NET ZERO CITIES SGA-NZC

Governance Innovation and Implementation in the Cities Mission

Theme 2: Anticipatory Governance in City Climate Planning and Policy

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Abbreviations and acronyms

Acronym	Description
CAP	Climate Action Plan
CCC	Climate City Contract
CIP	Climate Investment Plan
EIB	European Investment Bank
WP	Work Package
AFOLU	Agriculture, forestry, and land use
CA	City Advisor
CSG	City Support Group
EC	European Commission
ECF	European Climate Foundation
NZC	NetZeroCities
JTF	Just Transition Fund
GHG	Greenhouse Gases
TM	Transition Management
SECAP	Sustainable Energy and Climate Action Plan
IPPU	Industrial processes and products use

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Summary

This report examines how four European Mission cities Umeå, Tampere, Valencia, and Parma are integrating anticipatory governance approaches into their climate planning to better navigate uncertainties while pursuing climate neutrality. As participants in both the EU Climate-Neutral and Smart Cities Mission and the Adaptation Mission, these cities are developing innovative strategies to enhance resilience and adaptability in their climate transition work.

Anticipatory governance encompasses forward-looking approaches that help cities prepare for multiple possible futures rather than simply reacting to events as they occur. The report highlights three key components of anticipatory governance that cities are implementing to varying degrees:

- Strategic foresight and scenario planning: Developing plausible future scenarios to test the robustness of climate strategies under different conditions.
- Risk and vulnerability assessment: Identifying and evaluating potential hazards and vulnerabilities, and assessing how planned climate actions might be affected by future disruptions.
- Adaptive management: Establishing flexible governance structures with monitoring systems, trigger points, and contingency plans that allow for course corrections as conditions change.

The comparative analysis reveals that while all four cities have developed comprehensive frameworks to guide their climate action, they are at different stages of maturity in implementing anticipatory governance practices. All cities have conducted risk and barriers assessments as part of their Climate City Contract (CCC) development, primarily focusing on economic, financial, and social risks. However, more complex risks such as geopolitical disruptions or systemic cascading effects are not yet fully integrated into planning processes.

Key findings include:

- Scenario-based approaches are embedded in all cities' climate planning, though with varying degrees of sophistication and application.
- While monitoring processes are well-developed across all cities, formal adaptive management practices are not yet common.
- All cities face similar challenges: limited human and financial resources, data gaps and reliability issues, communication difficulties, and institutional fragmentation.
- Cities are increasingly recognizing the value of integrating forward-looking approaches (more traditionally associated with climate adaptation) into mitigation planning to build more resilient transition pathways.

The report identifies several opportunities for enhancing anticipatory governance:

- Establishing more robust adaptive governance structures with clear review mechanisms and trigger points
- Developing methods to identify "no-regret" climate mitigation actions that remain viable across multiple future scenarios
- Implementing diverse and complementary solutions rather than relying on singular strategies
- Strengthening cooperation across cities and multi-level governance to share knowledge and expertise

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As cities confront the uncertainties associated with climate change and global developments, anticipatory governance approaches provide practical frameworks essential for achieving sustainable, resilient urban environments. By integrating these forward-looking methods into their planning processes, cities can become better prepared to navigate complex challenges and recalibrate their climate strategies as needed.

Keywords

Mission Governance, Anticipatory Governance, Foresight, Risk Assessment.

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1 Introduction

Cities planning and implementing systemic and multi-faceted sustainability transformations face multiple potential interconnected challenges, including shifts in resource availability and trade dynamics, political and social shifts, and the need for effective adaptation to climate change. Traditional reactive governance methods often struggle to manage such complex uncertainties effectively. Consequently, forward-looking governance approaches have become increasingly important as cities seek proactive strategies to address these evolving challenges (Boyd & Juhola, 2015).

Complex, evolving systems require an integrated approach that combines multiple disciplinary perspectives and methodologies. Climate mitigation planning increasingly recognizes the importance of integrating technological, social, and behavioural dimensions with policy strategies (Edmondson et al., 2025; Morrison, 2022). Until recently, however, climate mitigation planning often neglected to fully consider how global and regional changes could impact future conditions, either as a consequence of present-day decision and actions, or independently. Recognising increased potential for turbulence and disruption, considerations such as the security of resource supply, the ability of socio-technical systems to withstand fluctuations in weather patterns, and the broader social implications of mitigation and adaptation actions are increasingly becoming essential components of strategic planning (Boyd et al., 2015; Jurgilevich, 2023; Muiderman et al., 2020) .

In response, scholars and practitioners have begun integrating anticipatory governance into large-scale urban development and infrastructure planning processes, employing strategic foresight tools and methods to better manage uncertainty. Scenario planning (Börjeson et al., 2006), risk and vulnerability assessments (Menk et al., 2022), and adaptive management practices (Folke et al., 2005) have gained significant traction internationally: e.g., UN Pact for the Future, Declaration on Future Generations); and regionally: e.g., resilience planning in Bristol (Stevens et al., 2020), adaptive planning in Aukland (Lawrence & Haasnoot, 2017). These tools provide processes and methods for better understanding and anticipating potential future developments, assessing related risks, and developing adaptive responses.

Anticipatory governance approaches hold considerable potential for local policymakers and city officials, shifting governance from crisis-management driven reactions toward proactive and resilience-focused planning (Stevens et al., 2020). By embracing these methodologies, cities can be better positioned to anticipate disruptions, mitigate risks, and adapt effectively to future changes. The following section offers an overview of these anticipatory governance concepts, their interrelationships, and their practical significance in the context of climate policy and urban resilience.

This report explores the potential for anticipatory governance to help cities better navigate uncertainty and complexity in climate transition planning. We conduct four comparative case studies which investigate how EU cities are seeking to advance their climate transition work by integrating aspects of anticipatory governance into the planning and implementation of their climate neutral transitions. The cities we focus on are participating in two of the EU's mission-driven innovation initiatives, the Cities Mission (100 climate neutral and smart cities) and the Adaptation Mission. We seek to better understand how these ambitious cities are experimenting with anticipatory approaches to enhance their governance capacities and how this could, potentially, support the aligning of their integrated climate work going forward. In doing so, we share valuable learnings, key insights, shared challenges and opportunities that emerge from these cities, in line with the overarching research question:

> *How are EU Mission cities adopting anticipatory governance to help steer, integrate and align their climate transition work to better respond to future uncertainties and increase resilience?*

This report details each city's approach through a dedicated case study while also providing comparative synthesis, common challenges and opportunities that emerged through the

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detailed work on each city. In the next section we introduce the core concepts of reflexive MEL, which is then used to analyse the city cases individually (See Sections "Individual city cases: Part 2": Umeå, Valencia, Tampere and Parma) and comparatively in the cross-city synthesis section.

2 Anticipatory Governance, Risk & Vulnerability Assessment, and Adaptive Management

We now introduce some of the most prevalent concepts and methods in *anticipatory governance*, before covering some approaches for *risks and vulnerabilities assessment*, and how uncertainties can be accounted for through *adaptive management*.

2.1 Anticipatory Governance

Anticipatory governance refers to a broad, future-oriented approach to planning and policy-making. Rather than addressing issues only after they occur, it emphasizes using foresight, planning, and continuous adaptation to shape desirable outcomes (Muiderman et al., 2020). It "denotes a forward-looking approach to policy-making and societal steering," emphasising proactive anticipation over reaction. Anticipatory governance involves a set of tools and processes to identify potential challenges and opportunities, assess their implications, and devise strategies in advance. The goal is to help align decisions made today with long-term objectives and to build resilience while acknowledging inherent uncertainty. By integrating anticipatory practices, city officials can better anticipate and prepare for multiple possible futures, such as economic shifts or climate-driven changes. Importantly, anticipatory governance is not a single tool but an umbrella model that integrates foresight methods, flexible planning, and learning-oriented management to navigate complexity.

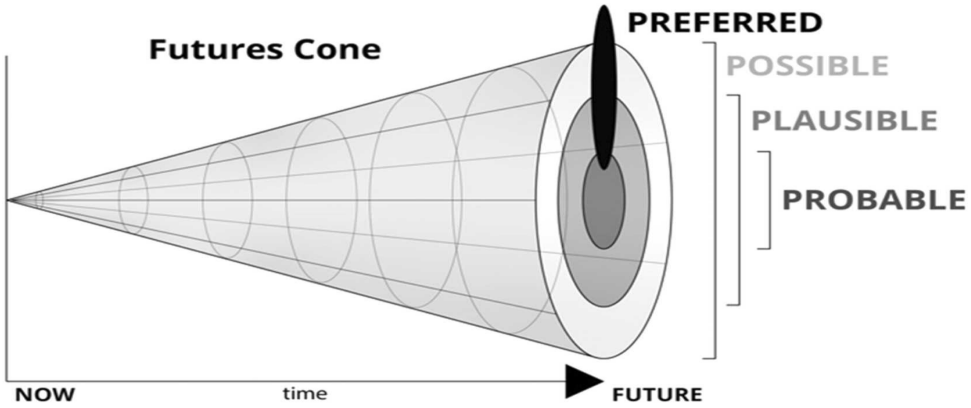

Figure 1 - Basic futures cone (Gall et al., 2022).

At the core of anticipatory governance is strategic foresight, a set of practices for helping navigate what the future might hold. Foresight helps policymakers understand uncertainty, complexity, and dynamic change, and translate those insights into policies and actions. Instead of predicting one definitive future, foresight examines a range of plausible futures so that cities can "better adapt to emerging issues, trends and risks" (Resilient Cities Network, 2022). Common foresight tools include

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horizon scanning (to spot early signals of change), trend analysis, road mapping, and importantly, scenario planning (**Figure 1**). These methods encourage long-term thinking in urban planning to enhance resilience and sustainability.

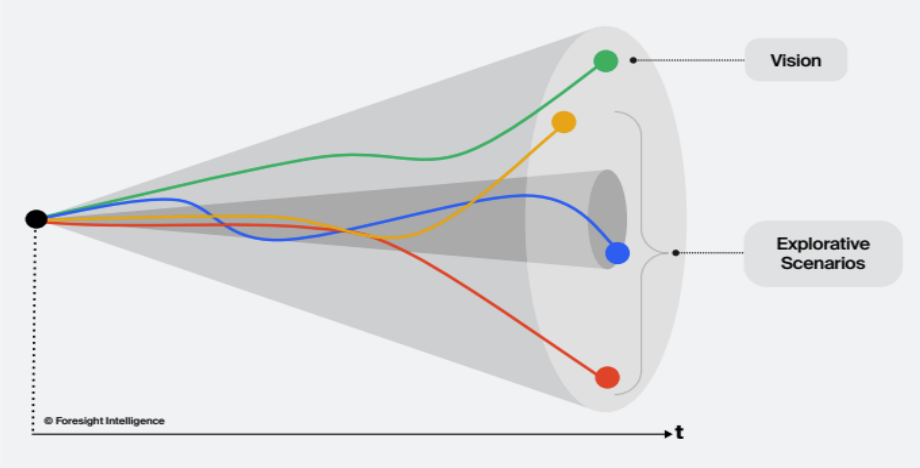

Figure 2 - Explorative future scenarios (European Climate Foundation, 2023).

Scenario planning is a process of developing multiple plausible stories about how the future could unfold, based on different assumptions (e.g. economic trends, technological developments, or climate trajectories). Scenario planning helps practitioners envision, prepare for and potentially respond dynamically to an unknown future (Börjeson et al., 2006), thinking in advance about the many ways events could play out (e.g. European Climate Foundation - Future of Trade in a Net Zero World, IPCC - socio-economic scenarios). By considering divergent scenarios, city officials can test (wind-tunnel) policies against various potential situations, often spanning from moderate projections to more extreme potential events (**Figure 2**). This preparation helps identify which strategies are most robust under divergent conditions, and identify 'no regret' options. For example, a city might use scenario planning to explore futures with different population growth rates or frequency of extreme weather events, and then identify strategies that perform well across those scenarios. Scenario planning exercises can help reveal critical uncertainties that inform urban development plans, and may highlight the need for contingency planning. Together, strategic foresight and scenario planning can better equip cities with a forward-looking perspective towards planning, which can reduce the risk of "tunnel vision" and encourage flexible strategies to respond to uncertainty.

2.2 Risk and Vulnerability Assessment

A key component of forward-looking urban governance is understanding potential risks and the related vulnerabilities that a city might face. While foresight and scenario planning might help identify potential disruptions and uncertainties, risk and vulnerability assessments systematically evaluate potential hazards or threats (like floods, heatwaves, geopolitical shifts, economic shocks and supply chain disruptions) and identify who or what is most at risk and why (LI et al., 2021). Cities can conduct these assessments to combine data on potential hazards with an understanding of vulnerable plans, measures, sectors, infrastructure and populations, and consider options to reduce the exposure and vulnerability to those potential hazards.

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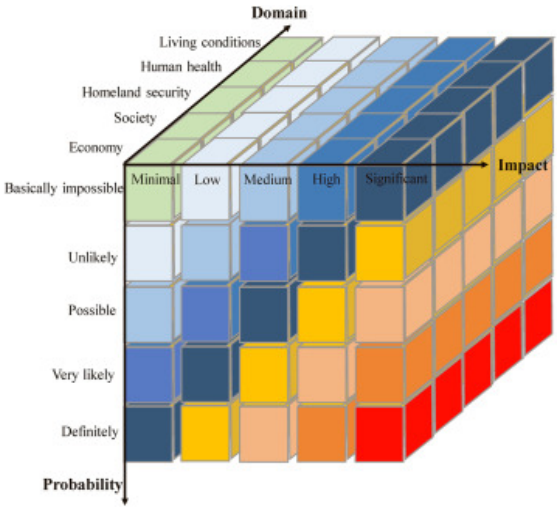

Figure 3 - Probabilistic Risk Matrix (LI et al., 2021).

Probabilistic risk assessments are methods for evaluating climate policy decisions under uncertainty by considering a range of possible outcomes and their associated probabilities, rather than relying solely on central estimates (Kunreuther et al., 2013). These approaches emphasize the importance of accounting for low-probability, high-impact events to better inform risk-aware decision-making in the face of complex and interacting uncertainties. The range of potential outcomes can cover a range of domains (**Figure 3**), such as the PESTLE indicator framework (**Figure 4**).

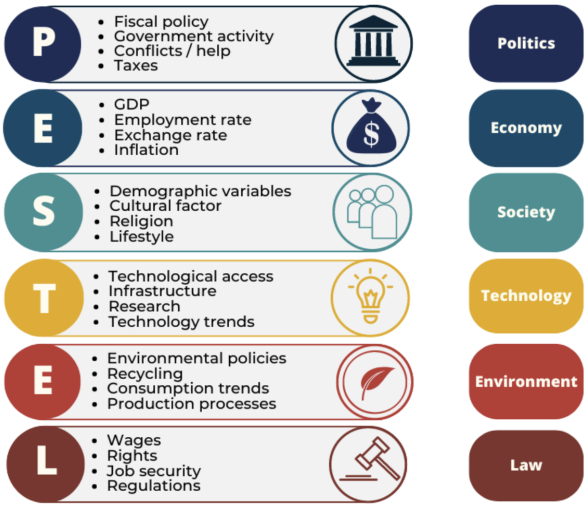

Figure 4 - PESTLE indicator framework. (Source: MSI)

Evaluation of risk from the perspective of a single hazard or threat examines how exposed and vulnerable systems, technologies, or communities are to threats and potential harm (**Figure 5**). Exposure refers to e.g. homes without cooling systems during heatwaves, homes in floodplains, vulnerability to e.g. elderly populations during heatwaves, and adaptive capacity to e.g. availability of cooling centres in the community. Considering risk across these three factors helps identify which aspects of planned actions might be most exposed or vulnerable, which can help prioritise interventions or alternative actions to reduce these factors. Single hazards and threats, combined with exposure and vulnerability, lead to risks which, when materialised, cascade to first and higher order impacts and consequences.

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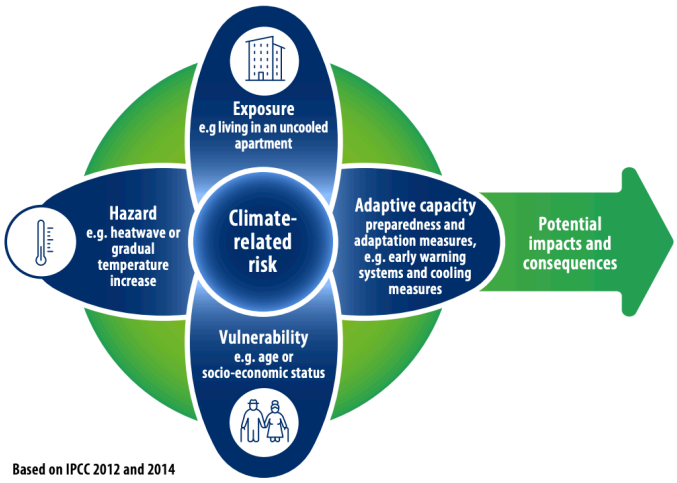

Figure 5 - Risk and Vulnerability Assessment (from climate related risk). (Preparatory group and secretariat of Finland's National Climate Change Adaptation Plan., 2024).

Systemic risk assessment moves beyond conventional risk perspectives to acknowledge how, in a poly-crisis world, risks are both *interlinked* and of a nature that - if they are materialized - threatens the integrity and function of the whole system it disrupts (hence the term systemic risk). Moving beyond first order effects, it considers the systemic potential implications of disruptions, in sequential *cascading* risk events or in situations where multiple crises materialize independently but exacerbate each other's consequences (**Figure 6**). Vulnerability and exposure are also viewed from a systems perspective, where e.g. reliance on international trade or specific infrastructure in combination with eroding 'local buffers' of critical supplies or a lack of alternative operation modes increase the exposure and vulnerability towards a multitude of hazards. Originating in the world of financial systems, systemic risk assessment is increasingly employed to aid decision-making under deep uncertainty in a broad range of sectors, including public governance. Systemic risks can typically be difficult to quantify and demand adaptive approaches rather than robust decisions.

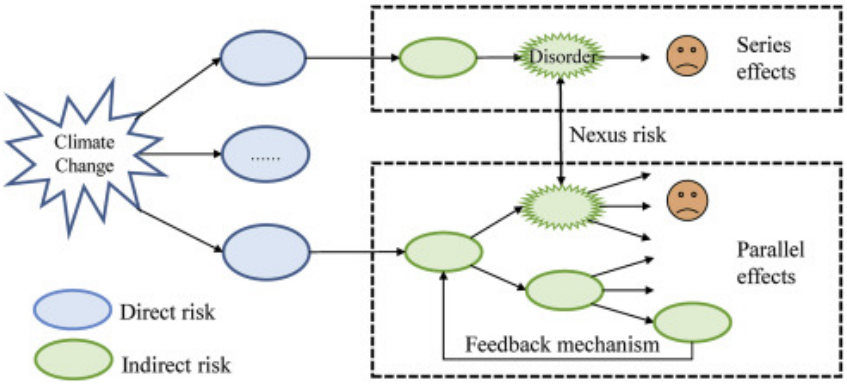

Figure 6 - Illustration of potential occurrence mechanisms of systemic risk (LI et al., 2021).

Together, these analyses can help highlight what parts of a city's sustainability plans and strategies are most at risk and why. An integrated risk assessment could consider the hazards or threats the community might face, how exposed the city is to the hazard or threat, and the vulnerability to that threat *and* ability to adapt, giving a more comprehensive picture of resilience gaps. By anticipating risks and vulnerabilities, city officials can prioritize interventions to reduce the vulnerability or the exposure, or put monitoring systems in place to assess if the risk increases over time. This kind of forward-looking risk management is fundamental to urban resilience, ensuring that development decisions account for future climate impacts and other uncertainties.

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2.3 Adaptive Management for Resilience

Even with the best foresight and planning, the future will always hold surprises. By acknowledging this inherent uncertainty, adaptive management processes can help cities establish agile governance structures and strategies to dynamically respond to change more effectively (Lal et al., 2011). Adaptive management is a structured, iterative governance approach built on flexibility and learning, that allows decision-makers to adjust course as new information emerges or conditions change.

Adaptive management promotes establishment of adaptive pathways and, connected, trigger points - which prompt a revision of previously planned actions. Rather than sticking rigidly to a plan, policymakers using adaptive management remain agile; if a strategy is not achieving desired results or is no longer well suited to a shift in external circumstances, they can adjust and promote an alternative approach (**Figure 7**).

Adaptive management can build upon scenario planning and risk assessment processes to prioritise monitoring processes, trigger points and contingency plans around actions or infrastructure where uncertainties are highest, or risks are considered to be greatest (Lawrence & Haasnoot, 2017). Adaptive management complements anticipatory governance: while foresight and assessment help inform planning, an adaptive approach helps keep those plans agile and effective as conditions and assumptions change over time. It embraces the reality that governance is uncertain, policies are improved through feedback, and success is determined by the ability to navigate change and unintended consequences.

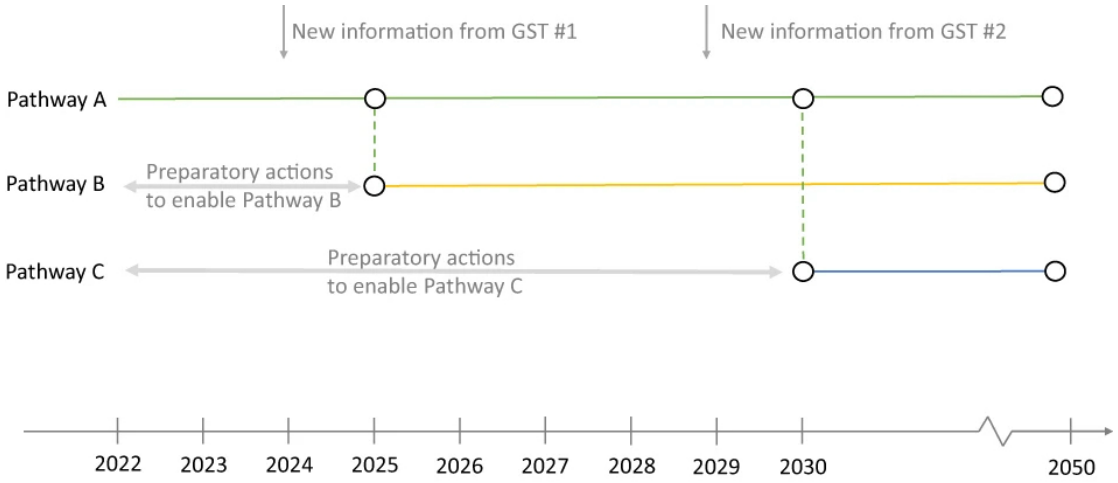

Figure 7 - Illustration of three adaptive pathways to decarbonisation by 2050. (Gambhir et al., 2023).

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3 Methods

3.1 Research Design and Methodological Approach

This research follows a comparative case study design, focussing on selected Mission Cities' approaches to anticipatory climate governance. We employed a mixed-methods and transdisciplinary design, drawing on interviews, workshops and a peer-to-peer workshop between city officials. The project team comprised an interdisciplinary group of both academics and practitioners, with expertise in climate policy and governance, energy systems modelling, risk and vulnerability assessment, climate adaptation, as well as foresight and adaptive planning. The research process combined multiple perspectives and helped the team establish a shared language across what are related but commonly divergent disciplinary perspectives.

The first stage of the work involved a desk-based review of the selected cities' Climate City Contracts and supporting documents, which helped identify the mitigation priorities and key planned actions for each city, along with how the city considers potential risks and barriers. We complimented this desk-based research with policy documents, white papers and grey literature about anticipatory processes the cities had engaged in.

The primary research involved a multiple stage engagement process with city representatives, which followed three main steps:

Initial Interviews: Initial discussions involved consortium members and city officials. Interviews followed a semi-structured format, with the number of participating city officials ranging from two to six per city, were 60 mins in length and were conducted November 2024 to Jan 2025.

Anticipatory Governance Workshop: Workshops in each city focused specifically on anticipatory governance, integrating scenario planning, risk and vulnerability assessments, and adaptive management into climate mitigation planning. The workshops were conducted with participating cities between January and February 2025. Each workshop included:

- An introductory presentation on anticipatory governance concepts.
- Structured exercises conducted via Miro, focusing sequentially on scenario planning, risk and vulnerability assessment, and adaptive management in response to uncertainty.
- Facilitated open discussions to explore the application and challenges of these approaches.

City Peer-to-Peer Workshop: The final step involved an online peer-to-peer workshop in March 2025 where cities presented their respective approaches to anticipatory governance. Following these presentations, facilitated discussions were held, encouraging direct exchange and collaborative learning among city representatives.

This collaborative research design invited city officials to be part of the sensemaking process through a peer-to peer workshop, with a facilitated discussion moderated by along with the project team.

Full individual city cases were prepared and sent to respective participating cities for review and validation. For each participating city we prepared full individual city cases. The four city cases for this topic are located at "Individual city cases: Part 2". Please refer to these extended cases for more information on any of the points included in the following synthesis sections.

The final synthesis of shared insights, challenges and opportunities across the city cases built upon these interactions but was conducted by the project team. Therefore such opinions or

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insights reflect those of the project team and do not necessarily represent the views of the participating city officials.

3.2 Research Case/City Selection Process

Cities included in this study were selected based on their participation in both the Climate-Neutral and Smart Cities Mission and the Adaptation Mission. Four cities were chosen to provide geographic diversity and differing priorities in climate mitigation: two from northern Europe (Umeå and Tampere) and two from southern Europe (Valencia and Parma). Each city had previously implemented anticipatory governance approaches to varying extents, providing a spectrum of experience and diversity in application methods and mitigation priorities (**Table 6**).

Table 1 - Comparative metrics of city cases (based on data from submitted CCC documents).

City	Population Size	Main Sectors for Decarbonisation	Employment Distribution	Access to Public Transport	Climate Hazards / Threats
Valencia	830,606 (2024)	Transport, Buildings	67.1% Trade/Services, 22.8% Prof./Art., 6.8% Construction, 3.3% Industry	Metro, Bus, Suburban Trains; High usage across modes	Heatwaves, floods, aridification, sea level rise
Umeå	132,235 (2023)	Transport, Buildings & Stationary Energy	Private services, research, knowledge intensive sectors	Strong focus on rail and cycling infrastructure	Flooding, erosion, heavy rainfall, potential heatwaves
Tampere	255,050 (2023)	Construction & Housing, Mobility & Transport	Services, ICT, health tech, automation	Well-developed, public transport prioritized	Flooding, heat, storms, drought, biodiversity loss
Parma	198,885 (2023)	Buildings, Transport	64% Services, 32% Manufacturing, 4% Agriculture	Above national average, good network	Heatwaves, poor air quality, changing precipitation

All cities had conducted risks and barriers assessments as part of the CCC label application. Comparison of Barriers Identified in CCC across cities indicates that cities consider a well-balanced range of potential disruptions to the planned implementation pathways covering social, technological and political/legal challenges (**Table 7**). In this work, we are interested in the processes through which the cities identified such potential barriers and risks, and if they consider a range of potential future conditions which might lead to such disruptions.

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Table 2 - Barriers identified in the submitted CCC planning documents across cities.

City	Institutional	Infrastructural / tech	Behavioural	Other barriers	Total
Parma	10	5	3	2	20
Tampere	7	3	1	0	11
Umeå	7	6	6	5	24
Valencia	11	6	4	1	22

Comparing the risks identified across the four cities shows that economic and financial risks were the most commonly identified. Social risks were also highlighted by all cities, while institutional and policy risks were also commonly highlighted (**Table 8**). The processes which underpin how these risks were identified and selected is a topic of interest for this research, which was integrated into our interactions with the cities.

Table 3 - Risks identified in the submitted CCC planning documents across cities.

Risk Category	Parma	Tampere	Umeå	Valencia
Other risks	1	18	3	8
Economic and financing risk	1	5	4	3
Technical risk		4	1	
Institutional, policy or regulatory risk	2		1	1
Social risk	1	1	1	1
Capacity and capability risks		2	1	
Safety risk		2		
Climate risk		1	1	
Asset transition risk		1		

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3.3 Glossary

Concept[1]	*Short definition*
Anticipatory Governance:	This is a way of making decisions about the future, based on hopes, ideas and plans for development. It can involve proactively thinking through and planning for potential disruptions and creating contingency plans before problems become urgent (Boyd et al., 2015; Jurgilevich, 2023; Quay, 2010). This distinguishes it from reactive governance, which is responsive to changes which are already occurring. The potential benefits of anticipatory governance are widespread, in terms of increasing resilience, reducing potential loss and damages, and improving citizen's health and quality of life. For the potential threats related to a changing climate, it involves planning and acting now to reduce risks and prepare for changes, rather than waiting for potential issues and disruptions to arise.
Foresight:	Systematic ways of *thinking* about the future with a view to influence its course of development.
Flexibility and Adaptability:	The future is uncertain. Uncertainty can be managed by establishing flexibility and adaptability mechanisms - by establishing planning and decisions-making processes that can adjust as new information or conditions emerge, and by planning actions with flexibility options (Rauws & De Roo, 2016).
Scenario Planning:	Scenario planning involves creating different plausible future scenarios based on different drivers (e.g. climate change impacts) and then assessing potential threats/hazards that may occur across these scenarios. This helps decision-makers prepare for multiple possibilities, rather than just one predicted future (Börjeson et al., 2006).
Resilience:	Resilience reflects the extent to which a system or population can cope with hazardous events. Resilience is the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPPC, 2023). This requires considering multiple objectives of mitigation and adaptation pathways, including strengthening communities and ecosystems to withstand climate impacts.
Learning and Knowledge Sharing:	There are uncertainties about how climate change will unfold, and we are still learning. Regularly or periodically collecting new data as it becomes available, is needed to effectively adapt assumptions, strategies and planning. This combines learning from past experiences with forward-looking assessments and can be strengthened by collaborative sharing of knowledge (locally, nationally and globally) to improve strategies.
Multi-Level Governance:	Climate change governance and increasing resilience are not just local challenges — they require cooperation across different levels of government (local, regional, national, international) (Bache et al., 2022). Multi-level governance looks at how to align actions, policies and strategies for collective action across these different levels.

[1] NB: Several concepts are partially overlapping, due to the fact that they have been developed in parallel by different research/practice communities.

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Co-Benefits:	Climate policies and measures aimed at one objective can foster multiple additional and complimentary benefits, such as economic development and redistribution, health improvements, and social equity. (IPCC, 2022) Doing so can help create more tangible and visible benefits which can help foster political support for climate policies. Anticipatory governance helps think-through and identify solutions that benefit multiple objectives at once.
Trade-offs:	Trade-offs in climate policy refer to the tensions or compromises between achieving one goal or objective (such as emissions reduction or risk reduction) and other socioeconomic objectives, including affordability, competitiveness, and equity. Trade-offs can arise when policy instruments designed to mitigate climate change produce unintended negative impacts, such as increased costs for consumers, reduced economic competitiveness for small firms, or disproportionate burdens on low-income populations. Identifying, managing, and, where possible, mitigating/ transforming trade-offs is essential for designing effective, equitable, and politically sustainable decarbonization strategies (IPCC, 2022)
Hazard / threat:	A hazard is any potential event, phenomenon, or activity (whether natural, human-induced, or a combination) that could lead to adverse impacts on people, ecosystems, infrastructure, or economic assets (UNDRR, 2017).
Exposure	Exposure describes the presence of people, livelihoods, infrastructure, ecosystems, or economic, social, and cultural assets in places and settings that could be adversely affected by hazards. Essentially, it highlights what could be harmed by a particular hazard—where people and assets are located relative to potential threats. Exposure is related to the location and distribution of assets or populations. A higher number or concentration of people/assets in at-risk areas increases exposure (IPPC, 2023).
Vulnerability	Vulnerability refers to the propensity or predisposition of a system, community, or individual to be adversely affected by a hazard or threat (IPPC, 2023). (It encompasses the sensitivity to harm as well as the ability (or lack thereof) to cope, adapt, and recover. Factors such as social inequality, lack of resources, inadequate infrastructure, and limited institutional capacities typically increase vulnerability. Vulnerability is Influenced by factors like poverty, education, governance, and access to technology.
Risk (interaction of Hazard, Vulnerability and Exposure)	Collectively the three previously listed elements (hazard, exposure, vulnerability, make up “risk”. Vulnerability and exposure are interrelated, If assets are highly exposed and also highly vulnerable, the risk escalates (IPPC, 2023).
Systemic risk	A (new) type of risk that threatens the collapse of an entire system. Systemic risks are becoming more common as the world is increasingly interconnected, and where 1) a disruption in one place has cascading effects - causing disruptions across larger areas and domains or b) specific hazards are becoming larger with potential to lead to multiple simultaneous disruptions (Sillmann et al., 2022).
Adaptive management	Adaptive management is a structured, iterative process used to make decisions in the face of uncertainty. It emphasizes learning-by-doing and continuous adjustment of strategies based on observation, foresight (horizon scanning and early warning signs) and planned junctures for re-calibration at defined trigger points (Kato & Ahern, 2008).
Wind tunnelling	Wind tunnelling in the context of climate and policy planning is a method of “stress-testing” strategies or policies against a range of plausible future scenarios to see how well they perform under different conditions. Policy analysts can use wind tunnelling to identify “no-regret” options: Actions that are beneficial under a wide array of future conditions, ensuring that the investment or interventions carry the least (foreseeable) risk. This can be done through participatory (qualitative) approaches or through quantitative modelling with e.g. scenario-discovery approaches, or a combination (Ramos, 2017).

4 Synthesis across cases and shared challenges

This section provides an overview of the four cases. First, we provide a synthesis across the cities, highlighting the key features of each city's work, key insights, common approaches and similarities (**Table 9**). We then turn to discussing common challenges that emerged from our discussions with the cities, both independently in bilateral workshops and those emerging through the peer-to-peer workshop.

Table 4 - Overview of cross-city synthesis.

Category	Umea	Valencia	Tampere	Parma
Anticipatory Governance Approach	Uses scenario-based planning centered around developing an idealized 'vision' scenario with back-casting. Worked with consultants (Material Economics) to develop data-driven climate neutrality scenarios focusing on major emitting sectors.	Integrates anticipatory elements through the València 2030 Climate Mission and Urban Strategy. Uses IPCC-based scenario development with regionalized climate models. Developed economic models for co-benefits that incorporate ROI analyses.	Focuses on developing foresight capacities across departments. Emphasizes impact pathways as a structured method in climate mitigation strategies.	Distinguished by extensive multi-stakeholder co-creation process (PARMA FUTURO SMART participative foresight). Early institutional commitment to climate neutrality goals is seen as a key element of future-focused scenario work.
Processes and Resources	Climate team of 4–5 people within strategic development office. Limited resources require external funding for projects. Stakeholder participation through Climate Roadmap partnership involved 65 local organizations.	Governance through Mission Fridays and Valencia Mission Team for cross-departmental collaboration. Mission Alliance includes 150+ organizations representing 20,000 businesses and civil society actors. Relies heavily on EU project funding, creating continuity challenges.	Dedicated foresight expert ensuring foresight is central in developing city strategy. Participatory processes central to identifying and prioritizing climate change risks.	Extensive multi-stakeholder co-creation process forms the core of anticipatory governance. Faces financial constraints and shortage of skilled personnel to manage complex climate projects.
Risk and Vulnerability Assessments	No formal risk assessment process for climate mitigation beyond CCC requirements. Focuses on financial and economic risks, demographics, technology, and skills supply. Stronger capacities for	Risk assessment primarily developed within CCC and Climate Adaptation Plan frameworks. Uses GIS-based climate modeling and vulnerability mapping. Economic and	Uses digital tools to support and structure risk assessments. Seeks improved risk and vulnerability assessment methods for climate mitigation and multi-	Participatory processes central to identifying and prioritizing risks and vulnerabilities. Interests center on enhancing capacity to anticipate climate risks and developing formal early warning

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	adaptation assessments. Recognizes need to transfer risk assessment skills from adaptation personnel to mitigation team.	financial risks are central. No structured risk assessment processes embedded in mitigation strategies.	risk assessment approaches.	systems to identify probabilistic risks. GIS techniques used for mapping climate vulnerabilities.
Monitoring and Adaptation	Annual monitoring of emissions, trends, and progress toward climate neutrality through Climate Neutral Umeå program. Faces “data lag” challenge with latest available data being 2 years old. No formalized adaptive management practices, but expressed interest in developing these.	Monitoring framework with KPIs focused on emission reductions, energy efficiency, and sustainable practices. Multi-level governance structure designed to support implementation and monitoring.	Established revision points in municipal roadmapping process with monitoring assisted through KAUSAL tool. Iterative annual or biannual planning cycles provide formal revision points. Interested in flexible policy-making planning, particularly Robust Decision-Making and Dynamic Adaptive Policy Pathways approaches. Faces “data lag” challenge with latest available data being 2 years old.	Systems and indicators, including metrics for climate action and emissions reductions. Currently working on the integration of digital tools in the implementation of adaptive planning and implementation.

4.2 Approaches to anticipatory climate governance

Application of anticipatory governance in city level planning is emerging as an important area of development and capacity building. In this report we have introduced some of the most prominent approaches, while acknowledging that there is not yet (at the time of writing) an integrated approach which combines these aspects together coherently, nor a standardized way to work in an anticipatory manner within the local governance for climate neutrality.

As such, **the cities we highlight are in some sense "on their way" and in the process of establishing or grounding anticipatory climate governance practices in their work**. They are at different maturity/development levels when it comes to incorporating risk assessments etc. and have taken different approaches based on their priorities and building on established processes and competencies.

In line with their Climate City Contracts, all cities have developed comprehensive and holistic frameworks to guide their climate action. Tampere implements its "Climate Neutral Tampere 2030 Roadmap," which contains 397 specific climate actions across seven themes. Parma has established the "Parma Città Climate Neutral 2030" action plan as a comprehensive strategy integrating various strategic plans related to climate neutrality, mitigation, and adaptation. Parma and Tampere have integrated climate mitigation and adaptation in their roadmaps. Meanwhile, Umeå approaches climate planning through a collaborative Climate Roadmap partnership that involves 65 different local organizations and companies who have signed agreements to work together on reducing greenhouse gas emissions in the city. Valencia has developed the "València 2030 Climate Mission," which serves as the city's strategic framework for achieving climate neutrality by 2030. This Climate Mission is integrated with the broader "València Urban Strategy," a comprehensive guiding document that outlines the city's long-term vision for urban development. Other cities also closely align or integrate their climate neutrality plan with other urban strategies, e.g. in Umeå with the energy plan and in Parma with the sustainability plan.

All cities have participated in European projects which have contributed to strengthening anticipatory governance capacities. An example for mitigation planning was the RUGGEDISED project, in which Parma both Umeå and participated. Through this project the PARMA FUTURO SMART participative foresight process helped to roadmap the city's vision to become a fully green urban center by 2030, and was embedded within developing Parma's CCC. Similarly, Valencia's participation in EU-funded projects have supported the development of advanced analytics and access to open data. Specifically, the ARCH project enabled the city to establish adaptation pathways to enhance long-term resilience planning.

Scenario based approaches are embedded in all cities climate city contracts, however, to varying degrees. Umeå's scenario planning centers around developing an idealised 'vision' scenario and back-casting from there. To develop data-driven climate neutrality scenarios Umea worked with consultants (Material Economics) that, in particular, helped set plausible levels of actions - based on experience from other cities - with a focus on major emitting sectors. In Parma, the early institutional commitment and adoption of climate neutrality goals is seen as a key element of its anticipatory governance and future-focused scenario work in itself.

Both Tampere and Valencia emphasize the development of impact pathways as a critical, structured method in their climate mitigation strategies. All Mission cities have constructed impact pathways following this temporal design as part of the CCC, which detail Systemic levers, Early changes (expected within 1-2 years), Middle/Late outcomes (expected within 3-6 years) and Direct and indirect impacts. Tampere and Valencia stressed this approach has helped them to develop detailed sector-specific pathways, which was considered a valuable process to refine their roadmapping processes. Tampere has, for example, outlined explicit transport sector assumptions in their emissions reduction scenario, assuming "strong electrification" of traffic and that all bus traffic

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becomes low emission. In Valencia's impact pathways, direct emissions reductions alongside co-benefits such as improved air quality, noise reduction, and public health are included.

Valencia has also, as the only city among the ones studied in this work, gone further and started to develop an economic model for co-benefits that incorporates economic assessments of climate actions, including Return on Investment (ROI) analyses, to demonstrate both financial and social benefits to stakeholders.

All cities identified key barriers and risks to their mitigation pathways as part of developing their Climate City Contracts. In the CCC templates risks are most prominently integrated into the Climate Investment Plans (CIP), consequently increasing emphasis on financial, economic and implementation risks of key climate mitigation actions. Climate change risks and vulnerabilities are assessed within the cities' climate adaptation work. In Tampere and Parma, participatory processes and both internal and external stakeholder engagement were central to identifying and prioritizing risks and vulnerabilities, while Tampere and Valencia highlight the use of specific tools to support and structure their risk and vulnerability assessments. Umeå highlighted that risk and vulnerability assessments are reviewed and updated regularly/continuously, and recognise integration of scenario planning as a method to enhance risk assessments.

The cities demonstrate a clear need for enhanced risk assessment and management capabilities in their climate work, reflecting a shared priority in enhancing preparedness for potential disruptions. Tampere is seeking improved risk and vulnerability assessment methods specifically for climate mitigation, as well as multi-risk assessment approaches that can address complex, interconnected challenges. These interests reflect Tampere's acknowledgment that while adaptation work naturally incorporates risk assessment, their mitigation planning could benefit from similar methodologies. Umeå focuses on practical risk management tools, expressing interest in methods to identify "no regret actions" and ways to incorporate risk assessment more explicitly in mitigation scenarios instead of driving scenario modeling solely toward "least cost" outcomes. The city also recognizes the need for transferring risk assessment skills from their adaptation team to their climate mitigation team, highlighting the value of cross-domain knowledge sharing within municipal structures. Parma's interests center on enhancing their capacity to anticipate climate risks and developing formal early warning systems to identify probabilistic risks. This reflects the city's desire to move beyond reactive approaches toward more proactive risk management. Meanwhile, Valencia seeks to enhance data integration and risk management practices, acknowledging the challenges of managing complex climate information effectively. More generally, risks beyond those related to climate change impacts and financial uncertainties (such as geopolitical risks) are not yet fully integrated in any city, although implicitly acknowledged as part of investment risks in Parma.

Monitoring processes are well developed in all cities while adaptive planning/management is not yet common practices. All cities have iterative annual or biannual planning cycles in place to establish formal revision review, evaluation points of their strategies, which demonstrates strong governance practices and increases responsiveness of planning processes to emerging conditions. Notably Tampere have established revision points as part of their municipal roadmapping process where monitoring of implementation is assisted through application of a tool provided by KAUSAL. Even so, none of the cities have currently developed formalised and structured adaptive management practices to support these planning processes, but was expressed as a topic of interest and further capacity building and engagement.

The cities express significant interest in developing and implementing more sophisticated adaptive planning methods and tools to enhance their climate work. Tampere sees potential in flexible policy-making planning, with particular interest in Robust Decision-Making and Dynamic Adaptive Policy Pathways approaches that could be applied to their climate neutrality efforts. Similarly, Umeå shows interest in adaptive planning approaches, highlighting the "Metro lines" concept from Dynamic Adaptive Policy Pathways as a potential avenue to increase adaptability around their current climate mitigation pathway. Umeå also emphasizes a high interest in establishing "trigger points" for re-evaluating current pathways, recognizing that "the future constantly changes."

Both Tampere and Valencia are exploring more dynamic methodologies to replace traditional static frameworks that cannot adequately address climate change uncertainties. Tampere expressed interest in learning from concrete examples of successful scenario work that has demonstrably helped cities prepare for risks that have materialized, seeking practical inspiration for their own planning processes. Meanwhile, Valencia is exploring tools for flexible policy-making, complementing their existing scenario-based approaches. These topics of interest demonstrate a growing recognition across cities that static planning approaches are insufficient for addressing the inherent uncertainties of climate change, and that more adaptive, flexible methods are needed.

4.3 Challenges and opportunities

The cities highlighted communication and stakeholder engagement as critical components of effective climate work. Tampere is interested in stakeholder and citizen engagement through communication and visualization of future uncertainties, acknowledging the challenge of making complex climate data understandable to different audiences from political decision-makers to citizens and companies. Valencia similarly is interested in tools for more effective visualization of climate change impacts when engaging with stakeholders, recognizing that clear communication can drive greater participation in climate initiatives. Umeå identifies communication as both a significant challenge and opportunity, noting that effective presentation of scenarios could foster broader discussions on climate neutrality and encourage wider collaboration on required actions. Umeå believes that involving more people in scenario planning creates a foundation for more diverse perspectives and richer outcomes. Meanwhile, Parma focuses on establishing cross-city collaboration platforms for peer-to-peer learning, highlighting the value of knowledge sharing across municipalities.

While engaging stakeholders and citizens effectively in planning for uncertain future scenarios and in effective climate work is seen as a key priority, cities acknowledged due to difficulties in communication. Common communication challenges identified across the cities include effectively conveying different scenarios to stakeholders, defining climate risks in understandable terms, making complex projections accessible to decision-makers and the public, and visualizing abstract concepts like carbon footprints in meaningful ways. These shared concerns demonstrate that communication and stakeholder engagement are recognized as essential elements

All cities highlight constraints in human, financial, and time resources as significant barriers to implementing anticipatory governance effectively. Parma struggles with financial constraints and a shortage of skilled personnel to manage complex climate projects, limiting its ability to leverage European funding opportunities. Valencia faces funding uncertainty, with heavy reliance on short-term EU project funding making it difficult to secure consistent financial support for anticipatory governance. Tampere notes that systematic scenario work is resource-intensive, and the city faces both time constraints and skills shortages. Umeå has limited resources (human and financial) for strategic climate work, with the climate team needing to secure external funding to go beyond core tasks.

The reliability and availability of relevant data, **as well as the appropriate timeframes for obtaining such data, also pose significant obstacles to informed decision-making**. Both Tampere and Umeå explicitly identify the challenge of "data lag" in their monitoring efforts, noting that the latest available climate data typically describes the situation from two years prior. Parma recognizes the need to enhance data monitoring and integration systems. Valencia identifies "insufficient data collection" as a barrier in its waste management sector and notes challenges in integrating environmental data across systems. Umeå also highlighted that defining clear and measurable key performance indicators (KPIs) for climate adaptation is often complicated by limited data availability and quality.

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Integration of anticipatory governance approaches into existing municipal planning processes also presents difficulties. Therefore, effective institutional coordination and alignment require considerable effort, particularly regarding the training of personnel in foresight methods and embedding established anticipatory governance practices into standard municipal planning routines. Tampere identifies a fundamental tension between four-year political cycles and the long-term thinking required for climate planning. Valencia demonstrates this challenge concretely, where the 2023 elections disrupted updates to their Urban Strategy and Climate City Contract, interrupting implementation continuity. Umeå emphasizes the structural complexity of climate governance, which stretches across multiple sectors with different priorities and leadership, complicating consistent planning. Meanwhile, Parma highlights the accountability dimension: without tangible results across successive administrations, cities risk losing credibility and public trust in their climate initiatives, especially when ambitious targets aren't matched by implementation. At the same time, several cities highlight the opportunities embedded in strengthening the (vertical) multi-level governance around these issues, as considerable capacities could be mobilized through greater collaboration between local, regional and national institutions.

Outlook

The Climate City Contract process requires cities to plan their urban development strategies until 2030 and beyond, meaning decisions made today may result in reinforcing path dependencies and infrastructure 'lock-in' which becomes difficult to reverse. When conducting such long-term planning processes, decision makers should think-through how actions pursued today might fare in an uncertain future, by considering alternative assumptions, conditions and challenges that might emerge. Doing so can help establish a course of action which is more resilient to a range of potential challenges that might emerge, complimented by iterative and adaptive capacities which help identify early warning signs, contingency measures and flexibility mechanisms that can allow mitigation pathways to be recalibrated as new emergent conditions arise. We argue that such approaches can help reduce the risks of 'mal-mitigation' or unintended consequences.

Anticipatory governance has the potential to assist cities in better navigating and preparing for potential challenges and disruptions while planning future development. Implementing strategic foresight tools, scenario planning, risk and vulnerability assessments, and adaptive management can better prepare cities to assess disruptions and adapt their mitigation strategies in response to changing conditions. These interconnected approaches shift governance from reactive management to proactive resilience-building. For cities confronting the uncertainties associated with climate change, rapid urban development and other global developments, these methodologies provide practical frameworks essential for achieving sustainable, resilient urban environments. These concepts work together as interrelated pieces of a forward-looking governance framework: foresight (including scenarios) explores possible futures, while risk/vulnerability assessments and adaptive management help to mitigate adverse outcomes and evolve strategies as needed. Together, they enable cities to become better prepared to transition to alternative mitigation pathways and actions, should the need arise. While the CCC incorporates elements of risk assessment and identification of barriers, supporting these processes with methods and practices from anticipatory governance can greatly increase the value of such assessment.

There is no single model for integrating these processes into city planning and each city included in this study has a different approach toward this.

Tampere's approach to anticipatory governance is characterized by developing foresight capacities across the municipal organisation in different departments. The city has also appointed a dedicated foresight expert that ensures that foresight perspectives are central in developing the new city strategy. This internal capability creates the potential for integration of

foresight exercises and development of anticipatory processes across several departments. Tampere's approach is further strengthened by significant integration across various municipal departments. Over time this configuration could enable systematic horizon scanning, and strategic planning, comprehensive planning and coordinated action in response to future challenges.

Umeå is notable for its integration of scenario planning, demonstrating the most advanced application among the cities included. Its anticipatory governance approach involves scenario development and analysis, supported by relatively mature risk assessments and detailed contingency planning. Umeå's processes provide clear guidance for responding to potential disruptions, ensuring resilient municipal operations in the face of uncertainties. This foundation makes it well placed to further develop these capacities over time, with more integration of climate adaptation perspectives to consider different types of plausible scenarios.

Valencia has made substantial progress in integrating anticipatory processes into its local climate adaptation strategies. It is particularly advanced in applying geographic information systems (GIS) mapping techniques, which enable precise identification of climate vulnerabilities and risks within the city. These spatial analyses have been instrumental in informing targeted adaptation actions and enhancing Valencia's overall resilience.

Parma distinguishes itself through an extensive multi-stakeholder co-creation process, forming the core of its anticipatory governance approach. Engaging diverse stakeholders, including local communities, businesses, and municipal agencies, Parma ensures broad participation and collaborative planning. This inclusive process underpins the city's strategic foresight activities, fostering collective ownership and enhancing the adaptability and effectiveness of future-oriented policies.

Considering these challenges, **several potential areas for further exploration have been identified as practical next steps** to help enhance anticipatory governance practices.

The establishment and strengthening of adaptive governance structures would enhance municipal flexibility and responsiveness to unforeseen developments. Proactively developing and implementing contingency plans can enable timely adjustments and reprioritization of actions as circumstances evolve. Building upon existing city impact pathways, identifying potential structural vulnerabilities, and establishing clear review mechanisms and trigger points would further enhance current mitigation pathways. While regular annual or biannual planning review cycles represent good practice, it is also important to acknowledge that specific actions may require more frequent and tailored monitoring, triggered by specific events or changing conditions rather than predetermined schedules. For example, if the vulnerability or exposure of a planned action could increase due to a change in global conditions (e.g. availability of EVs reduced by trade disruptions and geo-political tensions) then as conditions are perceived to change (through monitoring the development around established trigger points) alternative strategies should be increasingly emphasised (i.e. stronger emphasis on city planning and reducing demands for local mobility should be promoted over the electrification of private mobility).

A key area involves systematically identifying and highlighting effective climate mitigation actions that are least exposed and vulnerable to potential hazards or threats, and employing strategies and supportive measures that can be taken to reduce exposure and vulnerability . Developing robust methods to identify and choose actions with "least" vulnerability and taking steps to reduce exposure to a broad range of hazards (so called no-regret options) can help increase the resilience of mitigation planning. Practically, when iterating existing plans, prioritising, addressing and amending current actions that have been highlighted as most vulnerable and exposed though integrated risk assessment should be the first step, and would significantly help improve the resilience of the cities' long-term mitigation planning.

Similarly, **efforts could also focus on developing multiple complementary solutions and policies**, thereby reducing dependence on singular strategies and enhancing overall resilience in governance approaches. Such diversification aligns with the principle of employing varied actions and

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mitigation pathways. Economically-driven governance models frequently emphasize selecting actions with the highest cost-effectiveness and greatest impact while minimizing the number of actions to streamline administrative processes or reduce fiscal burdens, often due to limited resourced constraints and prioritisation of high-impact actions. However, this concentrated approach can increase vulnerability, as unforeseen conditions may compromise the effectiveness or feasibility of the prioritized options, potentially jeopardizing overall policy objectives. Consequently, employing diverse strategies with multiple reinforcing options capable of adapting to disruptive events significantly strengthens the resilience of mitigation strategies.

Strengthened multi-level governance and cooperation across cities can support cities with knowledge sharing and expertise, especially for some processes such as scenario planning. Not all processes need to be conducted locally or in-house, and resource constraints may mean that collaborative approaches and outsourcing of some anticipatory processes may be a necessity. There are multiple existing networks and actors engaging with anticipatory governance projects, such as scenario planning for global trade (European Climate Foundation) and socio-economic climate scenarios (IPCC socio-economic pathways). Similarly, some projects provide prospective analysis which integrates localised climate vulnerability with technology and supply chain effects (Jupiter Intelligence). Aligning with national and international networks and drawing on expertise reduces the resource burden on cities navigating complexity and uncertainty, especially in anticipating and adapting to global trends, shifts and scenarios. This places more emphasis on interpreting what such insights can mean at the local level and designing monitoring processes with an awareness of the potential disruptions, and implementation pathways with sufficient adaptability to navigate changing conditions as they arise.

Lastly, **promoting resilience at both the local level and through broader regional, national, and international networks** would help ensure cities are better equipped to manage future uncertainties and disruptions. Even with the best foresight, the future remains deeply uncertain. Collaboration and cooperation help build local and networked resilience (Liu et al., 2022), defined as “the capacity of interconnected systems to absorb shocks, adapt, and maintain core functions”. This form of resilience goes beyond the robustness of individual components and emphasises the cooperative capacity of entire systems. As cities and infrastructures become increasingly interdependent, collaboration across jurisdictions and sectors becomes a key strategy for resilience. Working towards establishing early warning and monitoring systems, interoperable planning, and mutual support arrangements could help cities not only to recover more effectively from disruptions, but also to reinforce the stability of the broader system and potentially increase its ability to withstand complex and cascading challenges, helping contribute to a more secure future.

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5 Individual city cases

5.1 Umeå

5.1.1 City Profile

General City Information

Umeå is a dynamic and growing city located in Västerbotten County, in northern Sweden. Recognised as the economic and urban centre of northern Sweden, Umeå aspires to play a leading role in shaping the future of the region. This ambition is embedded in the city's strategic planning and reflected in its long-term development vision.

As of the turn of 2022/2023, Umeå had a population of approximately 132,235 residents, with 91,916 living in the urban area. The municipality is experiencing steady population growth, gaining around 1,400 new residents annually over the past five years. Projections estimate a population of 147,832 by 2034, with a long-term target of reaching 200,000 inhabitants by 2050. Demographically, the city faces the challenge of a growing elderly population. Recent geopolitical events, such as the war in Ukraine, have increased uncertainty about predictions for migration, though national relocation is expected to increase due to labour demands linked to the Nordic green industrial transformation.

Umeå stands out as a regional powerhouse in northern Sweden. Despite challenges from national inflation and rising interest rates, the city continues to thrive, with robust employment in private services, research, and other knowledge-intensive sectors. Västerbotten's unemployment rate is notably low at 4.3%, and Umeå itself recorded a 4.4% unemployment rate in 2022, well below the national average of 6.6%. In response to ongoing economic expansion and demographic shifts, Umeå Municipality anticipates the need to recruit approximately 1,000 full-time employees annually through 2031.

Umeå has a temperate climate, bordering on being subarctic since average daily temperature exceeds 10°C for only three months of the year. Due to its proximity to the sea, Umeå also has a coastal climate, which makes the winters and summers somewhat milder.

Umeå is vulnerable to the local impacts of climate change, especially flooding and erosion along the Umeälven and Sävaån rivers. While rising sea levels in the Baltic Sea are currently offset by land uplift, the city faces additional risks from heavy rainfall and an increasingly impervious urban landscape. The municipality acknowledges the uncertainty of climate projections and is committed to preparing for a range of possible future scenarios, including forest fires, drought, and relative heatwaves.

In Umeå's climate change adaptation efforts, adaptation and preparedness is at the core. For example, as a regular, scenario type planning tool, city planners use the maps showing low points in the landscape, in order to understand where floodwater ends up in the city. For storm-water management, there are always specified technical safety margins that include a factor for future climate change. Hot-spot maps for heat waves and maps of land-slide risks are also used in Umeå, but can be expected to become even more useful in the future

Overview of the city's CCC

Transport is the largest source of greenhouse gas emissions in the city of Umeå, contributing approximately 122.9 kt CO_2e in 2021, accounting for over half of the city's total emissions. This high

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share results primarily from the city's continued reliance on fossil-fuelled vehicles for passenger transport, freight, and construction machinery. The buildings and stationary energy sector represents the second-largest emission source, emitting about 42.6 kt CO_2e, driven largely by heating demands linked to Umeå's northern climate. Emissions are predominantly from district heating provided by a city-owned combined heat and power (CHP) plant, which recovers energy mainly from waste and biofuels but still involves minor fossil fuel use.

Industrial processes contribute significantly to Umeå's emissions, with 34.6 kt CO_2e recorded in 2021, mainly from large-scale industrial plants, such as pulp and paper manufacturing. The agriculture and land use sector, emitting 14.6 kt CO_2e, primarily contributes methane and nitrous oxide emissions linked to livestock and fertiliser applications. Waste management emissions accounted for 3.3 kt CO_2e, largely associated with the treatment and disposal of solid waste and wastewater within city boundaries.

Table 5 - Umeå's planned actions by sector.

Sector	Current GHG Emissions (2021)	Planned Actions
Transport	122.9 kt CO_2e (largest sector, over 50% of total)	Transition to electric vehicles, enhance cycling and pedestrian infrastructure, expand sustainable public transport
Buildings & Stationary Energy	42.6 kt CO_2e (second-largest source, due to heating demands)	Energy retrofits, increased renewable energy, strict building standards, circular materials
Industry (IPPU)	34.6 kt CO_2e (from industrial processes, including pulp & paper)	Electrification, innovation partnerships, sustainable fuel use
Agriculture & Land Use (AFOLU)	14.6 kt CO_2e (methane, nitrous oxide emissions)	Sustainable agriculture, reduced fertiliser use, protection/restoration of carbon sinks
Waste Management	3.3 kt CO_2e	Improve recycling and composting, biogas production, methane capture

5.1.2 Anticipatory Governance, Risk and Vulnerability Assessment and Adaptive Management

Anticipatory Governance

Scenario-based planning is central to Umeå's climate governance strategy. The CCC Action Plan reflects a component of the city's efforts to work in an anticipatory way. When developing the mitigation pathway the city took a scenario based approach developing a positive vision scenario which was integrated into a back-casting exercise for how to move from the current trajectory to this ideal scenario. This process was helpful to think about which levers of change can deliver path-breaking shifts towards systemic reconfiguration.

Umeå worked with consultants to develop data-driven climate neutrality scenarios. The consultants (Material Economics) helped set plausible levels [of actions], based on their experience from working with many other cities, focusing on energy consumption, traffic flow, and key transition pathways.

These scenarios were developed for reaching climate neutrality, requiring rigorous data collection on the baseline and current status of the system. The city initially believed all necessary data existed in Climate View (a dominant local decarbonisation pathways modelling consultancy in Sweden) but later found it had to supplement with additional calculations. Accordingly, data was collected through a multi-faceted approach. This included many interviews with researchers and experts from practice, as well as a competition with the local university . Opportunities and barriers to reducing emissions were also collectively identified.

Umeå city officials used scenario planning to develop two distinct mitigation pathways aimed at achieving climate neutrality by 2030 and 2040. This approach involved constructing plausible visions of future development, underpinned by specific transition steps that would significantly reduce greenhouse gas (GHG) emissions. Key transition steps included ambitious targets such as reducing overall traffic volumes by 30% and increasing electric vehicle usage to 78% by the year 2040.

Actions and steps within the scenario planning were carefully assessed for its potential impact on emissions and feasibility of municipal action. Actions and measures were assessed by their contribution to emission reductions, considering both technological advancements (such as the deployment of electric vehicles and infrastructure), and behavioural changes (such as encouraging shifts from private car use to public transportation, cycling, or walking). This allowed the municipality to create realistic and actionable pathways tailored to local conditions.

While crafting these scenarios, Umeå explicitly incorporated anticipated population growth. Integrating a projected growth scenario, helped ensure that climate mitigation strategies were aligned with the city's vision of having 200 000 inhabitants by 2050. The scenario planning focused primarily on variables directly influenced by local governance and planning decisions, but did not explicitly account for external uncertainties such as global trade fluctuations or broader economic disruptions.

The development of these mitigation pathways was supported by a small but dedicated internal team working on the Climate City Contract (CCC). This core team actively engaged a broader municipal steering group, maintaining continuous communication to ensure alignment and political buy-in. Additionally, targeted dialogues with external stakeholders were conducted to gain specialized insights and secure broader societal support, reinforcing the robustness and practicality of the final mitigation pathways. These processes will be further discussed in the next section.

Umeå is developing its Climate City Contract (CCC) as a dynamic learning and alignment tool, closely integrating municipal energy planning processes. In collaboration with the consultancy company Profu and Gothenburg Business School, Umeå is applying a scenario-based approach to its planning and implementation processes. This process is envisioned to become iterative, which will not only provide an approach for robust planning decisions but is also designed to inform future updates of the city's CCC.

The central driving question of Umeå's municipal energy planning explicitly links energy system development to the city's broader climate and demographic ambitions. By consistently asking, "Where do we want to go, and how could the energy system develop to align with and support Umeå's goals?", the city strategically connects energy planning directly to its overarching sustainability and growth objectives. This deliberate integration ensures coherence between different municipal strategies, making sure that energy solutions are effectively aligned with long-term targets of climate neutrality and sustainable urban expansion.

Umeå has leveraged external methodologies and resources in the development of its Climate City Contracts. Umeå remains proactive in adopting innovative planning methods, closely monitoring emerging digital tools, such as those developed by ClimateView, for potential future integration. The

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city's openness to these resources demonstrates its commitment to continuously enhancing its approach to climate action planning and evaluation. The templates provided by NetZeroCities served as useful tools in structuring Umeå's CCC development process, ensuring alignment facilitating effective communication of its climate strategies and actions and comparability of best practices with other mission cities.

Acknowledgment of uncertainty

Umeå is currently moving towards establishing a more structured approach for explicitly managing uncertainty in its climate mitigation planning. While the city already implicitly acknowledges uncertainty through ongoing activities, discussions are underway regarding how uncertainty could be systematically incorporated into governance structures. Future uncertainties, especially those within a relatively short time frame (within a 3-5-year horizon), are significant but have not yet been formally recognized within the Climate City Contract (CCC). Issues surrounding data availability contribute significantly to this uncertainty, as unavailable or insufficient local data often requires extrapolation, downscaling, and approximation from other contexts. This introduces a higher likelihood of inaccuracies and uncertainties into scenario modelling. Acknowledging these uncertainties and a range of potential outcomes might increase the value of these outputs for mitigation planning processes.

For climate adaptation planning, uncertainty is inherently recognized and forms part of the everyday mindset of planners. A climate adaptation strategist describes uncertainty as "a moving target," emphasizing that conditions and scenarios are continually evolving. Climate change scenarios, therefore, are approached not as definitive projections but as plausible scenarios subject to change. The inherent complexity of potential climate impacts, involving numerous interconnected direct and indirect effects on multiple locations and societal functions, exacerbates uncertainty. This makes climate risks difficult to fully anticipate or prepare for. Simultaneously, overly simplifying these complexities to localised or first-order effects could overlook potential critical threats. These trade-offs highlight the challenges adaptation planners face in balancing perspectives while addressing uncertainty.

RESOURCES, PROCESSES AND STAKEHOLDER ENGAGEMENT

Municipal resources and practice

Umeå's anticipatory processes in climate mitigation governance, including the city's work on the CCC, is led by a small team within the city's strategic development office. Currently this team is around 4-5 people, however, there is flexibility to temporarily involve additional colleagues as well as external experts, for particular projects. This core mitigation team is currently establishing a **collaborative work process together with the municipal adaptation strategist**, in order to better integrate mitigation and adaptation efforts and strategies.

Financial resources for climate mitigation exist but are limited, and external funding is required to enable specific projects (that don't fall within the team's core operations). Financial resources for climate adaptation are primarily aimed at concrete adaptation measures in the city landscape. For both mitigation and adaptation efforts, funding also goes to information, analysis, developing systematic work processes and collaboration.

For developing scenarios for the CCC, the city relied heavily on external consultants for technological expertise. This included support in modelling and detailing relevant scenarios. While this dependency on external competence could be seen as a vulnerability, the core team experienced that they learned a lot from this process. As resources are made available for the Mission Cities (from e.g. NZC), Umeå hopes to build on these learnings and be able to do more of the technical modelling and analysis work "in-house" in the future. As a general reflection and hope for the future, it is

believed that when more people gain experience and skills in scenario planning, the city can 1) further increase the scope of future discussions and analysis; 2) create a foundation to include more perspectives and; 3) give scenarios more and more life-like outcomes.

External consultants have also been employed in the city's climate change adaptation work. For example, Umeå conducted a climate vulnerability assessment with external consultants. With a similar attitude as in when consultants supported on mitigation, the city's adaptation strategists anticipate conducting similar assessments internally in the future as institutional capacity grows.

Regarding processes for climate adaptation work in Umeå, the city broadly follows national climate adaptation guidelines, rather than creating entirely independent frameworks. Here, reports and maps from the Swedish governmental agency SMHI and the climate scenarios published by the IPCC provide solid foundations for adaptation planning. **However, even with reliable climate data at national or global scale, this must be translated into locally relevant narratives to be meaningful** for decision-makers, planners and the public. This includes anticipating what an extreme weather event means the first day of impact, the following weeks etc., and how different stakeholders are affected and how different actors can contribute to lessening the risk/vulnerability. In general, national guidelines for climate change adaptation emphasize the precautionary principle, science-based decision-making, and flexibility, favouring nature-based solutions when possible. These priorities are highly relevant also when building anticipatory governance practices around climate change mitigation.

Overall, current mitigation planning is aspirational, aiming for the best-case scenario, while adaptation planning is risk-based, preparing for adverse conditions. As described above, climate mitigation scenarios have focused on desired future outcomes, outlining pathways to achieve a "vision" of a positive future and back-casting. Climate adaptation scenarios on the other hand focus more on precaution, preparing for worst-case scenarios while hoping they do not materialize.

As Umeå's municipal organisation moves towards strengthening the integration of climate change mitigation and adaptation efforts, they emphasize that building a robust society involves using all pieces of the puzzle. This includes linking efforts and expertise on mitigation and adaptation with the local contingency work and risk assessment, in order to ensure robust, and synergistic decision-making in all these spheres. Bringing together different viewpoints, competences, instruments and methods can furthermore build important joint competence and methods that overlap.

Processes of collaboration

Stakeholder participation is seen as crucial for the climate mitigation work and Umeå engages in multiple stakeholder engagement processes. While much collaboration is focused on city-internal processes within and across municipal departments and companies, external partners are identified as critical for the transition, particularly in developing climate roadmaps and emissions reduction strategies.

Internally, the city has established a steering group under the Climate Neutral Umeå program. This consists of directors of the municipal technical departments and CEOs of the large municipal-owned companies – the departments and companies that have an influence over and can take actions to cut emissions in Umeå. These include utility services (energy, water & wastewater treatment) as well as Umeå's large municipal housing company that provides homes for a fifth of Umeå's population.

Recent engagement with municipal companies' sustainability officers has also sparked interest in climate adaptation, and continued collaboration is anticipated.

For climate adaptation, Umeå is assembling an "Adaptation task force", to move towards a collaborative practice where they – instead of pushing an errand from one department to another –

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meet up in a more team-based approach, that also includes the municipal owned companies. City planners are a key group to involve in this work, as are representatives from the water and energy company.

Externally, Umeå is establishing collaborative processes to enhance stakeholder engagement in both climate mitigation efforts in general and in scenario-based planning.

The Climate Roadmap is a partnership between 65 different local organizations and companies based in Umeå who have signed an agreement and work together to reduce GHG emissions in Umeå. While they are not directly involved in the writing of the CCC, it includes key actions from those stakeholders.

The city facilitates two types of broader stakeholder engagements around climate mitigation. First, it holds large meetings for "all stakeholders", e.g. celebrating steps taken towards the common goals while also informing on progress and plans. In parallel, Umeå gathers smaller special interest groups, e.g. around mobility or the built environment, that work together to develop actions to move forward in each sector.

While systematic engagement of external stakeholders is not yet as evolved as the processes for collaboration with municipal actors, broad stakeholder understanding is seen as crucial to align expectations and receive feedback on Umeå's climate neutrality goals. Here, communication of scenarios for different stakeholders, by creating narratives and supporting these with visualizations (e.g. sankey diagrams) is important to build engagement and a joint vision across different interest groups, to foster broader discussions on climate neutrality and encourage wider collaboration on required actions.

Risk and Vulnerability Assessment

This section gives an overview of the **barriers** and **risks** identified in Umeå's CCC, before discussing the assessment **processes** the city has used and is currently exploring.

Barriers (CCC)

In its CCC, Umeå identified several cross-sectoral institutional and behavioural barriers impacting the overall effectiveness of its climate actions. Institutional fragmentation, specifically the existence of "siloed" responsibilities within municipal operations, is currently hindering the integration and alignment of sustainability initiatives, significantly slowing progress towards climate neutrality. Behavioural challenges are also substantial, requiring deep societal transformation, including widespread changes in citizen and organizational behaviour, where the city has limited direct control.

Umeå identified several barriers across key sectors in its transition toward climate neutrality. Short-term obstacles include infrastructural constraints, behavioural norms, and institutional fragmentation; particularly visible in the transport and stationary energy sectors. For example, geographic and climatic conditions reinforce car dependency, while limited EV infrastructure and less mature technologies affect a more rapid transition to sustainable mobility. Economic challenges, such as high upfront investment costs and low energy prices were also recognised as constraining factors for quicker progress in energy-efficient building renovations.

Some anticipatory barriers were also identified in Umeå's CCC, recognising the importance of proactively addressing emerging challenges. These included uncertainties in market conditions and policy environments, slow permitting processes for renewable energy infrastructure, and skill shortages in renewable energy sectors. Cultural and behavioural attitudes toward waste management

and circular economy practices were also identified as ongoing challenges that require deeper societal shifts. The acknowledgment of such barriers demonstrates an awareness for integrating proactive planning strategies to navigate future uncertainties.

Risks (CCC)

In the city's CCC, Umeå's approach to risk assessment reflects its approach to proactive planning. Considering a range of external and internal factors helps the City plan for economic, demographic, and financial uncertainties.

Demographic changes play a crucial role in risk planning. Umeå monitors fluctuating birth rates, migratory patterns, and the impact of global events on population trends. Since these shifts affect demand for services and their delivery, the City regularly updates and supplements demographic data to inform decision-making and resource allocation.

A key area of focus is risks related to skills supply. Umeå assesses both immediate and long-term strategies in recruitment, training, and workforce retention. The city considers various economic and labour market indicators, including national and regional employment trends, sectoral workforce demands, and demographic shifts. Drawing on data from institutions like the Swedish Public Employment Service, the City analyzes unemployment rates, migration patterns, and projected workforce shortages to ensure a stable labour market. Additionally, the city assesses its own staffing requirements, estimating that it will need approximately 1,000 full-time recruits annually until 2031. Similarly, estimates for the overall labour market implies several thousand new employees will need to be recruited annually. These assessments support proactive strategies to attract and retain skilled workers, securing both short- and long-term labour supply for the region.

Umeå considers the influence of macro-economic and demographic risks on financial stability, service delivery, and resource availability. Economic fluctuations, changes in tax revenues, and evolving population dynamics require ongoing adjustments to financial strategies and city planning. To mitigate cyclical risks (associated with long term economic conditions, such as recession), the City relies on economic forecasts from agencies like the Swedish Association of Local Authorities and Regions (SALAR), integrating real-time data into its risk assessment framework.

Umeå addresses risks related to price development and resource availability, particularly in response to rising costs for materials, energy, and essential goods due to large-scale infrastructure projects and external economic pressures. The city employs rigorous budget forecasting, contingency planning, and supply chain optimization to ensure that critical projects remain viable while minimizing financial strain.

Umeå takes a multi-faceted approach to financial risk management, considering multiple types of risks that could impact city operations. These include interest rate risk, financing risks, counterparty risks and currency risks. These financial risk assessments are continuously reviewed to align with Umeå's broader strategic and investment plans, including long-term sustainability goals.

Risk and vulnerability assessment processes

The risks in the CCC were identified in close collaboration with the city's finance department, who is responsible for the annual budget and annual reporting. As outlined above, the risks identified in the CCC focus predominantly on financial and economic risks. Even so, the city also considers risks related to demographics, technology and skills supply and risks linked to climate change impacts and the need for adaptation (framed predominantly as risks related to new investments, e.g. new neighborhood or infrastructure projects). This highlights that the city is starting to consider how investments and actions planned towards climate neutrality might need to adapt to changing climate and conditions over time.

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In the city's more general climate change mitigation work – a lot of the assumptions are focused on targets and desired developments, and there is no formal or established risk assessment process for climate mitigation work in Umeå, beyond what was done for the CCC. Opportunities are always presented as early outcomes (e.g. emission reduction aims), co-benefits are highlighted, but the city largely lacks the risk perspective, including an assessment of "what happens if the goals are missed?". Linked to this, the city acknowledges that identifying barriers to implementation (of proposed climate mitigation actions) is difficult but important, in order to develop strategies to overcome them or choose pathways that are more viable. Scenario planning is seen as a key component here, and for the city's climate risk and vulnerability assessments in general, but this remains to be fully developed. Linked to the climate mitigation work, the recently developed municipal energy plan also lacked a risk assessment process, but there is interest to incorporate that in future iterations.

"[When] working with prioritizing [actions], I think we need to be a lot better at taking risk into consideration."

There is genuine interest to acknowledge risks more explicitly in mitigation scenarios instead of e.g. driving their scenario modelling towards "least cost", and a wish to learn more on identifying "no regret actions". Efforts are underway to enhance risk assessment as part of both the climate mitigation and adaptation planning - and is envisioned to support the integration of the two.

Looking at risk assessments in Umeå's climate change adaptation work, in the broader debate the challenge is often to define what a climate risk is. Many people assume climate change itself is the risk, rather than the disruptions it causes. **More structured risk assessment is anticipated to help bring focus to the important vulnerabilities in key services (e.g., water, energy, infrastructure) rather than just focusing on the climate hazards.**

Avoiding trade-offs between mitigation and adaptation actions is identified as important. For example, one identified risk here is the increasing reliance on energy-intensive cooling systems instead of passive climate adaptation measures (e.g., green shading). There is also concern about reliance on energy-intensive or climate impactful solutions for floodwater management instead of nature-based alternatives.

MONITORING AND ADAPTATION

Monitoring

Umeå's climate change mitigation work has a governance model based on annual monitoring of emissions, trends, and assessing progress toward climate neutrality. This is conducted by the Steering group within the Climate Neutral Umeå program. Review questions guide the decision-making, and includes asking:

- What should be done next?
- What should be stopped?
- What should be done differently?

One identified challenge in the monitoring work is the "data lag", which means that the Climate Neutral Umeå team relies on old data. For example, the latest available data on emissions were at the end of 2024 from 2022. To compensate for this delay, Umeå has been working with ICLEI and Google to access more recent data. For example, based on how mobile phones move around in the city, they have been able to collect and extrapolate data that describes transportation patterns and modes for up to year 2023.

Monitoring is done against a set of KPIs that enables Umeå to follow how the climate transition progresses each year with support from the city's statistics and analytics department. These KPIs currently focus on mitigation, but in line with the overall ambition to integrate climate mitigation and adaptation work better, there is a discussion on incorporating KPIs for adaptation and to explore how the monitoring, where relevant and possible, can be merged together.

In the adaptation work, continuous monitoring and evaluation is deemed necessary to keep track of whether your planned solution to a specific climate risk is still viable or if there's a risk of misadaptation. As adaptation expertise joins forces with the climate mitigation strategists, continuous monitoring may also become integrated into the mitigation work. In addition, **developing a deeper periodic assessment (beyond current annual monitoring) is considered relevant to better understand trends and their root causes.**

Adaptation and preparedness

In terms of processes for integrating and adapting to risks and barriers, the financial team is taking care of the financial risks, but in more general terms the climate neutral Umeå team has not been working with this. That said, there are still several concrete actions taken towards building resilience into key systems for the climate neutral city. For example, the energy companies are intensely working to strengthen the grid capacity, e.g. adding higher voltage distribution stations next to existing stations, as a way to build a robust energy system. When they're building a new electric grid, they also consider the need for climate adaptation, clearing trees around aerial cables where these are the best option and installing underground cables where possible. When it comes to adapting city plans and projects to identified climate risks, this is to some extent already happening in maintenance or development projects, but this is then largely framed around the circumstances of a specific spot and/or project.

Umeå acknowledges that changes in external conditions may require recalibrations to existing plans, that climate mitigation strategies need to be adaptable and decision-making processes allow flexibility to adjust as new information emerges. While such flexible adaptable processes are not fully in place in Umeå today, the city emphasizes that flexibility should not only apply to physical infrastructure but also to the governance structures managing climate mitigation and adaptation.

5.1.3 Summary and Outlook

Key strengths

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Umeå shows an openness and curiosity to pick up and develop new approaches, and humility towards the challenges and complexity in navigating the climate transition with anticipatory governance processes. The latter is for example visible in the statement:

"[a key challenge lies in] the complexity of the climate effects and their direct/indirect impacts on so many locations as well as on 'societal functions'. It quickly spirals into something 'messy' that´s hard to grasp and make use of. At the same time, narrowing it down risks masking threats/impacts that need consideration "

Meanwhile, the curiosity and willingness to learn in the city's transition team is exemplified in how it sees the recent support from external consultants as an opportunity to actively learn and internalize new skills and expertise, during the first round of the CCC iteration. Furthermore, the CCC itself is seen as a vehicle for internal learning and used to align other plans and processes (e.g. energy plan) to the same pathways.

While the dedicated team for climate mitigation work is small, the city engages in rigorous stakeholder engagement through a variety of fora. Establishing collaborative processes with both municipal actors in sectors central to the climate transition (e.g. water and energy utilities and large municipal property owners) and external partners in the local geography is seen as critical to ensure a common understanding and joint development of the city's climate roadmaps and emissions reduction strategies.

The integration of climate change mitigation and adaptation is underway in Umeå through: incorporating adaptation expertise in the core climate transition team; considering adding adaptation KPIs to the monitoring and; establishing a municipal Adaptation Task Force. This is seen as a strategic step towards more resilient decision-making.

"*A future fruitful collaborations between mitigation, adaptation and also the risk management part of our municipality is that we will build this collective competence in being confident to have forceful decision making under the uncertainty umbrella and all the while being alert and vigilant to the necessity of having a redo of the decision and not seeing that as a failed decision, but rather "the new normal". "*

Challenges

There are limited resources (human and financial) for the strategic climate work in Umeå and the strategic development office climate team needs to secure external funding to go beyond its core tasks. This can provide a barrier for developing new approaches and practices as well as for reacting to new developments. Some processes, such as envisioning multiple plausible scenarios, and planning viable mitigation pathways that respond to uncertain global and local conditions can be time intensive and complex. Given these constraints, attention may be focussed on more immediate and tangible needs and may limit capacity to engage with anticipatory processes systematically.

"A fundamental challenge is to get the right people in the room, with enough time" to work through the assessments. Beyond this, additional time and resources (including mandate) must be made available to communicate the results to relevant stakeholders and to implement the result in relevant decision-making processes.

Communication is in itself another key challenge. This spans many aspects of taking an anticipatory approach to climate mitigation work, and the integration of mitigation and adaptation. In scenario-based planning, conveying different scenarios to stakeholders is perceived as challenging. In climate adaptation, often the challenge is to define what the climate risk is. Many assume that climate change itself is the risk, rather than the damages and disruptions it causes. Others confuse adaptation and mitigation and believe that e.g. they are addressing climate *adaptation* simply by transitioning to electric vehicles. This highlights a need to further mainstream a common understanding.

A final, and fundamental, challenge related to the local governance of climate adaptation and mitigation lies in that it stretches across all public sectors and hence can not be managed sovereignly by any single department. Furthermore, they are embedded in and dependent on regional and national processes and actors. New approaches or practices - including anticipatory governance methods - to tackle climate change locally can thereby be challenging to implement as they need to be operationalized in many places in the organisation, and be supported by regional and national processes.

Opportunities

An acknowledged future opportunity that comes from the integration of local mitigation and adaptation expertise in Umeå lies in building collective competencies that bring confidence to forceful decision making under the uncertainty umbrella. This includes being alert and vigilant to the necessity of having to reconsider decisions as circumstances change - as well as norm shift to not see that as a failed decision, but rather as the new normal way of making decisions in these areas. The municipality further considers that an integrated approach between mitigation and adaptation could improve overall planning effectiveness.

While effective communication is found to be a challenge, it also provides opportunities. For example, presenting scenarios externally could foster broader discussions on climate neutrality and encourage wider collaboration on required actions. Furthermore, when more people get involved in and educated on scenario planning, the city can 1) further increase the scope of future discussions and analysis; 2) create a foundation to include more perspectives and; 3) give scenarios more and more life-like outcomes.

Adaptive planning approaches are currently *not* used in Umeås' climate work, but several elements are found to be interesting. The "Metro lines" from Dynamic Adaptive Policy Pathways approach, for example, gained particular interest, as an avenue to increase adaptability around Umeå's current pathway for climate mitigation. Having an approach to use adaptive pathways, including using "trigger points" for re-evaluating the current pathway, is seen as an interesting future development - "since the future [constantly] changes".

Increased integration of international expertise, collaboration through national and regional hubs and city networks can help reduce resource demands at the local level. National hubs are emerging in Sweden which are seeking to further engage with linking climate mitigation, adaptation and resilience. Integrating with these initiatives has potential to reduce the resource demands on the city, and allows utilisation of existing resources for interpreting systemic and cross-boundary effects locally (what they mean for Umeå), increasing local resilience and planning actions with flexibility mechanisms to account for inherent remaining uncertainties. Finally, learning from examples of good practices at the local level from other cities is an opportunity to strengthen and streamline the process of better integrating these approaches in local planning.

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Recommendations for future support and development.

Further development of Umeå's anticipatory governance approaches has potential to strengthen the integration of climate mitigation and climate adaptation in future planning. Scenario planning could include building a better and more systematic understanding of the city's envisioned future: "Sustainable growth and good life in Umeå" together with stakeholders. Advancing adaptive pathway design could also support a deeper understanding of which paths the city would *not* want to embark on and help identify when current plans become vulnerable (through e.g. "trigger points") - and then how to adapt the path or change to a different path.

Acknowledging and incorporating a broader palette of risks in future iterations of the CCC and in other local climate mitigation plans is important to build a broader resilience into the local transition journey. Specifically, the risk assessment skill that already exists in Umeå's climate adaptation team is something that needs to be transferred and built up also on the climate mitigation side. This relates to a broader prioritization to merge the competences within climate mitigation and adaptation as a key step to strengthen an integrated transition agenda.

Building a robust society involves using all pieces of the puzzle, [hence] going forward the city needs to link efforts and expertise on mitigation and adaptation with contingency work and risk assessment. Bringing together different viewpoints, competences, instruments and methods can build good [joint] competence and possibly method[s] that overlap.

5.2 Valencia

5.2.1 City Profile

Geographic and Regional Context

Valencia is the third-largest city in the country, following Madrid and Barcelona. The capital of the homonymous province and the Valencian Community, which is composed of three provinces: Valencia, Alicante and Castellón. The city is **located on the banks of the River Turia, on the Levantine coast of the Iberian Peninsula**, characterized by a Mediterranean climate. City Area = 13,465 ha

The Valencian Community is a territory that is highly vulnerable to climate change, with evidence such as rising temperatures, reduced rainfall, aridification of the territory, rising sea levels, the appearance of new invasive species and diseases, and an increase in the intensity of extreme events such as heat waves.

Specifically in the City of Valencia, in the next years, **the most dangerous climate events** would be rise of temperatures, decrease of precipitations, torrential rains, and rise of sea levels, mostly affecting greatly Biodiversity, Agriculture, Water and Health among others.

In October 2024, Valencia experienced devastating floods (DANA), underscoring the urgent need for resilient hydraulic infrastructure and the need to review land use planning and emergency protocols.

Demographic and Socio-Economic Profile

As of January 2024, the city of Valencia has a population of approximately 830,606 residents, composed of 294,294 men and 436,312 women. The broader metropolitan area is home to 1.5 million inhabitants, while the population of Valencia Province totals 2,709,433, with 1,324,325 men and 1,385,108 women. The city is currently experiencing a significant demographic shift, with an aging index of 161.7% between 2023 and 2024, indicating a growing proportion of elderly residents. The age distribution reflects this trend: 109,377 individuals are aged 0–15, 544,391 are between 16–64, and 176,838 are aged 65 and over.

Migration patterns have further shaped the city's demographics. The immigration rate between 2023 and 2024 was recorded at 72.8%, with the majority of new arrivals (54%) coming from abroad. Other sources of immigration include other parts of Spain (18%), the broader autonomous community (14%), and other parts of the metropolitan area (14%). Meanwhile, the emigration rate during the same period stood at 36.2%.

Valencia's cost of living is reflected in its Consumer Price Index (CPI), which reached 112.9 in December 2023. The accumulated inflation rate for the year was 3%. Housing affordability remains a key concern: in 2023, the average sale price of second-hand housing was €2,211 per square metre, while the average rental price stood at €13.5 per square metre.

In terms of mobility and access to public transportation, 328,228 private cars were registered in the city in 2024. Public transport usage remains high: in 2023, MetroValencia served 90,492,516 users, the EMT bus network recorded 100,832,000 users, and MetroBus, which connects the metropolitan area with the city, accounted for 14,871,456 users. RENFE train services also saw considerable activity, with middle-distance trains serving 609.51 passengers on departure and 606.60 on arrival, and suburban services handling 7,737.19 outbound and 7,698.11 inbound passengers.

Valencia's gross per capita income in 2023 was €26,453. The sectoral employment distribution in 2024 is led by Trade and Services, which accounts for 67.1% of employment, followed by

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Professional and Artistic Activities (22.8%), Construction (6.8%), Industrial Production (3.3%), and Livestock Activity (0%, despite 35 registered activities). In terms of broader annual employment figures from 2022, the distribution was 2.7% in agriculture, 35.1% in industry, 20.9% in construction, and an anomalous figure of 292.3% reported for services, which likely reflects cumulative or methodological factors rather than direct proportional employment.

Brief Overview of the City's Climate Change Commitments

The València 2030 Climate Mission is the city's roadmap for climate neutrality by 2030, integrating mitigation and adaptation efforts. Aligned with the EU's Cities and Adaptation Missions, it builds on **València's Urban Strategy** and informs the Climate City Contract (CCC). In parallel, the city is advancing towards a new Climate Adaptation Plan, which will replace the current one, initially approved in 2017, following a review in 2022 of the city's Vulnerability and Risk Assessment.

Timeline of Participation in the EU Cities Mission

Window 1 of application. Valencia received their Mission Label in October 2023

Main Areas of Planned Decarbonization and Key Actions

The final energy use by sector of origin is significantly higher for the Transport sector, followed by buildings (all the three scopes - SECAP inventory 2019)

Table 6 - Tampere's GHG emissions (2019).

Sector	CO2 Emissions (t CO2eq/year)
Transport	1176218.87
Buildings	536444.12
Agriculture, Forestry and Land Use	135000.0
Waste	114000.0
RES and Other	101248.35
Industrial Processes and Product Use	58227.02
Total	**2121138.36**

Systemic Changes for Achieving Climate Neutrality in the Climate City Contract:

- Sustainable, inclusive, and efficient urban and metropolitan Mobility
- Just and inclusive energy transition
- Inclusive and sustainable economic development
- Sustainable buildings and housings

- Urban regeneration based on social cohesion, accessibility, and sustainability
- Cross-cutting co-governance, learning and capacity building

In the Climate Action Plan (CAP), the city outlines a series of commitments it has undertaken:

October 16, 2014 – The Local Government Board approved the city's accession to the *Covenant of Mayors for Climate Change Adaptation*.

September 2019 – In a plenary session, the city approved the *Declaration of Climate Emergency*, which includes:

A commitment to reduce greenhouse gas (GHG) emissions to achieve net-zero balance no later than 2040, and if possible, before 2035.

The promotion of adaptation measures to address climate change.

5.2.2 Anticipatory Governance, Risk and Vulnerability Assessment and Adaptive Management

Climate and Anticipatory Governance Elements

Climate Governance Agendas in Valencia

The València 2030 Climate Mission is the city's strategic roadmap for achieving climate neutrality by 2030. It integrates both **mitigation** (reducing greenhouse gas emissions) and **adaptation** (strengthening resilience to climate impacts), aligning with the EU's **100 Climate-Neutral and Smart Cities Mission and Mission on Adaptation to Climate Change**.

València 2030 Climate Mission was created in synergy with The Urban Strategy, a comprehensive guiding document that outlines València's long-term vision for urban development.

València 2030 Climate Mission *and* The Urban Strategy serve as **central mechanisms** shaping the development of the city's **Climate City Contract (CCC)**—a key instrument aligning València with the **EU's Cities Mission** and the **NetZeroCities Project** to achieve climate neutrality by 2030.

The València 2030 Climate Mission aims for climate neutrality by 2030 is a localized version of the EU missions, aligning well both with the EU's "100 Climate-Neutral and Smart Cities" and "Mission on Adaptation to Climate Change." It provides a governance framework with 12 strategic areas, 48 objectives, and 200+ actions further integrated into the city's Urban Strategy.

It integrates mitigation and adaptation through a mission-driven, participatory process. Developed since 2019, it engaged civil society, businesses, and academia in defining strategic priorities. The city council approved the framework, followed by extensive stakeholder consultations and political consensus. The mission fosters cross-sectoral governance, innovation, and resilience, aligning with EU climate goals. Its iterative nature ensures adaptability, though political changes cast uncertainty over its future direction.

The Urban Strategy adopts a holistic approach to climate action, avoiding the traditional siloed treatment of mitigation and adaptation and general city development strategy.

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Figure 8 – Main areas of climate action and synergies between both EU missions

It was developed through an extensive participatory and collaborative process spanning several years. Various municipal departments contributed to its formulation, with **adaptation and mitigation teams actively engaging** alongside other departments and city stakeholders.

Adaptability is one of the defining features of the Urban Strategy. It is designed to be updated every two years to integrate emerging challenges, policy shifts, and scientific insights. After that it is supposed to feed the CCC. However due to the change in the political leadership, the future of Urban Strategy is unclear.

Valencia's CCC outlines a comprehensive pathway to achieve climate neutrality by 2030. It was developed from the Urban Strategy and was put together by a small group of municipal technicians with support from the *Consultancy Tech Friendly* and *CitiES 2030 national platform*.

The regional government endorsed this contract, submitted in spring 2023, and it was awarded the Mission Label by the European Commission in autumn 2023.

A distinctive feature of the CCC is its iterative nature; it is intended to be a "living document" that undergoes periodic updates. Regular revisions ensure that the contract remains effective, accountable to its commitments, and inclusive of new stakeholders, aligning with budgetary and monitoring cycles as well as citizen engagement processes. However, as the update of CCC is very much connected to the update of the Urban Strategy; the future of CCC is also uncertain.

Alongside the CCC, Valencia is advancing towards a new Climate Adaptation Plan, which will guide adaptation efforts in the coming years, aligning with the commitments made by the city in the framework of its participation in the Covenant of Mayors and the European Adaptation Mission. **Valencia is planning to develop it,** starting in late 2025 and continuing into 2026. The

tendering process (to hire external consultants for technical assistance) will start in the second half of 2025.

In Valencia, the interaction between the EU Missions—Climate-Neutral and Smart Cities and Adaptation to Climate Change—is evident through several integrated initiatives. These include the integration of renaturation processes into mobility decarbonization initiatives, which simultaneously reduce emissions and enhance urban resilience. Water management and sustainability in the tourism sector address both environmental impact and climate adaptation needs. Efforts to promote sustainable and local agriculture contribute to carbon storage while ensuring food system resilience. Additionally, climate shelters and comfortable itineraries provide adaptive solutions for extreme weather events, improving urban livability. The city also focuses on resilient urban regeneration, encompassing energy communities, building renovations, and public space renaturalization, aligning mitigation with adaptation goals. Finally, the promotion of circularity and waste utilization supports sustainable resource management, bridging both missions' objectives for a climate-resilient and carbon-neutral future (see fig.1). These main areas of climate action and synergies between both EU missions were identified in the framework of a collaboration with the regional government and a technical assistance team to analyse synergies between Missions and regional and local levels, which served as the basis for the development of a case study published in the EU Mission on Adaptation portal.

Valencia faces several interconnected challenges in its pursuit of climate actions (see fig. 2). Multi-level governance gaps hinder effective coordination between local, regional, and national entities, slowing down decision-making and resource allocation. Simultaneously, Valencia's parallel participation in two EU Missions (Cities & Adaptation) creates overlapping engagement efforts, inefficiencies, and stakeholder fatigue due to differing timelines and processes. Adding to the complexity, uncertainty surrounding long-term EU Missions support and funding pathways makes financial planning and investment strategies difficult. These issues are further compounded by insufficient localized data with outdated or missing indicators and a lack of integrated systems, which challenges the setting of measurable targets and tracking progress. The limitations of provided tools, particularly inadequate support for adaptation actions and impact assessments, make it harder to justify adaptation investments. Finally, the absence of a dedicated climate unit within the administration leads to fragmented efforts and a lack of a long-term strategic vision, ultimately impeding Valencia's ability to effectively address climate change.

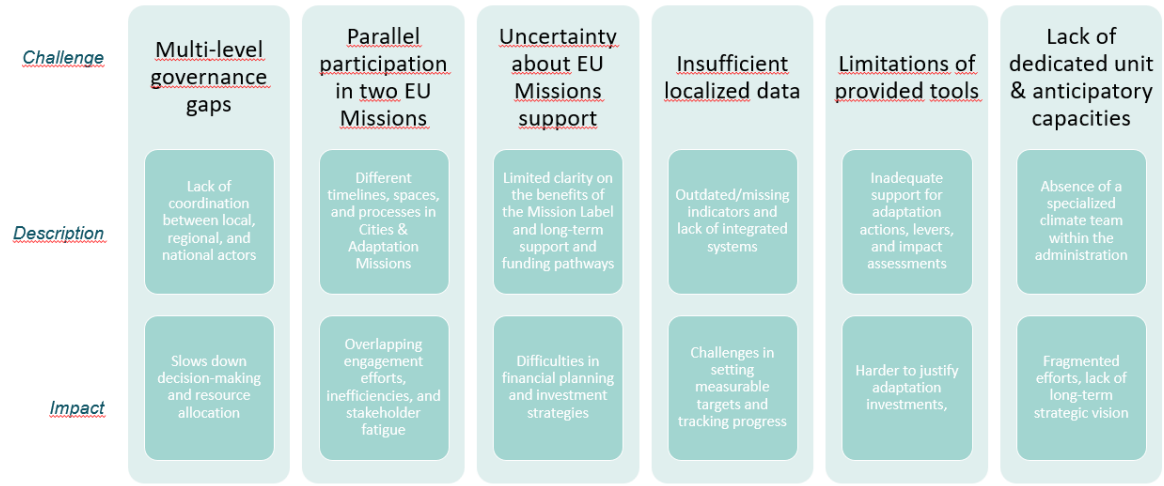

Figure 9 - Challenges in its pursuit of climate action in Valencia.

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Anticipatory Governance Elements in Valencia

Valencia has integrated elements of anticipatory governance into its climate adaptation and mitigation efforts, though these efforts remain fragmented and sector specific. Through its participation in initiatives such as **NetZeroCities**, **Pathways 2 Resilience**, and other EU programs, as well as from its own funds, the city has undertaken **risk and vulnerability assessments**, developed **adaptation pathways**, and experimented with **future-oriented methodologies**. However, a more systemic and long-term approach is still lacking.

Urban Strategy

Valencia's Urban Strategy incorporates both mitigation and adaptation measures, acknowledging future sustainability challenges. However, it does not yet fully integrate broader **uncertainties**—such as socio-economic shifts, demographic changes, and geopolitical factors—into long-term planning.

Climate City Contracting (CCC)

The CCC process in Valencia includes several key anticipatory components:

- **Risk and Barrier Identification**: Systematic assessment of challenges affecting proposed climate mitigation measures.
- **Impact Pathways**: Definition of short-term (1–2 years) and medium-term (3–4 years) outcomes, measuring direct emissions reductions alongside co-benefits such as improved air quality, noise reduction, and public health.
- **Sectoral Approach**: Climate action scenarios address multiple sectors, including:
- **Transport**: Reducing motorized transport demand, expanding bicycle and pedestrian infrastructure, and implementing **Low Emission Zones (LEZs)**.
- **Buildings & Heating**: Enhancing **energy efficiency**, promoting **renewable energy adoption**, and developing **carbon-neutral districts**.
- **Electricity & Waste**: Advancing **renewable energy transitions** and **waste management improvements**.
- **Business-As-Usual (BAU) Scenario for 2030**: Establishing a reference scenario to evaluate the impact of planned interventions against a baseline where no additional climate actions are taken.
- **Economic Model for Co-Benefits**: Incorporating economic assessments of climate actions, including **Return on Investment (ROI)** analyses, to engage stakeholders by demonstrating both financial and social benefits.
- **Emission Impact Domains**: Expanding beyond conventional mitigation sectors to include **re-naturalization**, **biodiversity**, **economic and industrial transitions**, and **urban planning**.

Climate Adaptation Strategy

Valencia has progressively strengthened its climate anticipatory work mainly thought its climate adaptation framework:

Climate Risk and Vulnerability Assessments. Valencia's climate risk assessment, first developed in 2015 and updated through projects like ARCH and GrowGreen, focuses on heatwaves and droughts but remains weakly linked to urban planning. Risk identification is fragmented, with limited use of long-term scenarios and no comprehensive socio-economic or geopolitical analysis. Vulnerability mapping relies on GIS to assess heat exposure and infrastructure risks, but social data is basic, and coordination across departments is limited. Despite better data from EU projects, integration into planning and real-time updates remain inconsistent.

Adaptation Plan (First issued in 2017 developed by the consultancy FactorCO2; a new Plan will be prepared during 2025 and 2026).

IPCC- Based Scenario Development:

Utilization of **regionalized climate models** to project medium- and high-emissions pathways.

Emphasis on **climate adaptation scenarios** rather than a more comprehensive **foresight-driven approach** that accounts for social and economic transformations.

Multi-Level Collaboration: Working with regional authorities and technical assistance teams to **align city-level adaptation efforts with regional and national climate strategies**.

Different EU projects:

Valencia's anticipatory efforts often stem from short-term EU projects like ARCH and GrowGreen. ARCH developed tools such as the Resilience Pathway Visualization Tool and Handbook to support long-term adaptation planning. These projects enabled GIS-based climate modelling and spatial analysis under different land use scenarios—an improvement over earlier methods based on single weather station data.

They helped identify local vulnerabilities and guide strategic actions. The Fair Local Green Deals project added a justice lens, enhancing participatory planning and climate equity in CCC processes.

Processes and Stakeholder Engagement

Valencia has made significant progress in participatory and multi-level climate governance especially in the development of the Urban Strategy and Valencia Climate Mission.

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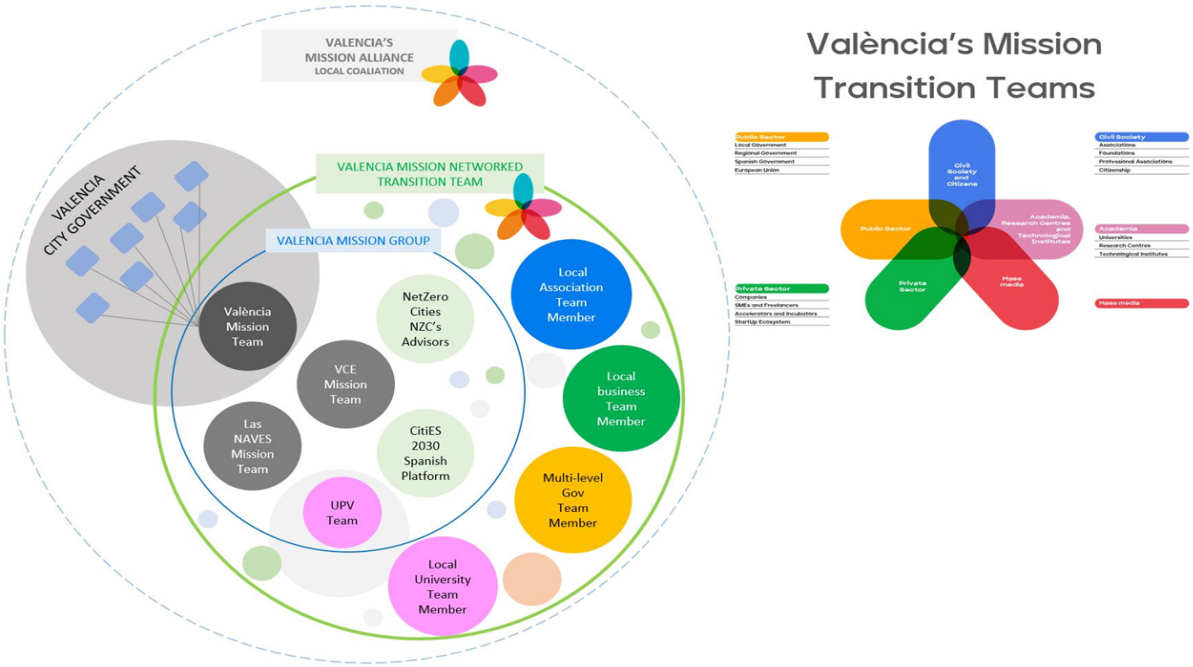

Figure 10 - Valencia Mission Transition Teams.

The development of the Urban Strategy and its Climate Mission were highly participatory and collaborative, involving various municipal departments and stakeholders over several years. Notably, those frameworks do not treat mitigation and adaptation as separate silos but instead take a holistic approach to climate action. Climate adaptation and mitigation teams, along with other municipal departments, contributed to its formulation, fostering a degree of cross-sectoral collaboration, through Mission Fridays and Mission Teams (see fig 3).

Mission Fridays and the Valencia Mission Team

An important informal mechanism for collaboration for co-creation of the mentioned frameworks were Mission Fridays, a weekly space where representatives from the València City Council, Las Naves (innovation agency), and the València Climate and Energy Foundation met to align efforts on climate initiatives. Though never officially formalized, this practice fostered a shared understanding and cohesion among departments. Over time, this evolved into the Valencia Mission Team , a structured entity under the Climate City Contract (CCC) framework, ensuring continuity and commitment across departments.

The València Climate Mission Group

It brings together not only different departments, but also academia, private sector representatives, and EU advisors to implement innovative urban climate solutions. The group includes key institutions such as València Clima i Energia (Local Climate and Energy Agency), Las Naves (Local Innovation Agency), NetZeroCities advisors, Universitat Politècnica de València and CitiES 2030, which collectively work to integrate research, policy, and practical solutions for urban sustainability.

Mission Alliance and Multi-Stakeholder Engagement

Valencia also established the Mission Alliance, a coalition of over 150 organizations representing 20,000 businesses, professionals, and civil society actors committed to climate neutrality. This broad partnership enhances policy coherence and collective action on climate goals.

Wider Public Participation and the Urban Forum Valencia 2030

To ensure broad community engagement in the future vision creation, Valencia carried out an extensive participatory process between October 2021 and May 2022. This participatory process culminated in Urban Forum Valencia 2030, held in May 2023. The month-long event featured dialogue tables (54 experts across 16 sessions), a metropolitan roundtable, and public co-creation sessions structured around key urban perspectives—Healthy, Sustainable, Shared, Entrepreneurial, Creative, and Mediterranean. With 1,500 participants and extensive media coverage, the forum helped refine Valencia's sustainability vision while reinforcing public trust and involvement in the transition.

Global Networks and EU Projects

Valencia integrates its urban transformation efforts within larger climate governance frameworks. It actively participates in Eurocities, Energy Cities, the Covenant of Mayors, ICLEI Europe and the Global Covenant of Mayors (GCoM), as well as in the Community of Practice linked to the EU Mission on Adaptation, ensuring its strategies align with European and international sustainability goals.

While interdepartmental and multi-stakeholder groups have been instrumental in shaping climate strategies such as the Urban Strategy and the Valencia Climate Mission, ensuring their long-term effectiveness remains a challenge.

Resource mobilization

Financial Resources: Climate projects receive funding from several EU programs. However, these funds are often project-based and time-limited, leading to challenges in sustaining long-term anticipatory governance structures.

Human Resources and Institutional Capacity: Valencia lacks a dedicated foresight or scenario-planning team. Existing municipal staff engage in climate governance on an ad-hoc basis, with responsibilities spread across multiple departments.

Technological Resources and Open Data Platforms: The city has GIS-based climate modelling tools and vulnerability mapping platforms, but these tools are not systematically used across all governance areas.

After DANA, the reallocation of funds exemplifies Valencia's strategy to mobilize financial resources for climate resilience projects. Companies are poised to participate in the anticipated investments in Spain's water infrastructure, indicating a collaborative effort between public and private sectors to address these challenges. But the clear understanding of how those funds will be used and distributed is missing.

Risk and Vulnerability Assessment

As previously noted, risk and vulnerability assessments were primarily developed within the framework of the Climate City Contract (CCC) and the València Climate Adaptation Plan.

Climate City Contract (CCC)

The development of the Climate City Contract (CCC) was closely connected to analyzing the existing Urban Strategy action plan and assessing how its actions aligned with the CCC's thematic priorities, axes, and lines of intervention. Actions were then directly integrated into the CCC adaptation strategy without reopening departmental consultations, as these contributions had already been established. However, this streamlined integration also meant that risks and vulnerabilities associated with these actions were not systematically reconsidered. The process was not designed as a fresh planning or

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co-creation exercise, but rather as an adaptation and alignment of existing material to fit the CCC framework.

The identification of risks and barriers in CCC was carried out through rather exploratory and experience-based analysis. Building on a previously developed list of financing instruments—such as public subsidies, energy performance contracts (EPCs), green bonds, and other innovative schemes—the process involved qualitatively assessing each option in terms of its estimated costs, anticipated savings, and the distribution of financial responsibilities between public and private actors. Drawing on relevant documents and general knowledge of urban financing practices, potential obstacles were identified across governance, market, and operational dimensions. These included issues such as administrative capacity limitations, investor uncertainty, and difficulties in scaling or replicating solutions. While the approach was not based on a formal risk assessment methodology, it provided a grounded narrative understanding of the factors that may hinder the uptake or effectiveness of CCC.

Barriers (CCC)

In its CCC, Valencia identified a series of cross-sectoral institutional, regulatory, and infrastructural barriers that constrain the implementation of its climate mitigation and adaptation strategies. These barriers span multiple governance levels—local, regional, national—and affect both internal municipal operations and wider ecosystem coordination, particularly in sectors such as energy, mobility, and innovation.

A prominent institutional challenge is the **lack of internal capacity and technical expertise** within local public administration. The city faces persistent difficulties in recruiting and retaining specialized personnel, especially within the constraints of public sector hiring rules. This lack of capacity slows progress and limits the ability to integrate climate objectives across departments.

Another persistent issue is **institutional fragmentation**. Responsibility for climate-relevant policy and action is dispersed across departments and levels of government, leading to inefficiencies, redundancies, and siloed approaches. While efforts are underway to introduce new cross-cutting roles and capacities, the inertia of existing bureaucratic structures remains a barrier to more agile and integrated responses.

Regulatory complexity also hinders progress. Valencia's CCC highlights **excessive bureaucratic procedures and rigid legal frameworks** as obstacles to innovation and public-private cooperation. This is particularly evident in difficulties establishing partnerships for renewable energy projects or neighborhood-level energy communities. The absence of a supportive legal framework for decentralized energy generation and citizen energy empowerment continues to stymie the expansion of local renewable solutions.

Economic barriers are equally critical. The **high upfront costs** of renewable energy systems, energy-efficient renovations, and digital solutions constrain experimentation and scaling. Market uncertainties—such as unfavorable electricity pricing schemes and unstable regulatory signals—add a layer of risk that discourages private investment. In addition, **financing challenges**—including a lack of access to credit and insufficient support for alternative funding models beyond traditional grants—limit the uptake of climate solutions, especially in underserved neighborhoods.

These barriers intersect in particularly acute ways in sectors like **renewable energy** and **electric mobility**. Despite growing local ambition, mismatches between municipal capacity and national regulatory frameworks, coupled with the absence of enabling incentives, are delaying implementation. Fragmented or even contradictory policies across governance levels make it difficult to coordinate complex climate solutions in a coherent, mission-driven manner.

Risks (CCC)

Economic and financial risks are central in the city's planning framework. Valencia acknowledges that **rising material and energy costs**, inflationary pressures, and global supply chain disruptions can destabilize large-scale infrastructure projects and climate investments. As a response, the city is

working to enhance its budget forecasting and contingency planning, though financial risk management remains largely concentrated within municipal finance departments and is not yet fully integrated into climate planning.

Labour market and capacity-related risks are also emerging areas of concern. With accelerating demands for climate-related expertise—particularly in renewable energy, sustainable construction, and digital innovation—**skills shortages** are seen as a medium- to long-term risk. The CCC underlines the importance of aligning vocational training, university programs, and municipal employment strategies with the evolving demands of the green transition.

Institutionally, Valencia faces governance-related risks linked to **regulatory instability and multi-level misalignment**. Climate action frequently depends on national or regional frameworks that may be misaligned with municipal ambitions, such as regulations governing electricity markets, energy communities, or mobility infrastructure. These misalignments create implementation risks, especially for long-term investments that require stable and predictable policy environments.

Climate-related physical risks, while not the main focus of the CCC, are beginning to be acknowledged in investment planning. The city has started integrating **climate adaptation risks**—such as urban heat, droughts, and flood risks—into project evaluation frameworks, particularly for new urban developments and public infrastructure. There is recognition that mitigation projects must be designed to remain resilient under changing climatic conditions. However, formalized climate risk assessments for mitigation actions remain underdeveloped.

A key gap identified in the CCC is the **lack of structured risk assessment processes** embedded within the city's climate mitigation strategies. Current planning still leans heavily toward target-setting and anticipated benefits, without fully considering uncertainties or "what-if" scenarios—such as delays in implementation, failure to meet emission targets, or unintended rebound effects. Stakeholders have expressed interest in developing scenario planning methods and identifying "no-regret" options, but these tools are not yet systemically applied.

Climate Adaptation Plan

In Valencia's climate adaptation, the initial anticipatory work began with a climate risk assessment in 2015, later embedded in the city's first Adaptation Plan (2017), developed with the consultancy FactorCO2. This early assessment focused on projecting future climate hazards—especially heatwaves and droughts—and identifying sectoral vulnerabilities. It was further developed within the city's SECAP (Sustainable Energy and Climate Action Plan) under the Covenant of Mayors initiative.

Recent updates to Valencia's risk knowledge base—supported by EU research projects such as ARCH and GrowGreen —demonstrate a more advanced use of anticipatory tools. These include GIS-based climate modeling, integration of open data, and localized projections derived from regional climate models. Such tools have improved the granularity of climate hazard mapping, particularly for heat exposure and ecosystem sensitivity. Yet anticipatory processes remain constrained by a lack of institutionalized, cross-departmental mechanisms for systemic risk identification, prioritization, and foresight.

Current assessments rely heavily on sectoral technical expertise and short-term impact modeling, while more holistic scenario-based or exploratory foresight methods are absent. Socio-economic vulnerability—central to anticipatory resilience thinking—remains underdeveloped, despite early efforts in projects such as Fair Local Green Deals. Assessments of long-term shifts in economic and geopolitical conditions, such as energy price volatility, infrastructure dependencies, or migration patterns, are rarely integrated into climate planning. Similarly, social indicators such as precarity, exclusion, or health inequality are not routinely embedded in vulnerability models.

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While technical capacities have improved, the anticipatory governance infrastructure necessary to turn these insights into transformative planning remains weak. Data is often siloed between departments or tied to project-based timelines, and no systematic mechanism exists for updating vulnerability assessments in real time or linking them to adaptive policy cycles. As Valencia prepares a new Adaptation Plan (2025–2026), this represents a critical window to deepen its anticipatory capacity—by institutionalizing cross-sectoral risk governance, expanding the scope of socio-ecological foresight, and embedding forward-looking assessments into mainstream urban and strategic planning processes.

Monitoring and adaptation

Climate City Contract (CCC)

The **València Climate City Contract (CCC)** integrates a comprehensive monitoring framework designed to track progress toward achieving climate neutrality by 2030. This framework includes the establishment of Key Performance Indicators (KPIs) focused on emission reductions, energy efficiency improvements, and the adoption of sustainable practices across various sectors. The monitoring process ensures that the city can assess the effectiveness of its climate mitigation and adaptation actions over time.

The development and implementation of the CCC are coordinated through a multi-level governance structure that includes **Mission Teams**, **Working Groups**, and a **Mission Alliance**. These bodies bring together key stakeholders from local and regional governments, businesses, research institutions, and civil society to ensure broad-based participation and alignment in the city's climate actions.

While the governance structure, including Mission Teams and the multi-level governance model, was designed to support the CCC's implementation and monitoring, the shift in political leadership has led to a lack of momentum. As a result, the ambitious actions outlined in the CCC are not being fully realized. This political turnover has created uncertainty regarding the city's commitment to the agreed-upon climate goals, and, in some cases, climate policies and initiatives have been stalled or deprioritized.

Climate Adaptation Plan

The **València Climate Adaptation Plan (VCAP)** also incorporates a comprehensive monitoring framework designed to assess the effectiveness of adaptation measures and enhance the city's resilience to climate change. This framework includes the regular evaluation of key indicators related to climate risks, vulnerability reduction, and the success of adaptation strategies across various sectors, such as water management, urban infrastructure, and biodiversity.

A notable initiative within the VCAP is the establishment of the **Valencian Collaboration Space**, a multi-level governance framework aimed at fostering coordination between regional and local authorities, as well as engaging a broad spectrum of stakeholders. This collaborative approach seeks to align regional and urban strategies, identify synergies, and jointly address climate adaptation challenges. The Valencian Climate Change and Ecological Transition Law further supports this framework by emphasizing collaboration and participation, establishing councils to coordinate climate policies, and encouraging the formation of local councils for climate change and ecological transition at the municipal level.

However, the integration of adaptation concepts into regional planning has encountered challenges. Discrepancies between climate change risk evaluations and spatial planning scales, as well as the absence of structured mechanisms to synchronize adaptation and mitigation strategies, have been

identified as barriers. These issues highlight the need for enhanced coordination and coherence across different planning levels to effectively implement adaptation measures

To address these challenges, the VCAP emphasizes the importance of **adaptive pathways**—dynamic strategies that allow for adjustments over time in response to evolving climate risks. This approach ensures that adaptation strategies remain flexible and responsive to new information and changing conditions. This part city has learned from the participation in the **ARCH project**, which developed adaptation pathways to guide long-term resilience planning. The ARCH project developed a Resilience Pathway Visualization Tool (RPVT) to support urban climate adaptation planning. The project produced a Resilience Pathway Handbook integrating insights from several co-creation workshops, helping cities to apply the RPVT to visualize different adaptation strategies and how they should evolve over time.

Through **ARCH and GrowGreen**, the city has developed **GIS-Based Climate Modeling**, leveraging spatial analysis and predictive tools, and even analysing in an integrated way future temperatures under different land use scenarios. These projects have provided valuable opportunities to develop spatially explicit analysis tools, allowing for a more granular understanding of climate vulnerabilities and adaptation priorities.

Previously, the city's adaptation planning and vulnerability assessments relied on climate change projections based on data from a single weather station. This approach did not account for the municipality's diverse environmental and social systems, limiting the ability to differentiate climate risks across different areas. As a result, prioritization of adaptation actions was challenging—there was no clear understanding of which areas experienced higher temperatures, housed more vulnerable populations, or had lower adaptive capacity. Thanks to these EU projects, the city has been able to develop advanced modeling techniques and analyze existing tools, taking advantage too of other recent developments by the city Statistics Office, including interactive dashboards that visualize vulnerabilities. These improvements have enhanced the capacity to prioritize investments and identify strategic opportunities for action.

5.2.3 Summary and Outlook

Challenges and opportunities

Some of the identified opportunities of engaging into an anticipatory governance process are as follows:

- **Access to Climate Data:** Valencia benefits from a wealth of open climate data thanks to the EU projects, facilitating informed decision-making and strategic planning.
- **Institutional Capacity:** The development of the Urban Strategy, the Valencia Climate Mission, and the Climate City Contract (CCC), along with multiple EU-funded projects, has strengthened human resources and institutional knowledge on climate issues.
- **Multi-Stakeholder Collaboration:** Established multi-departmental and multi-stakeholder groups create opportunities for participatory foresight mechanisms, including citizen-driven scenario planning and deliberative democracy approaches.

There are also some challenges that need to be overcome to guarantee the efficiency and successful implementation of the policies in this context:

- **Resource Constraints:** While climate data is available, there is a lack of resources to translate this information into actionable impacts and response strategies. Many initiatives have been dependent on EU-funded projects, with insufficient personnel and budgets to

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extend their reach. Approving plans and strategies (like the CCC) without guaranteed budget allocation makes effective implementation exceptionally difficult.

- **Limited Public and Political Engagement:** Citizen and political interest in anticipatory governance exercises remains low, reducing their effectiveness.
- **Funding Uncertainty:** Securing consistent financial support for anticipatory governance remains a challenge, as there is a heavy reliance on short-term EU project funding. Anticipatory governance requires not just foresight but also the financial means to act proactively. Without resources for a dedicated climate transition unit, engagement with the Missions is difficult, and the opportunities provided cannot be fully leveraged.
- **Coordination Gaps:** Effective integration of climate scenarios and risk assessments across different municipal departments remains a work in progress.Coordinating actions across Cities and Adaptation Missions continues to be challenging due to overlapping but separate processes.
- **Disinformation and Climate Denialism:** Misinformation and skepticism about climate change hinder the adoption of progressive policies and measures.
- **Over-Reliance on External Consultancies:** Firms such as Tech Friendly, Tecnalia, and FactorCO2 play a major role in Valencia's climate strategy due to the lack of resources to have a permanent pool of staff dedicated to these issues, who could bring the necessary skills and expertise in-house..

Insights and Recommendations

Key Strengths and Progress

Valencia has made notable progress in **anticipatory governance**, integrating **climate risk assessments, vulnerability mapping, and adaptive planning** into its **Valencia Climate Mission**, **Urban Strategy, Climate City Contract (CCC), and Adaptation Strategy**.

- The city effectively combines **mitigation and adaptation**, ensuring alignment with **EU climate missions**.
- **Multi-level, multi-stakeholder governance**, fostering collaboration across regional, national, and EU levels.
- **Advanced climate risk assessment tools**, including **GIS-based modeling** and **open-data platforms** for informed decision-making.
- **Early steps towards dynamic adaptation planning**, as seen in **ARCH and similar projects**.
- **Emerging use of digital tools** to enhance **data-driven decision-making**.
- **Challenges and Gaps**

Despite these strengths, several obstacles hinder Valencia’s anticipatory governance efforts:

- **Short-Term Prioritization Over Long-Term Resilience**: The **DANA disaster (Oct 2024)** shifted focus toward immediate recovery rather than long-term climate adaptation.

- **Fragmented and Project-Based Funding**: Overreliance on **short-term EU funding** leads to uncertainty in sustaining climate actions.
- **Lack of a Dedicated Foresight (Climate transition) Unit**: Without a structured **climate transition team**, efforts remain reactive rather than proactive.
- **Integration Challenges**: Managing **two EU climate missions** in parallel strains resources and coordination.
- **Limited Socio-Economic Scenario Planning**: Current anticipatory governance focuses **heavily on climate risks** but lacks **integration of socio-economic uncertainties**.

Recommendations for Strengthening Anticipatory Governance

- Establish a Dedicated Foresight and Climate Transition Unit
- Create a municipal foresight team to institutionalize scenario planning, resilience pathways, and anticipatory governance.
- Strengthen interdepartmental collaboration to ensure climate policies remain coherent and adaptable.
- Secure Long-Term Financial Commitments
- Move beyond project-based EU funding by integrating climate resilience into municipal budgets.
- Secure EU missions financial support.

The Climate Adaptation Plan as a Key Future Development

Among the most significant ongoing initiatives, the Climate Adaptation Plan update continues to advance, positioning itself as a key intervention for future anticipatory efforts.

Its success will depend on how well it integrates anticipatory planning elements as well as on cross-cutting collaboration opportunities among city departments and with citizens and other stakeholders.

Expanding Risk Assessments Beyond Climate Projections

- The city currently lacks structured anticipatory governance, particularly in integrating socio-economic uncertainties.
- Future climate adaptation planning needs to factor also socio-economic aspects.
- A more systematic scenario-based planning approach is needed, with emphasis on:
- Stakeholder-driven foresight exercises to capture diverse perspectives.
- Dynamic Adaptive Policy Pathways, ensuring flexible responses to climate uncertainties.
- Embedding trigger points to revise climate policies based on real-world changes.

Develop a Cross-Mission Coordination Framework

- Improve synergies between Cities Mission and Adaptation Mission to avoid duplication and maximize resource efficiency.

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- Advocate for EU-level mechanisms that facilitate better knowledge-sharing between climate missions.

5.3 Tampere

5.3.1 City Profile

General city information

Tampere is Finland's third-largest city, with a population of approximately 250,000. Population growth rate in 2023 was 2.4%. Tampere serves as a major economic and cultural hub in the Pirkanmaa region, recognized for its strong industrial heritage. Once a center for textile and machinery industries, Tampere has transformed into a leader in technology, healthcare, and education. Today, its key economic sectors include ICT, gaming, automation, and health technology. The city is also home to Tampere University, which plays a vital role in fostering innovation and research in the region.

Tampere has a humid continental climate with distinct seasons. Winters are cold and snowy, with temperatures frequently falling below 0°C and occasionally dropping below -20°C. Summers are mild to warm, typically ranging from 15°C to 25°C. Precipitation is moderate throughout the year, with consistent snow cover in winter.

Tampere has ambitious climate policies in place. The city aims to achieve carbon neutrality by 2030. This goal requires significant reductions in emissions, particularly in construction, housing, transportation, energy consumption, and overall resource use. The city's climate actions are outlined in the Carbon Neutral Tampere 2030 Roadmap, updated biannually.

The main governance instrument to guide the city's climate policy and action is the Climate Neutral Tampere 2030 Roadmap. The roadmap includes 397 climate actions under seven themes: climate leadership and stakeholder engagement, urban planning, mobility, construction, energy, consumption and urban nature. The implementation of measures listed in the roadmap are monitored in the Climate and Environment Watch (Ilmastovahti). The roadmap is updated every two years. The City Board approved the first Carbon Neutral Tampere 2030 Roadmap in August 2020. The currently valid roadmap was authorised on 4 November 2024.

Tampere is actively participating in the EU-level climate work. Tampere was one of the 100 first cities participating in the EU Cities Mission, with its Climate City Contract (CCC) signed. In 2024, Tampere received the EU mission label. The CCC is largely founded on pre-existing mitigation work in Tampere and builds on existing policies, in particular the Climate Neutral Tampere 2030 Roadmap. Tampere is also part of the EU Adaptation mission.

The Climate and Environmental Policy Unit leads Tampere's climate work. It is responsible for the updates of the Climate Neutral Tampere 2030 Roadmap, together with the city's other service areas, units, utilities and companies. The responsibilities for the actions outlined in the roadmap range across the departments, units and city-owned organisations, covering e.g., education, health and wellbeing, risk management, safety and preparedness, business services, procurement, public transport, transport system planning, land-use planning, city strategy work, strategic project development, and others.

Based on an expert review conducted for the climate vulnerability assessment of the city of Tampere (Tampere, 2024), the most significant climatic risks in Tampere are:

- risks related to water and water management, heavy rainfall, pluvial and fluvial floods
- periods of hot weather and drought

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- storms
- biological risks
- diseases and pests
- ecosystem changes (changes in species and alien species, loss of biodiversity).

The vulnerability assessment also concludes that

- as the city of Tampere continues to expand and become more condensed, it becomes increasingly exposed to factors such as heat and heavy rain
- the need for being prepared and responsive to the impacts of climate change increases.
- stormwater floods and heat waves pose a particular challenge to the Tampere city centre.
- areas dominated by agriculture and forestry in northern Tampere are prone to storms and droughts
- the urban population most at risk from severe weather includes small children, the elderly and persons with a general impairment in functional capacity or reduced mobility, as well as people with low income, homeless people and those belonging to linguistic minorities.

Overview of the city's CCC

Tampere was among the 100 cities selected at the launch of the EU Cities Mission in 2021, participating in the second application window. The current state of Tampere's Climate City Contract (CCC) implementation is structured around the city's strategic approach to achieving climate neutrality by 2030. The city's GHG emissions will be reduced by 80% compared to 1990 levels and the remaining 20% will be compensated.

According to the CCC, the Carbon Neutral Tampere Roadmap 2030 is the primary tool guiding Tampere's climate actions. It is updated biannually, with the most recent update in 2024. The CCC information provided here is based on the 2022 Roadmap, and the more recent figures from the 2024 update, published since the adoption of CCC, are presented in the footnotes. According to the CCC actions and projections, the 2022 roadmap can lead to 73 % reductions out of the 80 % reduction target by 2030, compared to the 1990 baseline. The CCC Action plan focuses on the 7% emissions gap remaining after the roadmap.

In the CCC, main areas of planned decarbonisation include construction, housing, mobility & transport, energy, and consumption, and co-benefits such as equality, safety, health, and nature preservation. In the CCC, the key actions are:

- Co-creating actions in pilot areas to make all forms of transport more equal
- Co-creating actions with big employers to promote sustainable transport
- Studying the public opinion
- Guiding city logistics transition to lighter vehicles and alternative propulsion
- Communicating with big fossil fuel users to update projections and plans
- Implementing Green Deal for zero-emission construction sites
- Oil heating advice to SMEs and to private homeowners, developing financing models
- Piloting energy advice to people with potential energy hardship

Tampere has tracked yearly climate emissions since 2010 using the nationally comparable CO2-report methodology (CO2-raportti). Emissions tracking focuses on several sectors including heating and electricity use in buildings (with particular attention to district heating, separate heating, electric heating, and ground source heat pumps), transportation (broken down by vehicle types, with emphasis on modal shift to sustainable modes), waste management, industry and work machines (covering fossil fuel use in industrial facilities), and agriculture. The inventory categorizes these emissions differently than the Common Reporting Framework while also beginning to address consumption-based emissions occurring elsewhere, particularly the carbon footprint of construction, which approximately doubles the total emissions count. The city is currently working to integrate F-gases and land use/forestry emissions into their inventory system, as these are not yet fully incorporated. Tampere also sets yearly targets for each emission sector in its Climate Budget as part of annual financial planning.

With 1990 as the baseline (1,300,000 t CO2e), Tampere aims for maximum residual emissions of 260,000 t CO2e by 2030. The latest inventory from 2021, presented in the CCC shows 898,000 t CO2e, a 31% reduction in absolute emissions and 51% in per capita emissions since 1990. Recent developments, including a new biomass power plant replacing peat in district heating, have further reduced emissions to approximately 45% below 1990 levels.

Projected residual emissions for 2030 comprise of diverse sources, including remaining emissions from waste incineration in district heating, a small fraction of oil heating, minimal electricity emissions (estimated 31g CO2/kWh), and transport emissions that remain challenging to reduce despite optimistic projections for electric vehicles and biofuels. Industry and work machines will retain some emissions as electrification progresses slowly, while waste emissions are expected to gradually decrease from existing landfills. Agricultural emissions, though small, are also transitioning slowly to more climate-friendly methods.

The European Commission's feedback on Tampere CCC highlights that all sectors, scopes, gases, and geographical areas seem to be included in the target. However, four aspects can be observed:

While there are no explicit exclusions indicated in the commitment with respect to gases, inventories currently account for CO2, CH4 and N2O, but the city states that F-gases will be included in the future as relevant data become available.

With respect to sectors, IPPU (industrial processes and product use) is not explicitly excluded from the target, but the city states there is next to no industry with climate emissions from product use; however, the emissions from ETS facilities have been quantified in the inventory and, consequently, seem to be included in the target.

Air and water transport-related emissions are considered negligible, therefore it can be assumed they are not covered by the target; a confirmation of this assumption would be desirable.

It is currently unclear whether scope 3 emissions from waste are included in the target. A clarification in this respect would be desirable.

In other areas the city's ambition exceeds the minimum requirements of the Mission, for instance with the ambition to start tackling consumption-based emissions; the strong focus on circular economy, counting on an Advisory Board for this purpose; or the aim to consider climate change vulnerability and adaptation.

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5.3.2 Anticipatory Governance, Risk and Vulnerability Assessment and Adaptive Management

Anticipatory Governance

Tampere uses scenario-based approaches in climate mitigation and to a certain extent in adaptation planning. According to its CCC, Tampere utilizes impact pathways as a structured method to plan and evaluate future scenarios regarding climate neutrality. The pathways detail systemic levers, early changes (1–2 years), late outcomes (3–6 years), and their direct and indirect impacts. For example, in the energy sector, the city has outlined pathways including the transition to renewable energy sources, investments in heat storage and solar panels, and strategies for demand-side management. Also for instance the inner-city master plan includes scenario reviews and climate impact assessments to evaluate the implications of different urban planning decisions on greenhouse gas emissions for 2030

In its Climate Roadmap, the city explains the main assumptions behind emissions projections for different sectors. For instance, the plans for emission reductions in the transport sector build on a scenario that assumes strong electrification of traffic and all bus traffic becoming low emission.

Increased utilisation of scenarios in adaptation planning is under development in the city, e.g., through a project implemented with the Finnish Meteorological Institute. In adaptation planning, the interviewees consider there to be potential in scenarios for helping to move attention away from adapting to current climate impacts to future impacts and planning for those. It is found challenging that the public discussion on adaptation often focuses on currently visible climate impacts instead of how to prepare for future impacts.

The Climate Roadmap is updated biannually and new data and information is considered. According to the interviews, major revisions were made to the latest update. However, the interviewees acknowledge challenges on data availability, as mostly the latest available climate data describes the situation two years prior.

Although the city uses scenario planning, the interviewees note that they are currently not actively using tools for making plans flexible to changing events or circumstances. In choosing measures or making plans, the most likely development scenarios are chosen as a basis for planning, and the interviewees note that there is no current practice of considering different options in parallel or building in checkpoints, aside from the regular updates of the Climate Roadmap and the City Strategy.

The city is in the process of developing a new, more agile impact assessment tool for its climate work, with the aim of the new tool being more flexible and able to handle parallel differing assumptions of possible developments. Tampere is involved in the Baltic Sea Region INTERREG project Climate-4-CAST that will develop and pilot a climate action decision tool especially for climate budgeting processes. The tool will visualise cities' mission forecasts and targets, as well as the emission and economic impacts of climate actions. The project will also develop practices that ensure that the information produced by the tool is utilised in decision-making processes.

Acknowledgment of uncertainty

The climate work in the City of Tampere does not typically prepare for uncertainty by preparing for different possible future scenarios. Instead, planning and policy takes place based on which developments are deemed most likely. Flexibility is, however, built-in in the informal everyday work practices as the city officials can react to new climate-related knowledge and revise existing measures or take on new measures even if they are not included in the Climate Roadmap that is updated only every two years.

Communicating different possible futures and uncertainties is a challenge. In climate change adaptation work, the interviewees mention that in discussions with citizens, attention is easily focused on current climate impacts, and that new approaches would be useful in how to make uncertain future climate impacts more understandable in order to bring the discussion into how to increase future resilience now. How to communicate and visualise uncertainties is a major challenge also for emission reduction work. It is difficult to communicate and make uncertain and complex foresight knowledge understandable and usable for decision-makers, citizens and companies.

Processes and Stakeholder Engagement

Actors

Tampere engages both with internal and external stakeholders in its foresight, anticipation and scenario work. The city departments involved include the following.

- **The Strategy Unit of the City of Tampere** guides and supports the city's strategic management and development leadership. The unit is responsible for preparing, supporting the implementation, and monitoring the city's strategy, and coordinating and developing sustainable development at the city level, among other things. Scenario work is part of the strategy process. Diverse stakeholders are involved in the city's strategy work.
- **The Climate and Environmental Policy Unit** leads Tampere's climate work. It is responsible for the updates of the Climate Neutral Tampere 2030 Roadmap, together with the city's other service areas, units, utilities and companies.
- **The Team for Risk Management, Safety, and Preparedness** coordinates the safety work of the city. It engages with city departments, external organizations and civil society in order to monitor and assess the safety situation of the city. Risk management and safety planning form a crucial part of this work.

External partners in the foresight work include regional actors, research organisations, consultants, partners from externally funded projects:

- **Tampere City Region (Tampereen seutu)** is a regional coalition of municipalities, owned by the eight municipalities in the Tampere region. One of the focal points of Tampere City Region is the foresight work, aiming to produce forward-looking insights to support the strategic planning of the city region. The foresight work analyzes environmental changes, societal trends, and future scenarios while maintaining trend maps and conducting regional impact assessments. It also fosters future-oriented thinking among municipalities, stakeholders, and residents through discussions and participatory forums. Its outputs include scenarios and contingency plans for various future developments, as well as analyses of the changing operating environment.
- **The Council of Tampere Region** (Pirkanmaan liitto) operates as a regional development and regional planning authority. It plays a key role in shaping the region's future through regional programs and planning. Future-oriented work involves multiple stakeholders to gain diverse perspectives on development trends. The goal is to identify change phenomena and anticipate possible futures. The council aims to strengthen collaborative future work by collecting, sharing, and refining information in ways that benefit regional stakeholders.
- **External consultants** have been involved in future-related work in the city strategy processes, and vulnerability assessments. According to an interviewee, Tampere utilises external consultants in their climate work, but that work is often refined in a certain way internally by the city experts.

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- **Research organisations** contribute to the city's climate work. In the mobility domain, the city has utilised the research made by Verne, the mobility research institute at the University of Tampere, with focus on impacts of different policy measures and external factors on traffic-related mitigation efforts. The Technical Research Centre of Finland (VTT) has been running a foresight training course for the city for the past year, which will end at the beginning of December. Tampere collaborates with the Finnish Meteorological Institute, for example through the TAPSI project, which focuses on climate change adaptation.

Also, **partners in externally funded projects** are important co-operation partners for the city. These projects act as a vehicle to develop, test and implement future-oriented approaches, and to build cooperation with peer cities and regions. As the everyday municipal work often focuses on everyday issues and time and resources for foresight work are limited, EU-funded projects have provided possibilities for more future-oriented development work. The Climate-4-cast project develops an open-source tool that visualizes the realization of cities' emission forecasts and targets, as well as the emission and financial impacts of climate actions implemented by cities. The We make transition! project utilises future-oriented approaches in fostering sustainability. More climate-focused projects of Tampere can be found here (in Finnish).

Residents have been engaged in many climate related processes of the city, including the biodiversity programme and climate roadmap, where residents' perceptions have been asked, for example of their concerns and perceptions of the environmental changes and opportunities for a more sustainable life.

Processes and Resources (for anticipatory governance)

At the city level, there is no separate unit for foresight and anticipation. The topics are, instead, considered to be cross-cutting. According to the interviewees, the whole city organisation in Tampere is thinking about how their foresight and knowledge management should be organised at city level, in order to better understand important issues such as demographics, migration, planning, and sustainable growth.

For the city strategy process, a person responsible for foresight has been appointed, coordinating foresight activities from all departments as part of the city strategy process.

A cross-sectoral foresight training has been organised for the city employees.

A key component of the Climate Neutral Tampere 2030 Roadmap is the emission reduction scenario which outlines the pathway to overall 80% emissions reductions by 2030. The representatives said all city departments and city-owned companies are involved in the preparation of the roadmap. Diverse stakeholders were engaged in preparing the emission reduction scenarios and pathways.

While the Climate Neutral Tampere Roadmap 2030 covers both climate change mitigation and adaptation, the institutional arrangements and responsibilities are in many cases separate, also reflecting the different stakeholder engagement processes in the two domains. However, the interviewees acknowledged that there are increasing efforts to strengthen the dialogue between the climate change mitigation, adaptation and risk management.

The CCC preparation process of Tampere relied on the city's internal resources. For example, the risks and barriers identified in its investment plan (IP) and action plan (AP) were compiled as the city's internal expert work, utilising the existing materials for Tampere's climate action. Broader stakeholder views are included in the CCC indirectly. The risk listing in the CCC derives from the established risk management and vulnerability assessment processes of the city, that involve external stakeholders. A climate vulnerability assessment, published in January 2024, was conducted by a consultancy, with key contributions from different city departments.

Overall, foresight and anticipatory methods are emerging approaches, but not mainstream activities in many of the city departments. There is increasing interest, and new initiatives around the theme, but they are not embedded in many of the city's processes and institutions. One interviewee said the importance of anticipation is not fully recognised in all departments and units. As foresight work is not traditionally a core function for many, human resources and expertise in this domain often remain limited.

The skills and capacities of foresight work differs between city departments, and the interviewees also note that as different departments do different kinds of work, their time perspectives also differ. In construction and real estate sectors, long-term thinking can be more in-built than, for instance, in care where the everyday work is more focused on solving acute issues. Thereby the role of foresight is also seen differently in the different departments.

Systematic scenario work is time-consuming and often more pragmatic and simplified work is required. Skills and competence shortage among both city officials and consultants is another identified challenge that is partly addressed by the training and development process of the city. However, Tampere considers it to be important to have foresight competence in the city organisation instead of relying on consultancy services only.

There is a lot of data and knowledge in the city organisation but it is scattered and not always readily available. The interviewees felt there is an increasing collaboration between different futures oriented processes in the city, for example between the climate unit's work and the city's risk management system.

Addressing barriers, risks and vulnerabilities

Tampere has identified critical systemic barriers to climate neutrality in its CCC, with certain key sectors failing to meet emissions reduction targets. District heating, traffic, and waste management are lagging behind emissions targets in Tampere's climate budget. District heating faces challenges with fossil fuel use during peak demand periods and emissions from waste incineration for heat production. Traffic presents a larger challenge, with private cars and logistics accounting for over 90% of emissions. Despite investments in tramways and public transport, even optimistic projections for electric vehicles and biofuels won't meet the 2030 target, necessitating an actual reduction in kilometers driven despite population growth.

Several sectors show progress but face ongoing challenges. Waste management has implemented solutions like biogas production and underground wastewater treatment, but struggles with potentially unreliable emissions data. Industrial emissions appear on track but depend heavily on finding alternatives to fossil gas for major facilities. Oil heating shows positive movement thanks to national financial support, though recent government cuts may slow this progress. The city also faces systemic barriers in financing climate action, both for investments and operational costs, requiring new working methods and better documentation of both cost savings and sustainability impacts.

Based on the CCC Investment plan, Tampere conducts risk management according to City Council-approved principles and current legislation. Climate change risks are incorporated into the city's risk profile. The Risk and Security department oversees risk management processes, while various city entities maintain their own risk profiles and internal control descriptions.

The risk assessment protocol aims to analyze environmental changes, identify risks and opportunities affecting objectives, assess their impacts, maintain current risk profiles with management strategies, and evaluate effectiveness of risk measures.

Tampere uses the Granite risk management system for risk assessment operations. During budgeting, investment planning accounts for financial consequences, and the city regularly monitors progress toward goals. Construction projects undergo regular risk assessments with budget deviations reported to decision-makers. Budgets typically include risk reservations for unexpected

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costs.Financial aspects are integrated into the Granite risk model, though financial risk identification may vary between departments. Market and economic changes affect Investment Plan implementation.

The Investment Plan contains a multitude of risks impacting the mitigation work of Tampere. The fields of action where risks have been identified are Transportation, the Built Environment, Energy Generation, Green Infrastructure and Nature-based Solutions, Waste and Circular Economy, and Cross-cutting. Economic risk and Technical risk are the most frequently mentioned risk categories. Climate/environmental risk is mentioned twice, in the 1) Transportation Field of Action, as Weather and climate risks cause challenges to road infrastructure; slipperiness, rail network and road maintenance problems, the risk of railway embankments and roads collapsing increases, and 2) Increasing vegetation carbon sinks Field of Action, different kinds of trees/ plants have different growth rates so the need to focus on variation in the selection of trees when planning green areas and planting new trees exists. Certain capacity/capability risks were also identified, such as Lack of experience among different actors.

For the investment plan, risks were identified by extracting information from the Granite system, supplemented with expert assessments and dialogue with the risk management team. However, city representatives acknowledged this approach was limited. The process took risk factors into account somewhat more widely, but still represented the view of a limited set of experts rather than providing an all-encompassing assessment. No specific criteria or structured methods were identified for risk assessment; instead, Tampere has attempted to identify the most significant risks without employing particularly structured methods or criteria.

Tampere's approach to risk prioritization for climate mitigation remains at an early stage of development with limited formal processes in place. Risk identification for the CCC Investment plan was based mostly on internal expertise and intuitive assessment rather than structured methodologies. City representatives acknowledge that discussions around risk identification have been somewhat superficial, noting that deeper identification would be beneficial but time-consuming. Economic calculations have been included in the latest Climate roadmap using shadow pricing of carbon to estimate potential costs of inaction.

For adaptation work, Tampere has developed systematic vulnerability analysis and risk assessment approaches. Climate risks are tracked in the Granite risk management system; where climate change is categorized as a compliance risk. However, the system has limitations in addressing cross-cutting themes as it focuses on how risks affect specific service groups rather than facilitating collaboration across units, and internal discussions have occurred about whether this is appropriate since climate risks cut across multiple risk categories. The Safety and Risk Management Unit processes adaptation-related risks annually, which informs activities developed by the Climate and Environmental Policy Unit.

In 2024, Tampere published its first assessment focusing on socio-economic vulnerability to climate change. The aim of the vulnerability assessment was to identify the key factors affecting vulnerability in Tampere, to map the manifestation of vulnerability in the geographical area of the Tampere city centre in relation to climate risks, and to develop proposals for measures to take vulnerability into account in the work of the different actors. Until then, Tampere's climate change adaptation work had mapped the key hazards, but no vulnerability analysis to identify the most vulnerable groups and risk locations in Tampere had been conducted. The vulnerability analysis process involved stakeholder engagement, with the city conducting specific work not only with internal city actors but also with stakeholder networks. This included discussions with vulnerable groups and their representatives.

Cross-border climate change risks have been acknowledged but deferred for future consideration. These issues have been mentioned but set aside for the next round of assessment.

Monitoring

The city's processes to identify and to respond to emergent changes to barriers and risks.

A key mechanism for Tampere to identify and respond is the iterative update of its climate roadmap, where new information, including emissions data and stakeholder inputs, leads to recalibration. The most recent roadmap was thoroughly updated, as several measures were redrafted when it was found that they were no longer relevant or needed as new information became available.

As mentioned, Tampere's risk management operates through the Granite system. The city has three larger service areas divided into service groups and units, with each service group identifying important risks and defining actions to avoid them along with timeframes. The system sends email reminders when risk measures have not been updated. This city-wide system is monitored by the risk management unit, with city-level risks specifically tracked and reported in financial reporting. The process requires each service group to review the risk management report three times per year, though some groups may only review it once annually.

Systems and indicators used for assessment of progress.

Tampere is using a digital Kausal Watch tool to monitor and communicate the city's climate actions. The Kausal Watch presents 397 measures, divided into seven different themes:

- Sustainable urban planning
- Sustainable transport system
- Sustainable urban transport
- Sustainable urban transport - Sustainable energy
- Sustainable urban planning Sustainable transport
- Sustainable urban nature, and
- a cross-cutting theme: 0. Climate governance and stakeholder work.

The themes and measures of the Kausal Watch are based on the second update of the Carbon Neutral Tampere 2030 Roadmap. The Kausal watch describes the measures Tampere is taking to achieve carbon neutrality, how the measures affect the carbon neutrality target and how the measures are progressing. Also progress on adaptation is described.

Insights and Recommendations

Key strengths

One strength of the city is that it has established a structured risk assessment processes and systems for climate change adaptation. As previously mentioned, the city utilizes a digital risk management system called Granite that tracks various risk categories including strategic, operational, financial, compliance, damage, and external risks by service group. Climate change is categorized under the compliance risk family. The Climate and Environmental Policy Unit has developed a collaborative approach with the Safety and Risk Management Unit, conducting annual reviews of adaptation-related risks to better target their activities. This cross-departmental cooperation helps

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identify emerging issues and ensures that adaptation considerations are integrated into the city's broader risk management framework.

Another strength of the city of Tampere in anticipatory climate governance is that the importance of improving foresight capacities across the organisation has been acknowledged. Resources have been allocated to increase foresight capabilities across all departments instead of, for instance, focusing foresight tasks to the climate and environment or risk management departments only.

In practice, this has been done by organising foresight training across the organisation, and starting a development process looking at how foresight and anticipation could become a more integral part of the city's operations. This also links to another strength of Tampere, that is ensuring that competence on scenario-building and foresight exists in-house, which is a way to avoid dependency on external support (e.g. consultancies) and to build continuity.

Building a strong portfolio of climate-related projects is another key strength of Tampere. As challenges of lack of time and skills have been identified as obstacles for anticipatory climate governance, especially EU projects have been used as a way to connect to external competence and to broaden the city official's horizons from everyday work towards more future-oriented approaches.

Challenges and opportunities

Despite the value of anticipation being increasingly recognised within the city organisation, foresight work and anticipatory governance are not widely embedded in all the city departments yet. The city departments work with different time perspectives, creating inconsistent approaches to anticipatory governance. The foresight work is not traditionally a core function of most departments, and therefore, human resources and expertise in this domain remain often limited. Systematic scenario work is resource-intensive, and the city faces both time constraints and skills shortages.

Building even more structured collaboration and synergies between different organisations, projects and initiatives would be an opportunity to further address the challenge of scattered knowledge and expertise. Tampere has already, for instance, collaborated in regional anticipation work with the city-regional authority "Tampere City Region" and has built a portfolio of externally funded projects in anticipation.

Other cities could learn from Tampere's ongoing efforts of mainstreaming foresight capacities to the entire city organisation. As the nature of different departments' work differs, their work to different extents include long-term perspectives if no special attention is given to the importance of foresight and anticipation in all municipal work. Inviting officials to all departments to foresight training and developing the institutionalisation of foresight work into municipal processes, as Tampere is doing, could be useful also in other cities.

The reality of short political cycles affects how future-oriented thinking is included in the city's work. The four-year political cycle does not naturally encourage long-term thinking, making it challenging to maintain focus on distant climate goals. Furthermore, public and political discussions tend to focus on immediate climate impacts rather than preparing for future scenarios, particularly in adaptation work.

Other cities could learn from Tampere's approach of integrating climate change risks and adaptation into their existing institutional risk management framework. By incorporating adaptation considerations into the digital Granite risk management system and establishing regular collaboration between the Climate and Environmental Policy Unit and the Safety and Risk Management Unit, Tampere has created a structured process for identifying and monitoring climate risks.

This cross-departmental cooperation, featuring annual reviews of adaptation-related risks, provides a foundation for more targeted climate activities. Cities looking to enhance their climate risk management could benefit from emulating Tampere's systematic digital tracking of risks, regular interdepartmental collaboration on climate issues, and clear assignment of responsibility for foresight work, while potentially improving upon Tampere's model by developing better frameworks for cross-cutting challenges that span multiple municipal departments.

However, the current risk management system faces limitations in addressing cross-cutting themes. It primarily focuses on how risks affect individual service groups rather than facilitating collaboration on interdepartmental challenges.

While anticipation and foresight work are inherently in-built in the climate change adaptation through risk assessments and vulnerability analysis, thence approaches are less used in the climate change mitigation. Mitigation planning has often focused on emissions reductions without fully assessing external risks to, or assumptions behind emission reductions pathways. Risk management in mitigation could benefit from a more systematic approach and strengthened collaboration with external stakeholders, such as academia.

Given the readiness and interest in adopting the foresight and anticipatory methods in their climate work, Tampere could be in a position to embed even more advanced anticipatory tools and methods in their strategy work and roadmap processes. For example, more advanced risk assessments and adaptive governance methodologies could be brought into the city's mitigation work. The interviewees considered Robust Decision Making and Dynamic Adaptive Policy Pathways (DAPP) as potentially useful tools, and future updates of the climate roadmap and biodiversity programme would be opportunities to pilot these approaches. Due to resourcing constraints, externally funded projects could be used to leverage piloting and adopting new tools.

Tampere also identified data integration and visualizing the critical impacts of climate change as a challenge, particularly when engaging with stakeholders. Both internal departments and external partners focus more on the current observable effects rather than future climate scenarios. Recognizing this challenge, Tampere is now developing tools for integrating environmental data, for instance scenarios from the Finnish Meteorological Institute with the city's own measurement data on air pollution and green environments. The tools are being developed in conjunction with the city's wider digital innovations.

Recommendations for future support and development.

Tampere is interested in learning about risk and vulnerability assessment methods in the context of climate mitigation. At the moment, it represents a challenge for Tampere, as insufficient resources have been allocated to this area of work. The process requires detailed analysis of complex systems, specialized expertise, and robust methodological approaches that are currently beyond the scope of what the city can independently support. Tampere is interested in multi-risk assessment methods, and one area of interest is also if climate change related risks are relevant for their mitigation actions. Moving forward, increased cooperation could provide a viable solution to this resource gap. By pooling technical knowledge, sharing methodological frameworks, and collaboratively developing evaluation tools, Mission cities could create more comprehensive risk assessment processes without individually bearing the full resource burden.

Tampere is interested in learning from the experiences of the other mission cities. Themes for potential peer-to-peer learning mentioned by the interviewees are mitigation related risks that mission cities have identified in their CCC investment plans and learning about whether other mission cities have identified commitment and resourcing of their mitigation measures as a political risk.

Tampere is also interested in learning about tools for flexible policy-making planning, such as Robust Decision-Making and Dynamic Adaptive Policy Pathways. Currently, Tampere's work on

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anticipation and foresight mainly builds on regular updates of the roadmaps where the plans are made based on what scenarios are considered most likely to become the reality, but the city is interested in developing how they could better use alternative scenarios and for example different tools to identify possible trigger points in different pathways and how to react to those.

Examples of actual successful scenario work that has helped to prepare for risks that have later become reality was raised as an interesting point for inspiration. There was particular interest to apply these tools in the mitigation work of the city. Support on the types of tools available and how they could be adapted in Tampere's climate neutrality work could be an area for future support.

Furthermore, Tampere is very interested in learning about communication and visualisation of the future uncertainties to different audiences. The interviewees note on several occasions that communicating complex knowledge in simple ways is a challenge, and peer-to-peer learning or other support could be useful in this area. While adaptation measures address tangible issues like urban flooding, storms, and heat waves, mitigation efforts face the additional communication hurdle of addressing invisible emissions. The abstract nature of carbon footprint measurements makes it difficult for the general public to contextualise what constitutes significant versus minimal impact. City officials therefore struggle with the delicate balance of simplifying risk communication and future projections in a way that informs and motivates action.

5.3.3 Summary and Outlook

Key processes and good practices

Tampere has a structured climate roadmap process. Tampere uses a Climate Neutral Tampere 2030 Roadmap, updated every two years, which incorporates new data and adapts to changing circumstances. The roadmap includes 397 climate actions across seven themes. The city involves all departments and city-owned companies in the development and implementation of the roadmap, with the Climate and Environmental Policy Unit being the key department coordinating the work. This creates shared ownership of climate initiatives across the municipal organization.

The city has institutionalised processes to anticipate and track future risks. For example, Tampere employs a digital risk management system called "Granite" to track various risk categories including climate-related risks, facilitating systematic monitoring and response. The city strategy preparation utilises scenario work.

Tampere uses scenario-based approaches for climate planning, particularly in mitigation efforts. The city creates alternative scenarios for achieving carbon neutrality in different sectors with explicit assumptions about future developments. There is also an interest in, and potential to, use scenario-based methods more systematically and also in adaptation work.

Tampere is increasingly acknowledging the importance of foresight and anticipation. The city has invested in foresight training across departments to build anticipatory capacities throughout the organization rather than siloing these skills in specific departments. The city actively uses EU-funded projects to connect with external expertise and develop future-oriented approaches, addressing resource constraints for anticipatory work.

Main obstacles the city faces in advancing work on anticipatory governance.

While the importance of anticipatory climate governance is increasingly recognised in Tampere's city organisation, there are barriers for making it fully institutionalised and mainstream.

The reality of short political cycles affects how future-oriented thinking is included in the city's work. The four-year political cycle does not naturally encourage long-term thinking, making it challenging to maintain focus on distant climate goals. Different departments work with different time perspectives (e.g., construction naturally takes a longer view than healthcare), creating inconsistent approaches to anticipatory governance. Furthermore, public and political discussions tend to focus on immediate climate impacts rather than preparing for future scenarios, particularly in adaptation work.

While anticipation and foresight work are inherently in-built in the climate change adaptation through risk assessments and vulnerability analysis, these approaches are less used in the change mitigation. Mitigation planning has often focused on emissions reductions without fully assessing external risks to, or assumptions behind, emission reductions pathways.

The foresight work is not traditionally a core function or responsibility of most many city units or departments, and therefore, human resources and expertise in this domain remain often limited. Systematic scenario work is resource-intensive, and the city faces both time constraints and skills shortages. Foresight work is being done by different organisations regionally, but the initiatives are not closely coordinated.

Next steps and support needs: future plans and areas where external support is required.

Through the case analysis of Tampere, the following opportunities were identified to strengthen the foresight and anticipation work in the city of Tampere:

- Exploring possibilities to include foresight and anticipation in the climate change mitigation work. For example, the specific tools like Robust Decision Making and Dynamic Adaptive Policy Pathways (DAPP) in climate work were considered as interesting to explore in the mitigation context.
- Developing how to communicate uncertainties to different audiences and making abstract concepts tangible to different kinds of audiences including citizens, companies and politicians. The city is interested in better ways to integrate and visualize data from different sources to support forward-looking decision-making and communicate complex information clearly. Climate scenarios are seen as a means to do this.
- Exploring new methodologies and framings to assess risks and uncertainties in the mitigation context. For example, the interviewees were interested in exploring whether the impacts of climate change to the planned emission reductions are an issue that should be addressed more thoroughly in the mitigation planning.
- Learning from other municipalities' experiences on risks identified in the CCC and anticipatory governance, including political risks to mitigation efforts.

Key recommendations

The following actions can help Tampere in leveraging foresight and anticipation approaches in their climate change mitigation:

- Establish further mechanisms for coordinating foresight activities across city departments and with external stakeholders to address the challenge of scattered knowledge and expertise and to ensure that existing data and knowledge is used and shared efficiently.
- Investigate possibilities and further assess the potential of introducing tools such as Robust Decision-Making and Adaptive Policy Pathway approaches in upcoming roadmap updates.

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- Develop approaches for communicating and visualizing climate scenarios and uncertainties for different audiences, including decision-makers and the public. Co-operation and peer-learning with other mission cities could be useful in gaining new insights.

5.4 Parma

5.4.1 City Profile

General city information

The city of Parma is a major economic and cultural centre in the Emilia-Romagna region in Northern Italy. **With a population of approximately 200,000, its growth has remained relatively stable in recent decades.** The city is known for its rich history, renewed cuisine, and strong industrial base. Its reputation in agriculture and food production has earned it international recognition. Beyond these traditional sectors, Parma has expanded into pharmaceuticals, automotive components, and advanced manufacturing. It is also home to the University of Parma, a leading institution that fosters innovation and research in food science, engineering, and biotechnology.

The Parma's territorial area has a temperate continental climate, with a temperature range that is wide due to cold winters and hot summers. Rainfall is mostly concentrated in the autumn and spring months. During the summer, the flatland where the city is placed experience intense heating that can lead to thunderstorms, sometimes severe. Low wind levels, resulting in low air circulation, often causes foggy days in winter and stagnant conditions in summer. Overall, these factors, contribute to a decline in air quality, promoting the rise of pollutants such as PM10 in winter and ozone in summer (ARPAE Emilia-Romagna, 2023).

Climate data for the City of Parma clearly highlight the local effects of climate change. Since the eighties the temperatures have shown a steady rise, with a marked acceleration since the early 1990s. Average, maximum, and minimum temperatures have all increased, especially in summer reflecting the impact of the Urban Heat Island effect, which amplifies due to factors such as limited green areas, dense urban development and sealed surfaces. Extreme weather events are now more common, with fewer frost days and more hot days (Tmax >30°C), very hot days (Tmax >34°C), and tropical nights (Tmin >20°C). Heatwaves are becoming more and more frequent, and rainfall patterns are changing too, with drier periods and longer dry spells becoming more frequent, while autumn sees more intense rainfall (Comune di Parma, 2021).

Parma has therefore taken steps to address climate change and sustainability. The city is taking steps to reduce greenhouse gas emissions and improve air quality through a set of initiatives focused on greening, renewable energy and sustainable mobility. These initiatives are part of broader sustainability strategies on which the city has been historically active in the last twenty years. Parma's proactiveness on Climate related issues has made it possible for it to become a participant of the EU Cities Mission, working towards climate neutrality through its local sustainability strategies. Measures include expanding cycling infrastructure, promoting electric mobility, increasing urban green spaces, and improving energy efficiency in buildings.

The city's climate policies are guided by regional and national frameworks, with a focus on integrating sustainability into urban planning and transport systems. Parma developed the

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"Parma Città Climate Neutral 2030"[1] action plan that is a comprehensive strategy that extends beyond the effort developed within the EU Mission and the Climate City Contract, aiming to **integrate all the strategic plans** and the actions related to Climate Neutrality, Mitigation and adaptation, such as the **Sustainable Energy and Climate Action Plan (SECAP)** (Comune di Parma, 2021), the **Sustainable Mobility Plan (PUMS)** and the **Regional Integrated Air Plan (PAIR).** The overall strategy includes various actions such as, among others, the the **City Climate Assembly**, which brings together public, private entities and citizen to collaboratively pursue carbon Neutrality in Parma by 2030. The strategy integrates regional and EU environmental programs sustaining the monitoring effort of Parma's climate initiatives aiming to ensure progress towards the emission reduction goals. Local government departments, in collaboration with universities and businesses, play a key role in implementing and refining these policies to enhance sustainability and resilience against climate-related risks such as heat waves and air pollution.

Brief overview of the city's CCC

General Information on the CCC

Parma submitted its candidacy to the EU Mission "100 Climate-Neutral and Smart Cities by 2030" in 2022 and, after being selected, submitted its Climate City Contract (CCC) within the second application window in September 2023. Its Climate City Contract, including the Action and Investment Plans have been endorsed by the European Commission, earning the city the prestigious Mission Label. Parma's decarbonization strategy includes a comprehensive greenhouse gas (GHG) inventory, which informs targeted mitigation actions across various sectors. The city's effort focuses on a few key areas of interest: enhancing energy efficiency in buildings, promoting sustainable mobility through increased public transport use and active travel, improving waste management practices, reducing emissions from industrial processes and product use (IPPU), and advancing sustainable agricultural and land-use strategies (AFOLU).

Parma has involved 46 stakeholders in shaping its climate action portfolio, resulting in 130 planned actions across five key sectors. Of these, 86 target buildings, 19 focus on transport, 11 on agriculture, forestry and land use (AFOLU), 2 on waste management, and 2 on industrial processes and product use (IPPU). The strategy also includes 10 behavioural measures and 7 overarching strategies to address residual emissions. These strategies, already in motion, fall under governance, quantifiable actions, and behavioural change. These include the electrification of the territory, planning, mobility, resource circularity, food policy, afforestation, and education.

The portfolio of actions has been designed through a co-creation process with the local stakeholders. This process allowed a synergistic approach aimed at the activation of the ecosystem, which identified barriers and opportunities for each sector.

GHG inventory (from CAP and EC feedback)

The City of Parma drew on a range of institutional and technical sources and on the Monitoring Report of the SECAP (Sustainable Energy and Climate Action Plan) to develop its greenhouse gas (GHG) emissions inventory. The SECAP was updated in June 2023, and it incorporates the Monitoring Emission Inventory (MEI) for the reference year 2019, compiled by the

Territorial Agency for Energy and Sustainability of Parma (ATES), offering a comprehensive overview of emissions across key sectors, forming the backbone of the city's climate planning framework. This dataset was complemented by the Greenhouse Gas Report of the **Province of Parma**, also covering 2019, and jointly developed by the **University of Parma and the University of Siena**. This report contains detailed estimates for emission in the AFOLU and waste sectors, known for their complex emission profiles. Other analyses have been carried out by the Agency for Sustainable Energy and Development (AESS). Through this collaborative and data-driven inventory Parma established a baseline emissions figure of 1,126,647 tonnes of CO_2 equivalent for 2019, a critical benchmark for defining its reduction targets and tracking progress toward climate neutrality.

The city developed a climate strategy that aims to drive deep emissions reductions across several areas of urban life drawing directly from the baseline. Starting from the developed figures the city developed the Action Plan (AP) that outlines a rich range of interventions expected to reduce the emission by 378,365 tCO_2e. The plan, however, falls short of the reduction required to meet Parma's 41.4% emissions reduction target. Three are the main drivers of the actions included in plan. First, the municipality and its partners are expected to implement actions that will reduce emission by 8,221 tCO_2e; second, external stakeholders that already agreed to take actions that will reduce the emission of 328,143 tCO_2e; and third, other actors that are still in the process of determining actions with an estimated impact of 42,001 tCO_2e. Each of these three categories represents a meaningful contribution, but the current shortfall highlights the need for the city to expand the planned actions and enrich the current city's pipeline. The relatively high baseline of emission, standing at 5.68 tCO_2e per capita, according to the European Environment Agency (EEA), highlights how Parma has still capacity for impactful reductions. If the Action Plan provides an overview of sectorial data, offering clear insights of the sectors where the emissions are being tackled a detailed breakdown of emissions that are more likely to remain after 2030 is still lacking.

Parma has identified a series of thematic intervention areas to address the residual emissions. The identified themes are enhancing sustainable mobility, accelerating electrification across the territory, promoting circular economy practices, advancing food system reform, increasing urban forestation, and investing in public education and awareness. The plan to tackle these themes through a holistic and integrated approach reflects how the municipality is integrating diverse efforts within a systemic plan that reflects its commitment to shaping social and environmental systems. Despite this promising direction, the city's approach to residual emissions remains a work in progress. Future iterations of the climate plan are expected to offer more detailed strategies, clearer implementation timelines, and a breakdown of unavoidable emissions across sectors. In particular, the inclusion of true offsetting measures, such as certified carbon credits, will be essential to tackle progress towards climate neutrality with credibility.

Adaptation Mission and Cities Mission

Parma is actively participating in two pivotal programmes under the EU's Horizon Europe framework: the "Climate Neutral and Smart Cities" and "Adaptation" Missions. The strategic plan "Parma Città Climate Neutral 2030" integrates the objectives of both missions by promoting nature-based solutions, enhancing urban sustainability, and optimizing resource management. Parma's approach includes coordinating effort on urban greening, boosting energy efficiency, and upgrading infrastructures to support sustainable mobility. The city's Climate City Contract (CCCs) is a strategic document that aligns local policies with the EU's broader adaptation goals, integrating the planned portfolio of actions with multi-level governance practices and plans.

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The European Commission's has recognized Parma's approach for its inclusive design and strong stakeholder engagement, ensuring that climate adaptation and mitigation efforts are both ambitious and locally grounded.

To address both programmes Parma has developed a governance model that emphasizes participation and multi-level cooperation, involving local authorities, businesses, and civil society at different governance levels. Such governance model includes a steering committee composed of key city councillors and a working group led by the general manager. This structure ensures that climate adaptation is integrated into broader city governance. Additionally, Parma has involved external stakeholders and technical experts to strengthen the robustness of its climate action plans. The focus of the effort made by the city has been on incorporating risk assessments, prioritizing investments, and ensuring cross-sectoral coordination, by addressing financial and capacity-related risks, issued raised during workshops with stakeholders. The overall participatory and integration process has supported Parma refine its investment strategy and align it more closely with the Adaptation Mission's objectives.

5.4.2 Anticipatory Governance, Risk and Vulnerability Assessment and Adaptive Management

Anticipatory Governance

Parma has actively engaged in anticipatory governance processes despite not having a dedicated unit *within* their organization. The main effort in relation to anticipatory governance action refer to **three different aspects that characterize anticipatory governance: foresight activities, participatory and policy integration processes**. These three aspects were addressed by the administration through the city's early engagement in climate action, participation in European projects, institutional measures, and collaboration with stakeholders.

The city has taken several institutional and regulatory measures throughout its journey towards Climate Neutrality that supported its future preparedness. Parma established a *local Energy Agency* already in 2004-2005, laying a strong foundation for climate related initiative and actions. This institutional measure was complemented by the development of local regulations focusing on energy in 2010 that introduced ambitious building standards and incentivizing sustainable construction practices. The Energy Agency continues to play a pivotal role in overseeing climate-related projects, facilitating investment in green technologies, and ensuring that urban planning integrates climate adaptation priorities. These regulatory advancements illustrate Parma’s commitment to long-term climate action through a diverse set of measures. The proactive establishment of such regulatory frameworks has positioned Parma at the forefront for other mid-sized cities aiming to uptake the journey towards climate neutrality. The existence of such an agency has boosted the city’s ability to participate into calls and European projects related to climate action.

Parma's involvement in European projects has been instrumental in enhancing its anticipatory capabilities. The journey the city has embarked is leveraging their ability to learn how to anticipate challenges and incorporate risk management practices into its strategic planning, influenced by the guidelines and experiences of these projects. As part of the RUGGEDISED project, Parma participated as a "follower city" together with Brno and Gdańsk, of other three lighthouse cities, Rotterdam, Umeå and Glasgow. This projected represented a fundamental step for the city to engage in foresight activities and process through which the city was able to set the goals for 2030. Already, within RUGGEDISED framework the city has set ambitious goals through the PARMA FUTURO SMART ***participative foresight process.*** Such process was aimed at accelerating the city's efforts to become a fully green urban centre, aligning its future's plans with the identified goals.

Already in 2022 the city's commitment and policy guidelines were centred onto three majors' principles that guided the development of future policies, regulations and institutional action: "The City of People", which emphasized inclusivity and community cohesion; "The Changing City," which fostered economic growth, cultural vibrancy, and urban regeneration; and "The City of Tomorrow", which aimed for a green, safe, and connected urban environment. These principles were established to support the city's broader vision of bridging divides by developing a portfolio of actions that address various aspects of climate adaptation, mitigation, and neutrality. Such principles guided the development of guidelines related to the regeneration of the existing built environment, the reduction of land consumption, the guarantee of hydraulic and geological safety, the expansion of service networks, and the promotion of centres of excellence.

These principles and guidelines sustained the development of the "Roadmap towards Parma Smart City" which includes four scenarios: "towards smart, shared and sustainable mobility", "towards a carbon neutral city", "towards digital transitions and innovation: the city as a laboratory", "towards a cultural and inclusive city" (Cassolà et al. 2022). These four directions set the base for the development of an action and investment plan already within the RUGGEDISED project. This experience has been fundamental for the city application for being part of the "100 Climate Neutral and Smart Cities" of the EU Mission. The results of the roadmap were then embedded within the process of the development of Parma's CCC. Additionally, the city's participation to other prizes such as the ECO label, provided valuable insights and helped the city to strengthen partnerships with external stakeholders giving credibility to their journey.

Parma's foresight processes are characterized by collaborative projects, sectoral and cross-sectoral risk assessments, and an evolving approach to integrating these insights into strategic planning and policy development. The city's proactive stance in engaging with European initiatives and local stakeholders reflects its commitment to anticipating and mitigating future climate challenges. These collaborative and participatory stakeholder engagement processes are key strengths of Parma's integration of anticipatory governance and will be further discussed in the next section.

Another key aspect of Parma's anticipatory approach is the municipality's focus on organizing both sector-specific and cross-sectoral workshops to strengthen risk management capabilities within its administration. By leveraging knowledge gained through participation in EU projects, Parma has enhanced its local governance capacity, though challenges remain in fully institutionalizing these processes.

Moreover, **rather than merely adhering to regional directives, Parma has strategically integrated its climate policies with policies and regulations from other governance levels such as the broader European frameworks**. This integration has raised the city's ambitions and strengthened its anticipatory governance approach. One of the clearest examples of this is the synchronization of its Sustainable Urban Mobility Plan (PUMS) with European standards.

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Finally, Parma's ongoing stakeholder engagement through workshops and participatory projects is a key aspect of the city's anticipatory commitment. For example, the integration of the PAESC (Sustainable Energy and Climate Action Plan) with the PUMS (Urban Sustainable Mobility Plan) thanks to the EU project SIMPLA was achieved through extensive stakeholder involvement, ensuring alignment in methodologies and monitoring indicators. This participatory approach has fostered a shared understanding of climate risks and long-term sustainability goals. This approach has also facilitated access to European funding opportunities and reinforced the city's role in transnational climate collaboration.

Processes and Stakeholder Engagement

The Municipality of Parma successfully engaged 46 partners in the development of its Climate City Contract (CCC), collaborating with major industries, the private sector, local agencies, and academic institutions. At the forefront of this initiative was the Transition Team, an internal municipal working group tasked with steering the city toward climate neutrality by 2030. Such team received support from the NetZeroCities Platform and the Energy and Sustainable Development Agency (AESS). Moreover, key institutional support came from the Local Energy Agency (ATES) along with a dedicated foundation created to manage energy communities and strengthen governance (Fondazione CER 2030).

The private sector has played, and continues to play, a key role in Parma's sustainability strategies by facilitating financial investment and driving technical innovation. These partnerships have accelerated the implementation of solutions aligned with the city's overarching goals. Additionally, academic institutions such as the CNR and the University of Parma have contributed valuable research and data-driven insights, helping ensure that climate strategies are scientifically grounded and effective. Together, these entities played a crucial role not only in providing essential expertise but also in fostering partnerships with businesses and organizations to drive climate action toward the city's goals. Through its multi-stakeholder approach, Parma has positioned itself as a leader in stakeholder engagement and transdisciplinary collaboration for sustainable development, leveraging cross-sector expertise to build a robust climate action plan.

Processes and Resources (for anticipatory governance)

Parma established task forces and periodic workshops to foster continuous dialogue with stakeholders, ensuring effective climate governance. These workshops tackled both specific and cross-sectoral challenges, promoting the integration of Parma's climate neutrality, mitigation, and adaptation strategies. A clear example of this alignment is the coordination between the Sustainable Energy and Climate Action Plan (PAESC), the Sustainable Urban Mobility Plan (PUMS), and the Climate City Contract (CCC) ensuring that these documents and instruments complemented each other avoiding overlaps.

Moreover, the municipality internal coordination mechanism to streamline climate-related initiatives foresees a political steering committee and a working group led by the general manger to oversee climate projects. Such structure improved communication and coordination across municipal departments, ensuring that climate actions are embedded in broader urban planning and development strategies, including mitigation and adaptation. Several key actors played a vital role in Parma's anticipatory climate governance, including personnel from municipal departments, local organizations, and private sector partners. These stakeholders contributed their expertise to drive forward climate policies, bridge gaps between different sectors, and facilitate the implementation of sustainable urban initiatives.

Through these collaborative efforts, Parma strengthened its capacity to develop and implement climate strategies, ensuring to integrate climate action into the city's long-term

planning. However, in Parma, foresight and anticipatory methods are gaining traction but have yet to become a core component of many city departments. While interest in these approaches is growing and new initiatives are emerging, they are not yet fully embedded in the city's institutional processes. Foresight skills and capacities vary across city departments, depending on whom has been involved in previous foresight activities. Conducting systematic scenario work often necessitates specific capacities, the shortage of expertise among city officials has been identified as another challenge, as well as the difficulty of attracting human resources, which the city is addressing through training and capacity-building efforts. However, Parma recognises the importance of developing in-house foresight competencies.

Risk and Vulnerability Assessment

The City of Parma conducted specialized workshops with stakeholders to assess risks and barriers associated with its Action Plan and Investment Plan for the development of their CCC. Unlike broader stakeholder consultations, these discussions were conducted primarily at the municipal and territorial levels to refine the city's financial strategy. These specific workshops played crucial role in identifying risks at sectoral levels (i.e. mobility and transport, buildings and infrastructures, etc.) and at the cross-sectoral levels including financial capacities and investment-related risks.

A key component of Parma's climate strategy was vulnerability mapping, aimed at identifying vulnerable assets and climate mitigation pathways. Intersectoral working groups established by the municipality conducted a comprehensive mapping risks and vulnerabilities across a range of sectors, ensuring a holistic understanding of the challenges, informing climate adaptation and mitigation efforts. Through these workshops participants were able to rank the mapped risks according to their urgency, ensuring that the most critical issues were tackled first.

Interviewee noted that these procedures are still lacking an overall integration in the administration's practices and organisational structure as the above process was developed specifically for the development of the CCC.

Barriers

Stakeholders identified multiple barriers hindering the effective implementation of climate action plans. These obstacles span regulatory, economic, infrastructural, technological, behavioural, and political domains.

First, regulatory and institutional barriers include cultural heritage restrictions, legislative gaps, bureaucracy and evolving regulations. The Municipality's real estate assets fall under the jurisdiction of the institutional body of the "Soprintendenza ai Beni Culturali" (the authority preserving cultural heritage), which imposes stringent regulations and surveillance on cultural heritage assets. These restrictions significantly limit the scope for energy efficiency upgrades and creates bureaucratic hurdles, as many interventions aimed at improving energy performance are considered illegitimate under current regulations. Moreover, local and national legislative gaps as well as constant changes in environmental policies represent barriers to climate-related initiatives, creating uncertainties which create issues for long-term planning.

Second, economic and financial barriers refer to the high cost for climate interventions for energy efficiency. Many planned projects and interventions are blocked or scaled back due to financial constraints. Furthermore, geopolitical instability, particularly the war in Ukraine, has driven up the costs of raw materials. The increase in photovoltaic system prices has made renewable energy investments less feasible, even when substantial European funding through initiatives like PNRR (National Recovery and Resilience Plan) is available. Many planned projects have been abandoned

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due to the unpredictability of supply chain costs. Local governments, including Parma Municipality and private stakeholders struggle to access necessary funding for green projects.

The limited awareness about innovative financial instrument and the insufficient support from different levels of government in clarifying available incentives prevent effective mobilisation of resources for climate initiatives. Without clarity on financial incentives, the willingness of businesses and households in investing in eco-friendly technologies remain low due to high initial costs and expensive maintenance.

The adoption of sustainable transport options remains limited due to high costs and lack of awareness. Public transport systems require substantial investment in current infrastructures to become viable alternatives to private vehicles.

The high costs for the Maintenace of green areas limit the development of new green spaces. Financial constraints and the lack of human resources further hider reforestation efforts.

Many individuals and organizations remain sceptical about adopting new technologies and sustainable practices. A lack of understanding, combined with fear of high costs, contributes to reluctance in embracing green initiatives. Public engagement campaigns are often insufficient in addressing these concerns.

Finally**, the shortage of skilled personnel, particularly in technical and administrative roles, limits the effectiveness of climate action plans**. Inadequate training programs for public employees and professionals prevent efficient implementation of sustainability policies.

Risks

Additionally, several **key risks** pose challenges to achieving climate neutrality.

The participation of market players in emissions reduction efforts remains a crucial factor for the success of climate action plans. However, there is a risk that businesses and industries might evade their sustainability commitments. This challenge can be mitigated by increasing consumer awareness and promoting environmentally and socially responsible practices.

Climate change policies have gained significant traction in Europe and on a national level. However, the *proliferation of regulations* has also introduced complexity, making it difficult to implement clear and actionable strategies for reducing CO2 emissions. Bureaucratic red tape often slows progress, necessitating coordinated action at the European and national levels to streamline climate policies.

Economic challenges at both macro and micro levels divert attention and funding away from climate neutrality initiatives. Budgetary constraints, economic crises, and shifting political priorities often lead to underfunding of sustainability projects. However, it is crucial to emphasize the intersectionality of climate mitigation actions, which influence multiple areas of political and economic planning, including environmental and social dimensions.

Monitoring

The City of Parma has not yet established an institutionalised process to identify and respond to emerging risks and barriers, ensuring its climate strategies remain adaptable. These processes integrate horizon scanning and early warning mechanisms to anticipate

probabilistic risks and key vulnerabilities. To track progress, Parma utilizes a combination of systems and indicators, including metrics for climate action and emissions reductions and they are currently working on the integration of digital tools in the implementation of adaptive planning and implementation, enabling the city to analyse data, refine strategies, and adjust pathways as new risks emerge. However, Parma has not yet implemented a periodic review mechanism and adaptive management practices to refine its strategies.

Parma is committed to maintaining transparency and stakeholder trust, recognizing that continued engagement is essential for the success of its climate action plans. To mitigate the risk of the potential loss of credibility if ambitious climate targets are not backed by tangible results. By aiming to integrate data-driven decision-making and continuous adaptation, the city is strengthening its ability to navigate evolving climate challenges effectively.

5.4.3 Summary and Outlook

The city of Parma has demonstrated strengths in anticipatory governance by the development of a broader sustainability agenda that integrates foresight activities, participatory processes, and policy integration. The city has effectively embedded anticipatory practices into its practices, despite not having a dedicated unit at their institution. One of Parma's core strengths lies in its early institutional commitment to climate action. These early regulatory actions illustrate Parma's proactive approach to integrating climate actions into policy, ensuring that anticipatory governance is embedded within the city's broader climate strategy. The city's engagement in European projects played a crucial role in ensuring that anticipatory governance practices such as foresight have become part of the organisation capabilities.

The early development of the "Roadmap towards Parma Smart City" supported the integration of foresight activities into long-term climate governance. As well as the integration of climate action with urban mobility and energy efficiency strategies has ensured that Parma's sustainability goals are cohesive and actionable.

Parma's anticipatory governance approach emphasises collaborative decision-making and knowledge transfer. The intersectoral working group established by the city has facilitated collaboration between municipal sectors, investee companies, and external partners, ensuring that climate adaptation measures are inclusive and well-informed.

Parma has proactively integrated its policies with European sustainability frameworks,

rather than merely complying with regional climate directives. This proactive approach ensures that expertise remains embedded within local governance structures, promoting continuity and institutional memory in climate action planning.

Parma established an intersectoral working group to align roles and responsibilities across municipal sectors and external stakeholders. Such group brings together various municipal departments, investee companies, and external partners to ensure that climate actions address not only sector-specific challenges but also broader cross-sectoral issues. This collaborative approach helps tackle financial constraints, capacity limitations, and citizen engagement more effectively, fostering a more integrated response to climate risks. Internal discussions have been crucial in prioritizing climate actions based on financial, capacity, and cross-sectoral risks.

Financial limitations and a shortage of skilled personnel remain key challenges. The city struggles to secure the human resources needed to manage and implement complex climate projects, limiting its ability to fully leverage European funding and other financial opportunities. Given the city's budget constraints, decision-making has focused on balancing ambition with available resources, ensuring that responsibilities are clearly defined while addressing funding gaps.

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Moreover, the city has recognized the risk of losing credibility if its ambitious climate goals are not met with tangible actions. This awareness reflects a forward-looking governance approach that prioritizes managing both external and internal risks effectively.

Additionally, Parma faces difficulties in attracting investment compared to larger cities like Milan, further constraining its capacity to execute climate initiatives at scale. For the city is essential to search for innovative funding solutions and to strengthen internal expertise to drive long-term sustainability effort.

The City of Parma has recognized the need to enhance data monitoring and integration, acknowledging delays in data collection, with some information being outdated by up to two years. To improve foresight and anticipate climate risks, it is recommended that Parma invests in real-time data monitoring systems and integrates them with existing decision-making frameworks. Enhanced data analytics capabilities would enable the city to swiftly identify emerging risks and take proactive measures.

Expanding stakeholder engagement further is another critical step in strengthening anticipatory governance. By broadening the scope of stakeholder workshops to include smaller municipalities and local businesses, Parma can gather diverse insights on potential risks and emerging trends. This inclusive approach would provide a more comprehensive understanding of challenges and solutions.

To further enhance anticipatory governance, Parma should formalize horizon scanning and early warning systems. Implementing a system that uses data analytics and AI could help detect early signs of climate risks, complementing existing monitoring practices and allowing the city to respond more effectively.

Addressing the shortage of skilled personnel is also essential for Parma's success. By investing in training programs focused on data analysis, risk management, and digital tools, the city can build internal capacity and better implement anticipatory governance practices.

Participating in European projects offers valuable funding and frameworks for long-term climate planning, as demonstrated by Parma's involvement, which has significantly boosted its foresight and stakeholder engagement capacity.

Additionally, Parma could support other small and medium-sized cities by creating a regional knowledge hub that compiles best practices from European projects. This collaboration could focus on climate adaptation, energy transition, and anticipatory governance, helping to scale successful practices across Parma's territory. Finally, establishing cross-city collaboration platforms would facilitate peer-to-peer learning, allowing cities to collectively address common risks and barriers through shared foresight and scenario planning exercises.

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