



Chapter 8:

Fostering Innovation for Inclusive Climate Action in Cities

Quick Facts

1. Technological innovations like renewable energy sources and electrified vehicles cannot, on their own, break the dependencies on unsustainable economic pathways.
2. Social innovation, which drives behavioural change and promotes broader participation in climate action, plays a critical role in the transition to more inclusive and resilient cities.
3. Urban innovation is not well integrated or clearly framed in Nationally Determined Contributions.
4. Ignoring inequalities and injustices in existing city structures risks reproducing worsening conditions for vulnerable groups, especially those with limited resources to recover from climate-related events.

Policy Points

1. Policy and planning at all levels should address integrated and coordinated approaches to innovation, bringing together technological, social, and nature-based innovations.
2. In revising Nationally Determined Contributions in 2025, national governments should strengthen their focus on urban innovation.
3. National governments should lead in setting appropriate institutional and regulatory frameworks that address injustices associated with climate innovation and adopt national and regional policies to ensure just urban transition.
4. Local governments should actively foster inclusive innovation ecosystems that broaden the range of innovation actors and knowledge perspectives.



Innovation—representing both the creation of something “new” and the process of distributing it—is central to the ability of cities to deliver effective climate action. While businesses tend to define innovation in terms of the development and marketing of breakthrough products and services,¹ the true scope of innovation extends far beyond this towards solving societal challenges, regardless of economic value. In the context of climate change, “transition innovation” refers to the framework of creating “new” ways of adapting to environmental impacts and reducing carbon emissions, including the overarching structural and institutional processes needed to move towards a more resilient future.

Innovation in cities is particularly important for climate action because many feasible responses have some level of dependence on urban settings, such as the concentration of skills and capacities, as well as access to the built environments in which many innovations happen. UN-Habitat’s *World Cities Report 2022: Envisaging the Future of Cities* highlighted the central role of urban areas in fostering innovation, noting the rise of digitalization as an important tool to deliver the transition to net zero.² However, digitalization and the Internet of Things (IoT) that find expression in the “smart city” are on their own insufficient to deliver climate-resilient futures and may even, in some cases, be counterproductive. For instance, analysis suggests that smart cities may reinforce technocratic approaches to urban management that, on the whole, prevent rather than advance sustainability.³ While recent advances in artificial intelligence (AI) and automation offer promising innovations to scaling up climate action, translating these innovations into ready-to-use urban solutions is not straightforward and often results in unintended consequences.⁴



Climate-resilient urban futures can only be achieved if no one and no place is left behind

In this area as in others, climate-resilient urban futures can only be achieved if no one and no place is left behind. This demands a different perspective on transition innovation—not only to create ‘new’ ways of responding to climate change challenges, but to do so in such a way that collective resilience is strengthened rather than weakened, especially for those most vulnerable. A people-centered approach to transition innovation is therefore crucial for effective urban climate action and a broader shift towards a just urban transition.

The chapter begins by defining approaches to transition innovation and how they reflect urban dynamics in Section 8.1, highlighting the centrality of just urban transition and inclusive innovation for effective urban climate action. Section 8.2 situates transition innovation within the global trends and policies developed in Nationally Determined Contributions (NDCs). This leads to a diagnosis of the need for integrative approaches to transition innovation. Section 8.3 explores the domains and strategies for these integrative approaches, highlighting examples and key opportunities. Section 8.4 reflects on the ethical dilemmas of transition innovation that are analytically distinct from the already captured negative unintended consequences of innovation. Finally, Section 8.5 reflects holistically on how a people-

centered approach to transition innovation can help foster low-carbon, climate-resilient cities of the future.

8.1 Approaches to Transition Innovation

By its very nature, innovation disrupts established ways of doing things. This is certainly the case with the transition to climate-resilient, net zero cities: at a fundamental level, it demands a move from an extractive to a regenerative economy, where cooperation, democracy, ecological health and social well-being are prioritized over profit. Furthermore, as the climate crisis and rapid urbanization raise new uncertainties, old certainties are no longer tenable. Today’s innovators find themselves navigating a rapidly changing landscape with implications that are not yet fully understood.

The transition is also being shaped by existing structures of privilege, which influences transition priorities and how they are implemented.⁵ The challenge is that many innovations for climate action fail to confront the inequalities and injustices that underpin an unsustainable economic system, meaning that new forms of climate urbanism have the potential to reproduce or exacerbate existing injustices.⁶ These injustices are themselves the product of both *omission* (where insufficient action has been taken) and *commission* (when the action taken is detrimental to the most vulnerable groups).⁷ In these regard, policy has shifted more focus on the how innovation impacts on people, including the justice and equity questions raised by the transition to a climate-resilient society.⁸

A justice-centered approach to transition innovation is therefore central for effective urban climate action. Such a perspective seeks to deliver innovations that respond to climate change-related challenges at the required scale and speed without causing further harm to people, especially those most vulnerable. As discussed in the context of urban infrastructure in Chapter 6, adopting a justice lens moves beyond *sensitive* or *responsive* approaches to urban marginalization and exclusion, aspiring instead to be *transformative*: that is, actively challenging the structural drivers and historical injustices that shape inequalities (see Table 8.1). A justice perspective further acknowledges the diverse ways in which place-based innovation takes shape and works to connect these innovations to people’s needs. Additionally, this approach promotes learning across different contexts and domains of innovation that together work to accelerate the process of transition.⁹



Los Angeles illuminated cityscape downtown at night, California, USA with Hologram of Artificial Intelligence concept/Shutterstock

Table 8.1: Approaches to marginalization and exclusion in urban innovation

Approaches that are:	
<i>Sensitive</i> to marginalization and exclusion	Diagnose differences in access to innovation processes and technologies that lead to marginalization and exclusion
<i>Responsive</i> to marginalization and exclusion	Actively meet the needs of people who are marginalized or excluded
<i>Transformative</i> for marginalization and exclusion	Challenge marginalization and exclusion by putting marginalized people at the center of the innovation process

8.1.1 Just urban transition

A long history of environmental justice activism and thought has demonstrated that social and environmental injustices are interconnected and ought to be simultaneously addressed. A case in point is the rising demand for cars in many African cities, which is increasing pollution and GHG emissions while at the same time deepening the divide between those who are mobile and those who are not.¹⁰ Sometimes climate action may itself even lead to negative social consequences: for example, in Bengaluru, India, beautification programs to restore riverside areas are often delivered at the expense of vulnerable communities that live on their banks.¹¹

The drivers of injustice lie beyond specific projects and actions, deeply entrenched in dynamics that reproduce unsustainable political, economic, socio-ecological and technological relations. There are plausible responses to counter these drivers, such as: enabling plural and dissenting dialogue; promoting community economies and social infrastructures for the exchange of knowledge and innovation; facilitating forums for co-creating future visions; and engaging with alternative proposals emerging from activist networks. The common thread in these approaches is their focus on how knowledge is produced – a key point of intervention for a just urban transition.

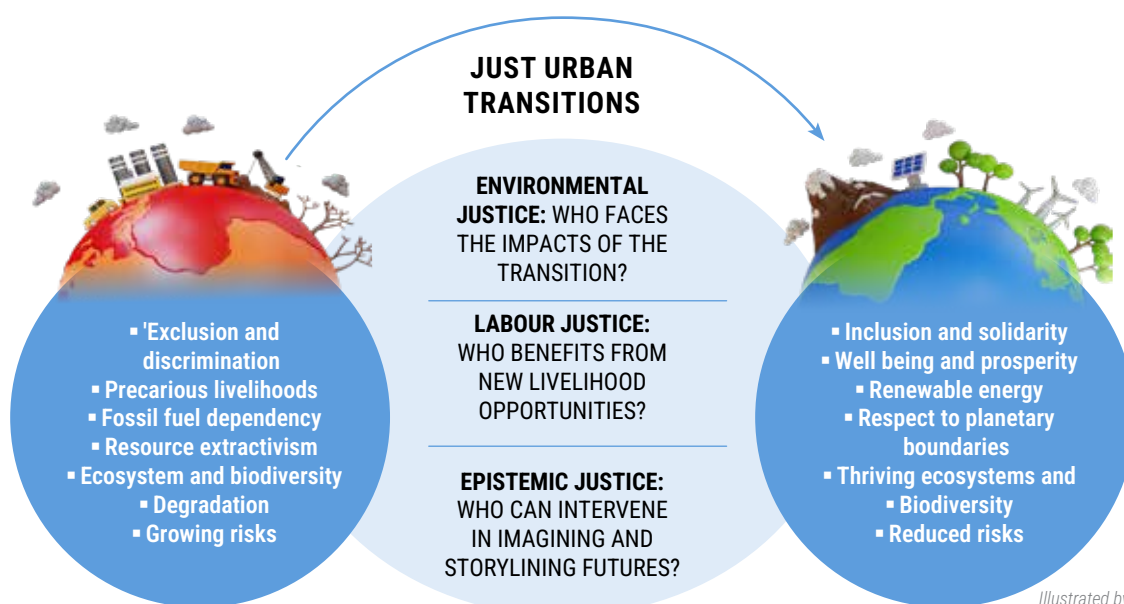
Box 8.1: Defining just urban transition

Just urban transition refers to policy and planning agendas that anticipate and mitigate the unequal distribution of risks and benefits, ensuring that climate action does not disproportionately burden marginalized groups. Central to a just urban transition is the democratization of governance and decision-making and the inclusion of multiple knowledge systems and perspectives, with the overall objective of redressing historical legacies of exclusion and injustice.

Source: Hughes & Hoffmann, 2020.

Figure 8.1 represents the magnitude of change required in a just urban transition from a fossil fuel-dependent urban economy to a climate-resilient one. Such a jump will require multiple forms of innovation to adapt people's lives and work to the new context. However, such adjustments may be particularly taxing for the most disadvantaged groups. At the same time, there have been calls to innovate in climate policy and planning to redress historical legacies of exclusion and injustice.

Figure 8.1: Magnitude of change in a just urban transition and the questions it raises



There are three main challenges pursued by a just urban transition (Figure 8.1):

- First, *climate action may disproportionately impact disadvantaged groups*. A just urban transition must include measures to ameliorate or avoid those impacts (*environmental justice*).
- Second, *economic restructuring will directly impact current labour conditions*. A just urban transition requires innovation to facilitate the integration of workers into the new economy (*labour justice*).
- Third, a transition requires imagining and creating responses for the future, but *only certain actors in society are legitimately able to drive the process of innovation* and design visions to shape the future. A just urban transition requires reevaluating the sources of knowledge and integrating multiple knowledge into transition innovation (*epistemic justice*).

A just urban transition is therefore not a superficial change that can solely be achieved by introducing new technologies. Rather, it demands a profound transformation in contemporary societies, a shift in values, and a rethinking of our relationship with the environment.¹² Transition innovation should therefore not only address what innovations are developed, but also how they are developed. What knowledge comes to matter in the transition process is also crucial to identifying and addressing inequalities and injustices.¹³ For that reason, the just urban transition strongly depends on creating inclusive forums for the development of innovation, whether this is done in practical urban labs, ongoing consultations or through specific forums to target the concerns of marginalized social groups.



Transition innovation should not only address what innovations are developed, but also how they are developed. What knowledge comes to matter in the transition process is also crucial to identifying and addressing inequalities and injustices

8.1.2 Inclusive innovation: lessons and models

Inclusive innovation models take a normative approach to innovation as a social good. They move beyond the economic and industrial development concerns of mainstream approaches, to consider the broader contribution of innovation to social and environmental benefits (see Figure 8.2).¹⁴ Inclusive innovation policies challenge mainstream narratives of innovation by broadening the range of actors, providing different strategies for recognition and access to innovation arenas, and centering the understanding of how particular innovations impact daily lives.

In the context of urban climate action, inclusive innovations are needed to palliate the negative impacts of the transition to net zero and address the needs of the most vulnerable groups of people to ensure a resilient city. The requirements for inclusive innovation will naturally depend on

the context of need. For example, many transition innovations relate to food production and distribution in cities: inclusive innovations in urban agriculture must therefore ensure that the new knowledge generated meets the needs of small-scale farmers.¹⁵ This could include access to supply chains, innovative tools for organizing and aggregating produce, or knowledge exchange and labor-saving technologies.

Inclusive innovation mobilizes wider sectors of the population to find responses to the climate crisis within their environment, especially those most disadvantaged. It can lead to surprising interactions between cultural life and developing a place-based, locally relevant economy. For example, research in 23 provinces of China found that spiritual beliefs motivated villagers to develop place-based innovations to adapt local resources to ongoing challenges.¹⁶ However, inclusive innovation depends on creating opportunities for marginalized groups and civil society associations to speak for themselves in a free and fair environment, without any top-down impositions or expectations.¹⁷

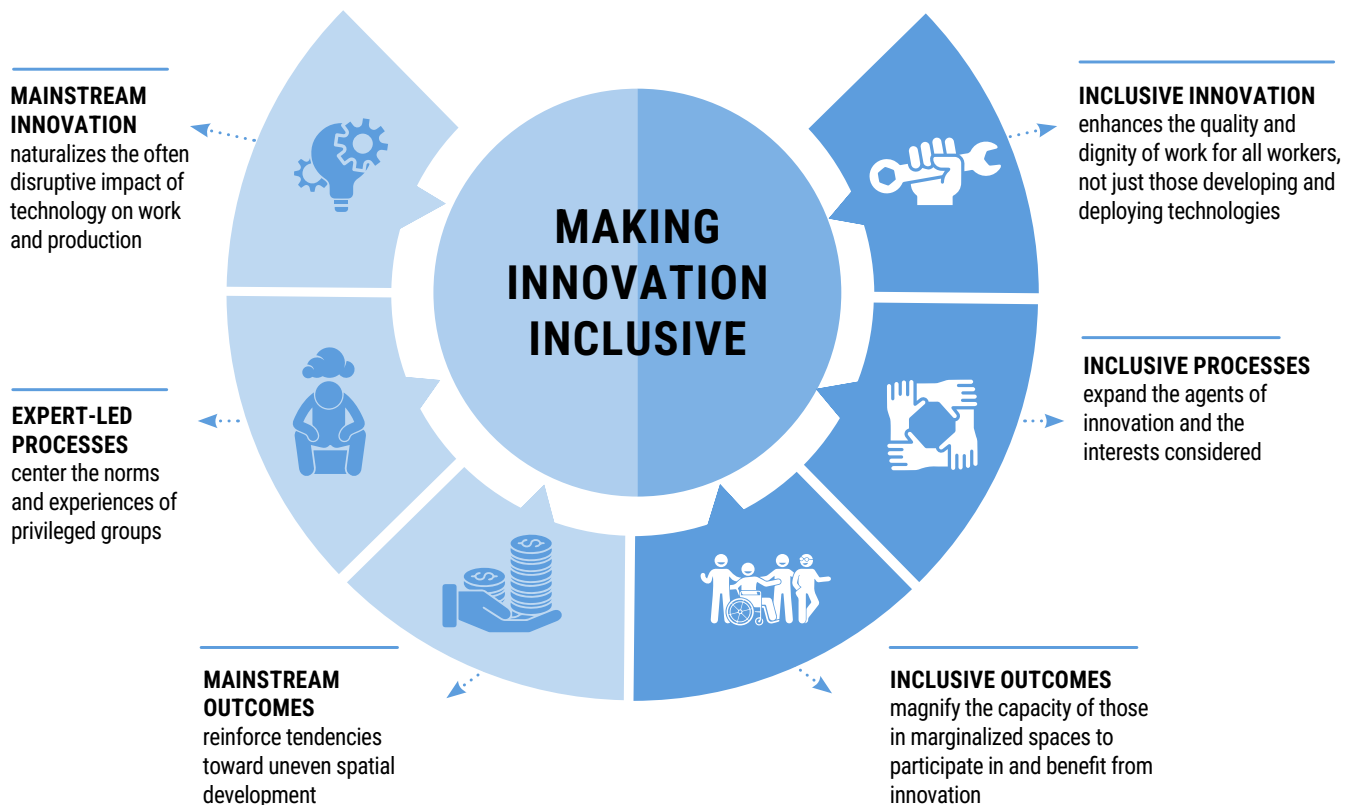
International support for innovation and technology transfer has long been part of the Conference of Parties (COP) climate negotiations but seems not enough to palliate current deficits

There are, however, obstacles to the development of inclusive innovation. International support for innovation and technology transfer has long been part of the Conference of Parties (COP) climate negotiations but seems not enough to palliate current deficits. Countries with weaker institutional systems struggle to generate, exchange and collaborate on ideas, leading to lower rates of innovation. At the same time, they often face barriers to accessing traditional financing mechanisms to advance their capacity to innovate.¹⁸

In contexts where public resources are unavailable, international aid programs may promote inclusive innovation. For example, the United Kingdom (UK) Department for International Development (DFID, now integrated into the Foreign Commonwealth and Development Office) delivered place-based innovations to improve women's safety in cities like Nairobi.¹⁹ However, critical research showed that such programs are transformative only when they directly tackle existing drivers of discrimination, for example by facilitating the visibility of women in electoral processes.²⁰



Global aviation © Shutterstock

Figure 8.2: Mainstream innovation vs inclusive innovation

Illustrated by Vanesa Castán Broto based on the discussion in Schrock & Lowe, 2021.

Neither public support nor international aid can substitute for dynamic networks of innovators able to link existing technological developments with specific social and environmental outcomes to respond to climate change. In practice, inclusive innovation is not well integrated into development programs.²¹ The spread of the internet and digital technologies facilitates knowledge spillovers that benefit smaller companies with less access to research and development (R&D),²² but those seem insufficient to accelerate inclusive innovation. The private sector is often slower in taking up inclusive innovation programs articulated in development programs.²³ Limited resources and time, alongside a poor understanding of innovation processes, hinder inclusive innovation.²⁴ Fostering diversity within private sector companies, for example through gender-diverse boards, tends to foster inclusive innovation.²⁵

Even when the conditions are appropriate, there are risks in delivering inclusive innovation. First, inclusive innovation tends to generate place-based forms of practical knowledge that, without reaching scale, may not receive further support or funding within existing markets. Second, when inclusive innovation provides scalable solutions, powerful companies or other stakeholders may appropriate them as commercial products at the expense of their inherent public value. Further, those trajectories also depend on dominant ideas about knowledge production and the concentration of innovation resources in certain locations and

sectors of the population that are formally sanctioned as “knowledge producers”, influencing policy and planning practices.²⁶ Expanding the range of actors engaged in innovation helps direct resources to people who are already making efforts to deliver it and challenge established innovation trajectories.

Policy strategies must deliberately address the concepts of inclusive innovation to reach vulnerable populations. A supportive national agenda for inclusive innovation can catalyze and integrate inclusive innovation into large-scale actions. However, local institutions also provide additional momentum and support, particularly when inclusive innovation is closely tied to local development agendas. For example, since 2016 the Design Tech Academy in the city of Saint-Etienne, France, has provided digital skills to low-income immigrant youth through the combination of the local government’s prioritization of urban design, the availability of national funding and the participation of intermediaries such as Telecom Saint Etienne.²⁷ Other cities have also established similar examples of integrated, inclusive innovation strategies (Box 8.2).



Policy strategies must deliberately address the concepts of inclusive innovation to reach vulnerable populations

Box 8.2: Integration of inclusive innovation in urban development strategies in large cities



WASHINGTON DC

In Washington, DC in the United States (US), the mayor adopted the 2016 Pathways to Inclusion Strategy to diversify the tech economy and established an Innovation and Technology Inclusion Council. An inclusive innovation incubator provides disadvantaged groups access to tech-entrepreneurship.



PITTSBURGH, PA

Pittsburgh (US) has branded itself as an “inclusive innovation city” and in 2015 adopted an inclusive innovation roadmap.

Action areas: improving city operations, closing the digital divide, connecting citizens to local governance, supporting local businesses and clean technologies, and championing open data.



LONDON, UK

In London, UK, inclusive innovation is integrated into existing strategies for economic development, such as the local enterprise partnership London LEAP.

Specific “inclusive innovation districts” include the Olympic Park site and the Borough of Camden’s inclusive innovation network.

Source: Lee, 2023.

Beyond public policy and urban development planning, local governments can further facilitate inclusive innovation for just urban transitions. One way to do this is to tie inclusive principles to the actual practices of innovation that occur in urban environments through models that redefine the agents of innovation in climate action, bringing forward the role played by citizens and communities. These are below-the-radar, citizen-oriented approaches to inclusive innovation that can play a crucial role in development and urban climate action.²⁸

Involvement in *innovation platforms* is one way that city governments have gained a presence in innovation processes at the local level.²⁹ Innovation platforms consist of nodes of encounter for multiple stakeholders to work together to respond to a shared challenge. For example, a case study of four municipal-led innovation platforms in Sweden showed that the presence of embedded municipal institutions served to establish clear normative frameworks and create opportunities for knowledge exchange and development. They intervened in a range of areas, from accelerating



Sustainable neighbourhood in Almere, The Netherlands. The city heating (stadswarmte) in the district is partially powered by a solar panel island (Zoneiland) © Shutterstock

the adoption of technologies for a bio-economy to developing large-scale sustainable regeneration projects, as well as delivering material improvements in the environment of deprived districts.³⁰

Sometimes, strategies focus on *cluster innovation*. Cluster innovation refers to instances where a process is created which then makes it possible for the innovation to emerge: participants may have different roles, but it is the process, rather than the activities of any one actor, which makes a difference. International development assistance programs in countries like Bolivia have emphasized the potential of cluster innovation to manage polluting industries, such as the leather industry. Still, the emphasis on business innovation sometimes distracts from the potential inclusive effects of these programs, which depend heavily on having intermediary institutions, such as universities or NGOs, capable of mediating such inclusion.³¹



While activist-led networks routinely play an important role in delivering grassroots innovations, their maintenance over time depends on maintaining sustainable partnerships with local governments and institutions

Grassroots innovation refers to bottom-up solutions generated by networks of activists and organizations in ways that respond directly to the local context of action and include the interests and values of the communities involved.³² Local governments can work with intermediaries and other interlocutors that help mobilize communities in planning and implementation of the just urban transition. For instance, organizations such as the Climate Justice Network³³ and the Voices for Just Climate Action³⁴ actively work to deliver grassroots innovations. However, while activist-led networks routinely play an important role in delivering grassroots innovations, their maintenance over time depends on maintaining sustainable partnerships with local governments and institutions. Box 8.3 elaborates on two examples of how community-led organizations in Kenya and the Philippines have engaged in climate innovations through partnerships with local governments and other actors.

Box 8.3: The role of community-led partnerships in catalyzing innovative climate action

Community partnerships, particularly with those traditionally excluded from decision-making such as informal settlements, have enormous potential to drive innovation. Besides strengthening the rights and opportunities of marginalized groups, these collaborations also tap into local skills, perspectives and knowledge that all too often are overlooked during the development of climate actions. Local governments, businesses and other city residents can benefit enormously from such alliances through grassroots engagement, participatory data collection and other activities.

This is illustrated by an array of initiatives in developing countries across the world that have brokered community-led collaborations. For instance, the Philippines Alliance, a network of NGOs that support the Homeless Peoples Federation of the Philippines, has worked since the 1990s to facilitate access to housing and manage disasters among the poorest communities in the country. In 2023, one of the Philippines Alliance partners, the Technical Assistance Movement for People and Environment, Inc. (TAMPEI), launched the project “Resilience of informal communities in rapid urbanization” (RURBANISE) to increase the resilience of informal settlement dwellers across the country.³⁵ Working in collaboration with the University of the Philippines and other partners, the project aims to introduce a variety of risk management innovations, such as advanced spatial analysis and the co-production with communities of 3D maps with 3D printers. The project demonstrates innovative ways to combine technology and forms of collaborative knowledge production to deal with the immediate challenges in vulnerable communities.³⁶

In Kenya, the Kisumu Waste Pickers Welfare Association (KIWAPWA) - a collective of 15 groups, comprising 250 waste pickers dedicated to innovating waste management solutions – has made significant contributions in advancing locally – led climate action. Their efforts have improved environmental hygiene in Kisumu and enhanced public health by reducing the prevalence of communicable diseases like diarrhea and cholera. As one of the networks of Muungano wa Wanavijiji, a federation of slum dwellers in 21 counties in Kenya, KIWAPWA has successfully partnered with the Kisumu County government. Through this collaboration, they advocate for the construction of waste recovery centres in every ward and collaborate with the city government and other stakeholders to promote household-level waste segregation.³⁷

Source: University of Sheffield, Urban Institute, 2024, and Muungano Wa Wanavijiji, 2024.

Frugal innovation is innovation that aims at reducing the input in economic and social activities to achieve sustainability. Since the objective is minimizing the use of resources (such as raw materials, energy, fuel, water, waste and finance), frugal innovations tend to be affordable and accessible, making them ideal for large-scale transformations in rapidly growing urban areas where resources are scarce.³⁸ Frugal innovations recognize the role of simple, accessible alternatives. Examples in the energy sector include electricity-free clay fridges, lights made with plastic bottles and the adoption of traditional construction techniques to improve house ventilation. Local institutions may play a fundamental role in helping replicate some of these frugal innovations, sometimes simply through information-sharing campaigns.

Mundane innovation relates to all the above categories but focuses on the innovations that address routine day-to-day contexts without aiming to disrupt existing regimes. Mundane innovations emerge from the observation of routine activities. Anyone can lead them, but it is increasingly evident that when innovation programs at any level of governance engage with mundane challenges, those innovations have greater relevance and may lead to social change of the kind required for a just transition. These ideas of innovation provide insight into how to do newness differently. They start by putting people’s ideas and interests at the core of the process, at the same time ensuring that those interested in innovation are themselves leading the innovation process. In doing so, inclusive innovations can advance the interests of groups of people who may otherwise be excluded from the just urban transition. Table 8.2 summarizes the different models that local government can engage to further advance inclusive innovation.

Table 8.2: Models to deliver inclusive innovation

Models	Mechanisms	Benefits
Innovation platforms	Mechanisms whereby multiple stakeholders work together to respond to a shared challenge	Creation of multi-stakeholder arenas for the discussion of collective challenges
Cluster innovation	Collective forms of innovation in which the innovation can only be attributed to the collaborative process	Co-design studios in which facilitators catalyze innovation processes
Grassroots innovations	Innovation generated by citizens’ groups or communities.	Support and mobilization of activists fighting for a common cause.
Frugal innovation	Innovation directed to simplify and reduce production processes, especially at the local scale	Active engagement with challenges about reducing the local use of resources and energy
Mundane innovation	Innovation that emerges within the needs of specific life practices	Connecting knowledge generation to routine experiences of living in the city

In summary, local governments can foster inclusive innovation through a variety of approaches, including policy, urban planning and models for generating inclusive innovation. Table 8.3 provides an overview of strategies that support an inclusive innovation ecosystem capable of routinely generating locally relevant and just transition innovation.

Table 8.3: Approaches for local governments to foster inclusive innovation ecosystems

Areas of action	Policy	Objective	Examples
Strategy and policy making	Participation in innovation policy	Facilitate the inclusion of diverse perspectives in the development of innovation policies	Citizen boards or councils that provide advice on innovation policy
	Prioritization of sectors that favor inclusion	Shifting innovation funding to foundational or mundane sectors	Prioritization of key sectors in national innovation strategies
	Diversification of innovation	Facilitate the development of an innovation environment in low-innovation regions	Regional development policies
	Innovation for inclusion	Invest in innovation in the areas of concern for disadvantaged populations	Focus on innovation in public and social services
Participation and access	Participation in entrepreneurship	Provide access to disadvantaged groups to entrepreneurial resources and skills	Business incubators for disadvantaged groups
	Participation in the innovation workforce	Provide access to disadvantaged groups to jobs in STEM	Employment programmes and fairs in STEM sectors
	Participation in education	Provide access to disadvantaged groups to STEM education	Educational policies to promote STEM
Impact and outcomes	Minimizing impacts of innovation	Ensure that innovations have minimal impacts on disadvantaged populations or provide remedial action	Technology impact assessments
	Specific inclusive innovations	Focus on a particular innovation that favors disadvantaged groups	Solar lamps designed for informal settlements
	Innovation for inclusive development strategies	Tie in specific innovations to wider development objectives	Innovation-focus development programmes
	Innovation diffusion	Policies that facilitate access to new technologies	Policies addressing the digital divide

8.2 Implications of Global Development Agendas for Urban Transition Innovation

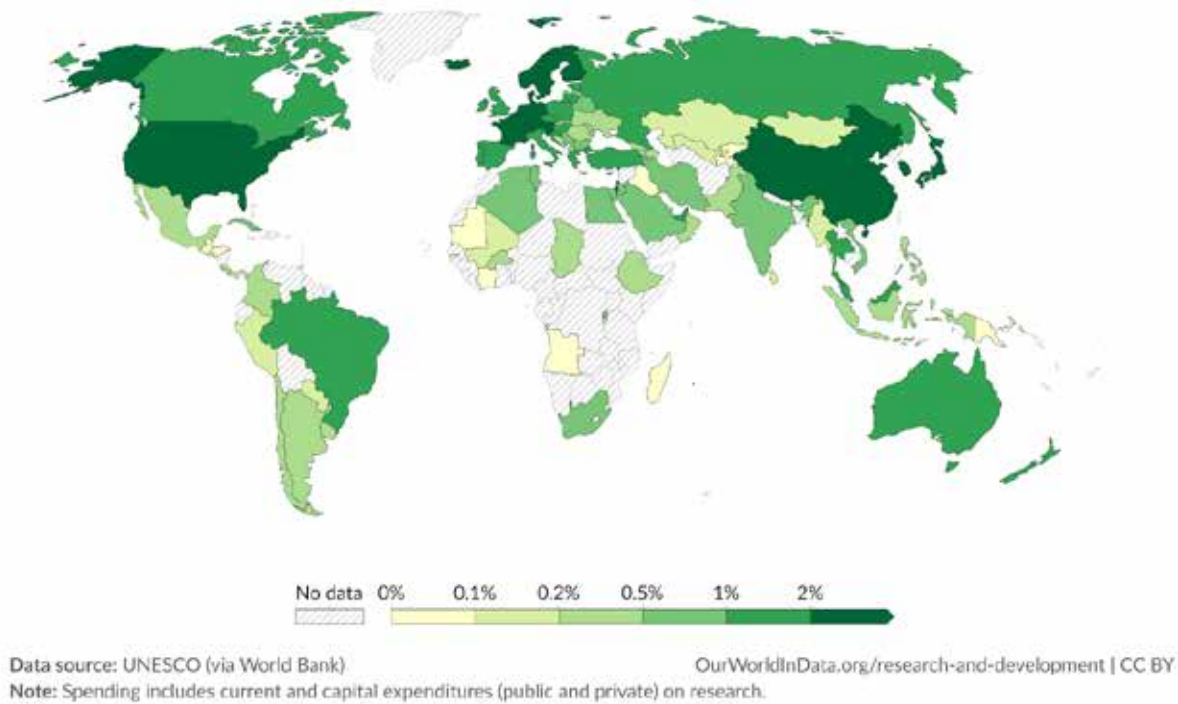
Policy and strategies for urban transition innovation occur within the broader context of global agreements aimed at fostering innovation. The Sustainable Development Goal 9 (SDG 9) seeks to “build resilient infrastructure, promote sustainable industrialization and foster innovation”. SDG 9 recognizes the relationship between knowledge production and innovation capacities, seeking to increase public and private R&D spending. The last progress report explains that investment in R&D has increased globally, alongside advances in mobile connectivity that enhance research and knowledge production infrastructures.³⁹ However, this progress is uneven.

8.2.1 Analyzing innovation indicators from SDG 9

Investments in R&D as a share of Gross Domestic Product (GDP), as reflected in SDG indicator 9.5.1, suggests wide disparities between countries in the investments available for innovation (see Figure 8.3). Furthermore, within countries innovation also tends to concentrate spatially, though it is unclear to what extent geography and the level of urbanization are significant determinants in themselves of the pattern innovation takes.⁴⁰



Sustainable Industrial Facility with Solar Power Plant

Figure 8.3: R&D spending as a share of GDP, 2021

Source: Our World in Data, 2024a.

Rather than concentrating only in the largest urban centres, innovation appears to emerge in diverse locations and settings, although in countries such as Republic of Korea and the United States (US), patents are concentrated in large metropolitan areas.⁴¹ The focus on patents has generated a discussion about how urban areas provide opportunities to grant higher returns on innovation, for example, facilitating the rapid patenting of new ideas to bring to markets.⁴² However, the indicator of patents does not reflect the diversity of innovation. Many innovations for climate-resilient development, especially nature-based and social innovations aimed at lifestyle changes and adaptation, are not easily formalized or marketable. Their success in promoting transitions depends more on the quality, adequacy and direction of innovation than on their quantity.⁴³ Secondary cities, overlooked regions, rural locations or remote areas may provide the conditions for the diversification of entrepreneurship, generating latent or unpublicized innovations that

while often ignored in dynamic urban economies – are nevertheless crucial to building resilience.⁴⁴ This underscores the urgency and significance of approaches to innovation policy that emphasize regional balance across the different dimensions of innovation.

Table 8.4 shows an overview of conventional economic policies to stimulate innovation at different geographical levels and across sectors. The specialization of certain cities, for example, in the creative industries may provide an innovation advantage that policymakers may wish to support through targeted policies.⁴⁵ Fostering innovation in a particular location and sector, for example, may require concentrating resources in particular areas. However, imbalances in access to knowledge and resources may also generate structural inequalities in access to knowledge resources. Such policies therefore may not be sufficient to stimulate the broader range of innovations required for resilience.

Table 8.4: Conventional policies to stimulate innovation across different geographical levels and sectors

Levels Of Governance	General Policies	Industry And Sector Policy	Firms
National State	Tax Code Patent Policy Non-Compete Clauses	Industry-Specific Tax Support or Subsidies	Loans and Guarantees
Local Government	City-Wide Taxes and Business Regulations Supporting Infrastructures (E.g., Mobility)	Industry-Specific Support for Specific City- Based Sectors	City-Level Tax Breaks City-Tied Contracts
Neighbourhood	Empowerment Zones Local Infrastructures	Innovation Clusters Targeted Infrastructures	Specific Infrastructures and Labour Force Support

Source: Adapted from Chatterji et al., 2014.

Innovations are, however, driven by people. Hence, another indicator of innovation is the presence of an “innovation class” capable of driving innovation forward. The SDG indicator 9.5.2 focuses on the proportion of R&D researchers (professionals “engaged in conceiving or creating new knowledge, products, processes, methods or systems”), showing gross inequalities across countries once again (see Figure 8.4).

However, at the urban level, rather than the overall number of R&D researchers, what counts is the interactions between a class that could be thought of “creatives” (those who produce original ideas) and “makers” (those who transform those ideas into useful outputs).

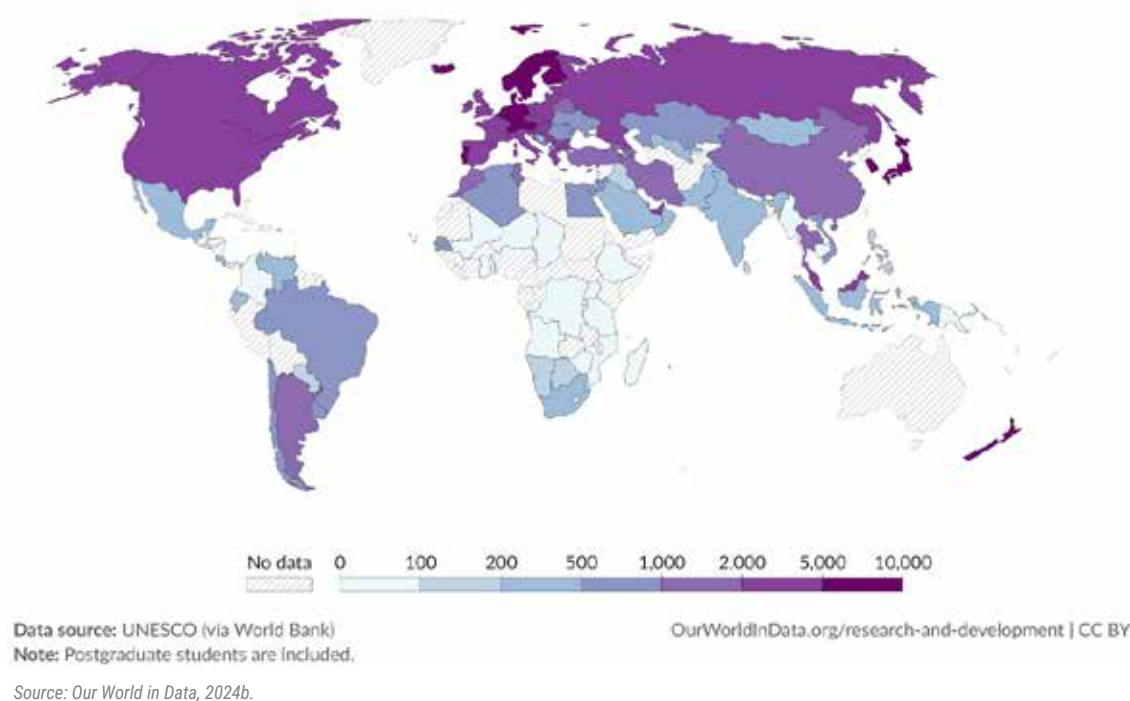
For example, in US cities, empirical evidence suggests that the combination of creative and STEM activities fosters innovation.⁴⁶ Promoting innovation thus depends on accommodating different industries and groups of workers, prioritizing diversity over the development of specific skills. In

advancing climate-resilient development, the diversification of innovation actors must be extended to incorporate those actors with specific experiential or historical knowledge, particularly seeking to reveal those types of knowledge that may remain invisible.⁴⁷ For example, many cities can benefit from the creative storytelling and oral transmission methods through which Indigenous Peoples share knowledge relevant to understanding and responding to climate change.⁴⁸



Many cities can benefit from the creative storytelling and oral transmission methods through which Indigenous Peoples share knowledge relevant to understanding and responding to climate change

Figure 8.4: Number of R&D researchers per million people, 2021



This analysis suggests the following policy recommendations:

- While specialization may give an advantage to some regions, a balanced approach to facilitate innovation (including supporting overlooked regions) may provide further opportunities for innovation in the longterm.
- Within cities, facilitating the interaction between creatives and practically-oriented STEM workers and technicians may generate innovations that bridge originality with social purpose.

8.2.2 Innovation and urban policy in Nationally Determined Contributions (NDCs)

Perhaps the most important policy tool for transitions to climate-resilient development is the NDCs. Since the Paris Agreement, the NDCs have become the main instrument for international negotiations, including establishing the “headline numbers” that indicate progress towards global emission reductions (see also Chapter 2).⁴⁹ At the same time, given that at least in principle they signal a country’s budgetary commitments and political priorities for years to come, NDCs play an important role in shaping local level action.⁵⁰ However, the influence of NDCs on innovation, specifically urban innovation, is not well understood.

The first generation of NDCs, produced in the wake of the Habitat III conference and the New Urban Agenda, contained urban references. Still, only 26 out of 164 NDCs were judged to have “strong” urban content, mostly countries facing the challenges of rapid urbanization in countries in Africa or large-scale urban challenges such as in India and China, with another 87 having “moderate” urban content.⁵¹ In general, urban innovation was not a strong concern of the NDCs. However, an updated report in 2022 found increasing urban content, with a greater emphasis on responses rather than challenges in sectors such as energy, transport and waste.⁵²

Current policies of transition in cities depend first of all on the NDCs and how they have translated into national and urban policy. In this regard, it is tentatively encouraging that over two-thirds of the NDCs pay substantial attention to the question of innovation in climate action, either putting innovation at the core of their strategies or proposing specific measures to promote innovation. NDCs from countries such as Azerbaijan, Bolivia, Brazil, Canada, China, Indonesia, Mexico, Panama, Sri Lanka or Türkiye highlight innovation as a key enabler of climate change mitigation, adaptation and sustainable development. The need for collaboration at multiple scales between governmental institutions, civil society, academia, and international organizations to facilitate innovation is central to many national strategies, including Bahamas, Cambodia, Egypt, El Salvador, Lesotho, Oman and Saudi Arabia. For example, Lebanon’s policies seek to foster an innovative environment driving public research investment in research and encouraging innovation labs.⁵³ Liberia’s NDC explains the development of an education and communication plan to establish R&D centres and multi-stakeholder platforms within communities.⁵⁴ Technology transfer is a common theme in many NDCs.

Over two-thirds of the NDCs pay substantial attention to the question of innovation in climate action, either putting innovation at the core of their strategies or proposing specific measures to promote innovation

The majority of NDCs adopt a sectoral approach to innovation. One of the sectors that receive most attention is agriculture, with proposals to advance digital technologies and smart techniques,⁵⁵ irrigation technologies,⁵⁶ social innovation to improve the effectiveness of the supply chain,⁵⁷ vertical farming,⁵⁸ hydroponics⁵⁹ or organic cultivation methods.⁶⁰ The NDC of South Sudan, for example, pays particular attention to innovative business models that can enable adequate transport and cold-storage solutions to reduce post-harvest losses.⁶¹ Innovations in forestry,⁶² aquaculture⁶³ and coastal restoration⁶⁴ are also commonly mentioned in the NDCs. Other sectors that are perceived as innovative are energy, water and waste management, and adaptation. A few countries mention climate technologies for carbon capture, storage and use, and in some cases nature-based solutions (NbS) for mitigation.⁶⁵

There are, however, few NDCs that consider urban innovation explicitly, although different forms of urban innovation intersect with sectoral proposals. Innovations in mobility (smart mobility and clean technologies) are the most common.⁶⁶ The built environment is also perceived as providing opportunities for innovation, for example through designs that

improve energy efficiency,⁶⁷ the incorporation of nature-based design in buildings and infrastructures,⁶⁸ or the incorporation of traditional materials and construction techniques.⁶⁹ Singapore, for example, has established a Green Buildings Innovation Cluster program to support the development of energy-efficient building technologies.⁷⁰ Similarly, Moldova recognizes the role of municipalities in advancing innovative solutions in infrastructure resilience projects.⁷¹ Morocco’s eco-district proposal, meanwhile, aims to capitalize on innovative sustainable city systems by establishing a charter for eco-neighbourhood projects to leverage finance and engage residents in sustainable futures.⁷²

While the NDCs anticipate a supportive policy landscape for transition innovations, there is a need for a coordinated approach to building partnerships across actors and sectors to deliver net zero and resilient cities

There is a strong theme through the NDCs linking innovation and economic development. The assumption of growth is a constant in every NDC. Some see innovation as a means to attract private investment in sectors where they have less presence, such as Disaster Risk Reduction (DRR),⁷³ or to foster productivity⁷⁴ and facilitate industrial development.⁷⁵ Republic of Korea, for example, proposes the establishment of “innovative green industry ecosystems”.⁷⁶ Innovation is also seen as a means to advance more sustainable economic arrangements, for example by facilitating the establishment of a circular economy,⁷⁷ the entry of small companies,⁷⁸ inclusive economic growth⁷⁹ or the provision of the means for economic diversification, particularly in economies dependent on one sector, such as tourism.⁸⁰ The UK’s Net Zero Strategy, for example, foregrounds innovation together as a means for job creation with a focus on green, high-skilled jobs, but urban concerns are only highlighted in transport and mobility questions.⁸¹

Nevertheless, most NDCs take an expansive view of innovation beyond narrowly defined technological innovation. Many propose measures for a range of social innovation: innovation that generates new social practices and institutions. A number of NDCs emphasize the need for financial innovations. Some of the suggestions include mechanisms to facilitate payment for ecosystem services,⁸² cooperation mechanisms such as blended finance,⁸³ risk-sharing insurance products,⁸⁴ and adaptive green finance using ICT technologies: for example, innovations that enable the distribution of funds across government⁸⁵ or allow disadvantaged groups to access finance.⁸⁶ The 27 European Union (EU) countries, in a collective NDC, have now established their Emissions Trading System (ETS), the world’s first and biggest carbon market, as a means to finance a €40 billion (approximately US\$44 billion) innovation fund from 2020 to 2030, supporting innovations in mobility and net zero buildings among other areas.⁸⁷ The combination of carbon restrictions and financial support appears to have a positive impact on patents and innovation. Still, there is generally a consensus that the system has not delivered the technological breakthrough to achieve carbon neutrality.⁸⁸

Some NDCs also explain specific aspects of policy innovation, such as measures to increase equality, planning policies and implementation mechanisms. Some countries, such as Mexico, have targeted areas of social innovation, for example through a National Strategy of Remote

Working.⁸⁹ Social innovation is also a means to tackle disadvantages, although the means to tackle these challenges are usually modest.⁹⁰

In summary, the comparative analysis of the NDCs shows the growing importance of innovation, including NbS and social innovation, as a strategy for climate-resilient development. However, a sectoral approach still dominates. In urban environments, innovations are emphasized in the energy sector, the built environment, and transport and mobility. Thus, while the NDCs anticipate a supportive policy landscape for transition innovations, there is a need for a coordinated approach to building partnerships across actors and sectors to deliver net zero and resilient cities.

The following section explores integrative approaches to transition innovation that seek to mobilize and coordinate three domains of innovation: technological, nature-based and social innovations. It highlights four key areas with significant potential for urban transition—energy mix, networks and storage, urban electrification, and demand management—and discusses interrelated strategies for scaling transition innovations in these areas.

8.3 Domains and Strategies for Integrative Approaches to Transition Innovation

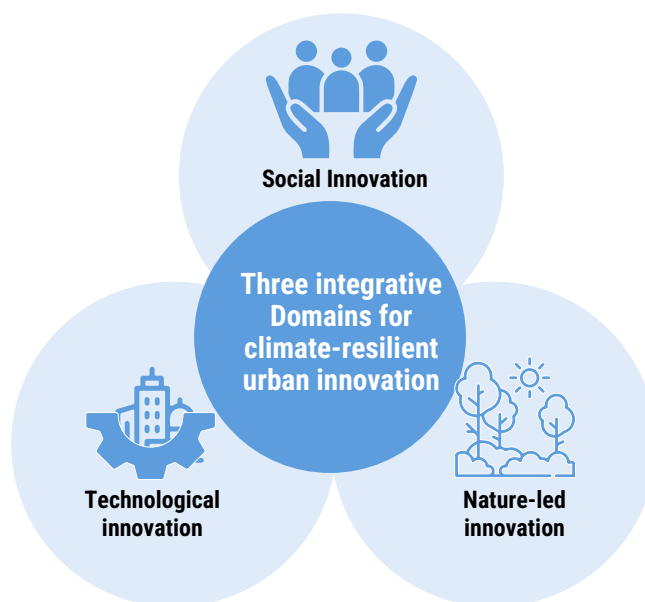
As highlighted by the IPCC, there is a wide range of technological innovation that can be deployed for climate action.⁹¹ Affordable and existing innovations will enable significant emission reductions and adaptation before 2030, but further innovation, as well as integration and coordination across innovations, will be needed to break dependencies from unsustainable economies to realize climate-resilient net zero cities. For example, lifestyle changes to reduce dependence on fossil fuels are interlinked with changes in infrastructure and urban form that privilege the petrol car over more sustainable modes of transport, as well as changes in extractive practices, reaching within and beyond the city.⁹²

Therefore, thinking of the transition towards net zero requires looking beyond specific innovations to consider the broader perspective of the shifts needed in existing technologies, infrastructures and the supporting ecosystems towards more sustainable social practices

and economic systems. These include appropriate governance and institutional conditions that enable the sharing, diffusion and co-creation of innovation, for example through collaborative spaces to test and pilot urban innovation, as well as the fixity of infrastructures and the ecological dynamics of the city.⁹³

Three domains of innovation are possible to foster a transition, but achieving this potential depends on integrating responses across such domains (see Figure 8.5).⁹⁴ Transition innovations can emerge in any domain, but impact on all of them.

Figure 8.5: Three domains for climate-resilient urban innovation



Illustrated by Vanesa Castán Broto based on Dodman et. al., 2022.

Agents of change in urban environments—policymakers, planners, private actors and civil society—face the complex question of how to exploit the possibilities for place-based action offered by cities to catalyze transition innovations while mobilizing global knowledge and facilitating learning across contexts.⁹⁵ This means recognizing that transition innovations are generated within a wider context of innovation.



Digital graphics overlay a cityscape © Shutterstock

Figure 8.6: Dimensions of transition innovations in an urban context

As outlined in Figure 8.6, there are three main areas of intervention that may support the generation of contextually situated, integrated transition innovation in an urban context.⁹⁶

1. *Facilitating spaces for entrepreneurial experimentation* with multiple innovations, whether this is within existing businesses and industries or in purposively developed arenas such as urban labs: for instance, local governments, national-level institutions, and donors may choose to *develop policies* that favor entrepreneurial experimentation, such as supporting SMEs or facilitating the development of innovation systems.
2. *Articulating an appropriate governance and institutional context* that enables the sharing, diffusion and contestation of innovation through collaborative spaces to test and pilot urban innovation: for example, local authorities and partners can support an innovation-oriented political culture through *forums of debate and exchange* that enable sharing and contesting innovations.
3. *Promoting innovation within a spatial and socio-cultural reconfiguration* that creates demands for innovation within existing infrastructures, inhabitation practices or ways of thinking: for instance, local actors may *support practical actions* to intervene through place-based innovations in existing infrastructures and cultures, for example, by identifying incremental innovations emerging spontaneously within the current systems of provision and workforce.

The three domains are closely interrelated and broaden the possibilities of action to develop innovation policies at the local level and extend the range of actors in transition innovations. Each one is discussed further below, highlighting key opportunities within each domain.

8.3.1 Technological innovation

Technological solutions for reducing carbon emissions and enhancing adaptation are being deployed across various urban systems, including renewable energy, energy efficiency, food systems, urban planning, data analysis, water supply and waste management. Energy systems are especially important as they underpin urban life and modern economies. Urban areas account for as much as 70-80 per cent of the global carbon footprint,⁹⁷ predominantly in electricity and heat generation, transportation and the production of industrial goods. Transition innovations that focus on the structural shift in energy source towards clean energy, as well as improving energy consumption efficiencies such as upgrading fittings in buildings and appliances, can significantly contribute to restraining emissions.⁹⁸

Four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management

Four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management.

First, the proliferation of *accessible and versatile renewable technologies* allows the diversification of the energy mix through the use of various alternative energy sources and the decentralization of power systems (for example, small-scale household solar photovoltaic systems). The surge in the adoption of solar systems within urban areas has spurred a growing demand for solar panels that exhibit enhanced flexibility and reduced weight.⁹⁹ These qualities are vital for ease of mobility, efficient distribution and adaptability to diverse applications, especially on uneven surfaces, while remaining cost-effective. While renewable energy continues to be a key area of interest, the past decade has seen a significant shift in focus

toward exploring and advancing novel energy forms such as hydrogen.¹⁰⁰

Second, there have been fascinating advancements in delivering *more efficient networks and better storage alternatives*, with increasing attention to the development of the battery industry and how it is shaping regional and urban policy. Increasingly, attention is being given to the potential of infrastructures as energy generators. Roadway energy harvesting¹⁰¹ uses innovative electromagnetic technologies that have been proposed and developed to efficiently capture and convert energy from diverse sources present on roadways.¹⁰² Solar energy harvesting technology is gaining popularity globally,¹⁰³ and in increasingly innovative ways: for instance, installing solar panels atop pavements transforms them into functional driving surfaces.¹⁰⁴ These and other technologies are also enabling the development of community and off-grid energy systems (see Box 8.4).

Box 8.4: The promotion of off-grid community energy systems in informal and peri-urban settlements in Malawi

Community and off-grid energy systems, which have often been seen as a solution for remote rural areas, are increasingly also recognized as a viable alternative in informal settlements and peri-urban areas where residents lack access to electricity even when living under the grid.¹⁰⁵ The deployment of these flexible, autonomous modes of energy generation can enable the adoption of more accessible, citizen-controlled electricity networks in urban areas. Moreover, community energy systems may help accelerate shifts to more sustainable urban practices, such as the electrification of cookstoves (still a significant source of household air pollution in developing cities in particular).

In Malawi, a suite of regulatory mechanisms has enabled the development of community energy innovations, supporting the diversification of the country's energy network. Since 2006, various micro-and mini-grids powered by renewables – solar PV, wind power, hydropower and hybrid systems – have been implemented, supported by institutional innovations like cooperatives and community associations and a conducive regulatory context. The 2004 Malawi Electricity Act and 2017 Renewable Energy Strategy were pivotal, enabling community energy systems and collaborations with NGOs.

Initiatives in the energy sector have been complemented with regulations in other sectors. For example, the 2017 National Charcoal Strategy, aiming to reduce deforestation, promotes using alternative fuels through community development. Despite challenges such as equipment access and natural disasters, these projects have advanced low-carbon energy and community resilience, as well as social co-benefits to the community.

Source: Hara et al., 2024.

Third, *urban electrification* is increasingly seen as an important strategy to facilitate fast decarbonization. Urban electrification entails the adoption of electric power as the primary source of energy in city-wide urban infrastructures, the built environment and transportation. In addition to efficiency gains, urban electrification supports a positive feedback cycle with the development of renewable sources close to the city, enabling greater autonomy for local governments in their energy planning. For example, innovations in developing alternative propulsion systems (such as new battery and cell technologies) have been a key strategy for sustainable mobility. Electric vehicles, for instance, are an important form of technological innovation that bring both environmental (reduced air pollution and carbon emissions) and social benefits (improved health and productivity).¹⁰⁶ Data from the International Energy Agency (IEA) shows that the proportion of electric cars in overall sales has surged, more than quadrupling in just three years—from approximately 4 per cent in 2020 to a remarkable 18 per cent in 2023.¹⁰⁷ The environmental and social benefits of the electrification of road transport depend on having renewable energy sources available, as well as appropriate charging points and road infrastructure planning. It is also important that different

mobility needs are adequately recognized.¹⁰⁸ Cities are increasingly mobilizing transition innovations to integrate built environments and infrastructures into the grid.¹⁰⁹

Fourth, *demand management* solutions also hold significant transformative potential. These are aimed at optimizing how and when energy is used to reduce overall consumption and shift usage patterns to align with sustainable practices.¹¹⁰ How to deliver such transformation remains contentious, however. One approach is through delivering designs and infrastructure that facilitate sustainable choices, such as energy smart meters, automated building systems to manage electricity consumption or low-emission Bus Rapid Transit (BRT) lines. Another approach is through financial incentives or regulations, such as charging higher rates for electricity during peak hours or passing legislation mandating the transition to green energy systems within set timelines. Yet another approach advocates for the transformation of broader cultures of sustainability: in China, for example, there has been a concerted effort to build an “ecological civilization” to benefit society and the economy (see Box 8.5).

Box 8.5: Delivering an ecological civilization in China and its impact on cities

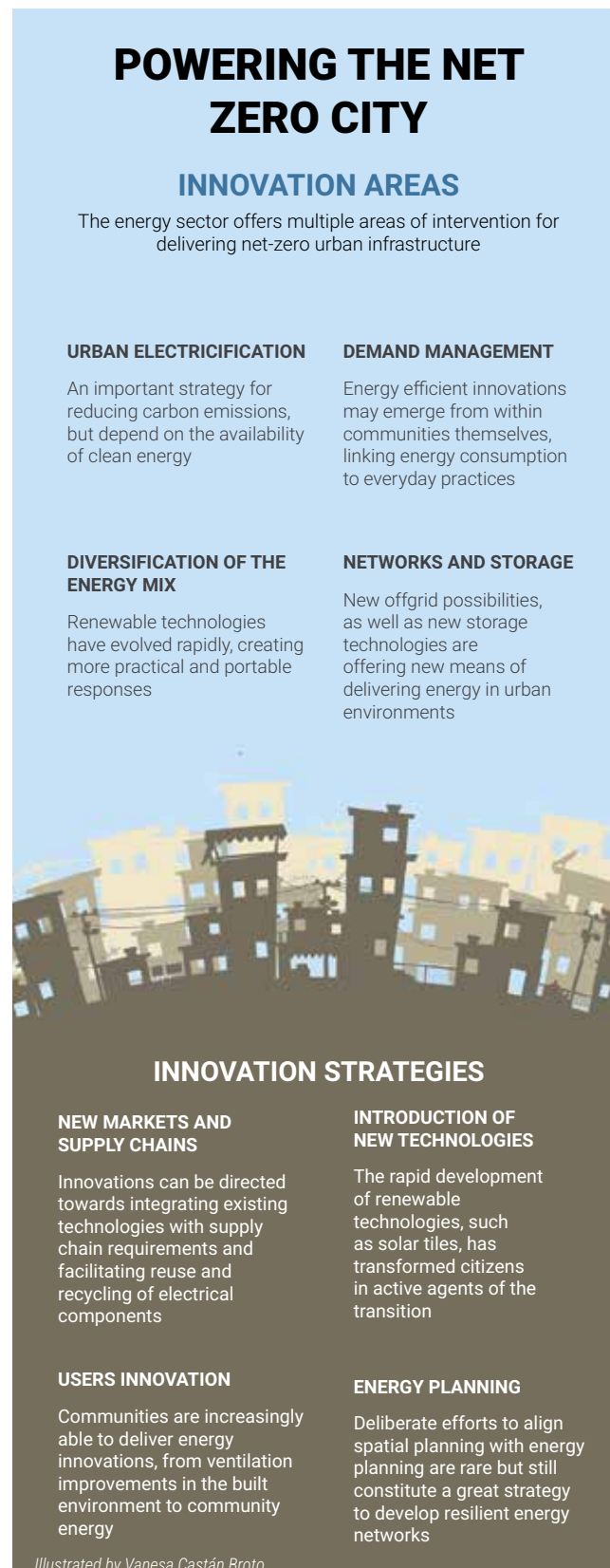
In 2018, China enshrined “ecological civilization” in its Constitution, signifying a national commitment to integrating ecological sustainability in its development strategy. The era of ecological civilization sets the stage for a wide range of environmental and climate initiatives, particularly in urban areas where the majority of China’s population reside and climate action is most urgently needed. This commitment builds on previous efforts to promote a more sustainable mindset among city residents. Since 2006, for instance, local governments in China have piloted different forms of social organization, from group walks to outdoor sports events, that promote positive behaviours and interactions with nature and the environment.

A notable example is the revitalization of the traditional tea steaming practice in Enshi, a small city in central China, and transforming it through industrial innovation to bolster a more environmental – friendly and sustainable green tea industry. This has promoted a green transition of the local economy and brought about societal benefits such as poverty alleviation by raising the income of local tea farmers. Enshi’s climate action illustrates the power of synergizing traditional practices with contemporary ecological goals to drive sustainable development and enhance social well-being.

Source: Based on analysis, *Global Tea Hut, 2020, p.5 and Tea Spring, n.d.*

Figure 8.7 provides an overview of the four transition innovation areas proposed in this section, together with four strategies that can activate the urban innovation ecosystem: supporting *new markets and supply chains* that respond to concrete urban needs, *introducing new technologies* through local programs of support, *engaging with community-led innovation* in saving and generating energy and *integrating innovation into local planning processes*. These should not be seen as four separate approaches to transition innovation, but rather closely interlinked strategic components that depend on the integration between urban planning, development and an understanding of local needs. For example, the EU introduced the Strategic Energy Technology Plan, aiming to establish 100 Positive Energy Districts by 2025 as part of its commitment to climate neutrality through enhanced energy efficiency and a net zero energy balance.¹¹¹ Concurrently, the continuous advancement of intelligent monitoring tools underscores a noticeable surge in the popularity of energy-saving technologies, seamlessly incorporated into the infrastructure of smart homes.¹¹² In terms of climate adaptation, increasing attention is paid to the relationship between energy and associated resource systems, particularly water and land resources.¹¹³ The integration and coordination of these strategies suggest that local governments remain key actors who can advance transition innovations in urban environments.

Figure 8.7: Key areas and strategies with strong potential for transition innovation



8.3.2 Innovating with nature

There is a growing interest in NbS for adaptation and mitigation strategies. NbS involves using ecosystems and biodiversity to address climate-related challenges, such as coastal protection through mangroves, urban green infrastructure, and reforestation projects.¹¹⁴ This requires reimagining nature as an integral part of the city, an area previously explored in detail in the *World Cities Report 2022*.¹¹⁵

The NDCs provide multiple examples of nature-related innovations. In some cases, these innovations address the negative impacts of urbanization on land transformations (see Box 8.6). These are particularly important not only because of urban expansion, but also because growing urban energy demands are met with large-scale renewable energy infrastructures that have direct impacts on ecosystems and can disrupt wildlife habitats.¹¹⁶

Box 8.6: Pine Island Project, Bahamas: An innovative approach to managing the increasing impact of urbanization on local ecosystems

Almost a third of the land in the Bahamas is covered by forest.¹¹⁷ The pine forests are an important source of biodiversity and protection for both its soil and water. However, this invaluable natural asset is endangered by unsustainable land use planning and large-scale urban development, including the illegal dumping of waste and the displacement of traditional land uses. These threats are exacerbated by climate change impacts such as rising sea levels and coastal inundation.

In 2015 the Bahamas government, with support from the Global Environmental Facility, launched the Pine Island Project in an effort to balance the preservation of its natural ecosystems with the demands of managing urban expansion. A central focus of the initiative was its innovative approach to community co-management and enhanced land use planning methods that integrate biodiversity values, ecosystem services and concepts of sustainable forestry and land use. Recognizing the specific pressures posed by urbanization, the project expanded its team in 2019 to include an urban planning consultant, ensuring that urban growth does not undermine the project's implementation.

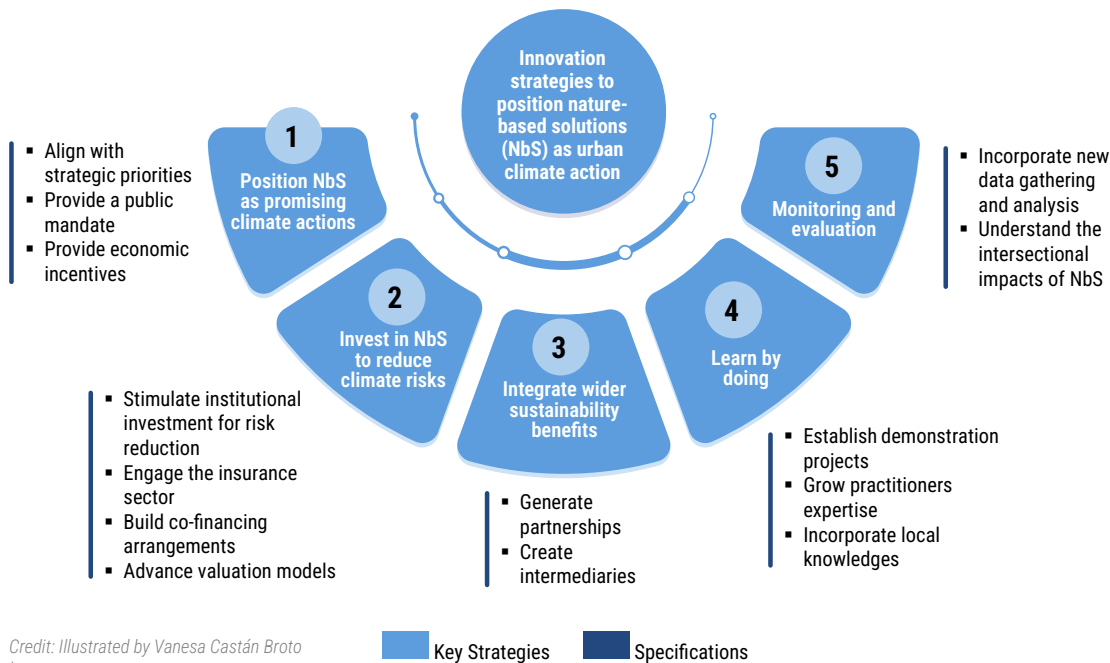
Source: UNFCCC, n.d., Bahamas NDC and UNEP, 2021b.

Sometimes NbS are also designed to create social solutions. The NDC in St Vincent and the Grenadines reports an innovative project that repurposes abandoned land into sustainable farming systems, with a parallel program to teach young people in schools the principles of organic agriculture, environmental art and innovative land uses that work with nature.¹¹⁸ Many nature-based innovations enable engagement with the experiences of Indigenous Peoples (see also Chapter 6). In the case of Dominica, for instance, the government takes inspiration from innovations in waste and natural resource management by the Kalinago people, whose lives are directly threatened by climate change.¹¹⁹

A review of the role of NbS in climate change adaptation and mitigation identified a range of innovation strategies that can be advanced within urban environments.¹²⁰ Some of those strategies are directed toward changing narratives about the promise of NbS as climate action and integrating them into broader sustainability benefits. Other strategies are directed toward creating an appealing investment environment. Figure 8.8 illustrates various strategies to advance NbS in urban climate action. Two key strategies hold potential in scaling NbS within the urban context: on the one hand, learning-by-doing, and on the other monitoring and evaluation processes that facilitate such learning. Despite the growing enthusiasm for NbS and the range of benefits they bring, they are still a relatively novel area of action whose full potential has yet to be realized.



Volunteer picking up a plastic bottle in the woods. Green and clean nature/ Shutterstock

Figure 8.8: Strategies for positioning NbS in urban climate action

8.3.3 Social innovation

Unlike supply-side solutions that predominantly focus on technology, demand-side strategies emphasize harnessing social innovation.¹²¹ Social innovation aims to cultivate new relationships through new practices and institutional networks that promote collaboration and learning beyond the traditional boundaries of citizen, government, private sector and civil society.¹²² Social innovation is not in itself opposed to technological innovation (and often emerges associated with it):¹²³ for instance, social innovation can help reshape the consumption of goods and services by influencing decisions regarding technology adoption, consumption habits, behaviour and lifestyles.¹²⁴ However, because social innovation emphasizes the importance of building collective resilience, it is grounded on principles of cooperation rather than competitiveness.

Innovations for demand-side mitigation options operate through three strategies, known collectively as *Avoid-Shift-Improve*:¹²⁵ *Avoid* involves mitigating strategies that trim surplus consumption by redesigning service-provisioning systems; *Shift* entails transitioning to existing competitive low-carbon technologies and service-provisioning systems; and *Improve* concentrates on boosting efficiency in current technologies, emphasizing adoption by end users. Adopting a nuanced strategy for contextualizing climate solutions within urban settings necessitates the formulation of context-sensitive, place-based approaches intricately tailored to each city's unique dynamics.¹²⁶

Indigenous knowledge, deeply rooted in the urban fabric, proves especially adept and often underpins important social innovations that are not even recognized.¹²⁷ For instance, in a city grappling with urban heat island effects, leveraging Indigenous wisdom may involve the

integration of traditional architectural techniques that enhance natural cooling and promote sustainable urban design. Where flooding poses a recurrent threat, Indigenous insights could inform the development of resilient green spaces and community-driven flood preparedness plans. Despite their importance, however, Indigenous voices are most often absent from urban development planning.¹²⁸



Indigenous knowledge, deeply rooted in the urban fabric, proves especially adept and often underpins important social innovations that are not even recognized

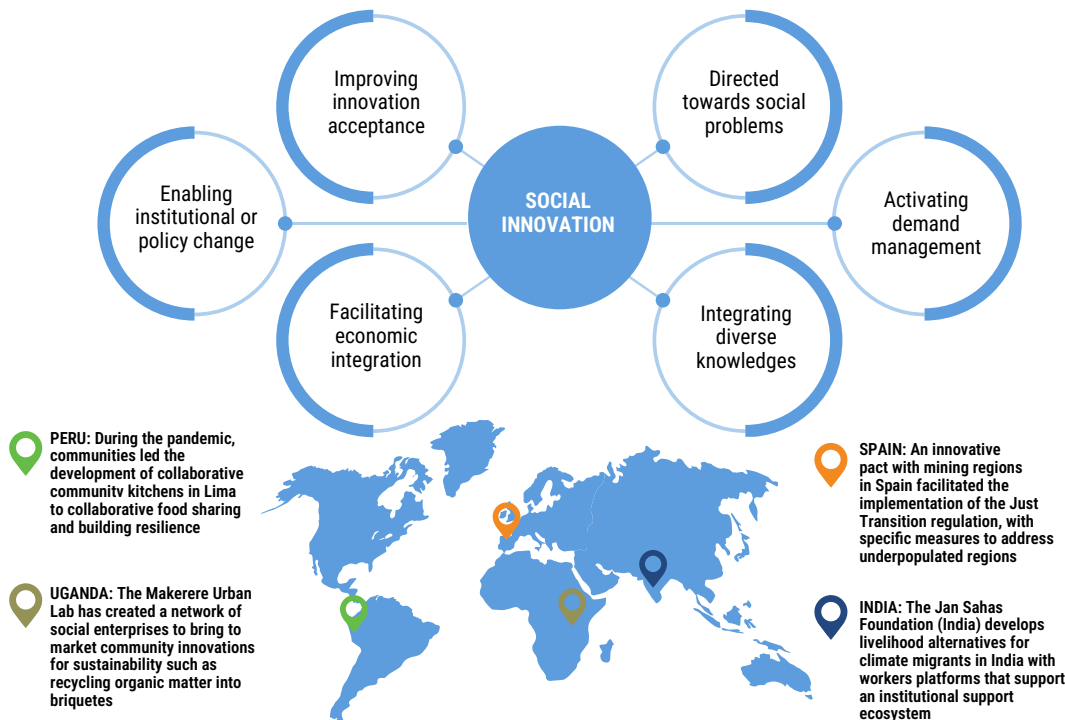
By fostering locally adapted and embedded solutions, social innovation broadens the spectrum of innovation agents, extending participation to ordinary individuals within local communities. By engaging a diverse array of actors, from grassroots community members to local institutions, the innovation landscape becomes more inclusive and reflective of the varied needs and insights present at the local level (Figure 8.9). This diversification enhances the effectiveness of climate initiatives by fostering a sense of collective ownership, empowering individuals to contribute actively to sustainable practices and resilience-building efforts.¹²⁹

Social innovation is also linked to social infrastructure, which includes the spaces and institutions that allow people to connect and interact in mutually supportive ways. This can range from physical locations like meeting halls to organized networks of community support. Social infrastructure plays an enabling role in building cohesive communities and enhancing collective well-being, from fostering social connections

for delivering effective disaster response.¹³⁰ Many social innovations help build social infrastructures, which in turn support social innovations that attend directly to community needs. For instance, a project by an NGO

in a flood-hit area of Bangladesh operated boats as mobile emergency service providers, becoming a vital “beacon of hope” and cohesive public space for disaster-affected communities.¹³¹

Figure 8.9: Characteristics of social innovation and some examples from around the world

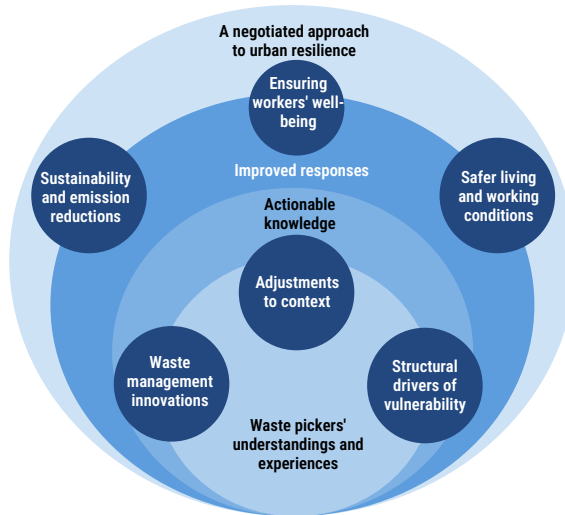


Illustrated by Vanesa Castán Broto based on different sources.

Social innovations may help integrate the environmental and social benefits of climate action. New models of circular cities and circular economies have led to innovations to favor the mining of resources from existing waste in an emerging discourse that could help reappraise the work of waste pickers in cities and make visible their contributions to urban sustainability.¹³² In Belo Horizonte, Brazil, the collaboration with the Estate of Minas Gerais, led by waste pickers cooperatives and NGOs such as WIEGO, has supported the development of policy innovations such as the *bolsa de reciclagem*, a form of payment that recognizes the workers’ role in recycling by paying for the materials recovered.¹³³ Further work is needed to integrate waste pickers in a negotiated approach to urban resilience that begins by recognizing the workers’ capacities, particularly their ability to deliver waste management innovations. This should be accompanied by innovations to improve their well-being and achieve safer living conditions: for example, through new models of waste collection and processing adapted to changing weather patterns and recurrent experiences of flooding and heat (Figure 8.10).

Municipal civil servants play a crucial role in implementing urban climate commitments, and their engagement and personal convictions can significantly drive climate action

Figure 8.10: A negotiated approach to urban resilience: Integrating waste pickers into city-wide systems in Belo Horizonte, Brazil



Source : Dias et al., 2024.

The waste-to-energy initiative in Freetown, Sierra Leone offers yet another compelling example of how social, technological and financial innovation can be combined for urban climate action (see Box 8.7).

Box 8.7: The use of digital technologies in circular waste-to-energy systems in Freetown, Sierra Leone

Freetown Waste Transformers (FWT) exemplifies an innovative approach to waste management in Sierra Leone, integrating the principles of the circular economy, digital technology and citizen collaboration. Established in 2019, FWT addresses the pressing issue of waste management by using anaerobic biodigesters to convert organic waste (which comprises 84 per cent of waste produced in the city) into biogas and fertilizer. This not only mitigates landfill overflow but also contributes to reducing reliance on an unstable power grid. A pilot biodigester was installed at the Aberdeen Women’s centre in 2022 to help transition the health centre from its over-reliance on costly diesel-powered generators.

A pivotal element of FWT’s success is the use of the DortiBox App, which digitizes waste collection, allowing residents to schedule pickups easily and securing a reliable supply of organic waste for FWT. This innovation enhances operational efficiency and improves communication between citizens and waste collection enterprises, fostering a sense of community involvement in sustainable practices. FWT has leveraged blended finance to include own funding, in-kind support grants and private sources, providing a good example of strategic integration of diverse finance sources for enabling locally-led climate action (an area explored in Chapter 9).

Collaboration with the Freetown City Council (FCC) is also crucial in creating an enabling environment. Through partnerships with the FCC, FWT supports local initiatives aimed at strengthening community-based waste management practices, pivotal in executing the “hub and spoke” business model. The council’s micro-enterprise schemes aid in door-to-door waste collection, ensuring that even hard-to-reach areas are serviced. This multifaceted collaboration not only promotes efficient waste management, but also aligns with broader climate action objectives, making FWT a model for integrative approach to transition innovation in urban settings.

Source: Asare & Bailey-Morley, 2024; Freetown City Council, n.d.; DortiBox, n.d.; The Waste Transformers, n.d.

Institutional innovation, specifically, encompasses transformative shifts in legal frameworks, policies, financial institutions and organizational structures designed to mitigate and adapt to the impacts of climate change effectively.¹³⁴ In recent years, new and innovative approaches to climate change governance have surfaced within urban environments. These include practices like urban experimentation¹³⁵ and urban laboratories¹³⁶ that attempt to adapt the urban governance system better to tackle the risks of climate change. Urban laboratories, for instance, highlight knowledge co-production processes involving business, civil society and other end users as innovative activity sources.¹³⁷ Achieving innovation in climate policy involves intricate processes whereby diverse

policy entrepreneurs collaborate with bureaucrats and politicians to advocate for and implement their solutions.¹³⁸ With greater attention attached to demand-side solutions for climate change, innovative policy interventions are beginning to target human behaviour-related arenas of action.¹³⁹ Municipal civil servants play a crucial role in implementing urban climate commitments, and their engagement and personal convictions can significantly drive climate action. The example of how municipal employees in Amsterdam (the Netherlands) helped trigger a “tipping point” that saw the city undertake an ambitious process of institutional innovation to drive climate action is a case in point (see Box 8.8).



Open landfill of household waste.
Plastic waste/Shutterstock

Box 8.8: Working towards “our city for tomorrow”: The role of municipal innovation in driving climate action in Amsterdam, the Netherlands

Amsterdam is one of the most vulnerable cities in the world to climate change, threatened by sea-level rise and even the risk of encroachment by the North Sea. However, like other local governments, the municipality of Amsterdam faces a number of dilemmas that hinder its ability to act decisively in response to the climate crisis. Even with the right political will in place, city authorities have to navigate the existing status quo and the continued dominance of fossil fuel-favoring technologies and policies. The situation is further compounded by government structure that are inherently averse to abrupt change and are therefore only able to adapt slowly.

On 31 October 2022, all 17,000 of Amsterdam’s municipal employees received an email from seven civil servants. It called attention to the fact that the city was failing its own stated goal of achieving a 60 per cent reduction in CO₂ emissions by 2030, compared to 1990 - a target it also criticized as insufficient. The authors urged the municipal management to close the gap between rhetorical ambition and actual implementation. This letter prompted management to host “climate events”, fostering dialogue and inviting civil servants to actively support the necessary actions to bridge this gap.

Subsequently, in 2023, the city issued an administrative order directing the entire municipality to develop a detailed policy roadmap to guide the development of “our city for tomorrow”. The city’s sustainability efforts were restructured, shifting from a separate top-down focus in the city budget to a horizontally integrated approach that allowed for stronger alignment across administrative functions. Additionally, with all municipal employees encouraged to use their own initiative in identifying priorities and roadblocks, any issues are now directly escalated for decision-making by a dedicated city council team. Over the space of just two years, some 200 “climate dilemmas” have been reported this way. The success of this model of institutional innovation has inspired municipal employees in other cities such as Utrecht and Almere to urge similar systems to be set up there.

Source: Case study submitted by Gemeente Amsterdam—Municipality of Amsterdam

Another emerging area of innovation is climate finance, with multiple ideas suggested in the NDCs, often linked to financing NbS and facilitating new forms of value (for instance, see further discussions on green bonds in Chapter 9). Encouraging innovations in scaling finance at the local level can provide grassroots, non-state local actors with the opportunity to access much needed resources.

8.4 Towards Transition Innovation Ethics

By its nature, transition innovation is not a neutral process and directly impacts people’s lives. Its development is commonly associated with complex trade-offs and ethical dilemmas. To date, no attention has been paid to the ethics of transitions, and when ethical questions have been raised, they have almost always been subsumed under more prevalent concerns about justice in transitions.¹⁴⁰



Transition innovation is not a neutral process and directly impacts people’s lives. Its development is commonly associated with complex trade-offs and ethical dilemmas

However, the ethical dimensions of transition innovation are undeniable and analytically distinct from the identification of negative unintended consequences. In this section, the ethics of transition innovation are examined, both in terms of the normative aspects – how we judge the adequacy of certain actions – and the practical implications of envisioning alternative urban futures through an ethical lens. The section begins by discussing the ethical dilemmas associated with knowledge generation, before discussing some examples of how emerging general concerns about knowledge and ethics are managed in local contexts.

8.4.1 Ethical dilemmas in transition innovation

Research agendas are often shaped by societal biases and the normative value attributed to different types of knowledge, leaving many relevant fields of knowledge underexplored or “undone”.¹⁴¹ For instance, in urban contexts, there is abundant evidence that the emphasis on data and modelling in transport research has directed attention away from analyzing actual transport experiences.¹⁴² There are questions whether some innovation efforts are wasteful or produce more harm than benefits—what is referred to as “the dark side of innovation”.¹⁴³

For some urban residents, particularly those from disadvantaged groups, the negative impacts of introducing net zero innovations in the built environment may outweigh the positives. If the technologies developed are inappropriate or dominant knowledge generation processes distract attention from more urgent challenges, then climate policies may even reinforce disparities between poor and affluent urban communities. These divides, when they occur, raise fundamental questions about who is really paying the price of the crisis. Whether at the global, national or local level, it all too often appears that those who contribute least to climate change through lower-emitting lifestyles – low-income communities and developing countries – are typically left to bear the brunt of its impacts.

The framework of undone science offers some hypotheses that explain the interconnected mechanisms whereby this happens, providing a range of areas for local governments and social movements to intervene. These have been related to a number of factors that serve to prioritize, overlook or shut down different areas of knowledge and research:¹⁴⁴

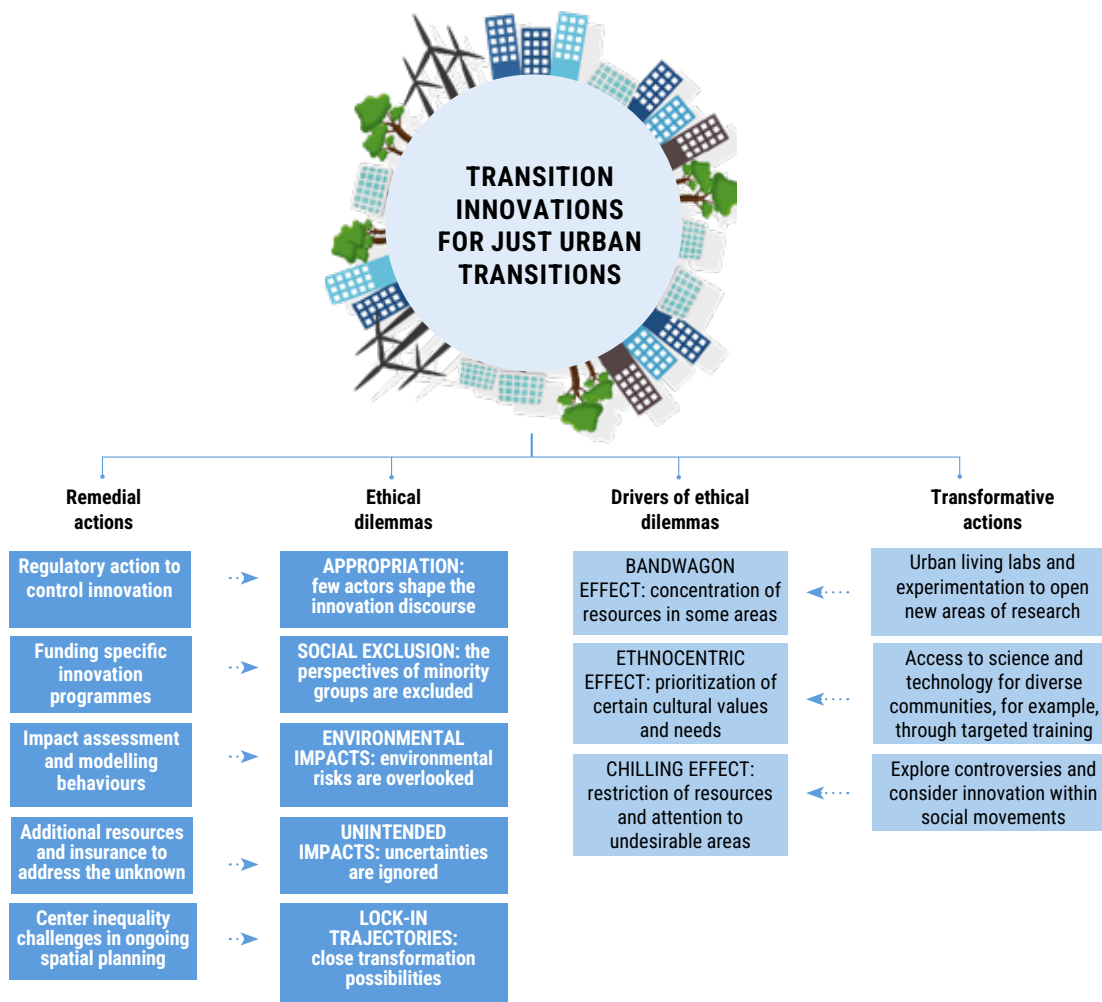
- The *bandwagon effect* occurs when resources, labour and attention are diverted to certain research areas, in the process neglecting other valid concerns. For example, the early successes of BRT transportation networks in some cities led to disproportionate attention being focused on these systems, often at the expense of developing alternatives based on the informal transportation systems that shape many rapidly growing cities.¹⁴⁵
- The *ethnocentric effect* prioritizes dominant cultural practices, particularly in the postcolonial context, while frequently disregarding Indigenous practices better adaptable to specific urban environments. For instance, this may hinder efforts to restore vacant land in urban areas that rely on native plants in favor of more commercialized alternatives that may be far less suited to local conditions.¹⁴⁶



For some urban residents, particularly those from disadvantaged groups, the negative impacts of introducing net zero innovations in the built environment may outweigh the positives

- The *chilling effect* refers to the active closing of areas of research because they are not profitable or otherwise valuable to powerful interests. This was evident, for example, in the way many car manufacturers previously turned their attention away from electric vehicles in favor of more efficient petrol and diesel combustion engines.¹⁴⁷

Figure 8.11: Causes and consequences of undone science and harmful innovation in the urban environment, with proposals for action



Illustrated by Vanesa Castán Broto

Figure 8.11 offers examples of the ethical dilemmas that emerge in the production of transition innovation. On the left-hand side are some examples of specific ethical dilemmas and the remedial actions that are taken to address them. The right-hand side illustrates how the interlocked drivers of ethical dilemmas can be tackled directly through three transformative strategies:

- *Creating arenas of experimentation*, such as urban labs and open research areas, enables diverse actors to try out various strategies to deliver a just urban transition.
- *Expanding knowledge sources* and deliberately finding ways to recognize the views of disadvantaged groups increases diversity and access to R&D forums, in line with the inclusive innovation policies discussed in Section 8.1.2.
- *Encouraging open debates* to acknowledge controversies helps capture society’s varied perceptions of innovations.

The field of ethics is vast, but some dilemmas may become clearer by focusing on a particular technology or field of innovation. The following section presents some examples of what an ethical response to key areas of transition innovation may look like.

Initiatives that support the mobilization of local knowledges or recognize Indigenous perspectives constitute valuable social infrastructures that increase urban resilience

8.4.2 Ethical responses in key areas of the transition to net zero cities

As discussed in detail in Section 8.3.1, four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management. While multiple strategies can be advanced to support innovation in these areas, it is crucial to remember that transition innovations are associated with trade-offs. By definition, these trade-offs can have negative social and environmental implications, particularly for marginalized urban groups, underscoring the need for a responsible and thorough evaluation of the impacts in the context of a just urban transition. Local governments and other urban actors may proactively handle such trade-offs through appropriate responses that recognize the range of effects that transition innovations entail. As Table 8.5 shows, these drivers can be addressed through targeted urban policies that specifically respond to the causes and the consequences of undone science and harmful innovation.

Table 8.5: Examples of trade-offs in transition innovation and suggested responses

Transition innovation area	Positive impact	Potential negative impact	Responses to limit negative impacts
New renewable technologies for the diversification of the energy mix	<ul style="list-style-type: none"> ▪ Cheaper renewable technologies facilitate autonomy and access to electricity and cleaner fuels. 	<ul style="list-style-type: none"> ▪ Renewable technologies may need land and water resources that communities depend on and cause forced displacement (e.g., in large-scale installations). 	<ul style="list-style-type: none"> ▪ Participatory planning in the design and installation of renewable technologies in consultation with affected communities.
Restructuring networks and storage	<ul style="list-style-type: none"> ▪ Flexibility and modularity may increase the social resilience of the electricity network. 	<ul style="list-style-type: none"> ▪ Fragmentation of infrastructure systems may lead to the differentiation of systems with poorer sectors of the population being excluded from reliable services. 	<ul style="list-style-type: none"> ▪ Appropriate design may increase the reliability of off-grid designs.
Urban electrification (households, services, industry)	<ul style="list-style-type: none"> ▪ Reduction of indoor air pollution and health improvements. ▪ Less time spent collecting fuel. 	<ul style="list-style-type: none"> ▪ Increased costs of energy and appliances may limit access. ▪ Services and industrial products may become more expensive. 	<ul style="list-style-type: none"> ▪ Making electricity affordable through supporting renewable energy initiatives. ▪ Local governments, NGOs, and other institutions can facilitate access to appropriate appliances by subsidizing them or enabling local production.
Energy efficiency retrofitting and demand management	<ul style="list-style-type: none"> ▪ Household improvements may reduce the costs of electricity. 	<ul style="list-style-type: none"> ▪ New technologies and designs may make housing unaffordable for certain population groups. 	<ul style="list-style-type: none"> ▪ Housing programs that incorporate energy efficiency measures can co-design models with future residents.

8.5 Concluding Remarks and Lessons for Policy

A people-centred approach to innovation is central for effective urban climate action. Such an approach prioritizes a just urban transition within the framework of transition innovation. Therefore, transition innovation

not only creates “new” ways of responding to climate change challenges, but does so in a way that builds collective resilience and avoids worsening conditions for any particular groups, especially the most vulnerable. This chapter argues that the transition innovation approach, inspired by ideas of just transition, requires three strategies:

- Use innovation to *tackle the structural drivers of climate injustice*.
- Recognize the *multiple forms in which place-based, inclusive innovation occurs* and facilitate their emergence in ways that *link innovations to people's needs*.
- Create the conditions for the *exchange of knowledge through justice-based approaches*.



A people-centred approach to innovation is central for effective urban climate action. Such an approach prioritizes a just urban transition within the framework of transition innovation

This chapter further argues that integration and coordination across the three domains of innovations—technological, nature-based and social—is necessary to unlock co-benefits and optimize synergies for realizing climate-resilient net zero cities. Social innovation is particularly important to facilitate a just urban transition, acting as an important catalyst to mobilize a range of knowledge, address social demands not covered in competitive sectors, and bridge the gap between users and a rapidly changing technological landscape. Initiatives that support the mobilization of local knowledges or recognize Indigenous perspectives constitute valuable social infrastructures that increase urban resilience.

National governments have numerous opportunities to develop policies that support transition innovation for a just urban transition at the local level, such as subsidies and tax breaks, regulation, public sector procurement drives, financial incentives for diffusion and adoption, labelling or certification schemes, and broader changes in the overall architecture of innovation systems. As the NDCs show, national governments can lead innovations that address the injustices associated

with transition innovations, as well as adopt national and regional policies to guide just urban transitions.

While national governments can play a key role in creating a policy environment that supports transition innovation for a just urban transition, local governments can lead a range of inclusive policies to support a local innovation ecosystem. Policies in this area can challenge the mainstream narratives of innovation that overlook social and environmental impacts, broadening the range of actors able to access to innovation arenas. This also requires a detailed understanding of the characteristics of innovations and how they impact daily lives.

International agencies, city networks, activist groups, grassroots organizations and other narrative-making actors are key in supporting a people-centered approach to transition innovations. They may organize and collaborate with multiple stakeholders, leading the development of transition innovations (such as grassroots, frugal or mundane innovations) as well as adopt ethical principles to shape innovation processes. Businesses can lead transition innovations with added social value and participate in collaborative innovation processes, such as innovation platforms or cluster innovations. Intermediaries such as universities and think tanks can also support innovation development and create sustained partnerships. In sum, the urgent need for a just urban transition calls for the participation of all actors and the generative potential of knowledge sharing and mutual learning through ethically informed exchange platforms to move towards a better urban future.

The urgent need for a just urban transition calls for the participation of all actors and the generative potential of knowledge sharing and mutual learning through ethically informed exchange platforms to move towards a better urban future



Renewable energy power plants - photovoltaics, wind turbine farm and battery container © Shutterstock

Endnotes

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