Building Climate-Resilient Cities: A Systemic and Participatory Design Process

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1 Introduction

The NetZeroCities program, promoted as part of Horizon Europe's Eu Missions, gives selected cities the important mission of experimenting and testing innovative solutions in order to achieve climate neutrality by 2030. These solutions could set an example for other European cities to achieve the same goal by 2050. In the presented context, the Municipality of Prato has been selected among the 100 climate-neutral and smart cities that will implement the NetZeroCities goals by 2030. The following intervention presents the codesign process designed by the Service Design Lab (UNIFI) that was commissioned by the Municipality of Prato to lead and facilitate to support the city elaborating the Climate Change Contract draft, the document in which the city presents its commitment to climate neutrality through a concrete portfolio of actions. The NetZero Prato strategy is based on four main pillars: *energy efficiency, sustainable mobility, circular economy, and agriculture, land use, and urban forestation*. In this scenario, as design researchers, we were asked to design and lead the participatory process in order to collect and analyze systemic barriers, challenges, and opportunities to the city's climate neutrality and make explicit the baseline at the local level for the transition. Climate mitigation and adaptation represent the most complex challenge of our times both at local and global levels having multiple fields-related implications (social, cultural, economic, and environmental); we therefore do need to configure holistic solutions to face

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climate change combining them with participatory processes which can actively involve all stakeholders calling for a more intense engagement of citizens, with the aim of activating individual and social capacities, [11] while generating sustainable solutions over time. To drive the presented process, we adopted the approaches proper to Participatory Design, involving stakeholders in the activities of "understanding the system" to define the actions for climate neutrality (codesign portfolio) accordingly. The people-centered perspective of Service Design, together with the Systemic Design and Design for Sustainability approach, allowed us to develop a specific toolkit that, beyond detecting needs and setting solutions, helped spotting cross-sectors interconnections preparing the ground for the setting up of a local collaborative governance which might steer such a complex transition in the medium-long term as well.

2 Background: NetZeroCity and Participatory Process

The urgency of addressing climate change demands transformative action at all levels of society, with cities playing a critical role in driving progress towards climate neutrality. However, achieving ambitious climate goals requires effective collaboration and coordination among diverse stakeholders, as well as robust data management systems to inform decision-making and track progress. In the context of NetZeroCities'mission to support cities in their journey towards climate neutrality, improving collaborations and data sharing between municipalities and citizens emerges as a crucial component for success. This paper outlines a framework for enhancing collaborations between designers and municipalities in driving initiatives, within the context of NetZeroCities', focusing on integration, coordination, and stakeholder engagement. At the heart of NetZeroCities'approach is the Climate City Contract (CCC) model, which provides a structured framework for cities to engage stakeholders and enact ambitious climate action plans. The CCC model emphasizes collaboration, accountability, and systemic change, guiding cities through the process of developing and implementing strategies to achieve climate neutrality. The participatory process here presented was built on two pillars of the CCC model, the Stakeholder Engagement and the Systemic Change. The CCC model encourages cities to engage a wide range of stakeholders, including government agencies, businesses, community organizations, and residents. By fostering collaboration and inclusivity, cities can leverage diverse expertise and resources to drive meaningful change [8, 10]. Therefore, the CCC model recognizes the need for systemic change to address the root causes of climate change. This may involve transforming policies, regulations, and business practices to align with sustainability objectives and foster long-term resilience. The current approach to climate initiatives at city level and business level (completely integrated in the Municipality of Prato context) is fragmented and uncoordinated, with multiple reporting requirements for cities, and inconsistent terminology hindering connectivity between support platforms and services. To maximize the impact of the CCC model, it is

essential to integrate with existing development and reporting services within the public and private sectors. This involves establishing connections between the NetZeroCities Portal and other platforms used for climate planning, data management, and reporting. By integrating these services, cities can streamline their climate data management processes, reduce duplication of effort, and enhance the consistency and quality of data. Therefore, applying a participatory process to the CCC model within the context of NetZeroCities'mission offers multifaceted advantages rooted in democratic principles and sustainable governance frameworks. Specifically, the participatory approaches, through engaging a diverse range of stakeholders, ensure inclusivity of the process. It brings to the table diverse insights and expertise, and thus encourages cooperation among stakeholders, breaking down silos and fostering partnerships to leverage collective resources and expertise and promote capacity building and empowerment among stakeholders. On the municipality side, the participatory processes on one hand build trust and transparency, while involving stakeholders in decision-making enhances the quality and legitimacy of decisions, where climate action plans are responsive to community needs and priorities, making them more resilient to changing circumstances.

3 Methodology: A Specific Codesign Process for Prato Carbon Neutral

The codesign methodology we present is an experiment in which the Prato public administration commissioned to the Service design Lab the task of infrastructuring a participatory action research [9]. According to Le Dantec and Di Salvo [7], "infrastructuring is the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design" (p. 247). In other words, infrastructuring is an ongoing, long-term process where agency is distributed among different participants and fosters participants' appropriation, creating in turns opportunities for shared decision making within the design process itself [14].

To drive the presented process, we adopted the approaches proper to Participatory Design [12], involving stakeholders in the activities of "understanding the system" to define the actions for climate neutrality (co-design portfolio) accordingly. Incorporating designers as intermediaries for the Climate City Contract (CCC) model represents a strategic approach to enhancing climate action planning. Designers bring valuable skills in stakeholder engagement, visual communication, codesign methodologies, and storytelling to the process. By facilitating collaborative workshops, translating complex climate data into accessible formats, and involving stakeholders in the design process, designers foster inclusivity, creativity, and ownership. Their ability to craft compelling narratives and communicate the CCC model's vision inspires support and mobilizes action from stakeholders and the broader community. Ultimately, leveraging designers' expertise enhances the effectiveness, engagement, and sustainability of climate action plans developed under the CCC model, driving progress towards climate neutrality.

Effective communication on data related to actions already ongoing, planned, or suggested is essential for informed decision-making and tracking progress towards sustainability goals. In the pursuit of climate neutrality, cities face complex challenges that demand systemic solutions. However, the current approach is often fragmented and lacks coordination, hindering cities' ability to leverage data for impactful action. The codesign process presented here shows a systemic framework for enhancing climate data management within the context of NetZeroCities'mission, aiming to foster integration, collaboration, and innovation across sectors and stakeholders.

The systemic framework proposed by the NetZeroCities revolves around three interconnected components: integration, collaboration, and innovation. Integration involves connecting the Climate City Contract (CCC) model with existing development and reporting services, ensuring interoperability, aligning reporting requirements, and facilitating data sharing. Collaboration entails engaging diverse stakeholders in the CCC process, fostering partnerships, and promoting knowledge exchange to leverage collective expertise and resources towards shared climate goals. Innovation focuses on encouraging experimentation, harnessing emerging technologies, and promoting a culture of continuous improvement to address climate challenges effectively and adapt to evolving risks and opportunities.

4 Workshop Framework and Stakeholders Involved

The process presented was three-months long and meant to infrastructure the relations between multiple and heterogeneous actors, via a set of methods and tools from service and strategic design, to detect and unlock capacities and resources toward Prato climate neutrality. As part of a very complex domain, the PCN participatory process was designed and implemented building on Systemic Design, which can be conceived as "optimising processes for group design and decision making under conditions of overwhelming conceptual complexity" ([6], p. 16): hence systems' cocreation identifies stakeholders as the designers in cocreation and designers as participants invested in their future aims, plans, and outcomes. Moreover, Systemic design emphasizes adaptability, facilitating the collaboration of multiple stakeholders in addressing 'wicked problems'—complex, interconnected challenges without straightforward solutions [1]. We conceived the participatory process in two phases leveraging on the proposition framework of NetZero Cities. First phase, *Understand the system*, understand the interdependencies between the actors in the area and their actions in order to explain the barriers that hinder change. Second phase: Codesign a portfolio, cocreate a portfolio of actions that support overcoming the identified barriers. Moreover, to ensure the Municipality of Prato defined and addressed the impact pathways towards climate neutrality, we designed a bridging phase between first and second phase in order to create the baseline for a meaningful cocreation process. These two main phases crosscut another level of inquiry, made up of two more stages, which helped us to continuously connect the

local context to the systemic level: (i) *Front-end, the local-based facilitation process*: this was the cocreation level, where stakeholders act as designer in identifying systemic barriers and cocreate experiments to make the change possible via a set of tools and methods; (ii) *Back-end, the systemic interconnectedness process*: this was the systemic level, where we continuously zoomed from the micro (our process) to the macro (the PCN strategy) and back to help the city steer the whole process toward a context-based CCC elaboration.

To prepare the ground for the whole process, we mapped the climate ecosystem stakeholders (Fig. 1). As convened stakeholders were already used to attending Municipality-led participatory processes, we benefited from fruitful conversations which, leveraging also on previous experiences, allowed us to activate a fertile ground where proposals and suggestions arose. First group: utilities, trade associations, banks and foundations, research institutes, large-scale retailers, GMO, companies, short agriculture supply chain associations, farms, professionals, environmental associations, mobility companies, and public administration; second group: trade associations, businesses and start-ups, sports clubs, public administration; third group: third sector organizations, citizens' committees, and public administration; fourth group: the "Consiglio Comunale dei ragazzi e delle ragazze", a students' council held by public administration aimed at citizenship education. Finally, to facilitate cross-sectoral collaborations even beyond the end of the participatory process, we took advantage of digital tools (together with paper ones) to

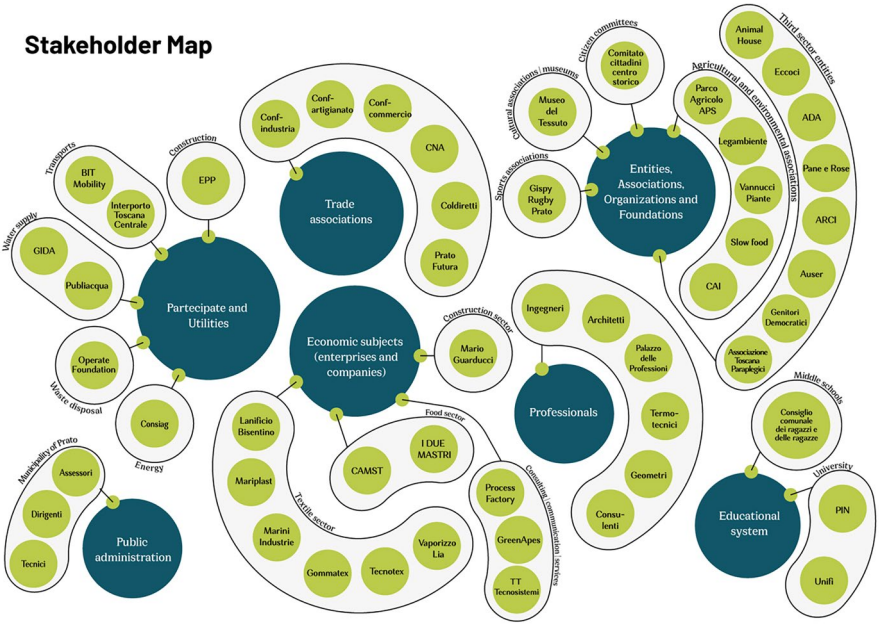

Fig. 1 PCN Stakeholders Map

provide the Municipality of Prato with a sort of platform to keep on working toward CCC elaboration and beyond.

5 Framework and Tools

5.1 Phase1: Understand the System by "3 N" and "3Loops Tool"

The aim of the first phase of the process was twofold: put together the existing pillars-related initiatives undertaken from the different stakeholders—while understanding their interdependencies—and detecting systemic barriers to address to make the change happen. Then in the front-end stage we organized nine focus groups sessions (Fig. 2) (in some cases we group categories to optimize the process) where we set roundtables (Fig. 1) for every convened category: every focus group aimed at interrogating participants about one of the topics related to the Prato strategy four pillars: energy efficiency, sustainable mobility, circular economy, and agriculture and land use and urban forestation. With the goal of mapping both the activities already undertaken toward climate neutrality and related barriers hindering the change, a specific tool was designed, called "3 N Tool". Participants were asked to put together the climate neutrality activities on horizons of time-basis, that is activities they had already undertaken (NOW), to be undertaken in the short term (NEAR) or planned in the next 10 years (NEXT). When it comes to circular economy focus-groups, we asked participants to collect undertaken or planned activities

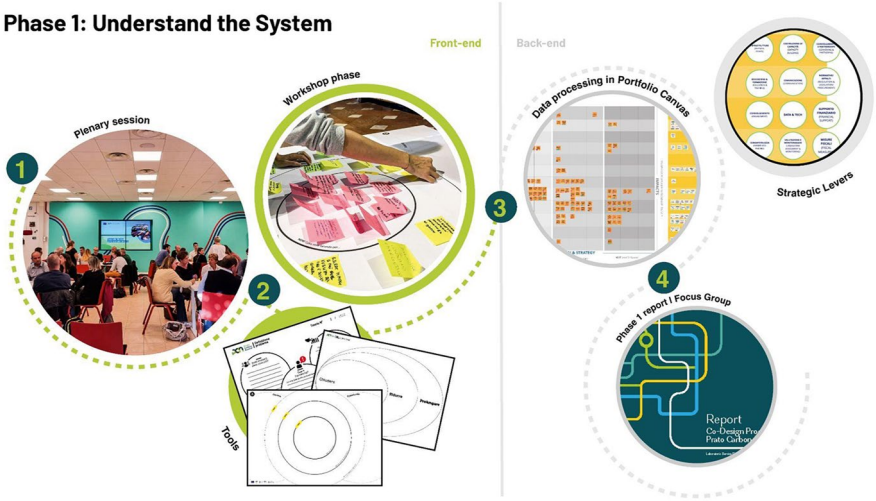

Fig. 2 Phase 1:Understand the system

on circular loops-basis (close, reduce, extend) via a "3 Loop Tool" we designed and supported. Finally, during a plenary session they were asked to return their outcomes to reflect collectively about the barriers hindering the transition towards climate neutrality. Every spotted barrier was described in a dedicated tool where interconnections across sectors were spotted. In the back-end stage, we utilized a Portfolio canvas tool to organize collected data and identify systemic interconnections. We categorized initiatives based on strategic levers (regulations, financial support, new materials, data and their monitoring, education and training, capacity building, or communication) and time horizons (NOW, NEAR, NEXT). Levers can be defined as tools capable of guiding the change of individuals and the community towards systemic changes [2, 4]. This approach helped prioritize intervention areas for the Municipality of Prato and provided insights into opportunities for development and system strengths and weaknesses. A resort of each phase was updated on the Municipality of Prato channel to allow us to give back to stakeholders and citizens the outcomes of the Prato Carbon Neutral pathway.

5.2 Bridging Phase: Turning Barriers into Scenarios

In preparation for the development of impactful pathways for the PCN strategy, the Municipality of Prato required a set of local future scenarios derived from the previously analyzed context. We clustered systemic barriers identified in the previous phase into main topics and transformed them into scenarios. This resulted in 13 future scenario pathways: 3 for energy efficiency, 4 for sustainable mobility, 3 for the circular economy, and 3 for agriculture, land use, and urban forestry, along with 2 additional cross-cutting scenarios. Before commencing the second phase (Codesign a portfolio), a panel of experts, each representing one of the PCN pillars, validated and enriched the scenarios. These scenarios served as a meaningful bridge between the two main phases, acting as both the conclusion of the first phase and the starting point for the second phase.

5.3 Phase 2: Codesign a Portfolio. Overcoming Barriers Through Local Actions

In the second phase, four thematic workshops were established with the support of experts to validate scenarios and cocreate a preliminary portfolio of place-based activities aligned with PCN pillars. The goal was to foster synergies among public administration, climate stakeholders, the private sector, citizens, academia, and research institutions to advance meaningful pathways toward climate neutrality. Through these workshops, existing connections with stakeholders across sectors were identified to facilitate collaboration and action. The front-end thematic

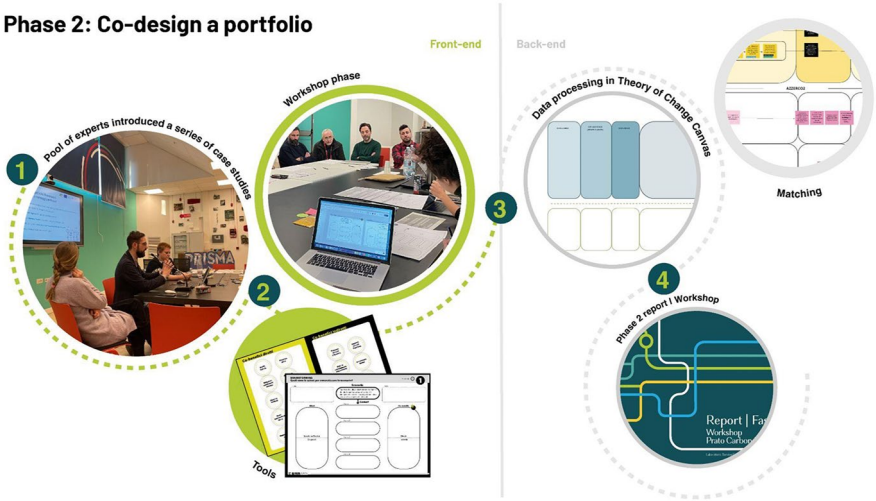

Fig. 3 Phase 2:Codesign a portfolio

workshops operated in two steps: a preparatory step where validated future scenarios were presented, and experts introduced case studies to deepen related themes; followed by a cocreation activity where participants used specific tools to envision actions and experiments, identifying stakeholder systems and delivery methods for envisioned activities. During the "Consiglio Comunale dei ragazzi e delle ragazze" codesign workshop, students assumed various roles (e.g., city administrator, young citizen, adult citizen, farmer, entrepreneur) to generate ideas, fostering active listening and introducing them to wicked problems, which are complex systemic issues with diverse stakeholders and conflicting agendas. In the final back-end stage, we prepared for the elaboration of the Climate City Contract (CCC) by organizing data collected from codesign workshops using a strategic tool based on the Theory of Change (ToC) method (fig. 3). ToC outlines the sequence of events necessary to achieve desired change. This tool visually supported the definition of logical connections between scenarios, stakeholders, activities, outputs, long-term objectives, and impacts [13]. Each scenario was presented with linkages to related stakeholders, supporting activities, outputs, and long-term objectives. Connections between activities and the four PCN pillars or cross-cutting scenarios were highlighted. Additionally, the tool facilitated alignment between the cocreation process and the draft portfolio of actions developed by the Municipality, ensuring meaningful pathways toward climate neutrality were addressed. All materials developed throughout the process were shared with participants through two reports and two Miroboards, promoting transparency and collaboration.

6 Main Takeaways for the CCC

The examination of key takeaways from each thematic area—Energy Efficiency, Sustainable Mobility, and Circular Economy and Urban Forestation—reveals critical insights into the current state and potential pathways towards climate neutrality in the Municipality of Prato. In terms of Energy Efficiency, the prevalence of private initiatives underscores a proactive stance within the community towards energy conservation. Furthermore, the implementation of data collection mechanisms demonstrates a commitment to evidence-based decision-making. Particularly noteworthy is the emerging interest and knowledge surrounding the formation of "energy communities," suggesting a nascent yet promising trend towards collective action in advancing energy efficiency goals. Conversely, Sustainable Mobility presents more significant challenges, notably in the cultural adoption of sustainable transportation practices. While there is recognition of the potential strategic role of the local interport, concerns persist regarding infrastructure deficiencies and safety issues. Addressing these barriers will be crucial in fostering a sustainable mobility culture and realizing the interport's potential as a hub for eco-friendly transportation solutions. The Circular Economy and Urban Forestation domain exhibit promising initiatives aimed at resource optimization and waste reduction. Notably, the emphasis on utilizing waste materials from key sectors like textiles and agro-alimentary industries reflects a commitment to circularity principles. Additionally, the focus on short supply chains and initiatives against food waste underscores a growing awareness of sustainable practices within the local ecosystem. The proposed scenarios for each thematic area outline actionable pathways towards climate neutrality. In Energy Efficiency, strategies such as enhancing training pathways and promoting regulatory stability highlight the importance of capacity-building and policy support. Sustainable Mobility scenarios emphasize the transformation of infrastructure and the promotion of a sustainable mobility culture through awareness campaigns. Similarly, Circular Economy scenarios underscore the importance of cross-sectoral collaboration and education in fostering circular practices. The cross-cutting scenarios—establishing a liaison office between municipal departments and creating a shared platform for data collection and citizen engagement—emphasize the need for integrated governance structures and robust community engagement mechanisms. These initiatives aim to break down administrative silos, promote interdepartmental collaboration, and enhance transparency and communication between the government, businesses, and citizens. In summary, the analysis highlights both the progress made and the challenges ahead in Prato's journey towards climate neutrality. By leveraging existing initiatives, addressing systemic barriers, and implementing targeted strategies outlined in the scenarios, the Municipality can effectively advance its climate agenda and foster a sustainable future for its residents.

7 Conclusion

The research has investigated current opportunities for designers and municipalities to collaborate together in driving societal challenges such as the green and digital transition. The experience of the participatory process described in the paper demonstrates the active role played by the Service Design Lab (UniFI) in preparing the baseline for the Climate City Contract, the main milestone for the Municipality of Prato along the European NetZero Cities program. Design profession and discipline are undergoing transformation that enable a rich set of frameworks for Design for Transition [5]. Methods and tools provided to the codesign process belong to the Participatory Design, Service Design, Systemic Design, Transition Design and Circular Design approaches. The presented codesign strategy can be intended as a "public service" that public administration may offer to citizens with two aims: fostering more democratic and inclusive societies and infrastructuring more collaborative networks of stakeholders [9]. The proposed methodology applies the concept of design as a catalyst for change [3] and ensures the Municipality has proper representation and involvement of all different stakeholders in the dialogue across the four pillars: energy efficiency, sustainable mobility, circular economy, and agriculture and land use, urban forestry. Keeping a systemic vision, our effort was to give representatives in the CCC at the work made up with the city, meeting administration, companies, topic-experts, and citizens, ranging from representatives of the "Consiglio Comunale dei ragazzi e delle ragazze'to members of the General Confederation of Italian Industry. A systemic approach to the management of data related to climate activities is essential for empowering cities to achieve climate neutrality. By integrating the CCC model with existing services, fostering collaboration, and promoting innovation, cities can overcome the barriers of fragmented data systems and unlock new opportunities for sustainable development. Capacity building and knowledge sharing play a crucial role in driving systemic change, enabling cities to leverage data effectively for informed decision-making and impactful action. As cities continue to lead the way in addressing climate change, a systemic framework offers a pathway towards resilience, sustainability, and prosperity for all. As a result, the effectiveness of the codesign process enabled the Municipality to compile the CCC with three important outputs: (1) the ecosystem map, (2) the systemic barriers definition, and (3) a first baseline for the portfolio of actions definition. From both the front-end and back-end stages, results highlighted the cross-sectoral nature of barriers to climate neutrality, where the main strategic levers (or areas of intervention) are: Education and training, Capacity buildings, Regulation, legislation & procurement, Convening & partnerships, Physical assets, Financial-support, Communication and Data & Tech. Simultaneously, we foresaw the need to strengthen the CCC value giving more voice to the citizens, going deeply in citizens' awareness via capillary actions that should be embedded in the PCN strategy. Therefore, we proposed as the next step to undertake a series of Open Labs in order to open a direct channel of communication and awareness with the city and aim at establishing a long-lasting engagement of citizens in the PCN framework. Hence, the main takeaway for the Municipality is to capitalize the identified pooling of distributed assets and resources, allowing to move forward carbon neutrality

strategy as a coral action. As part of a long-term transition, this work aimed therefore at preparing the ground for a local collaborative governance, that is as a long term, systemic process of steering and coordination of all the different levers in cities—policy, regulation, funding, knowledge, collective intelligence, and many others—in such a way that allows distributed capacity, legitimacy, and agency for change across public and private sectors.

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