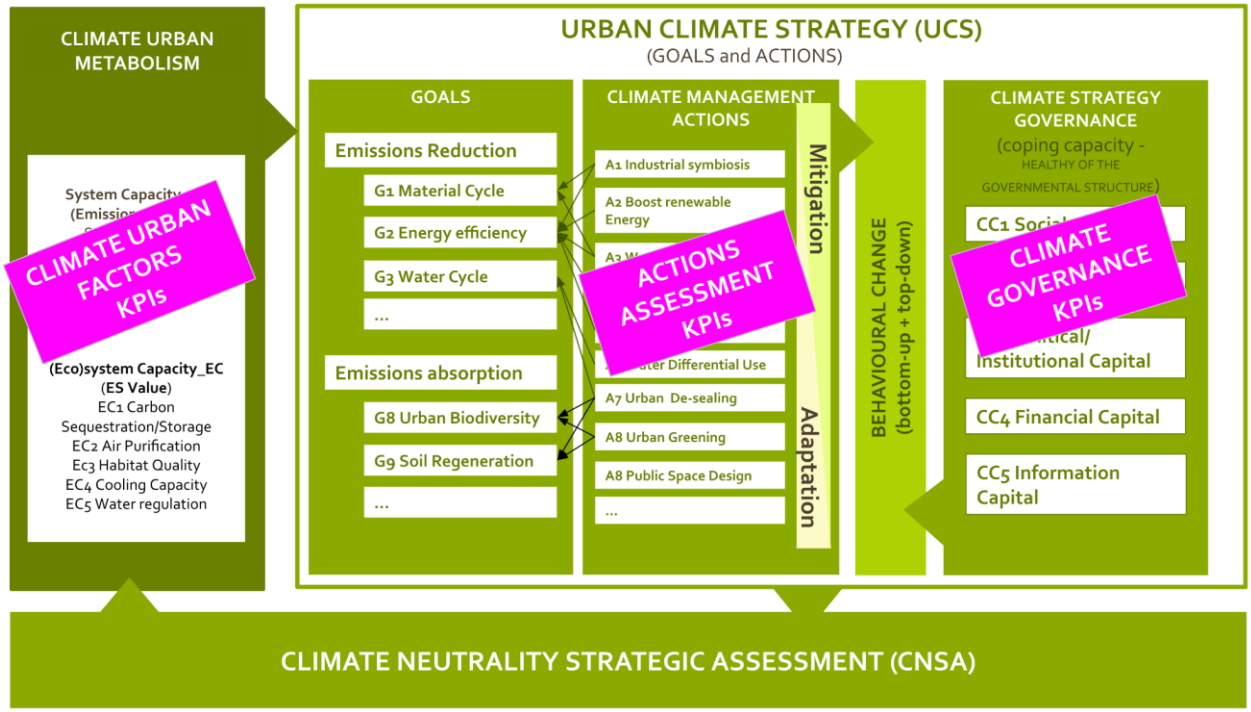

Figure 14: KPIIs mapping over the CLIMABOROUGH Urban planning Framework

The first family is the climate urban factors. These are the KPIs related to climate urban metabolism. They address both the characteristics of urban systems concerning the capacity to control emissions in relation to solid wastewater, energy, soil and their management, as well as ecosystem capacity is related to the capacity to produce and emulate ecosystems, services and, therefore, the sequestration of pollutants from the metabolism.

The second family is at the actions assessment family. These are KPIs related to actions put in place by cities. These KPIs consider the impact of actions combined with the framework of an urban climate strategy and address both the reduction and the absorption of emissions which are key goals of any climate strategy. And these series of KPIs have the scope to measure the potential impact of actions such as urban greening, urban de-sealing, boosting renewable energy and more.

For the third family of the block of KPIs, we refer to those related to climate strategy governance. They consider the coping capacity of a governmental structure toward the climate neutrality goal. Actions included in an urban climate strategy are clearly not enough to guarantee the forecasted

impact. Suppose the strategy implementation governance is not able to implement it, therefore, cities are required to adopt their organisational and decision-making structures to guarantee a coping capacity that develops in relation to different capital, social, financial, institutional, political and human.

6.2 A framework to design the KPIs for the Climate Neutrality Strategic Assessment

In relation to these three different families, we have already developed some references to known KPIs and the proposed set of them also described briefly in D2.1 as follows:

CLIMATE URBAN FACTORS KPIs: Related to Climate Urban Metabolism. The KPIs address both the characteristics of urban systems concerning the capacity to control emissions (Solid Waste, Water, Energy, Soil and Air management), as well as Ecosystem capacities related to the capacity to produce/emulate ecosystem services (Carbon Sequestration/Storage; Air Purification; Habitat Quality; Cooling Capacity; Water regulation).

ACTIONS ASSESSMENT KPIs: Related to Actions put in place by cities. The KPIs account for the impacts of actions combined within the framework of an Urban Climate Strategy and address both the reduction and the absorption of emissions (key goals of any climate strategy). KPIs under this group have the scope to measure the potential impacts of actions such as Urban De-sealing, Waste differentiation, or Efficient mobility onto Climate Urban Factors.

CLIMATE GOVERNANCE KPIs: Related to Climate strategy governance. The KPIs consider the coping capacity of a governmental structure towards the climate neutrality goal. Actions included in an Urban Climate Strategy are not enough to guarantee the forecasted impacts if the strategy implementation governance is not able to implement it. Cities are required to adapt their organizational and decision-making structures to guarantee such coping capacity that develops in relation to different capitals: social, financial, institutional, political and human.

The following tables describe some tentative attempts to outline some examples of the KPIs of each family.

Table 14: Towards a system of KPIs

SYSTEM CAPACITY

SC1 Solid Waste
- Waste Management
  - % of differentiated waste
  - % of reuse adoption
  - Amount of un-differentiated waste
  - …

SC 2 Water
- Water management

% of differentiated use
  - % water loss in pipelines
  - Water runoff
  - ….

SC 3 Energy
- Energy production
  - % energy consumption from Renewable Sources
  - % of energy derived from Fossil
- Total Energy Consumption
  - Energy consumption for mobility
  - Building Efficiency
  - Energy consumption by industry
  - …

SC 4 Soil
- Soil Pollution
- Land consumption
- …

SC 5 Air
- GHG total emission per capita
  - Traffic emissions
  - Industrial emissions
  - Residential emissions
  - …
- Air Quality Index (AQI)
  - PM10 concentration
  - Nitrogen Dioxide (NO2)
  - Ozone (O3)
  - …

ECO-SYSTEM CAPACITY

EC1 Carbon Sequestration/Storage

Cleaner and efficient energy
- Pushing the shift to renewable energy
  - Funding for solar panels installation
  - Microgrid infrastructure
  - Activation of energy communities
  - …
- Reduce energy consumption
  - Improving buildings turmeric resistance
  - Smart urban lighting infrastructures
  - Adoption of low consumption lighting infrastructure
  - …

Clean and efficient mobility
- Reduce traffic volume
  - Car and bike sharing
  - Accessible public transports
  - Bike lanes creation
  - …

- Clean mobility
  - Incentives for electric cars adoption
  - …

Waste to circularity
- Waste reduction
  - Amount of waste produced
  - Resource Recovery Rate
  - …

- Recycling and Material recovery
  - Waste Diversion Rate
  - Recycling Rate
  - Waste-to-Energy Contribution
  - Construction and Demolition Waste Recycling Rate
  - …

- Organic Waste Management
  - Organic Waste Diversion
  - …

Urban de-sealing
- Surface to be de-paved from asphalt
- Volume of death soil to be removed from the surface

Social capital

- Presence of volunteer citizens programs related to climate emergencies
- Presence of governmental networks related to climate issues involving citizens
- Discussion of climate-related issues on the local media

…

Human capital

- Level of education and background studies of local government employees (or collaborators)
- Presence of a figure (Resilience officer; Climate manager; etc.) with specific competences and skills for climate neutrality management in the local government
- …

Political/institutional capital

- Presence of local adaptation and local mitigation plans
- Presence of a department with specific responsibilities competences related to climate neutrality management
- Presence of cross-sectoral plans related to climate neutrality
- Percentage of population taking part in municipal elections on average (last 5

- Amount of carbon stored in 4 different carbon pools
- Amount of sequestered carbon over time
- …

EC2 Air Purification
- SO2 removed annually,
- NO2 removed annually,
- PM2.5 removed annually
- PM10 removed annually
- O3 removed annually

Ec3 Habitat Quality
- Extent of habitat quality
- Habitat degradation

EC4 Cooling Capacity
- Index of heat mitigation based on
  - Shade
  - Evapotranspiration
  - Albedo
  - Air temperature
  - Quantity and quality of urban green areas
  - Imperviousness
  - Building intensity
  - …

EC5 Water regulation (Urban Flood Risk Mitigation)
- Reducing runoff production
- Slowing surface flows
- Creating space for water (in floodplains or basins)
  - Retention volumes
- …

Urban greening
- Urban forestation
- Green roofs
- …

Public Awareness and Education
- Public Campaigns
  - Nr individuals reached through various communication channels (website traffic, social media impressions)
  - Changes in consumption patterns
  - …
- Workshops and Training
  - Participation rates in initiatives.
  - Levels of engagement
  - …
- School Programs
  - Tracking the number of partnerships formed
  - The extent of collaboration,
  - The impact of joint initiatives on public awareness and education
- …

Financial capital
- Main sources activated by the local government to obtain funds to tackle climate
- Percentage of private investments targeting climate strategic actions
- …

Information capital
- Level of differentiation by user of the available climate services: user-driven climate services
- Availability of climate services in the local language
- Presence of local government policies and/or plans for climate information management
- …

As suggested by the Table above, some indicators for system capacity could be:

for **solid waste, circularity and waste management**:

- the percentage of a differentiated waste,
- the percentage of reuse adoption in a city in a neighborhood
- the amount of differentiated waste in general;

for **water management**:

- the percentage of differentiated uses,
- the percentage of water loss in pipelines water transportation,
- the amount of water runoff or

- dimensions of soil characteristics relevant for water penetration or water flow;

for **energy and energy production**:

- energy consumption from renewable resources
- the percentage of energy derived from fossil sources
- distinguish know how much energy is produced or is used from renewable resources in the residential processes, in industrial processes, in agriculture…

When detailed data is lacking, that will not allow us to get to these indicators it could be possible to consider and define some proxies, visualizing what's going on as per all these different capacities. Principally, the more we miss granular data, the more it is difficult to develop KPIs related to the metabolism into sectoral specific climate-related measures. In case we need to know the emissions in the air but we don't know how many industries are releasing into the air and what, how much each car disperses in the air or how many electric cars are used or how many endothermic power engine cars are used measuring the situation from the emission side would be un-doable and the only think we can do is to measure the quality of the air by collecting data from detecting sensors and the KPI on emissions could be synthesized in the proxy of pollutant contents in the air. In this respect, while this is useful yet, it is difficult to translate such a KPI into a specific action being sectoral oriented and there will be a need for some relevant hypothesis to decide for priorities among interventions whether in mobility or industrial emissions. A similar approach can be followed in the second dimension (pollutant absorption).

An effort like the one described above is already planned in four CLIMABOROUG cities to explore how the Urban Planning Framework and the related Climate Neutrality Strategic Assessment can work in the CLIMABOROUGH dashboard.

6.3 Assessing cities' capacity to achieve climate neutrality: the capital approach

Actions to address climate change require coordination among multiple stakeholders, groups, departments, sectors, policies and, therefore, robust governance models to manage complex and interrelated processes. Tackling climate change and adapting to current and future impacts is "fundamentally a governance challenge" (OPM, 2018). Máñez et al. (2014) agree that assessing governance structures is of primary importance for maintaining cities' capability to react to natural hazards, detecting the weaknesses that might need to be addressed and evaluating local governments' performance over time. It can be claimed that governance is a necessary (but not sufficient) pre-condition for climate goals fulfillment and – more specifically – for climate neutrality achievement. The Intergovernmental Panel on Climate Change (IPCC) identifies the "limited integration or coordination of governance" as a major constraint that interacts to impede climate measures planning and implementation (IPCC, 2023).

There is large consensus that climate change governance is a "wicked" (Alford et al., 2017) or even "a super wicked" (Lazarus, 2008) issue. Bovair et al. (2009) even state that "trying to define public governance seems to open Pandora's box". This "wickedness" of climate change governance derives from i) the high uncertainty surrounding climate change effects and impacts on urban systems; iii) the intrinsic complexity of urban systems; iv) the consequent difficulties in evaluating the potential beneficial impacts of planned mitigation and adaptation measures and in assessing the effectiveness of the already implemented actions on risks reduction; v) the heterogeneity of the involved

stakeholders; vi) the lack of resources to finance actions; vii) the influence of cultural issues and the lack of trust in politicians; viii) the inadequacy of regulatory frameworks; ix) the insufficient quality of climate information and/or of information management practices and tools; and many others.

Different forms of governance adopted and applied by local governments and other institutions can be observed and studied; however, an empirical investigation of the most effective governance model to achieve climate mitigation and adaptation goals in cities seems to be lacking (Molenveld, 2020). How to assess cities' capacity to cope with climate goals? And – entering into the merit of the specific focus of Climaborough WP1 – how to assess the adequacy, the fitness of cities' governance with respect to the climate neutrality challenge? The literature offers several approaches and methodologies that constitute a useful basis to build on. For the purpose of this research, three main sources resulted to be particularly relevant and comprehensive of a variety of approaches and points of view on the different aspects of climate governance:

i) The recent report "Making EU Climate Governance Fit for Net Zero", released in 2022 by the German Environment Agency, provides a list of eight "climate governance main elements", which are namely:

1) Context, legal framework, political support;
2) Targets: long and short term;
3) Strategic planning;
4) Policy cycle;
5) Progress monitoring;
6) Internal coordination;
7) Scientific advice;
8) Public participation.

ii) The European Climate Foundation contributed to the debate proposing the view of "cross-sectoral dimensions increasingly considered central in achieving climate neutrality": these are elements that correspond to "important fields of actions" and that form the basis for deriving the indicators. Five "horizontal elements" are hence proposed:

1) Finance;
2) Technologies;
3) Lifestyle changes;
4) Just transition;
5) Governance.

iii) The Oxford Policy Management – an important research group within the University of Oxford with an experience of four decades in sustainable policy change – developed and tested in 2018 a Climate Governance Assessment tool which allows practitioners to "identify political and institutional opportunities and barriers for tackling climate change" (OPM, 2018). The tool was intended to be used in the process of monitoring and evaluating progress in climate action, hence is very similar in scope to the Climate neutrality governance self-assessment tool presently under development within CLIMABOROUGH project and described in the next paragraph. It is suggested that the assessment can be repeated each year to highlight what has changed in the overall context for tackling climate change in each location. The Oxford Policy Management adopts seven dimensions of climate governance:

1) Evidence base;
2) Policy framework;

3) Awareness and understanding;
4) Political commitment;
5) Participation and influence;
6) Institutional capacity;
7) Finance and investment.

Despite these three approaches were broadly recognized as valid and have resulted useful tools to be applied in reality, they all show a non-negligible limitation with regard to the intent of CLIMABOROUGH project: they are designed to be applied with the support of an intermediary subject (consultants, experts, etc.). CLIMABOROUGH aims instead at improving cities' awareness, empowering local governments in the face of the transition towards climate neutrality, boosting cities' action capacity through the provision of re-applicable tools which can be used independently.

It was hence considered necessary to develop an ad-hoc tool in order to enable cities' governance self-assessment. This is based on the "capital approach", theorized by Sen (1983), Bebbington (1999) and Goodwin (2003) and applied by Máñez et al. (2014) – among many others – for assessing governance performance in partnerships dealing with natural hazards. The concept of "capitals" was originally employed to analyze sustainable development and sustainability livelihood and basically refers to "the assets, capabilities, properties or other valuables which collectively will represent the good functioning" (Máñez et al., 2014) of a governance model. The maintenance or the enlargement of capitals might contribute to the maintenance or the improvement of the capability of a city to tackle environmental hazards.

The capital approach differentiated between five capitals:
1) Financial;
2) Social;
3) Human;
4) Natural (environmental);
5) Man-made.

Máñez et al. (2014) proposed the introduction of the "Political capital", seen as "the capability of institutions to enact rules, laws or frameworks that might change the course of actions" (Máñez et al., 2014) and developed factors representing the most relevant issues included in each capital; each factor was then combined with a set of indicators which enabled performance measurement. This system of capitals-factors-indicators-units was configured as shown in Table 15:

Table 15: Structure of the analytical framework for governance assessment based on the capital approach proposed by Máñez et al. (2014)

Social capital	Equitable treatment of all partners	2 indicators	Y/N
	Communication and information	3 indicators	Y/N
	Participation	3 indicators	Y/N; yearly meetings
	Knowledge	3 indicators	Y/S; %

	Trust (in stakeholders, other partners)	3 indicators	Y/N; duration (years)
	Rules and norms of society	4 indicators	Y/N; $
Human capital	Skills and competences	3 indicators	Y/N; high-medium-low
Political capital	Transparency and trust in political actions	5 indicators	Y/N; %
	Regulatory framework: formal rules and norms	5 indicators	Y/N
Financial capital	Disaster funds	5 indicators	%; $
	Risk of impoverishment	3 indicators	Y/N; high-medium-low
Environmental capital	Regeneration of environment	2 indicators	%
	Management and strategies and planning processes	5 indicators	Y/N; $; %; ha
TOT	**13 factors**	**46 indicators**	**7 units**

This integrated set of indicators (see Annex 01) – specifically adapted to the objectives of CLIMABOROUGH project – constitutes a key operative tool to support cities in identifying the transformational changes in governance required for the achievement of climate goals and the transition towards climate neutrality and to monitor improvements along the CLIMABOROUGH project period.

7. Conclusions

7.1 Preliminary results and additional questions

The present document represents a work-in-progress towards the Urban Planning Framework for Climate Neutrality to be finalized by the end of the CLIMABOROUGH project. It takes into account the need to test it within the real context of climate neutrality city action and to be finalized with cities in relation to:

1. the **final set of KPIs** depending on the data/information available;
2. the **Climate action approach,** the priority identified and the extent to which they are expected to contribute to Climate factors;
3. the **organizational structure** that accompanies the implementation of the climate neutrality plan.

Also the present draft of the concept disclosed a theoretical void that needs to be fulfilled with both operational reflections and theoretical explorations: a planning concept for climate neutrality needs a new framework of time. Climate neutrality, and in general any planning action within the climate challenge, needs to guarantee a responsiveness capacity to the fast changes of climate phenomena and at the same time to maintain the long term perspective necessary when developing a governing/planning tool for complex systems like cities are. How to embed in the Urban Planning Framework for Climate Neutrality both these time dimensions? What are the organizational requirements for a city to guarantee such a responsive capacity? What the normative, procedural and regulative settings can help such a capacity. These questions, opened up by the work carried out till now, are looking for answers whose relevance may affect the re-shaping of the draft framework presented in this deliverable.

7.2 The steps forward

To proceed the work reported in this deliverable and in collaboration with WP3 and WP2 leading and participating partners, the pathway towards the finalization of the Urban Planning Framework for Climate Neutrality includes:

Action 1. Data mapping and KPI development in each of the 4 CLIMABOROUGH cities

a) Data identification
b) Data collection plan
c) Data Architecture
d) KPIs design

Action 2. Dashboard usage scenario to support the Climate Neutrality Strategic Assessment.

e) Use case development
f) Scenario creation (application of a Climate Neutrality Strategic Assessment)
g) Test planning

Action 2 is mainly relate to the need to align the work between WP1, WP2 and WP3 so to make the ICT platform developed in WP3 supportive of the pilots action as well as integral part of the planning framework that will be developed at the end of the project

The plan is to start immediately with two cities each from one of the hubs. With them we will use the current version of the framework to activate Action 1 and later on transfer the experience on the additional 2 cities while in the first two implementing Action 2.

Parallel to the work with the cities, a series of panels and round tables will be activated to explore the topic of “responsive planning”, “planning in a hurry”.

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ANNEX 1. Towards the CLIMABOROUGH capital approach for climate neutrality governance self- assessment

Capitals and related factors

The comparative analysis of different climate governance assessment methodologies and tools and of the related different sets of indicators (see section 6.3 of the main document) will lead to the proposal of an ad-hoc assessment framework, specifically designed and tailored on the objectives of the CLIMABROUGH project. The figure below shows the five capitals selected to "breakdown" climate neutrality governance in the pilot cities of the Climaborough project.

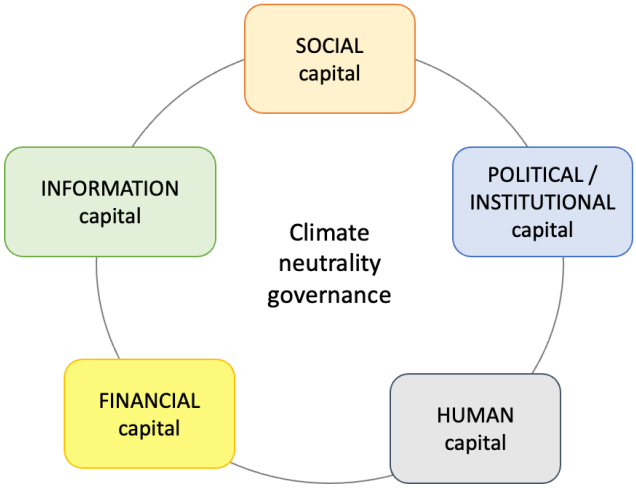

Figure 15: The five capitals of Climate neutrality governance as a framework for cities' self-assessment and Climaborough project's impacts monitoring. Adapted from Máñez et al. (2014).

The following paragraph defines and discusses the proposed division into five capitals and their related factors.

Social capital and related factors

Social capital focuses on relationships between multiple stakeholders, shared norms and values that qualify a certain society. It contributes much to the capacity of local governments to implement effective climate measures and achieve climate neutrality, as well as on the well-being level of citizens. It can be described and quantified by indicators referred to three Social capital factors:

1.1) Participation: is the "ability to join a governance process and to act within it" (Máñez et al., 2014). Integrating heterogeneous stakeholders from multiple sectors in this process should be intended as a fundamental step in climate neutrality governance, since it guarantees the success of comprehensive participation processes. The set of indicators linked to participation take into account different possible forms of collaboration to involve in climate neutrality-related planning and implementation activities both private businesses, citizens and other institutional and non-institutional partners: these are networks, working groups, series of meetings, deliberative events, volunteer programs, participatory budgeting activities, demonstrations and strikes, and others;

1.2) Communication and knowledge: knowledge at the society level is closely related to past societal and natural experiences as well as to the particular cultural and historical context. As higher is citizens' and other stakeholders' knowledge level about climate risks and possible options to tackle them (adaptation and mitigation), as much individuals and the entire society have the capacity to increase their resilience. Education can play an important role in raising collective knowledge. The ALLEA 2020 Report highlighted the beneficial impacts of education initiatives across Europe having

as targets primary, secondary and higher level education. Education has been recognised as a key premise for climate change awareness, mitigation and adaptation. Thus, "a strong emphasis should be placed on strengthening the environmental awareness of the young generation through education and other forms of youth engagement" (Darren, 2021).
Effective communication strategies and competences are required to improve knowledge among all stakeholders and to implement successful governance processes. Publication of periodic reports, frequent discussion of climate-related issues on the local media presence of citizens committees, awareness campaigns, trainings, forums, capacity-building courses in schools are all good options to increase knowledge and, consequently, to boost climate neutrality achievement;
1.3) Rules and norms of society: informal rules and norms in a society mainly come from historical background and cultural context and are relevant factors in the success of climate neutrality governance processes: solidarity, cooperation, donations and volunteering initiatives are all adequate indicators of the informal norms characterizing one specific social context.

Human capital and related factors
Human capital commonly refers to individual skills and competences. In the case of local governments the human capital results from the sum of employees' and collaborators' skills and competences.
It can be measured by assessing the average level of education of local government's employees and the adequacy of employees' background studies to manage climate-related issues, as well as the distribution of these competences in the different departments/working groups/divisions: do every departments have assigned at least one nominated focal person for climate issues management? Have some staff in every departments received specific training on climate related-issues? HOw many local government's employees are members of technical aid organizations such as fire brigades, red cross, THW, etc.?
2.1) Skills and competences: they can be gathered from formal or informal learning. Skills, knowledge and experiences are closely connected to risk awareness and preparedness ((Máñez et al., 2014).

Political/institutional capital and related factors
Political capital has as its focus the governmental processes and procedures performed by political and administrative figures, which write and apply laws, strategies and plans and implement policies. The term "institution" here refers to "the rules and customs of a special group of similar interest" (Máñez et al., 2014), whereas the common interest is achieving climate neutrality. Máñez et al. (2014) mention the principle of "institutional fitness". The complexity of political/institutional capital can be interpreted and managed by distinguishing three factors:
3.1) Local government's organizational structure: enlightening, representing and assessing the organizational structure of public administration entities such as local governments is particularly challenging since these are characterized by a high grade of hierarchy and bureaucracy and are not "single, monolithic entities" (Aubry et al., 2014). In fact, public administration institutions are often split into multiple organizations, agencies, departments, divisions. Nevertheless, studying in detail local governments' organizational structure allows an in-deep understanding of internal processes and enable the detection of gaps and criticalities that lie in communication, coordination, control.
Andrews (2010) claims that organizational structures "provide the pervasive foundation for achieving coordination and control within an organization" and that they have a significant impact on the fulfilment of objectives, placing emphasis on the relationship between structure and performance.

In the case of Climate neutrality achievement, it is of outmost importance assessing local governments' organizational structures to correlate it with the typical lack of coordination and communication between different departments, which constitutes a primary barrier to the effective implementation and efficient management of climate measures.
The indicators applied to measure the performance of local governments' organizational structures are the distribution of responsibilities and tasks related to climate management into multiple departments, the organization of regular alignment-meetings or other initiatives aimed at guaranteeing inter-departmental and territorial coordination;
3.2) Regulatory framework: the regulatory framework of climate neutrality includes every type of urban planning, mitigation, adaptation and emergency laws, norms, strategies and plans. These regulatory tools can be cross-sectoral, sector-specific, hazard-specific, target-specific and can have a compulsory nature or a non-compulsory nature. Some aspects are of primary importance in order to assess and measure a local government's climate neutrality governance performance: the update level of the regulatory documents, their permanency, the figures responsible for their redaction, the possible involvement of experts in the redaction process (consultants, collaborators) and of citizens communities through participatory processes (co-development). Furthermore, the inclusion in these tools of indications and guidelines on monitoring procedures and the actual implementation of regular and frequent monitoring activities of their impacts is an aspect that makes the difference in climate governance performance;
3.3) Transparency and trust in political actions: the latest released European Social Survey[24] (2020) reports that "trust helps to sustain a cooperative social environment, to facilitate collective behaviour and to encourage a regard for the public interest". Measuring trust in political actions requires the adoption of heterogeneous indicators referred to the level of citizens' perceived prioritization of the climate issue by the local government, the percentage of population expressing a vote in political elections, the duration of the government's mandate; the level of transparency in political actions is measurable on the basis of the publication of periodic statistical surveys reflecting the opinions of the population in regards to government's performed work, the presence of anti-corruption policies, the presence of laws and guidelines that provide a legal basis for the freedom of media, the periodic submission of newly approved laws or decrees in a public document.

Financial capital and related factors

Financial capital corresponds to the most common meaning of the term "capital". It refers to tangible resources and involves all types of wealth (funds, substitutions, compensations etc.) that are provided to local governments by banking industries, private businesses or by means of public funding programs at the international, European, national or regional scale. Financial capital enables both medium and long term investments in climate neutrality and immediate reactions to climate extremes or *ex-post* compensations.
4.1) Climate finance: the availability of resources for climate finance (financing the implementation of measures aimed at reducing CO2 emission and/or at increasing resilience) and their sources are assessed and measured by a dedicated set of indicators;
4.2) Disaster funds and different loss compensation instruments are the second factor of financial capital. Assessing this aspect of climate neutrality governance basically consists in investigating what is the ratio of public and private investments on disaster funding and what is the total amount of the budget devoted to disaster expenses. Insurances are important sources of losses compensation: insurance policies are the most common compensation instrument. Furthermore. as argued by

24 https://ess-search.nsd.no/en/study/172ac431-2a06-41df-9dab-c1fd8f3877e7

Bernardini et al. (2023), insurance brokers can play an important role in supporting cities in climate change impacts mitigation not only by providing convenient and adequate insurance products but also – and here lies the innovation – by providing information and advisory to design and implement climate adaptation measures (ex-ante) thanks to their access to valuable disaster-related information.

Information capital and related factors

This newly introduced capital is closely linked to information management, tools and procedures and it is indeed seen as one of the pillars of climate neutrality strategies. An optimal exploitation and interpolation of the available climate and non-climate information enables informed decisions in complex anthropic systems. Despite the growing availability of data and of climate data, a general lack of actionable information is still characterizing urban decision-making processes. This topic hence deserves particular attention in the context of cities' transition towards climate neutrality.

The attention of governments is actually being increasingly driven to the issue of climate information management: the United States of America, for example, recognized that up to one third of its gross domestic product depends on accurate weather and climate information (Brasseur et al., 2016).

Information management processes related to climate change management are affected by numerous and serious shortcomings. Hence, there is much room for improvement. In order to achieve optimization it is necessary to operate on different levels at the same time.

In the proposed Climate neutrality governance assessment framework, two levels (two factors) of Information capital are taken into consideration:

5.1) Information availability and quality: this factor refers to climate and non-climate information sources, resolution, level of detail, level of disaggregation and differentiation and availability of information visualization tools. Local governments acquire information from various sources which are more or less reliable and in some cases even contract specialized consultants to be supported in information interpretation and application;

5.2) Information management practices and tools: the indicators measuring this factor are linked to three interconnected levels: the regulatory level (guidelines, policies, plans, obligations, standards on climate information management), the administrative level (local government's information management operations), the technical level (presence of sensors for the acquisition of urban real-time data, interoperability between databases).

Both these two factors composing the Information capital have great impacts on the adequacy and fitness of cities' governance in view of their transition towards Climate neutrality.

Table 16: Structure of the Climate neutrality governance self-assessment tool for cities.

1. Social capital	1.1 Participation	1.1.x	11 indicators	Y/N; frequency (years)	...	...
	1.2 Communication and knowledge	1.2.x	8 indicators	Y/N; frequency (years);	...	...
	1.3 Rules and norms of society	1.3.x	3 indicators	Y/N; yearly meetings; $	...	...
2. Human capital	2.1 Skills and competences	2.1.x	6 indicators	Y/N; high-medium-low	...	...

3. Political/ institutional capital	3.1 Organizational structure	3.1.x	6 indicators	Y/N	...	...
	3.2 Regulatory framework	3.2.x	16 indicators	Y/N; %	...	...
	3.3 Transparency and trust in political actions	3.3.x	9 indicators	Y/N; high-medium-low; %; years; n° of people	...	...
4. Financial capital	4.1 Climate finance	4.1.x	4 indicators	Y/N;%	...	...
	4.2 Disaster funds/ Compensation of losses	4.2.x	7 indicators	Y/N; %; $	...	...
5. Information capital	5.1 information sources and quality	5.1.x	11 indicators	Y/N; cells dimension (mq)	...	...
	5.2 Information management practices & tools	5.2.x	6 indicators	Y/N	...	...
TOT	**11 factors**	/	**87 indicators**	**10 metrics**		

The Table above gives a picture of the preliminary output of the investigation work performed in WP1 to integrate the Urban Planning Framework for Climate Neutrality a conceptual framework of climate neutrality governance and an analytical framework composed by clusters of factors and related sets of indicators to assess the performance of climate-related cities' governance processes.
The final result is the proposal of a Climate neutrality governance self-assessment tool for cities. The tool aims to be at the same time very refined but easy-to-use in order to constitute an easily applicable (and re-applicable) instrument.
Achieving ambitious climate goals and managing the transition towards climate neutrality requires adequate organizational structures of the involved subjects, multi-disciplinary knowledge and competences, ad-hoc support tools and optimized information management processes. Local governments are often unable to fulfill all these requirements.
The observation of the real cases contributed to shaping the idea that gaps and criticalities affecting climate neutrality governance processes lie not much in the single performed actions or cities' capitals as, instead, in the complex relationships involving multiple stakeholders and in the systems of formal and informal norms and regulations regulating these relationships.

More detailed indicators will be developed together with the involved cities to set a self assessment tool consistent with their data/information availability and data collection plan

Building a KPIs-based tool for cities' climate neutrality governance self-assessment

A Climate neutrality governance self-assessment and monitoring tool. Scope and methodology

The research question posed above (see section 6.3.1 of this document) about how to assess the adequacy, the fitness of cities' governance with respect to the climate neutrality challenge led to the application of the Capitals approach for the development of an indicators-based assessment tool with the purpose of:

- verifying the presence of favourable pre-conditions – the availability of adequate tangible and intangible resources and processes – enabling climate neutrality achievement in cities (assessing cities' capacity);
- detecting weak points in cities' governance models and processes hindering climate neutrality achievement; and
- monitoring and evaluating improvements in cities' capacity along the Climaborough project after the implementation of mitigation and adaptation measures.

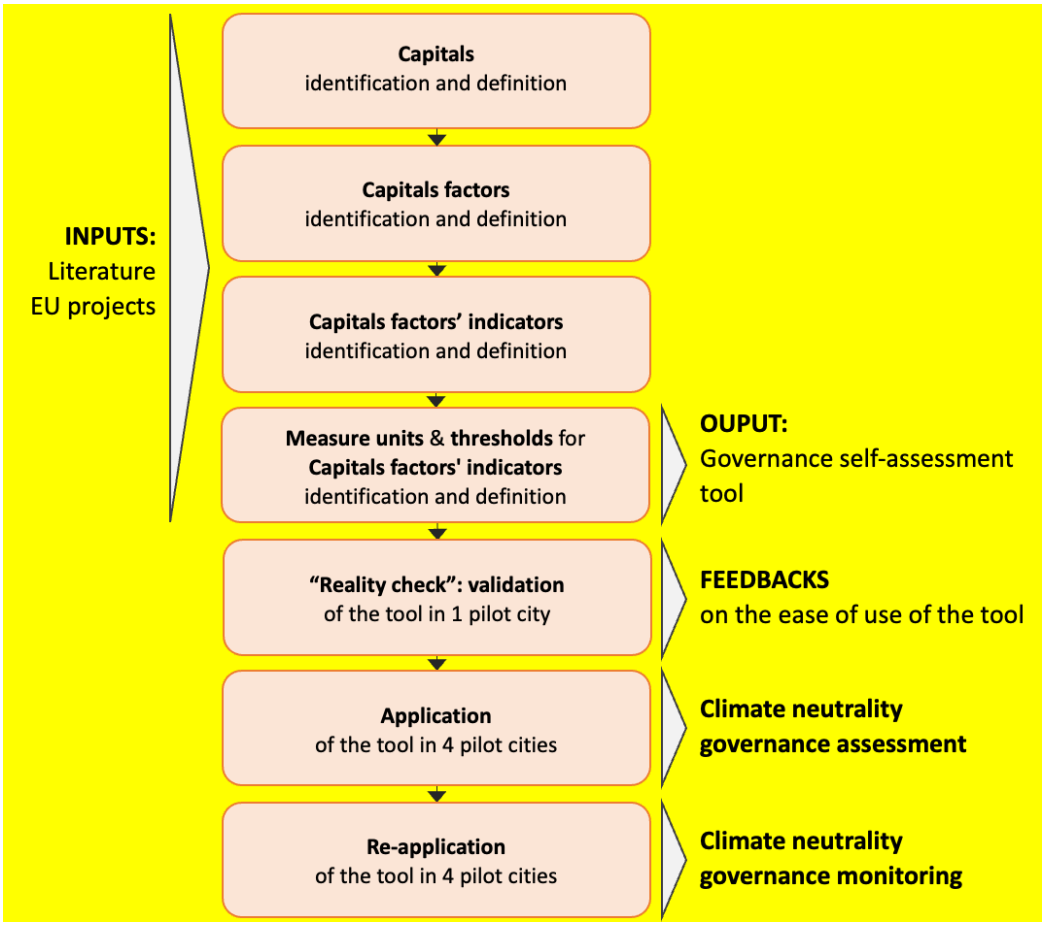

Figure 16: Methodology steps for the construction of the Climate neutrality governance self-assessment tool.

After a first "test" of the tool in one pilot city and its validation, it will be applied in the other three selected pilot cities. A first climate neutrality governance assessment will be carried out, which will give back a picture of weak points in governance models and processes and gaps in cities' tangible and intangible resources (Capitals) at the "time 0".

Further governance assessments are intended to be carried out repeatedly over the Climaborough project, tracking the impacts of changes in governance on the capacity level and comparing improvements in different cities.

The stakeholders which will answer the questions and provide the information required by the Climate neutrality governance assessment and monitoring tool are the primary source of inputs to the assessment process. Thus, the selection of individuals for the application of the assessment will actually directly influence the assessment outputs and hence it is a critical step which requires a previous knowledge of the different available "candidates" and an accurate evaluation of personal background, skills, role, level of involvement and engagement in climate neutrality related issues etc.

The people selected for this critical task will be identified with the term "Key informants", already used by the Oxford Policy Management group in the report on Climate Governance Assessment (2018).

The preferable number of Key informants depends on the characteristics of the pilot city and its institutional and social context, as well on the organizational structure of the local government: for example, the more fragmented is the structure (many different departments responsible for different issues related to climate neutrality), the highest number of people will be required to answer the questions and provide information.

In the evaluation, the need for diversity of points of view in the respondents should also be taken into consideration, to be balanced with time and resources available for the application of the tool.

Potential candidates to be Key informants may include:

- Local government political representatives;
- Local government technical representatives;
- Consultants working with local government on specific climate-related issues;
- Governmental agencies working on specific climate-related issues representatives;
- Non-governmental organisation (NGO) working on climate-related issues representatives;
- Academics and researchers working with local government on specific climate-related issues;
- Private sectors representatives collaborating with the local government on sector-specific climate-related issues.

Selection of performance indicators for cities' climate neutrality governance self-assessment

This Climate neutrality governance assessment and monitoring tool is designed to be carried out independently by cities, through a self-assessment process.
The final product consists in a set of fillable tables similar to a survey in its ease-of-use: each indicator is formulated like a multiple-choice question that requires the respondents to tick YES or NO or to choose between few options (e.g. frequency in years or percentage under or above 33%).

Given that the proposed assessment framework includes both "common" indicators (broadly agreed in reference literature) as well as "new" ones in order to incorporate underrepresented climate governance aspects, it is not surprising that new metrics are required to measure the performance of cities in such unexplored dimensions.
In view of this, some metrics have been assigned to each indicator but will be subject to further updates based on the feedback provided by the pilot cities' that will test first the Climate neutrality governance self-assessment tool (supported by Climaborough research team members).

The same goes for thresholds, whereas they were extracted by reliable literary sources but they need to be further investigated and refined in the light of cities' feedback.

A separate remark regards weights assignment to each indicator: the scope of this tool is not ranking cities but rather detecting weak points in their governance models and processes and gaps in their tangible and intangible resources (Capitals) in order to identify rooms for improvements and

implementing effective climate measures to support cities' in their transition towards climate neutrality. Thus, assigning weights to the different factors included in the governance framework would only be useful in terms of prioritizing actions in what would emerge to be the most important and impactful aspects of cities governance.

Nevertheless, the different weight (the impact) of the different governance dimensions depends on multiple factors that are highly case-specific (city-specific).
The examples of governance assessment methods and tools reported in section 6.3.1 of the present document share this choice: the European Climate Foundation chooses not to rank the indicators and applies no weighting, claiming that "establishing a hierarchy, ranking and/or weighting would need additional research and should involve stakeholders to support the final selection" (ECF, 2021).

For the same reasons, in the Climate Governance assessment methodology proposed by the Oxford Policy Management (2018), each of the dimensions are given equal weightage even if "in reality, some dimensions are more important than others" (OPM, 2018).

The following tables are the first result of the still ongoing development work on the development of the Climate neutrality governance self-assessment tool for cities.

Table 17: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Social Capital assessment.

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
1. SOCIAL CAPITAL	1.1 Participation	1.1.a	Involvement of private and civil partners through different forms of collaboration (networks, groups, regular meetings or activities...)	Y/N	/
		1.1.b	Presence of governmental networks related to climate issues involving citizens	Y/N	/
		1.1.c	Presence of non-governmental networks related to climate issues involving citizens	Y/N	/
		1.1.d	Presence of networks related to climate issues involving private sector	Y/N	/
		1.1.e	Presence of non-governmental networks related to climate issues involving private sector	Y/N	/
		1.1.f	Organization of deliberative events open to citizens	Frequency	1-4 yearly; 5-9 yearly; +10 yearly
		1.1.g	Presence of volunteer citizens programs related to climate emergencies	Y/N	/
		1.1.h	Organization of activities for participatory budgeting for citizens	Y/N	/
		1.1.i	Redaction of a local government participatory strategy or plan	Y/N	/
		1.1.l	Implementation of participation monitoring processes (e.g. internal or external audits)	Y/N	/
		1.1.m	Organization of demonstrations and strikes for climate-related issues	Frequency	Never; Weekly; Monthly; Yearly
	1.2 Communication and knowledge	1.2.a	Organization of citizen science initiatives (forums)	Y/N	/
		1.2.a	Partnerships with schools and other training institutions for the organization of educational activities, capacity-building courses, trainings, awareness campaigns for young generations	Y/N	/
		1.2.a	Organization of educational activities, capacity-building courses, trainings, awareness campaigns for citizens	Y/N	/
		1.2.a	Organization of educational activities for specific target groups: women and socially excluded groups	Y/N	/
		1.2.a	Extent of a transparent and established communication processes (ex: publication of periodic reports on climate-related issues)	Y/N	/
		1.2.a	Presence of committees and networks where every citizens can join the process of knowledge exchange	Y/N	/
		1.2.a	Organization of public campaigns on climate-related issues at the local level	Frequency	Monthly; Yearly
		1.2.a	Discussion of climate-related issues on the local media	Frequency	Daily; Weekly; Monthly
	1.3 Rules and norms of society	1.3.a	Existence of informal boards/groups resulting from cultural-historic development	Y/N	/
		1.3.b	Solidarity in society: amount of donations given from the society/the local government to most climate impacted social groups	$	
		1.3.c	Availability of volunteer organizations/registers to activate in case of emergencies	Y/N	/

Table 18: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Political Capital assessment (PART I).

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
2. HUMAN CAPITAL	2.1 Skills and competences	2.1.a	Average level of education of local government's employees (or collaborators) responsible for climate-related issues	High school; university studies; more	/
		2.1.b	Adequacy of the background studies of local government employees (or collaborators) to manage climate-related issues	High; Medium; Low	/
		2.1.c	Presence in most of the local government's departments of at least one nominated focal person for climate management and/or some staff have received training on climate-related issues	Y/N	/
		2.1.d	Membership of local government's employees in non-governmental and governmental technical aid organisations (fire brigade, red cross, THW, etc)	%	% of the total number of employees +66%; +33% ; -33%
		2.1.e	Membership of citizens in non governmental and governmental technical aid organisations (fire brigade, red cross, THW, etc)	%	% of the total adult population +66%; +33% ; -33%
		2.1.f	Presence of a figure (Resilience officier; Climate manager; etc.) with specific competences and skills for climate neutrality management in the local government	Y/N	/

Table 19: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Political Capital assessment (PART II).

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
3. POLITICAL/ INSTITUTIONAL CAPITAL	3.1 Organizational structure	3.1.a	Breakdown of responsabilities and tasks related to climate neutrality management into multiple departments/groups/divisions as a primary barrier to objectives achievement	Y/N	/
		3.1.b	Presence of a department/division/group 100% dedicated to climate mitigation management, with specific responsabilities and competences	Y/N	/
		3.1.c	Presence of a department/division/group 100% dedicated to climate adaptation management, with specific responsabilities and competences	Y/N	/
		3.1.d	Presence of a department/division/group 100% dedicated to climate neutrality management, with specific responsabilities and competences	Y/N	/
		3.1.e	Multi-level governance, inter-departmental coordination: organization of regular alignment-meetings, presence of interdepartmental working groups	Y/N	/
		3.1.f	Multi-level governance, territorial coordination: organization of regular alignment-meetings, presence of territorial working groups, networks at the territorial/regional level	Y/N	/
	3.2 Regulatory framework	3.2.a	Presence of local mitigation plan and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.b	Presence of local adaptation plan and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.c	Presence of local joint mitigation-adaptation plan (Climate neutrality plan) and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.d	Presence of cross-sectoral mitigation plans and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.e	Presence of cross-sectoral adaptation plans and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.f	Presence of sector-specific mitigation plans and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.g	Presence of sector-specific adaptation plans and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.h	Presence of climate emergency plans and last update	Y/N Date:__/__/____	within the last 2 year; between 2-5 years ago; more than 5 years ago
		3.2.i	Permanency of climate related plans/laws/regulations (time period): update frequency	Frequency	1-2 years; 3-5 years; more than 5 years
		3.2.l	Compulsory nature of the climate mitigation-related plans/law/regulations	Y/N	/
		3.2.m	Compulsory nature of the climate adaptation-related plans/law/regulations	Y/N	/

Table 20: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Political Capital assessment (PART II).

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
3. POLITICAL/ INSTITUTIONAL CAPITAL	3.2 Regulatory framework	3.2.n	Integration of available climate services (climate projections/models, vulnerability assessment, risk assessments, cost-benefits analysis, etc.) into climate plans	Y/N	/
		3.2.o	Involvement of experts (external consultants/collaborators) for climate plans development	Y/N	/
		3.2.p	Co-development of climate plans with stakeholders (citizens, private businesses, NGOs) trhough participatory processes	Y/N	/
		3.2.q	Inclusion of detailed stakeholders identification, budget, implementation and monitoring procedures, other details in the climate plans	Y/N	/
		3.2.r	Implementation of monitoring procedures: regular monitoring and reporting on the impacts of the already implemented (to date) measures included in the climate plans	Y/N	/
	3.3 Transparency and trust in political actions	3.3.a	Level of (perceived) prioritization of climate action by local government	High; Medium; Low	/
		3.3.b	Percentage of population taking part in municipal elections on average (last 5 years)	n° of people	popolutation 66% +33% -33%
		3.3.c	Presence of climate change feature in the election programm of the last-elected political parties	Y/N	/
		3.3.d	Periodic statistical surveys published reflecting the opinions of the population in regards to government's performed work	Y/N	/
		3.3.e	Presence of comprehensive anti-corruption policies	Y/N	/
		3.3.f	Presence of laws/declarations, etc. in order to provide legal basis for the freedom of media	Y/N	/
		3.3.g	Periodic submission of new laws or decrees in a public document	Y/N	/
		3.3.h	Duration of the local government mandate	n° of years	?
		3.3.i	Organization of periodic formal meetings with stakeholders who are involved in continuous networking processes	n° of meetings/year	1-4 yearly; 5-9 yearly; +10 yearly

Table 21: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Financial Capital

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
4. FINANCIAL CAPITAL	4.1 Climate finance	4.1.a	Lack of funding for climate-related measures and activities as a primary constraint to climate neutrality achievement	Y/N	/
		4.1.b	Main sources activated by the local government to obtain funds to tackle climate change	%	Public (regional): %__ Public (national:%__ Public (international): %__ Private: %___
		4.1.c	Presence of a specific person/group dedicated to search and management of funds to tackle climate change within the local government	Y/N	/
		4.1.d	Availability of governmental disaster compensation funds	Y/N	/
	4.2 Disaster funds/ Compensation of losses	4.2.a	Ratio of public and private investments on disaster funding	%	losses 50% +50%/25% -25%
		4.2.b	Amount of disaster expenses of the total budget	%	GDP 50% +50%/25% -25%
		4.2.c	Local government's insurance coverage related to climate-related losses: insurance ceiling	$	?
		4.2.d	Existence of obligation to obtain insurance for privates	Y/N	/
		4.2.e	Percentage of households having insurance related to specific climate-related issues	%	66%; +33% ; -33%
		4.2.f	Percentage of enterprises having insurance related to specific climate-related issues	%	66%; +33% ; -33%
		4.2.g	Percentage of damages that were covered by insurances during the last extrem events	%	66%; +33% ; -33%

Table 22: The Climate neutrality governance self-assessment tool for cities: proposal of indicators, metrics and thresholds for the Information Capital

CAPITALS	FACTORS	CODE	INDICATORS RELATED TO FACTORS	METRICS	THRESHOLDS
5. INFORMATION CAPITAL	5.1 Information sources and quality	5.1.a	Local climate information sources: the local government contracted/established a partnership with specialized climate services provider/s	Y/N	/
		5.1.b	Local climate information sources: the local government acquires information from online portals only	Y/N	/
		5.1.c	Local climate information sources: the local government contracted specialized consultants for climate information interpretation/elaboration	Y/N	/
		5.1.d	Resolution of the available climate information at the local scale	cells dimension (mq)	?
		5.1.e	Performance/acquisition of vulnerability assessments at the local scale	Y/N	/
		5.1.f	Performance/acquisition of economic impacts assessments at the local scale	Y/N	/
		5.1.g	Level of disaggregation of the available climate information at the local scale: acquisition of information on climate vulnerability and impacts on specific sectors/economic activities	Y/N	/
		5.1.h	Level of disaggregation of the available climate information at the local scale: acquisition of information on climate impacts on women and/or socially excluded groups	Y/N	/
		5.1.i	Level of differentiation by user of the available climate services: user-driven climate services	Y/N	/
		5.1.l	Acquisition of visulation tools: maps, infographic products, etc.	Y/N	/
		5.1.m	Acquisition/translation of climate services in the local language	Y/N	/
	5.2 Information management practices & tools	5.2.a	Presence of local government guidelines, policies, plans, obligations, standards on climate information management	Y/N	/
		5.2.b	Availability of urban sensors providing real-time climate monitoring data	Y/N	/
		5.2.c	Accessibility of local climate information for citizens: availability on a dedicated local government's website (for free)	Y/N	/
		5.2.d	Accessibility of local climate information for citizens: availability of an Opensource central portal/platform housing all relevant local climate information	Y/N	/
		5.2.e	Availabilty of dedicated apps for climate emergency management (alerts, early warnings, etc.)	Y/N	/
		5.2.f	Interoperability between databases and information systems	Y/N	/