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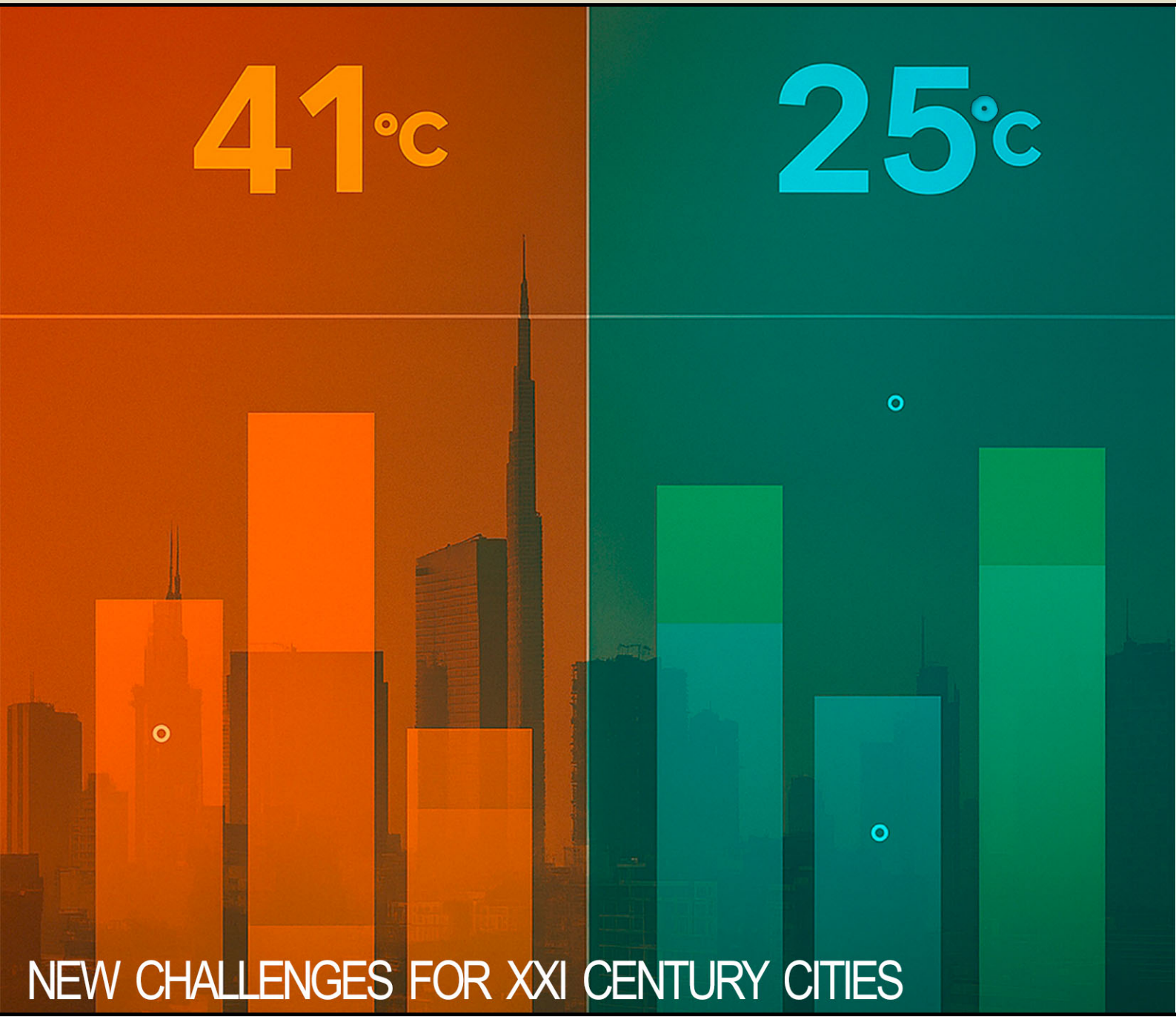

NEW CHALLENGES FOR XXI CENTURY CITIES

Multilevel scientific approach to impacts of global warming on urban areas, energy transition, optimisation of land use and emergency scenario

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TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2025 volume of TeMA Journal propose articles that deal with the effects of Global warming, reduction of energy consumption, immigration flows, optimization of land use, analysis and evaluation of civil protection plans in areas especially vulnerable to natural disasters and multilevel governance approach to adaptation.

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REVIEW NOTES
Urban practices

Competitive climate adaptation. Startups and urban innovation ecosystems driving climate change adaptation in cities

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Abstract
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of five parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban Practices section aims at presenting recent advancements on relevant topics that underline the challenges that the cities have to face. This note concludes a three-parts series exploring the potential driving role of climate tech startups in supporting urban planning processes for effective climate change adaptation in cities. It first provides an overview of urban planning tools that enable cities to integrate innovation ecosystems into goal-oriented urban transformation processes. These tools highlight the strong interconnection between advancing climate change adaptation and enhancing urban competitiveness. Subsequently, a set of representative case studies of climate startups that have successfully scaled up and are driving tangible adaptive transformations in urban contexts is examined. The note then outlines practical recommendations and future research directions. Overall, the case studies demonstrate that climate startups are not only highly promising allies for urban adaptation but are already shaping the pathways toward climate-resilient cities. Innovation ecosystems emerge as crucial actors in scaling up global efforts for urban resilience and competitiveness.

Keywords
Climate change adaptation; Urban practices; Competitiveness; Climate startups; Innovation Ecosystems

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1. Cities at the core of climate action and sustainability transitions

When dealing with climate action, cities play a pivotal role. Their population and infrastructures' density, the lifestyle they embody, and their critical systemic functions make them crucial both for the reduction of greenhouse gas emissions and the safeguard of vulnerable people and assets against harmful impacts (UN-Habitat, 2024). Accordingly, the international debate on mitigation and adaptation strongly involves urban areas and how to guide their socio-technical transition towards more sustainable configurations, that are also net-zero and climate-resilient, in line with the perspective of sustainability transitions (European Commission, 2020; Kuhl, 2019). The historical development of the academic debate has fostered a flourishing branch of literature on sustainability transitions (Köhler et al., 2019). As environmental issues began to be understood as systemic phenomena, the integration of evolutionary economics and innovation studies led to the recognition that solving complex, systemic challenges require long term, nonlinear and structural changes in how societal systems function (Li et al., 2024; Schandl et al., 2025). Innovation progressively gained a central role in the effective uptake of new sustainable models and structures, becoming a bridge between socially and environmentally sound development and economic sustainability (Silvestre et al., 2019). This trajectory has been articulated in approaches such as the Multi-Level Perspective (MLP), which conceptualizes how transitions occur through the emergence of niche innovations and the influence of broader landscape pressures on dominant regimes (Geels, 2019). As the urgency of climate change has grown in recent decades, together with rising interest from policymakers, the literature has further evolved, with cities increasingly emerging as key arenas for sustainability transitions, and with governance shifting from top-down control towards coordination, experimentation and learning (Frantzeskaki, 2018). These complex challenges involve multiple stakeholders and call for the application of management strategies also in the public domain, through tools and processes that support more action-oriented and economically sustainable forms of urban development. In urban planning, this has translated into new types of plans that explicitly integrate mitigation, adaptation and broader sustainability goals (C40 Cities, 2024; Davide et al., 2025; Giacomelli et al., 2025). These include, but are not limited to: strategic plans, climate action plans, climate adaptation strategies and plans, sustainable development plans, action plans for sustainable energy and the climate, and many other declinations of these. At the same time, the climate finance gap remains wide (UNEP, 2025), and the debate on sustainability transitions continues to expand, increasingly addressing transition arenas, stakeholder engagement and innovative processes as conditions for accelerating change. Within this broader framework, this review completes a series of three notes that examine the crucial, innovative role that climate tech startups can play in leading urban climate transitions (Pennino, 2025a, 2025b). Building on previous work that has highlighted the potential of Italian and European startups in mobilizing investments for climate action, often supported by dedicated European policies, this note explores examples of strategic plans that already integrate startup ecosystems as key stakeholders, and discusses two startups that are actively contributing to urban climate action on the ground.

2. Startups as innovation catalysts in transition arenas: a brief review

Startups represent quintessential niche innovations, defined by their emerging status as newborn companies, the deployment of novel technologies or business models, and the ambition to rapidly scale disruptive solution within incumbent-dominated markets (Blank & Dorf, 2020). In the context of sustainability transitions, startups and their surrounding innovation ecosystems serve as experimental arenas facilitating rapid iteration of solutions under uncertainty (Bevilacqua et al. 2023). These ecosystems foster multi-stakeholder engagement, spanning public, private and civic sectors, while creating vertical networks linking local governments to broader transnational innovation infrastructures (UNDP, 2025). Consequently, startups should be viewed not merely as economic agents but as integral governance partners capable of co-producing urban sustainability transitions (Olteanu & Fichter, 2022). Climate tech startups are notably active in sectors historically examined

through the lens of transition theory, such as energy systems and urban mobility. Indeed, the European Union has firmly placed startup-led innovation at the core of several EU initiatives for sustainable development and competitiveness, a long-standing choice that has been further analyzed within academic research (Gargiulo et al., 2022; Pidalà, 2025).

Recent scholarship highlights the pivotal role startups and innovation ecosystems play in enhancing urban climate adaptation and resilience. Boyd and Juhola (2020) underscore how urban experiments, including those deploying green technologies and infrastructures, embody principles of adaptive governance conducive to systemic change. Horta-Bellido et al. (2023) further argue that climate tech startups deliver innovative services that complement city councils' climate policies by enabling scalable urban climate solutions. Extending this discourse, Berniak-Wozny et al. (2024) emphasize startups' centrality in integrating risk and asset management within urban planning frameworks, proposing a sustainability-focused model for incubator-city collaborations. Whether framed within adaptive governance or broader transitions theory, startups are increasingly recognized as critical non-state actors participating in multi-level governance of climate-resilient urban planning. They contribute to shifting power dynamics by facilitating bottom-up innovation and fostering active citizen engagement, thus enriching urban climate governance with diverse perspectives and capacities.

3. Urban pilots

While academic literature on sustainability transitions and urban climate governance has expanded, several cities have already begun to translate these concepts into innovative strategic plans that explicitly mobilize startups and innovation ecosystems as partners in key sectors. These plans move beyond a purely infrastructural or regulatory approach and instead frame entrepreneurial innovation as a lever for experimenting with solutions in areas such as mobility, energy, digital services, and urban regeneration. In doing so, they position startups not only as economic actors, but as strategic stakeholders in the co-production of climate-resilient, competitive, and sustainability-oriented urban futures.

1.1 Turin. Strategic planning and innovation-driven entrepreneurship

Turin was the first Italian city to adopt a Strategic Plan in 2000, opening a path that many other cities later followed. By 2020, the city had elaborated three strategic plans (2000, 2006, 2015), each reflecting a different phase in its socio-economic transition and progressively strengthening the link between urban development, innovation and entrepreneurship. The first plan ("for the promotion of the city") emerged in a context of deep crisis of the Fordist manufacturing model and aimed to preserve Turin's capacity to generate wealth and innovation through diversification of the productive system and a radical renewal of the city's international image, culminating in the 2006 Winter Olympic Games. The second plan subsequently focused on the "knowledge economy", emphasising universities, research, advanced services and human capital as key resources for future development.

To manage this intense strategic planning activity, the association Torino Internazionale was created in 2000, with the mandate to promote strategic planning methods, animate local debate on development, and foster the emergence of new agencies, actors, themes and policy goals. In 2016, in the context of rationalizing municipal non-profit entities, the association was dissolved and its relational and project legacy was transferred to Urban Lab, which now acts as a key interface on urban transformation and innovation in Turin.

The third Strategic Plan, "Torino Metropoli 2025 – City of Opportunities", explicitly positions the metropolitan area as an "enabling and inclusive environment" that encourages innovation, business creation and talent attraction. The vision is articulated through objectives such as retaining and

growing firms, boosting research and technological innovation, and increasing qualified human capital, all of which are directly linked to the development of a vibrant startup and entrepreneurial ecosystem. In this framework, the plan identifies dedicated instruments to support new enterprises – such as venture accelerator programmes (e.g. "AcceleraTO"), civic tech and social innovation incubators, and coordinated actions with existing university and private incubators, to help nascent businesses reach critical mass and scale rapidly in strategically selected sectors.

Taken together, Turin's three strategic plans trace a clear trajectory: from crisis management and image repositioning to the construction of a knowledge-based economy, and finally to the deliberate cultivation of an urban innovation ecosystem where startups, incubators and accelerators are recognized as central actors in renewing the local productive base and contributing to more sustainable, competitive metropolitan development.

Source: https://urbanlabtorino.it/pianificazione-strategica/

1.2 Rio de Janeiro. Climate-oriented innovation districts and startup engagement

Rio de Janeiro's recent planning and climate policy frameworks present the city as a laboratory for integrating climate action, social vulnerability reduction and innovation-driven economic development. As a coastal metropolis highly exposed to climate risks such as flooding, landslides and heatwaves, Rio has adopted strategies that combine traditional infrastructure measures with nature-based solutions, risk-sensitive land-use planning and data-driven decision-making. Within this agenda, the city increasingly emphasizes the role of digital technologies, innovation hubs and partnerships with private and civil-society actors as levers to design and implement adaptation and mitigation measures in a more flexible and inclusive way.

A key feature of Rio's approach is the promotion of innovation districts and pilot areas where new technologies and services can be tested before being scaled up across the metropolitan area. These districts typically bring together universities, research institutes, startups, larger firms and municipal departments around themes such as smart mobility, environmental monitoring, resilient infrastructure and social innovation. By concentrating experimentation in specific neighbourhoods, Rio seeks to reduce the risks associated with novel solutions, gather evidence on their performance, and build collaborative relationships between public and private actors. This model has been used, for example, to trial sensor-based systems for urban heat and flood monitoring, shared mobility services and digital tools for community engagement in risk-prone areas.

Within these innovation districts and pilot projects, climate tech startups are encouraged to act as solution providers for municipal climate priorities. The city and regional partners support this through calls for projects, innovation challenges and collaboration agreements that invite startups to co-develop and deploy technologies for early-warning systems, urban climate analytics, nature-based solutions and resource-efficient services. In practice, this means that startups can access real urban datasets, test their products in complex environments and receive feedback from both municipal technicians and local communities, while the city gains access to agile, often lower-cost innovations that would be difficult to develop in-house. Although the institutional architecture and scale of support are still evolving, Rio's experience illustrates how a climate-vulnerable city can begin to treat startups as embedded actors within its urban innovation ecosystem partners that help translate high-level climate strategies into tangible interventions in streets, public spaces and critical infrastructures.

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1.3 Rome Tech Business 2030. Startups as pillars of the urban tech ecosystem

The Strategic Plan "Tech Business Roma 2030" positions Rome as a Mediterranean hub for tech business and innovation, explicitly linking digital transformation, smart city policies and sustainable development in line with the UN 2030 Agenda. The plan recognizes that Rome's ecosystem is already rich in universities, research centres, incubators and innovative SMEs, but fragmented, and therefore uses thematic working tables and a Town Meeting to involve institutions, large firms and startup representatives in co-defining data needs, priorities and strategic actions in areas such as digital infrastructure, startups and innovative SMEs, sustainability and skills.
Operationally, the plan contains several measures that frame startups and innovation ecosystems as co-producers of urban transformation. It calls for investment in high-capacity connectivity, cloud and data infrastructures (5G, IoT, AI, blockchain, cybersecurity) as prerequisites for smart city services and new business models, and analyses the structure and challenges of Rome's startup population (sectoral specialization, funding, limited accelerators, gaps in technology transfer). To address these, it proposes to strengthen open innovation networks connecting startups, corporates, venture capital, universities and the municipal administration, and to deploy tools such as Roma Open Lab – Casa delle Tecnologie Emergenti, Invest in Roma one-stop shop and smart districts as platforms where startups can test solutions on real urban challenges. In doing so, the plan explicitly identifies climate- and sustainability-oriented startups as strategic actors for developing green mobility, circular economy services and digital tools that support a more resilient, low-carbon city.

Retrieved from: https://www.comune.roma.it/web-resources/cms/documents/Piano_Strategico_Tech_Business_Roma_2030_12mb_giu2021.pdf

4. Startups Pilots

Alongside cities that proactively integrate startups into their strategic plans, a small but growing group of climate tech startups has managed to scale up and deliver adaptation services at the urban level. These companies no longer operate only as experimental "niches", but as service providers that support municipalities in achieving their climate goals through bottom-up, project-based collaborations. By offering deployable solutions for heat mitigation, green infrastructure and data-driven planning, they translate local pilots into replicable models that can complement and accelerate city-led climate adaptation.

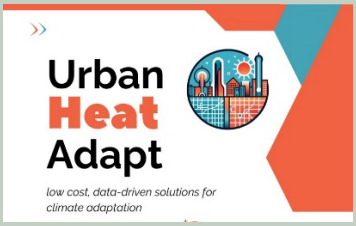
2.1 Roofscapes. Adapting the city from the roofs!

Roofscapes is a Paris-based startup founded by a group of architects and engineers with links to MIT, focused on transforming underused rooftops into lightweight, accessible green structures that enhance climate resilience in dense European cities. The company responds to a very specific urban constraint: in historic city centres such as Paris, limited ground-level space and highly mineral surfaces amplify heatwaves and limit the deployment of conventional green infrastructure. Roofscapes addresses this by designing timber-based systems that can be laid over existing zinc roofs without major structural works, creating new surfaces for vegetation, shading and social use while respecting heritage constraints.
In partnership with the City of Paris, Roofscapes implemented a flagship pilot on the roof of the Académie du Climat, a former town hall repurposed as a climate hub. The project installs a green roof system instrumented with sensors to monitor temperature, humidity, biodiversity and water retention

performance over time, providing robust evidence on the adaptation benefits of green rooftops under real heatwave conditions. Early results indicate temperature reductions of up to 17°C under the green roof compared to exposed zinc surfaces on hot summer days, alongside improved user comfort and the creation of a small urban habitat attracting insects and birds.
From a governance perspective, Roofscapes' work illustrates how a startup can act as a distributed adaptation partner for cities. Through public innovation procurement and R&D collaborations, the startup helps Paris test new design standards for rooftops and explore how regulatory tools, incentives and retrofit programmes could scale this solution across the city's extensive roofscape. In this sense, Roofscapes operationalizes climate adaptation at building and neighborhood scale, while offering municipalities a replicable model to integrate private rooftops into their broader climate and resilience strategies.

Startup page: https://www.roofscapes.studio/home-english

2.2 Urban Heat Adapt. Providing high resolution data for climate adaptation.



Urban Heat Adapt is a climate tech startup dedicated to providing cities with actionable, low-cost services for adapting to increasing urban heat. The company combines modular sensor systems designed for dense urban environments with an AI-enabled web platform that processes high-resolution climate data into decision-ready indicators. Its goal is to become a comprehensive service provider for urban climate adaptation, translating complex temperature and comfort data into maps, dashboards and scenarios that planners, health authorities and other stakeholders can use in practice.
The startup's approach addresses a critical barrier in many municipalities: the lack of fine-scale, operational information on where heat risks are highest, who is most exposed, and which interventions are most effective. By deploying mobile and fixed sensors, Urban Heat Adapt can generate neighborhood-scale datasets on heat stress, often at resolutions of around 100–200 metres, and derive indicators such as tropical nights, heatwave days, outdoor comfort and potential health impacts. These insights support cities in prioritizing adaptation measures – ranging from nature-based solutions and cool materials to shading, water features and targeted communication – where they are most needed.
Urban Heat Adapt typically works in close collaboration with municipal departments and regional climate agencies, embedding its tools into planning and early-warning processes. The platform allows users to test different adaptation scenarios, compare their potential impact on heat exposure and health outcomes, and align these with existing spatial plans and investment pipelines. In doing so, the startup not only supplies technology, but also helps build institutional capacities for data-driven, equitable heat adaptation, positioning itself as a long-term partner in cities' efforts to protect vulnerable populations and redesign public space under a warming climate.

Source: https://www.f6s.com/urban-heat-adapt

5. Conclusions

This review shows that cities and startups can form a mutually reinforcing nexus for advancing competitive climate adaptation, provided that their roles are deliberately aligned within sustainability transition frameworks. On the one hand, cities are increasingly recognized as key arenas of socio-technical change, where strategic plans, smart city strategies and innovation policies are beginning to explicitly integrate startups and innovation ecosystems as stakeholders in delivering climate-relevant solutions. On the other hand, a small but growing group of climate tech startups, such as Roofscapes and Urban Heat Adapt, have demonstrated

their capacity to scale from niche experiments to urban-scale service provision, supporting municipalities in translating climate goals into concrete interventions on roofs, streets and public space.

The cases examined suggest that startups can contribute to urban climate adaptation in at least three complementary ways: by providing highly specialized technologies and services (e.g. green roof systems, high-resolution heat monitoring); by acting as intermediaries that connect research, citizens and local administrations in experimental projects; and by helping to redesign governance arrangements around data, risk and infrastructure. However, they also highlight persistent challenges, including fragmented innovation governance, dependence on short-term projects, and the need for stable regulatory and financial frameworks that allow cities to systematically procure and scale startup-driven solutions.

Overall, the analysis confirms that climate tech startups can meaningfully support cities in leveraging more sustainable and competitive climate action, but that their potential is far from fully realized. Stronger alignment between urban strategic planning, climate policy, and innovation ecosystems – through dedicated urban labs, mission-oriented procurement, and clear pathways from pilot to scale – appears crucial to move from scattered experiments to structural change. Further research should therefore investigate which policy mixes, governance arrangements and financing instruments are most effective in institutionalizing city-startup cooperation for climate adaptation, and how these can be adapted to different urban, socio-economic and regulatory contexts.

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