

# CITIES AS CATALYSTS AND LABORATORIES FOR ECOLOGICAL TRANSFORMATION

Luise Fischer, Francesca Rizzo, Adriana O'Phelan, Anthony Zacharzewski, Andrea Gabaldon Moreno, and Carla Rodríguez Alonso on behalf of the NetZero Cities Initiative



Modern sustainable neighbourhood in Almere, The Netherlands. The city heating (stadswarmte) in the district is partially powered by a solar panel island (Zoneiland). Aerial view.

Coordinated by Europe's largest public-private partnership, EIT Climate-KIC, the NetZero Cities initiative supports European cities to reduce their greenhouse gas emissions. The four-year long initiative was launched in 2021 to support cities to overcome the existing structural, institutional and cultural barriers they face to achieving climate neutrality by 2030. This article is authored by Andrea Gabaldon Moreno, R&D Engineer and Climate-Neutral Cities Expert, Carla Rodríguez Alonso, Research Architect and Climate-neutrality Urban Planner, Anthony Zacharzewski, President at Democratic Society, Adriana O'Phelan: NetZeroCities Project Lead, Democratic Society, Luise Fischer: Systems Innovation Co-Lead, NetZeroCities, EIT Climate KIC, and Francesca Rizzo Ph.D, Full professor at Politecnico di Milano – Rector's Delegate for European Projects. The authors have all been commissioned by the NetZero Cities Initiative.

Cities comprise complex networks and systems that have long provided opportunities for innovation and human flourishing. However, the same systems contribute to today's major environmental challenges. Cities thus find themselves at the heart of driving innovation for a just ecological transformation. Not only do cities foster, pilot and scale high-tech solutions, but they can also enable low-tech and social innovation. This article explores the conditions that allow cities to foster various forms of innovation, and do so collectively, for an inclusive and just ecological transformation.

## INTRODUCTION

Cities are uniquely enriched by diverse uses of their space and diverse kinds of innovation, wrote the urban thinker and journalist Jane Jacobs in her book *The Death and Life of Great American Cities*: "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody."

Today, cities are also uniquely placed to address ecological transformation and to develop, pilot and scale the variety of innovation that ecological transformation demands. Again, these innovations must be designed and created 'by everybody', for everybody. Social innovation and democratic, participatory processes matter as much as investable, scalable technologies. Cities have a leading role to play, not just in meeting the climate goals and targets set out by international frameworks such as the COP21 Paris Agreement, but also in ensuring that decarbonisation efforts are just and equitable.

How can the public and private sector work together, in and across cities, to foster technological, economic, and social innovation for ecological transformation? How can cities pilot these innovations and scale them citywide and beyond?

NetZeroCities offers a model for transforming and decarbonising cities at scale. As the platform supporting the EU Mission: Climate-Neutral and Smart Cities, NetZeroCities supports cities as they work with their stakeholders to get to climate neutrality by 2030. As part of the Horizon 2020 Research and Innovation Programme in support of the EU Green Deal, NetZeroCities consortium organisations provide dedicated services to cities, with the objective of helping 100 European cities become climate-neutral by 2030 in equitable and inclusive ways. Cities from Barcelona to Budapest have become Mission Cities, which engages them with the process of writing a Climate City Contract – a new way of governing the climate transition through a combination of action planning, commitments, and ideas for investing in climate neutrality. Many have gone even further as Pilot Cities implementing and testing out on-the-ground activities from which others can learn.

Based on NetZeroCities's experience, we outline key opportunities for urban innovation to drive systems change; how cities can foster urban innovation at different scales, and how private-sector and other stakeholders can understand and play a role in city ecosystems to initiate and advance innovation for ecological transformation.

## WHY CITIES?

Human civilisations have long organised themselves into cities. Cities are politically, socially and economically vibrant, drawing citizens to a host of opportunities. Today, cities make up just 4% of the EU's land area but are home to 75% of EU citizens<sup>1</sup>. Thanks to this attractiveness and density, cities are hotbeds of culture and innovation of all kinds, from technological invention to art and design.

The size, resources and diversity of a city also force it to continually manage public opinion, coordinate and negotiate public-private partnerships, and build regulatory frameworks that both protect citizens and enable private sector innovation to flourish – all vital skills and practices for fostering innovation. Indeed, cities have supported business to become more energy-efficient and sustainable, while urban density can also facilitate reverse-logistics or sharing business models for the circular economy.

At the same time, cities need energy to keep their buildings, transport systems, manufacturing, food production, and countless other activities running. They consume and emit disproportionately to their population: globally, cities consume over 75% of the world's primary energy and account for at least 50-60% of global CO<sub>2</sub> emissions<sup>2</sup>. Cities face other environmental challenges besides CO<sub>2</sub> emissions. Burning fossil fuels for transport and heating leads to urban air pollution, and if waste is not well managed in a high-density city, it contributes to land and water pollution.

Between their carbon footprint and their key role in catalysing innovation<sup>3</sup>, it is imperative that cities drive innovation for ecological transformation.

## THE VISION

So what do climate-neutral cities look like compared to today's cities, and how should we get there? By the principles of ecological transformation, cities' net-zero or even zero-carbon-emissions plans should be inclusive, just, and well-integrated with other interrelated aspects of ecological transformation such as pollution, circular economy principles, and biodiversity.

Net-zero cities may arrive at their goals through high-tech or low-tech means or both. Technological pathways for emissions reduction include:

- Electrification
- Reducing energy demand, as well as smart energy technologies for managing energy demand
- Carbon capture
- Sector-coupling, which refers to a more integrated approach to electricity generation, heating, cooling, transport and other industrial processes that consume energy, with the

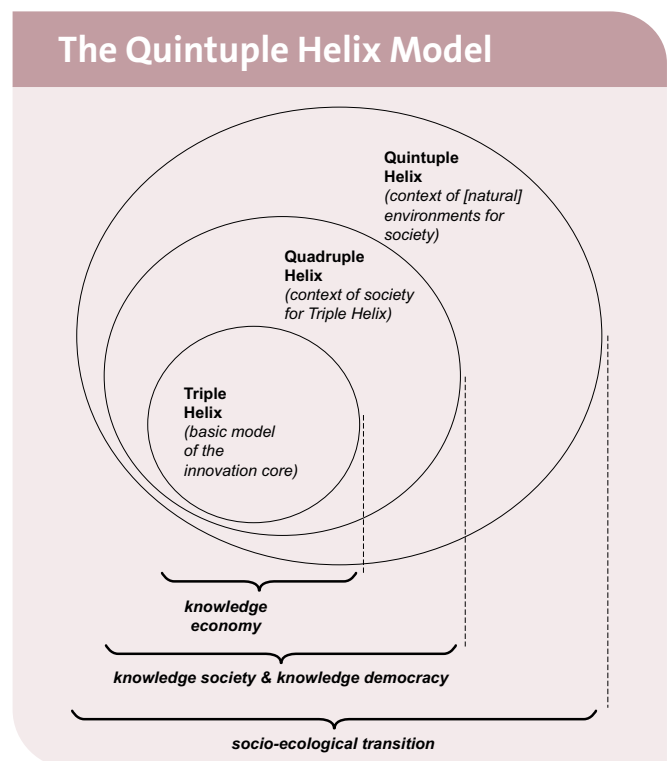
increasing electrification of more of the economy<sup>4</sup>. Today, increasingly it also includes supply - side sector-coupling, such as the production of green hydrogen.

These pathways can be pursued concurrently.

Urban planning and design also help manage cities' energy demand and emissions. For instance, cities of the future could be '15-minute cities' in which amenities are within a nearby, easily accessible travel radius; communities could be planned to integrate public transit, bicycling and other low- or no-emissions transport; and green cover can reduce energy demand for cooling.

## PILOTING AND SCALING HIGH-TECH INNOVATION

When a city adopts an innovative technology, that adoption must be implemented in consultation and synchronisation with the 'quintuple helix' of stakeholders: government, the private sector, science and technology, the public, and the natural environment. (The terms 'quadruple helix' and 'quintuple helix' are more typically used to describe innovation models that encompass these various stakeholders' knowledge and interactions<sup>5</sup>.) For example, NetZeroCities helps cities as they change how they govern their climate transition, ensuring that a wide swath of stakeholders have the chance to give input on their plans.



<sup>1</sup> EU Mission: Climate-Neutral and Smart Cities.

<sup>2</sup> Urban Energy, UN Habitat.

<sup>3</sup> Concilio, G., Li, C., Rausell, P., Tosoni, I. (2019). "Cities as Enablers of Innovation". In: Concilio, G., Tosoni, I. (eds) *Innovation Capacity and the City*. SpringerBriefs in Applied Sciences and Technology. Springer, Cham.

<sup>4</sup> Towards a greener economy in Europe through "sector coupling". UNEP, 17 April 2020.

<sup>5</sup> Carayannis, E.G., Barth, T.D. & Campbell, D.F. "The Quintuple Helix innovation model: global warming as a challenge and driver for innovation". *J Innov Entrep* 1, 2 (2012).





For example, the Greek city of Kozani has an old and poorly insulated building stock that is subject to cold winter weather. It struggles with uncertain generation of renewable energy locally, as well as fluctuating energy prices and supply due to the Ukraine conflict.

Kozani, a city of about 67,000 people in northern Greece, now seeks to develop and pilot the use of existing innovative technologies such as green heat modules, which convert green electricity into storable high-temperature heat for industrial processes. It plans to complement this with other technologies such as digital twins and Building Information Modelling for a just transformation. Adopting green heat modules could serve many district heating networks in Kozani and elsewhere, and the stored heat could be used for industrial, residential and commercial applications.

To most effectively implement this pilot activity, the city will need to work with stakeholders from across sectors, from citizens and academia to private-sector companies and NGOs.

Besides high-tech and social innovation, ecological transformation also demands low-tech or appropriate innovation, typically on the demand-side. Making public transport more accessible and convenient, increasing pedestrians' safety, or retrofitting buildings to be more energy-efficient can go a long way towards driving cities' net-zero transformation, for example.

## A FRAMEWORK FOR FOSTERING SOCIAL INNOVATION

Bringing about ecological transformation for cities is not just about implementing cutting-edge technological change or top-down urban planning, however. Climate change and

other sustainability challenges are a democratic problem, not just a technological one. Thus, for cities to engage in ecological transformation, they must also adopt and scale *social innovation* – as Jane Jacobs foreshadows when she writes 'cities...created by everybody'.

What is social innovation? It is not separate or distinct from other kinds of innovation. Rather, it is developed through a co-creative approach in a local context, addressing people's needs which are otherwise not solved by the state or private offerings. Social innovation for ecological transformation might look like community composting, co-housing, bike-sharing and car-sharing, or community solar programmes (versus solar panels installed by individual residents). Usually, social innovation has environmental and social co-benefits beyond the initial objective, such as better health outcomes, reduced waste, and improved engagement with residents.

Social innovation doesn't have to be free of charge for residents to access; these solutions can involve private sector actors and be part of a market economy. A community might charge a nominal fee to develop and host an app that residents can use; or make a collective decision about where its electricity (a paid service) comes from. What matters is that social innovation meaningfully includes the people who are meant to benefit.

Social innovation can take place at various scales. It may be bottom-up, led by neighbourhood-level activities; top-down, with city governments initiating and incorporating social innovation into their programming; or a mix of the two, with approaches such as participatory budgeting that co-create policies with residents. It can even be digital: integrating users into the design of digital services makes for a much smoother user experience on government platforms.

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What factors, then, contribute to an enabling environment for social innovation? Research by Universidad Politécnica de Madrid and Politecnico di Milano uncovers the following key enablers:

- Education and capacity-building strengthens the skills and processes that organisations need to engage in practices such as Tu Decides youth participatory budgeting, which expanded people’s capacity to act and interact with public administration
- Information and awareness-raising engage audiences through communications campaigns such as Climate Meal labelling, which highlighted climate-friendly dining choices
- Financial enablers provide strategic and long-term funding, such as the national-level Viable Cities initiative in Sweden
- Public policy: For example, as Paris’ ’15-minute city’ concept was infused into public policy, it has been translated into bike lane expansion, pedestrianised streets for safe trips to school, and the placement of amenities near where people live<sup>6</sup>.
- Regulatory frameworks such as Bologna’s Citizen Collaboration Pacts empower citizens to participate in climate and other decision-making, and are replicable elsewhere
- Technological innovation: many social innovation initiatives draw on clean energy and other technologies, and can themselves be the source of tech innovation.

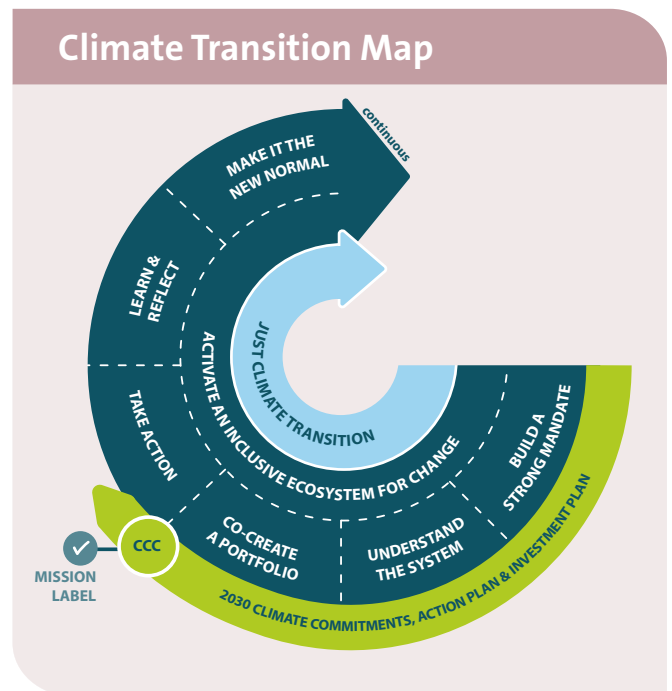
Finally, this framework must be underpinned by ways of measuring, monitoring and learning from ecological transformation initiatives and practices.

## CITIES, COLLECTIVELY

To accelerate innovation, cities might participate on national platforms, which together with other intermediaries can bridge the gaps between cities and across many levels of government, from cities to national governments to the European Commission.

For example, besides straightforward peer-to-peer knowledge-sharing, NetZeroCities facilitates cities’ collective innovation. NetZeroCities partner EIT Climate-KIC (Knowledge and Innovation Community) has facilitated exchanges between Spanish cities, which have built a platform for learning, communicating targets and coordinating action for sustainable innovation. Seven Spanish cities – Barcelona, Madrid, Seville, Valencia, Valladolid, Vitoria-Gasteiz, and Zaragoza – have teamed up on collective innovation like finding new financing models for ecological transformation. Meanwhile, seven Dutch cities together are exploring ways to leverage private and government finance for ecological transformation<sup>7</sup>.

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## CONCLUSION: MISSION-DRIVEN SYSTEMS INNOVATION

Finally, to make technological innovation, social innovation, or cities’ collective innovation truly transformative, systems approaches are needed.

“A systems approach is not a thing you do, it’s how you do things,” says Climate-KIC’s Luise Fischer, a consortium partner on NetZeroCities. What’s more, action for systems change is not linear: it is an ongoing, iterative process of analysing and understanding the system; designing solutions; acting; learning; building coalitions; and making improvements. Investment and participation in that iterative process stems from a long-term mission, in this case ecological transformation.

To meet the challenge of ecological transformation at scale, we need to rapidly multiply the number of agents of change taking part in transformation – and accomplishing that will require radical collaboration, from redefining who is a citizen or urban stakeholder, to significantly deeper engagement and participation<sup>8</sup>. We need distributed agency and collective action across public, private and civic sectors of the city – to create not just a city but also a future that is by everybody, for humanity.

6 Salome Gongadze & Anne Maassen (2023). Paris’ Vision for a ’15-Minute City’ Sparks a Global Movement. *World Resources Institute*, January 25, 2023.

7 Katherine Peinhardt, ‘Stronger Together: Multi-City Pilot Cities Teaming Up’.

8 NetZeroCities, (2022). Deliverable 8.1: Desktop report on engagement. A NetZeroCities call to action for a participative transition to carbon neutrality and beyond. Available at.



## URBAN RIGGER AND FLOATING CITY SOLUTIONS FOR ECOLOGICAL TRANSFORMATION

Anna Rosa Rylander and Signe Ryborg, Urban Rigger



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The Danish capital of Copenhagen, a port city built on two islands, has piloted an affordable and sustainable housing solution that floats on its unused inner harbour. Completed in 2019, the Urban Rigger student housing complex is designed to be energy-efficient and built from upcycled shipping containers. The floating construction offers cities a way to extend their liveable area and address housing shortages while potentially increasing resilience to sea-level rise.

For centuries, people who live near and on water have constructed floating communities and infrastructure. These include the floating islands of Lake Titicaca on the border of Bolivia and Peru, built by the Uros people out of bundles of reeds; *kelongs*, the stilted fishing platforms of Malaysia and Indonesia; and floating agriculture in Bangladesh, where people raise vegetables on water-hyacinth beds in the flood-prone monsoon season.

Floating infrastructure can be adapted, too, to the needs of densely populated cities. It can serve as an innovative

and equitable housing solution. It can be a means of climate resilience, given that more than a billion people in low-lying cities and settlements are at risk from coastal-specific climate hazards by 2050.<sup>1</sup> Designed well, it can also help to create a sense of community among residents.

The Urban Rigger housing complex was built with these objectives in mind. The first prototype 'Rigger' was developed in 2016 by Danish entrepreneur Kim Loudrup in close collaboration with the Bjarke Ingels Group, a Danish architecture firm, to address a dearth of student housing.

### DESIGN AND COMMUNITY

Each Rigger consists of nine upcycled shipping containers stacked atop a floating concrete platform to create 12 apartments plus communal living spaces. The platform also has a basement which houses amenities such as storage rooms and laundry. The structure is prefabricated and towed to its site.

<sup>1</sup> Dodman, D., B. Hayward, M. Pelling, V. Castan Broto, W. Chow, E. Chu, R. Dawson, L. Khirfan, T. McPhearson, A. Prakash, Y. Zheng, and G. Ziervogel, 2022: Cities, Settlements and Key Infrastructure. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 907–1040, doi:10.1017/9781009325844.008.

Urban Riggers are energy-efficient and use current energy technology. Each Urban Rigger gets about 75% of its heat from the surrounding seawater through pumps. It also generates electricity from rooftop solar panels, while its ventilation system recovers roughly 95% of heat.

The complex is designed to be a living community: communal spaces, a central open courtyard, annual investments to improve community welfare, and residents' meetings and a residents' app all help foster interaction. Altogether, some 100 residents live in its 72 apartments.

The complex is built at the disused industrial site of Refshaleøen, a former shipyard. Along with other public uses, such as events and festivals, art galleries and a street food market, it helps revitalise the space and brings conscious lifestyles to cities.

## PUBLIC ENGAGEMENT AND SCALING UP

In theory, replicating the Urban Rigger design requires only a sheltered harbour with sufficient depth and open space. In practice, developing urban floating housing can mean navigating a maze of regulations about what is allowed to be built where, as well as technical requirements and safety standards for connecting to the electrical grid and sewer system. Making floating infrastructure equitable also means ensuring access to city amenities and ensuring

that a diverse swathe of city residents has access to the infrastructure rather than creating wealthy enclaves.

While these regulatory and access requirements vary by location, in Copenhagen, the Urban Rigger complex rents harbour space from the municipality. The Urban Rigger team has engaged and continues to engage with city administrators, politicians, harbour-users and other citizens, and keeps abreast of current regulations.

Next, Urban Rigger plans to expand to other sites in Denmark and begin to build with wood as a more sustainable, renewable material. It has been cleared to rent apartments to seniors as well as students, to diversify its residential community. And in future, the Urban Rigger team also aims to design floating structures for other housing typologies.

## FUTURE PLANS

Today, as the crises of sea-level rise and housing affordability become more urgent, there is growing global appetite for floating infrastructure as an adaptation to these twin challenges. Floating infrastructure can also offer a sustainable alternative to land reclamation and provide space for agriculture or solar energy.

In the Netherlands, cities such as Rotterdam are already home to floating homes, office buildings and even a floating farm as part of its adaptation and resilience measures against flooding. Other floating cities and developments are being planned in Busan, South Korea, and in the Maldives.

In its Sixth Assessment Report, the Intergovernmental Panel on Climate Change notes that Rotterdam's municipal government and private sector work directly together to create "an institutional environment that favours eco-innovation", and that the city and its construction sector are building a body of knowledge, experience, and expertise around the technologies, design and engagement for floating cities. With its existing complex as proof-of-concept, Copenhagen's Urban Rigger project joins this body of knowledge and expertise. Replicating and scaling floating infrastructure is a vital opportunity for cities and the private sector alike.

Floating housing such as Urban Rigger's is not a silver bullet against coastal climate hazards. But driven by the urgent need for climate adaptation and resilience, with some 0.7m of sea-level rise already locked in by the end of the century, it can be one of the innovative solutions that humanity needs for ecological transformation.

