# From Local Action to Global Impact: How Cities are Driving Urban Sustainability Transition

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**Abstract**

Cities have become central actors in the global sustainability transition, often surpassing national governments in climate ambition and implementation. This paper examines how cities advance urban sustainability through voluntary commitments and locally tailored action, with particular attention to transnational networks such as C40. Using the four priorities identified in the 2017 report by C40 and McKinsey (decarbonizing electricity grids, improving building energy efficiency, enabling next-generation mobility, and strengthening waste management), the paper compares selected C40-affiliated cities. The cases illustrate diverse, context-specific strategies: renewable-energy power purchase agreements in Sydney and Rio de Janeiro; distributed solar incentives and mandates in New York, Paris, and Delhi; floating solar in land-constrained Singapore; a building-sector cap-and-trade program in Tokyo and building emissions caps and technical assistance under New York's Local Law 97; transit-oriented development through Copenhagen's Finger Plan; bus rapid transit in Lima and Bogotá; active-mobility initiatives such as Paris's 15-minute city and Copenhagen's Green Wave; and circular waste systems, including mandatory composting in New York, food-waste digesters in Singapore, and Copenhagen's CopenHill. The paper also analyzes C40's roles in knowledge sharing, agenda-setting, and accountability. It argues that the network's data-driven governance model, reinforced by Bloomberg-era norms of measurement and disclosure, links municipal accountability, external recognition, and access to climate finance. Drawing on interviews with four practitioners who designed, implemented, or replicated this model, the analysis assesses its effectiveness, financialization, democratic character, and justice implications. It shows that PlaNYC embedded this feedback loop in its accountability framework, but that its replication elsewhere could leave distributive and

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democratic questions unresolved. City-led, bottom-up sustainability transitions are therefore both viable and essential to meeting global climate goals, although the accountability regime supporting them has structural limits that the next generation of urban climate governance must address.

**Keywords:** Urban Sustainability, PlaNYC, C40 Cities, Case Studies

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## 1. Introduction

Human society's exploration of "sustainable" urban settlement has a long and evolving history and perhaps can be traced back to 18th century Malthusian theory of "environmental limits".[1] In the first half of the 20th century, countries in the developed world experimented with various concepts such as *garden cities* and the *new towns* in the UK and the US, where urban planners sought to create decentralized, low-density dwellings surrounded by green belts. Later in the 1970s and 1980s, cities in Scandinavian countries pioneered the community and municipal level initiatives on energy efficiency and reducing fossil fuel consumption. These early efforts were motivated more by the urgency to address "urban problems" such as congestion, housing, energy and green space, than by the need to conform to urban sustainability. It was not until the publication of the Brundtland Report in 1987 that the concept of "sustainable development" and "sustainability" received wider global recognition. Then, the Rio Earth Summit in 1992, and the resultant Agenda 21, further raised the strategic importance of mitigating the environmental impacts of urbanization through local action plans.[2] Most of the actions proposed in Agenda 21 directly involve municipalities, with Chapter 28 specifically calling for local authorities to develop Local Agenda 21.[3] The 1994 Charter of European Cities & Towns Towards Sustainability (the Aalborg Charter) states that "cities and towns are key players in the process of changing lifestyles, production, consumption and spatial patterns" and

[1] Bogachan Bayulken and Donald Huisingh, "A Literature Review of Historical Trends and Emerging Theoretical Approaches for Developing Sustainable Cities (Part 1)," *Journal of Cleaner Production* 109 (2015): 11-24, https://www.sciencedirect.com/science/article/pii/S0959652615000037?via%3Dihub.
[2] Bayulken and Huisingh, "Literature Review."
[3] Voula Mega and Jorn Pedersen, *Urban Sustainability Indicators* (Luxembourg: Office for Official Publications of the European Communities, 1998), https://www.eurofound.europa.eu/en/publications/all/urban-sustainability-indicators.

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therefore "city or town is both the largest unit capable of initially addressing the many urban architectural, social, economic, political, natural resource and environmental imbalances damaging our modern world and the smallest scale at which problems can be meaningfully resolved in an integrated, holistic and sustainable fashion".[4] After the turn of the century, both the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) imposed high expectations on municipalities for both service provision and monitoring of performance and costs, but offered municipalities minimal financial or practical support for delivering sustainability outcomes. In response, cities increasingly formed networks to draw upon the knowledge, advice, and resources of external partners within their own communities.[5] One of the most prominent is the C40 Cities Climate Leadership Group (C40).

C40 began to form in 2005 when mayors of 18 pioneering megacities met in London to begin a conversation on how cities could take initiatives and collaborate to cut emissions and combat global warming. This conversation quickly led to the formation of a coalition of cities that were committed to act on the climate crisis, known at the time as the "C20".[6] In the following years, under the chair of Mayor Ken Livingstone of London and Mayor David Miller of Toronto, the network grew to include more cities, particularly those from the Global South, partnered with the Clinton Climate Initiative, and facilitated peer-to-peer learning through knowledge sharing on buildings, transport, energy and adaptation.[7] In the early 2010s, when

[4] European Conference on Sustainable Cities & Towns, *Charter of European Cities & Towns Towards Sustainability (Aalborg Charter)* (Aalborg, Denmark, 1994), 1-2, https://sustainablecities.eu/fileadmin/repository/Aalborg_Charter/Aalborg_Charter_English.pdf.

[5] Katherine Maxwell, *Governance Networks for Sustainable Cities: Connecting Theory and Practice in Europe*, Routledge Explorations in Environmental Studies (Abingdon, UK: Routledge, 2023).

[6] C40 Cities, "Our History," https://www.c40.org/about-c40/our-history/.

[7] C40 Cities, "Our History."



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Mayor Michael Bloomberg of New York chaired C40, the network embraced the data-driven approach featuring emissions measurement, reporting, disclosure, and standardization, which was similar to the approach adopted by PlaNYC, also under the leadership of Bloomberg. This data-driven approach made member cities globally accountable and arguably shaped the shared identity of C40 cities.[8] In addition, Bloomberg's tenure also brought to the network significant funding, resources and infrastructure from Bloomberg Philanthropies and through merging with the Clinton Climate Initiative's Cities Program.[9] With the adoption of the Paris Agreement, C40 emerged to become a preeminent global organization in urban sustainability and has continuously disseminated research findings. In 2017, McKinsey Center for Business and Environment and C40 Cities published a report summarizing four strategic areas – *decarbonizing the electricity grid, optimizing energy efficiency in buildings, enabling next-generation mobility,* and *improving waste management* – that could assist cities in planning and achieving their sustainability agenda.[10] The group has also published research reports, policy briefs, implementation guides, case studies and best practice examples.[11] Although the overarching theme of C40 is climate change, the comprehensive action plan necessary to address climate challenge inherently extends to all economic, social and environmental aspects of sustainability.

This paper examines and exemplifies the global influence of cities in the transition

[8] David J. Gordon, *Cities on the World Stage: The Politics of Global Urban Climate Governance* (Cambridge: Cambridge University Press, 2020)
[9] Gordon, *Cities on the World Stage.*
[10] C40 Cities and McKinsey Center for Business and Environment, *Focused Acceleration: A Strategic Approach to Climate Action in Cities to 2030* (C40 Cities and McKinsey & Company, 2017), https://www.c40.org/other/focused-acceleration.
[11] C40 curates these publications on its Knowledge Hub. C40 Cities, "C40 Knowledge Hub," https://www.c40knowledgehub.org/s/?language=en_US.

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towards sustainability, particularly how the global sustainability agenda is pioneered and implemented by cities through voluntary commitment and actions. It highlights the climate actions and local policy interventions implemented by several cities, which are also C40 signatories. The key research questions the paper intends to address are: *What programs, regulatory policies, or interventions are cities implementing across the major areas of urban sustainability? What roles do city networks such as C40 play in municipalities' sustainability efforts? And how has PlaNYC's standardized accountability framework influenced cities' sustainability efforts, and with what limitations?*

To interpret these networked functions, the paper draws on David Gordon's account of urban climate governance, in which accountability operates through three linked forms: an external politics of recognition, by which disclosure earns cities standing with peers, funders, and global audiences; a network politics of ordering, by which benchmarking ranks cities and disciplines their conduct without formal enforcement; and an internal politics of translation, by which globally legible metrics must be adapted to local budgets, institutions, and priorities.[12] Around this frame, the paper reads the accountability model through four analytical lenses: its effectiveness in changing what cities actually do, its financialization as disclosure becomes a currency of recognition convertible into capital, its democratic character as cities weigh accountability to funders against accountability to residents, and its justice implications as standardized measurement renders some concerns legible while sidelining others.

[12] David J. Gordon, "The Politics of Accountability in Networked Urban Climate Governance," *Global Environmental Politics* 16, no. 2 (2016): 82-100, https://doi.org/10.1162/GLEP_a_00357.

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The analysis in Sections 2 through 4 draws, alongside the existing literature, on four semi-structured interviews conducted in August 2026 with practitioners positioned at successive points in the model's life: Rohit Aggarwala, who designed PlaNYC's measurement architecture and carried it into C40; Jonathan Dickinson, who built New York's greenhouse gas inventories; Adam Freed, who advised other cities on adapting the toolkit through Bloomberg Associates; and Yuko Nishida, who worked for the Tokyo Metropolitan Government on climate policy and designed the world's first city-level building-sector cap-and-trade program. Interviewees were selected purposively to span the design, implementation, replication and localization of the accountability model. Each interview followed a protocol built on a shared core of six questions organized around the four analytical lenses, with emphasis weighted toward the lens most relevant to the interviewee's role. Interview material was analyzed thematically against the four lenses and compared across interviewees for points of convergence and disagreement, and it is used to corroborate, qualify, or elaborate on findings from the literature rather than as a standalone basis for claims.

The remainder of the paper is organized as follows. Section 2 presents case studies of urban policies and interventions implemented by cities across the four strategic areas, beginning with the electricity grid, followed by building energy, mobility, and waste. Section 3 discusses the role of city networks across their functions of knowledge sharing, agenda-setting, and accountability, traces how PlaNYC's measurement architecture became a norm of C40 membership, and examines the tension between standardization, local relevance, and equity. Section 4 turns to the limitations of replicating the PlaNYC-style accountability regime in cities around the world, to what it has not yet achieved after twenty years, and to the limitations of

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this study. Section 5 concludes.

## 2. City Case Studies

The 2017 report by C40 Cities and McKinsey, *Focused Acceleration: A Strategic Approach to Climate Action in Cities to 2030,* laid out four strategic areas for urban sustainable development that are in line with the global climate targets: *Decarbonizing the electricity grid, Optimizing energy efficiency in buildings, Enabling next-generation mobility,* and *Improving waste management*.[13] The following case studies in this section will be organized according to these four areas.

The cases were selected purposively rather than to form a representative sample. Each city is affiliated with C40, each offers a well-documented intervention in at least one of the four strategic areas, and together they span the Global North and South, a range of fiscal and administrative capacities, and both mandatory and voluntary instruments. New York appears in several areas because it is the origin of the accountability model this paper examines, and Tokyo is included because its building cap-and-trade program offered a direct precedent for New York's building emissions caps. The cases illustrate the range of instruments cities use; they are not intended to establish which instruments are most effective. Consistent with the C40 and McKinsey framework on which they are organized, all four areas concern mitigation, so adaptation falls outside the scope of this section, although Section 3.4 returns to the difficulty of measuring and financing it.

[13] C40 Cities and McKinsey, *Focused Acceleration*.

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## 2.1. Decarbonize Grid

Cities around the world are striving to incorporate renewable energy into the local energy portfolios. *PlaNYC: Getting Sustainability Done* identifies three major objectives. Achieving the first objective – addressing Climate Threats – requires the city to double down on switching to clean energy.[14] Under PlaNYC, all suitable city-owned properties must have solar power, electric infrastructure, green roofs, and other renewable energy sources installed by 2035. This includes installing solar panels on public schools and other municipal buildings.[15] Furthermore, Public Solar and Future Housing initiatives combine renewable energy with equity by providing financial assistance to low-income homeowners in environmental justice communities, for rooftop solar panels, heat pumps, and other energy efficiency retrofits[16]; and by creating 3,000 energy-efficient and all-electric affordable housing units.[17]

Globally, there are three typical approaches to decarbonize grids for cities.

### *2.1.1. Decarbonizing through Power Purchasing Agreements*

The first approach is through power purchasing agreement (PPA) of renewable energy, to achieve 100% renewable electricity for municipal buildings and public infrastructure, exemplified by Rio de Janeiro and Sydney.

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[14] Mayor's Office of the City of New York, *PlaNYC: Getting Sustainability Done* (New York: Mayor's Office of the City of New York, 2023), https://a860-gpp.nyc.gov/concern/nyc_government_publications/m613n2121.
[15] Mayor's Office of the City of New York, "Mayor Adams Releases 'PlaNYC: Getting Sustainability Done,' New York City's Strategic Climate Plan," news release, April 20, 2023, https://www.nyc.gov/mayors-office/news/2023/04/mayor-adams-releases-planyc-getting-sustainability-done-new-york-city-s-strategic-climate-plan.
[16] Mayor's Office of the City of New York, "Mayor Adams Releases 'PlaNYC.'"
[17] New York City Department of Housing Preservation and Development, "Mayor Adams, Governor Hochul Launch New $15 Million Effort to Build All-Electric, Affordable Homes in NYC," news release, May 1, 2023, https://www.nyc.gov/site/hpd/news/016-23/mayor-adams-governor-hochul-launch-new-15-million-effort-build-all-electric-affordable-homes.

**Sydney.** The City of Sydney was certified carbon-neutral in 2011. It was the first local government to achieve this status in Australia. In July 2020, Sydney entered a ten-year power purchase agreement with Australian retailer Flow Power, for the latter to supply municipal buildings with 100% renewable electricity produced from solar and wind energy.[18] This incorporates all city-owned properties, including 115 buildings, community halls and office buildings, 75 parks, five pools and 23,000 streetlights, and the Sydney Town Hall.[19] The City anticipates that the transition will generate annual savings of up to AUD half a million (USD 353,000)[20] over the coming decade, while cutting $CO_2$ emissions by approximately 20,000 tons each year—roughly equal to the electricity used by over 6,000 homes.[21]

**Rio de Janeiro.** Similarly, in Rio de Janeiro, the "Green Energy Rio" (*Rio de Energia Verde*) program aims at procuring 100% non-hydro certified renewable energy for municipal buildings.[22] At the end of 2022, Rio pioneered the acquisition of renewable energy in Brazil's free energy market, starting with a five-year contract for 76,000 MWh (avoiding 40,000 tons of $CO_2$) to power the São Sebastião Administrative Center (CASS), or the City Hall, making Rio the first municipality in Latin America to use a PPA to power municipal buildings with renewable electricity.[23] In the following years, the program has expanded to supply 20 municipal hospitals,

[18] City of Sydney, "Sydney Flicks the Switch to 100% Green Power," news release, July 1, 2020, https://news.cityofsydney.nsw.gov.au/media-releases/sydney-flicks-the-switch-to-100-green-power.
[19] Sarah Wray, "Sydney Switches to 100 Percent Renewable Energy," *Cities Today*, July 6, 2020, https://cities-today.com/sydney-switches-to-100-percent-renewable-energy/.
[20] All currency conversions are approximate and use 2025 annual average exchange rates from Board of Governors of the Federal Reserve System, "Foreign Exchange Rates (Annual)," Statistical Release G.5A, https://www.federalreserve.gov/releases/g5a/current/.
[21] City of Sydney, "Sydney Flicks the Switch."
[22] Power purchased through Brazil's Free Energy Market from sources certified by the International Renewable Energy Certificate (I-REC). See C40 Cities, "Rio de Energia Verde: Procuring Clean Energy in Brazil's Free Contracting Environment," C40 Knowledge Hub, January 2024, https://www.c40knowledgehub.org/s/article/Rio-de-Energia-Verde-Procuring-clean-energy-in-Brazil-s-free-contracting-environment.
[23] C40 Cities, "Rio de Energia Verde."

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cultural centers like the Museum of Tomorrow, and the Rio Operations and Resilience Center, with further expansions planned to 74 public schools. Total contracted energy amounts to 500,000 MWh, which is estimated to generate savings of more than BRL 100 million (USD 20 million) over 60-month contracts.[24]

### *2.1.2. Distributed Renewable Generation Capacity*

The second approach is developing local renewable energy capacity. Within the city boundary, given the limited land resource, this is often achieved by distributed renewable energy generation from rooftop solar panels. To maximize the adoption of rooftop solar, city governments could install PV panels on municipal buildings. However, the adoption by most commercial and residential buildings would require financial incentives such as policy subsidies, or regulations on new buildings and retrofits.

**New York.** In New York City, Local Laws 92 and 94 (November 2019) mandate that for new buildings, building expansions, and buildings undergoing a full roof replacement, 100% of the roof area not used for equipment must be covered by either a solar photovoltaic (PV) system, a green (vegetated) roof system, or a combination of both.[25] The city offers several financial incentives that help property owners offset installation costs. The Green Roof Tax Abatement Program is a one-time property tax abatement of $5.23 per square foot of installed

[24] Municipal Government of Rio de Janeiro, "COR-Rio Begins to Receive Green Energy Supply, Saving R$3 Million in Five Years," news release, March 18, 2025, https://en.prefeitura.rio/cidade/cor-rio-comeca-a-receber-abastecimento-de-energia-verde-com-economia-de-r-3-milhoes-em-cinco-anos/.

[25] Hoffmann Architects + Engineers, "What Building Owners Need to Know about New York's Climate Mobilization Act," October 7, 2025, https://www.hoffarch.com/news-article/what-building-owners-need-to-know-about-new-yorks-climate-mobilization-act/.



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green roof, up to $200,000 (or the tax liability for the year).[26] NYC Accelerator Property Assessed Clean Energy (PACE) is an innovative financing mechanism that enables owners of commercial and multifamily buildings to pay for energy efficiency upgrades and renewable energy installations. The program provides long-term, fixed-rate loans that cover the full cost of a project, requiring no upfront cash from the building owner.[27] The loans are repaid as a benefit assessment on the property tax bill over a 20–30-year term.[28] The assessment transfers to the new owner if the property is sold.[29]

**Paris.** Paris expects to generate 45% of its electricity from renewable sources by 2030 and achieve carbon neutrality by 2050 by relying 100% on renewable or recycled energy.[30] In addition to the solar power plants providing centralized generation capacity, the city has been developing distributed generation to maximize the use of solar energy. According to Paris Deputy Mayor Dan Lert who oversees the city's ecological transition, climate plan, water and energy (July 2020 – March 2026), Paris has a large potential of using solar energy to generate heat and electricity.[31] The municipal government has carried out initiatives encouraging or incentivizing public participation in solar projects. One of the initiatives sought to involve volunteers in the installation of more than 10,000 square meters of solar panels on roofs, with a capacity to support around 800 households.[32] The city of Paris has also made available the

[26] New York City Department of Buildings, "Amendment of Rules Relating to Green Roof Tax Abatement," NYC Rules, adopted January 29, 2025, https://rules.cityofnewyork.us/rule/amendment-of-rules-relating-to-green-roof-tax-abatement/.
[27] NYC Accelerator, "NYC Accelerator PACE Financing," Mayor's Office of Climate and Environmental Justice, last updated November 14, 2025, https://accelerator.nyc/resources/finance/PACE.
[28] Clearwater PACE, "New York City (NYC) C-PACE Program," last updated June 24, 2025, https://c-pace.com/nyc/.
[29] NYC Accelerator, "PACE Financing."
[30] "Paris Looks to Citizen Power to Speed Up Energy Transition," *Euractiv*, April 16, 2021, https://www.euractiv.com/news/paris-looks-to-citizen-power-to-speed-up-energy-transition/.
[31] "Paris Looks to Citizen Power."
[32] "Paris Looks to Citizen Power."

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roofs of municipal buildings including schools and colleges as well as social housing. As of 2021, there were about 76,000 square meters of solar panels in the city, of which more than 10,000 square meters were located on the roofs of municipal buildings.[33] By 2030, the city aims to have 20% of building roofs install solar panels.[34] This was further aided by the passing of France's Climate and Resilience Law in 2021.[35]

Similar to New York's Local Laws 92 and 94, the French national law requires all new and commercial buildings with an area of more than 500 square meters in each municipality to have green infrastructure or renewable energy equipment (such as solar panels) on the roof. It covers buildings such as large warehouses, hangars, and indoor parking lots, but excludes historic buildings and buildings that are difficult to accommodate rooftop green infrastructure due to economic, technical, or cultural reasons.[36] However, compared to New York Local Laws 92 and 94 which mandate the utilization of 100% of the sustainable roofing zone for green roof or solar energy system, the French Climate and Resilience Law only require a minimum usage of 30% roof surface before 2026, 40% in 2026, and 50% from 2027 and beyond.[37]

Widespread installation of rooftop solar equipment in Paris is challenging. A major impediment is the large number of protected monuments and buildings in this historical and cultural city. Deputy Mayor Dan Lert said more than 95 percent of the buildings in the city are

[33] "Paris Looks to Citizen Power."
[34] United Nations Framework Convention on Climate Change, "City of Paris: Carbon Neutral by 2050 for a Fair, Inclusive and Resilient Transition," UN Global Climate Action Awards, accessed April 11, 2026, https://unfccc.int/climate-action/un-global-climate-action-awards/climate-leaders/city-of-paris.
[35] Sophie Rousset-Rouvière, "In France, a New Law Supports Green Roofs on Buildings," *Living Architecture Monitor*, March 23, 2022, https://livingarchitecturemonitor.com/articles/france-new-law-supporting-green-roofs-sp22.
[36] Rousset-Rouvière, "New Law Supports Green Roofs."
[37] Service-Public.fr, "Obligation to Produce Renewable Energy or Green Roofs," Direction de l'information légale et administrative, last verified December 22, 2025, https://entreprendre.service-public.gouv.fr/vosdroits/F38107?lang=en.

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located within the protection radius centered on various historic monuments. Any modification to the exterior of the buildings within the radius requires special planning approvals.[38]

**Delhi.** Delhi's renewable energy initiatives, including rooftop solar installations and utility-scale solar parks, are aimed at diversifying the energy mix and reducing dependence on fossil fuels. As of March 2024, the city's solar power capacity stood at 1,500 MW, including 250 MW from rooftop systems. The government aims to increase the city's solar power capacity to 4,500 MW by March 2027, making up around 20 percent of the city's electricity consumption from solar power.[39] As part of the effort to achieve this goal, "Delhi Solar Policy 2024" was rolled out with substantial incentives and subsidies to consumers who opt for rooftop solar panels. The policy introduces various incentives, including a capital subsidy of INR 2,000 (USD 25.4) per kW for residential consumers, with a maximum limit of INR 10,000 (USD 127) per consumer. Additionally, the Generation-based Incentives (GBI) proposed under the policy compensates residents for INR 2-3 per kWh of solar energy based on the capacity of the solar energy systems. For residential PV systems of 1-3 kW capacity, each kWh generated will be rewarded INR 3; for PV systems of 3-10 kW capacity, INR 2 per kWh generated. For all commercial and industrial PV systems, generation-based incentive is INR 1 per kWh. It is important to note that this GBI payment is separate from and on top of the savings from "net metering," where every unit of solar energy generated cancels out one unit of electricity consumed from the power grid. Furthermore, commercial and industrial consumers will witness

[38] "Paris Looks to Citizen Power."

[39] "AAP Govt Notifies New Solar Policy in Delhi," *Hindustan Times*, March 16, 2024, https://www.hindustantimes.com/cities/delhi-news/aapgovt-notifies-new-solar-policy-in-delhi-101710611700116.html.



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a 50 percent reduction in their electricity bills upon the installation of rooftop solar panels. The Delhi government has allocated INR 570 crore (USD 72.5 million) for the implementation of this policy.[40]

### *2.1.3. Innovative Solutions to Expand Renewable Capacity*

The third approach is finding innovative ways to expand renewable energy capacity.

**Singapore.** Improving energy efficiency and transitioning to cleaner energy make up Energy Reset, one of the five key pillars of the Singapore Green Plan 2030. As of 2021, natural gas generated about 96% of Singapore's electricity, with renewable energy, oil, and coal together accounting for the remaining 4%.[41] Singapore's geography presents significant limitations for renewable energy generation. The country experiences low wind speeds and a narrow tidal range while lacking fast-flowing rivers and geothermal resources. Consequently, Singapore has described itself in its national communications to the UNFCCC as "alternative energy-disadvantaged," meaning that renewable sources such as wind, tidal, hydroelectric, and geothermal power are not viable options.[42] Hence, as one of the only cost-effective and reliable renewable options available to Singapore, solar energy will play an important role in helping Singapore achieve its climate ambition of Net Zero emissions by 2050. However, Singapore's small size and land scarcity has called for innovative solutions to implement large-scale solar

[40] "AAP Govt Notifies New Solar Policy."
[41] U.S. Energy Information Administration, "Singapore," Country Analysis Brief, last updated August 2021, https://www.eia.gov/international/analysis/country/SGP.
[42] National Climate Change Secretariat, *Singapore's Fourth National Communication and Third Biennial Update Report under the United Nations Framework Convention on Climate Change* (Singapore: National Climate Change Secretariat, 2018), https://unfccc.int/sites/default/files/resource/067382541_Singapore-NC4-BUR3-1-Singapore%20Fourth%20National%20Communication%20and%20Third%20Biennia.pdf.

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capabilities in Singapore's limited land area and highly urban environments.

Singapore's Tengeh Reservoir is home to one of the world's largest inland floating solar PV projects, occupying 45 hectares of space (⅓ of the reservoir's surface area) and comprising over 122,000 solar panels spread out over 10 "islands". Tengeh's floating solar farm has a capacity of 60 MWp and reduces carbon emissions by about 32 kilotonnes per year, equivalent to taking 7,000 cars off Singapore's roads.[43]

The idea for a floating solar PV farm in one of Singapore's reservoirs came about as the country was looking for a cost-effective way to harness solar energy at scale, bearing in mind the high costs of land acquisition in Singapore due to limited space. Building a solar farm on the reservoir surface allows the large surface area of reservoirs to be dual-use, both as a water catchment area and in generating renewable energy on a large scale.[44] Furthermore, reservoir is an ideal surface for floating solar because compared to other water surfaces such as rivers, oceans or natural lakes, the calm freshwater environment of reservoirs is less corrosive than seawater and has minimal wave action, simplifying design and reducing maintenance costs compared to offshore systems.[45]

As the installation of large-scale floating solar systems was relatively new, before the deployment of Tengeh Reservoir's floating solar PV system, in 2016 PUB (Singapore's National Water Agency) and Singapore's Economic Development Board launched a 1 MWp floating solar testbed at Tengeh Reservoir, comparing installations from nine companies, to study the

[43] PUB, Singapore's National Water Agency, "Floating Solar Systems," April 2, 2024, https://www.pub.gov.sg/Public/WaterLoop/Sustainability/Solar/Floating.
[44] PUB, "Floating Solar Systems."
[45] Junaid Shah, "Can Giant Floating Solar on Oceans Work?" *Saur Energy*, January 6, 2023, https://www.saurenergy.com/solar-energy-blog/will-giant-floating-solars-on-ocean-surface-work.

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feasibility of deploying floating solar panels and to identify the PV installation with the best performance for the reservoir's conditions. Through these tests, PUB determined that floating solar PV systems perform 5-15% better than conventional rooftop solar PV systems in Singapore due to minimized shading from surrounding infrastructure and the cooler environment of the reservoir.[46]

To ensure that the floating solar system did not result in unintended negative environmental impacts, PUB also conducted an Environmental Impact Assessment prior to building the floating solar PV to assess the impact of the solar panels on the reservoir's biodiversity, water, air, and noise quality. After determining that the impact of the floating solar farm on the environment would be minimal, in 2020, construction was carried out with biodiversity-sensitive measures in place to ensure minimal disturbance to wildlife throughout the construction process. In July 2021, the solar farm began operation.[47]

Other biodiversity-sensitive measures implemented in the deployment of the floating solar PV system includes building gaps into the solar PV's design to ensure that sufficient light and air can continue to enter the waters and that the reservoir can continue to support aquatic life. Additional aerators were also deployed underneath the solar panels to maintain dissolved oxygen levels in the water. Lastly, the solar panels were overlaid with an anti-glare coating to minimize reflection from the panels that could interfere with wildlife's foraging and hunting habits around the reservoir.[48]

[46] PUB, "Floating Solar Systems."
[47] PUB, "Floating Solar Systems."
[48] Clara Chong, "Singapore's First Large-Scale Solar Floating Farm Opens at Tengeh Reservoir," *Straits Times*, July 14, 2021, https://www.straitstimes.com/singapore/singapores-first-large-scale-solar-floating-farm-opens-at-tengeh-reservoir.

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The deployment of Tengeh's floating solar farm has allowed Singapore to power all five of its water treatment plants using solar energy, allowing Singapore to produce clean water using renewable energy.[49]

## 2.2. Building Energy

According to the United Nations Environment Programme and the Global Alliance for Buildings and Construction (2025), the buildings and construction sector consumes 32 percent of global energy and contributes 34 percent of global $CO_2$ emissions.[50] Building standards on energy efficiency or emission are common practices that assist municipal governments in curbing this large emission sector. These standards could mandate design specifications for both new buildings and retrofitting old buildings. France's Climate and Resilience Law mentioned in the previous section is one example of such standards.

**New York.** In New York City, buildings account for approximately 70% of greenhouse gas emissions, with large buildings responsible for the majority.[51] *PlaNYC: Getting Sustainability Done* highlights the building sector in the key objective Climate Threats. Local Law 97 is one of the most critical regulatory tools the city uses to follow the roadmap set forth by PlaNYC. Passed in 2019 as part of the Climate Mobilization Act (NYC's "Green New Deal"), Local Law 97 is the binding legislation that turns a major part of PlaNYC's goal of "reducing citywide

[49] Chong, "Solar Floating Farm."
[50] United Nations Environment Programme and Global Alliance for Buildings and Construction, *Global Status Report for Buildings and Construction 2024/2025: Not Just Another Brick in the Wall* (Nairobi: UNEP, 2025), https://www.unep.org/resources/report/global-status-report-buildings-and-construction-20242025.
[51] Mayor's Office of the City of New York, "Mayor Adams Launches 'Getting 97 Done,' Comprehensive Mobilization Strategy to Reduce Building Emissions," news release, September 12, 2023, https://www.nyc.gov/mayors-office/news/2023/09/mayor-adams-launches-getting-97-done-comprehensive-mobilization-strategy-reduce-building.

greenhouse gas emissions" into enforceable action. Its core objective is to mandate that large buildings (over 25,000 sq. ft.) meet specific greenhouse gas emissions caps, so that by 2050 emissions from covered buildings fall by 80% compared to 2005.[52] To help building owners comply with Local Law 97, the city created support programs like *Getting 97 Done*, which facilitates compliance through financial support, technical assistance and enforcement.[53]

The administration is first identifying financial resources to support retrofit projects for Local Law 97 compliance, aiming to improve building efficiency and reduce emissions. The city estimates that $625 million in federal Inflation Reduction Act tax credits and subsidies will be available for this purpose. Meanwhile, the New York State Public Service Commission has directed utilities and New York State Energy Research & Development Authority (NYSERDA) to propose $5 billion in 2025–2030 programs under "New Efficiency: New York." The city will work with NYSERDA, Con Edison, and National Grid to align these programs with buildings requiring significant upgrades, particularly in disadvantaged communities where compliance lags.[54]

NYC Accelerator is the city's Local Law 97 technical assistance program. Along with *Getting 97 Done*, the administration launched a new initiative called "Climate-Friendly Buildings: Local Law 97 in Your Neighborhood." This program will create invitation-based workshops, developed in partnership with City Council members, where NYC Accelerator will provide direct information to buildings that need to undertake work to comply with the law by 2030.[55]

[52] Mayor's Office of the City of New York, "Getting 97 Done."
[53] Mayor's Office of the City of New York, "Getting 97 Done."
[54] Mayor's Office of the City of New York, "Getting 97 Done."
[55] Mayor's Office of the City of New York, "Getting 97 Done."

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Lastly, to facilitate enforcement, the Department of Buildings published rules to guide Local Law 97 implementation, focused on compliance and emissions reductions. Under these rules, building owners can potentially reduce compliance fines in 2024 – preserving limited resources for projects to achieve compliance – provided they demonstrate concrete decarbonization steps that will lead to meeting their 2024 targets by 2027 and their 2030 targets on schedule by 2030.[56]

**Tokyo**. New York's building emission caps had a direct precedent in Tokyo, whose metropolitan government launched the first city-level cap-and-trade program for buildings. Working from the conviction that buildings, which drive several pollution problems at once, are central to urban sustainability, the Tokyo Metropolitan Government's Bureau of Environment first combined building assessment with mandatory reporting under its Environmental Security Ordinance, effective 2001, while initially encouraging only voluntary reductions.[57] When that voluntary phase delivered only about a two percent average reduction between 2002 and 2005, the city concluded that reporting alone was insufficient. However, mandatory reductions were not politically feasible either, given sharply conflicting interests among stakeholders such as environmental groups, the power sector, and the real estate sector. The Bureau realized that a cap-and-trade system might be the only approach that could reach consensus among stakeholders and subsequently studied the European and Californian emissions trading systems. In 2008, the Tokyo Metropolitan Assembly passed a cap-and-trade ordinance, which

[56] Mayor's Office of the City of New York, "Getting 97 Done."

[57] Nishida, Interview; Marcus Lee and Kimberly Colopinto, *Tokyo's Emissions Trading System: A Case Study*, Directions in Urban Development (Washington, DC: World Bank, 2010), https://openknowledge.worldbank.org/entities/publication/32dd73b7-1820-5a1b-b511-b3ffcd3f40e6.

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took effect in 2010, combining aggregated mandatory reduction with flexibility for variable reduction levels.[58] Reaching that binding cap required extended negotiation with the power sector, real estate owners, and environmental organizations, and Tokyo's trajectory from disclosure to binding regulation is one that few cities have completed.

**Oslo.** Blue-Green Factor (BGF) norm, which started in 2014 in Oslo and Bærum, is a performance-based indicator designed to ensure adequate vegetation (green elements) cover and surface water (blue elements) management in new development projects. In application, the BGF is essentially a metric for neighborhood green space and green infrastructure based on stormwater retention, biodiversity support and recreation amenities. New development projects need to achieve above average metric score in the area to be approved. This metrics system applies to all new developments, covering both public spaces and privately owned land. Officially adopted as a city norm in 2019, the BGF has since become a national standard in Norway.[59]

## 2.3. Mobility

Globally, the transportation sector (including road, rail, air and marine) accounts for approximately 23% of total energy-related $CO_2$ emissions. Particularly, road transport accounts for 80% of the increase of transport emission in the past fifty years.[60] In New York, the sector contributes 25% of the city's greenhouse gas emission.[61] *PlaNYC: Getting Sustainability Done*

[58] Nishida, Interview.
[59] Interlace Hub, "Blue Green Factor Norm," May 4, 2022, https://interlace-hub.com/blue-green-factor-norm.
[60] ecoinvent, "Transport," September 4, 2025, https://support.ecoinvent.org/transport.
[61] New York City Environmental Justice Alliance, "Transportation Justice," last updated September 2, 2025, https://nyc-eja.org/campaigns/transportation-justice/.

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considers urban transportation an integral contributor to the major objective Quality of Life.[62] The key to reducing emissions is developing a range of appealing, affordable low-carbon transportation options that are accessible to all residents.[63] The case studies in this subsection showcase four approaches through which cities are improving the sustainability of urban transportation.

### *2.3.1. Urban Planning*

The first is people-centered urban planning that facilitates a sustainable lifestyle, such as meeting day-to-day needs via walking or bikes.

**Paris.** Under the leadership of Mayor Anne Hidalgo, the city began implementing the "15-minute city" (or *La ville du quart d'heure*) in 2020 as a core part of its climate strategy.[64] The concept of "15-minute city" was coined by Franco-Colombian scientist and mathematician Carlos Moreno in 2016.[65] In Paris, the transition to "15-minute city" started with reclaiming road space from private vehicles and evolved into a comprehensive urban strategy to redesign the city around proximity, ensuring that residents can access jobs, stores, medical services, and cultural venues without traveling far from where they live.[66] A key measure taken by Paris is reducing car dominance through vehicle restrictions, building cycling infrastructure, and converting motorways and vehicle parking space into pedestrian walking spaces and bicycle

[62] Mayor's Office of the City of New York, *PlaNYC*.
[63] C40 Cities and McKinsey, *Focused Acceleration*.
[64] Salome Gongadze and Anne Maassen, "Paris' Vision for a '15-Minute City' Sparks a Global Movement," World Resources Institute, January 25, 2023, https://www.wri.org/insights/paris-15-minute-city.
[65] Claire Elise Thompson, "How '15-Minute Cities' Could Save Time, Reduce Emissions, and Build Community," *Grist*, May 8, 2024, https://grist.org/looking-forward/how-15-minute-cities-could-save-time-reduce-emissions-and-build-community/.
[66] Gongadze and Maassen, "Paris' Vision."

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parking spots.[67] Furthermore, Paris is assisting local commerce through low rents and professional support to make it easier to set up businesses throughout the city. The development of local businesses not only enhances the "15-minute city" model but also mitigates the risks of gentrification and social isolation, as these risks are major critiques of the "15-minute city" model, along with potential restriction of mobility and lifestyle.[68]

**Copenhagen.** In Copenhagen, the transit-oriented urban planning known as "Finger Plan" dates to 1947.[69] The plan organizes metropolitan expansion along five commuter rail corridors radiating from the city center. Between each "finger" lie green wedges—protected zones reserved for agriculture, nature, and recreation. Concentrating housing development along major public transport corridors reduces reliance on private cars. The plan has enabled Copenhagen to densify strategically while preserving open space and ensuring accessibility to both jobs and nature. Recent updates to the plan have focused on intensifying development along key transit nodes and expanding infrastructure to meet population growth while maintaining its core transit-oriented development principles.[70] By integrating housing policies with transportation planning, Copenhagen enhances mobility, reduces congestion, and advances its goal of becoming a carbon-neutral city.

### *2.3.2. Mass Transit*

[67] Progressive Companies, "Paris in 15 Minutes: Lessons from the City on Designing Municipalities of the Future," October 28, 2025, https://www.weareprogressive.com/insights/paris-in-15-minutes.
[68] Carlos Moreno, "The 15-Minute City: Rethinking Our Urban Life in the 21st Century," Institute of Sustainability and Environmental Professionals, accessed April 10, 2026, https://www.isepglobal.org/engage/transform/features/the-15-minute-city-rethinking-our-urban-life-in-the-21st-century/; Thompson, "15-Minute Cities."
[69] Rebecca Thandi Norman, "A Brief Look at Urban Planning in Copenhagen," *Scandinavia Standard*, March 14, 2023, https://www.scandinaviastandard.com/a-brief-look-at-urban-planning-in-copenhagen/.
[70] Norman, "Urban Planning in Copenhagen."

The second approach to develop next generation mobility is through targeted enhancement of mass transit.

**Lima.** Lima's *Metropolitano* Bus Rapid Transit (BRT) system, which began operation in 2010, is the first BRT system in Peru, anchoring the municipal government's effort on sustainable mobility. The *Metropolitano* operates on a dedicated 33-kilometer north-south corridor connecting 16 districts of Lima, with 38 stations including 3 terminals. Like other full BRT systems, *Metropolitano* features a dedicated busway called the *Vía Expresa* with no stoplights, on which only small vehicles and the Metropolitano are permitted. The main trunk line is accessible by peripheral feeder buses (minibuses), forming "natural integration" that helps passengers reach BRT stations.[71] Stations have 90 cm platform height for level boarding; 76% of stations include passing lanes.[72] According to the Institute for Transportation & Development Policy, *Metropolitano* has a "Gold" rating based on an internationally recognized standard for the current best practices for BRT.[73] The system served an average of 665,000 passengers per day between 2014 and 2019. Direct benefits to riders include travel time savings and improved safety: a typical two-hour commute during peak hours can be reduced to less than half an hour with the BRT, while monthly traffic accidents dropped by 90% since 2010.[74]

Currently, the system operates a fleet of more than 300 natural gas-powered buses.[75] The Urban Transport Authority (ATU) has announced a major project to incorporate 150 new

[71] Anais Cisneros Vitor, "Q&A with Hernan Navarro: Lima's El Metropolitano BRT," *TheCityFix*, May 16, 2013, https://thecityfix.com/blog/interview-hernan-navarro-el-metropolitano-lima-peru-brt/.
[72] Far East Mobility, "Bus Rapid Transit," BRT Data, last updated April 13, 2026, https://www.brtdata.net/.
[73] Institute for Transportation and Development Policy, "BRT Scores," accessed April 11, 2026, https://itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/brt-scores-2024/.
[74] Vitor, "Q&A with Hernan Navarro."
[75] Far East Mobility, "Bus Rapid Transit."

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electric buses for the system, paired with the installation of solar panels on the roofs of 44 Metropolitano stations to generate clean energy for charging the buses.[76] The electrification of the fleet, along with integrated renewable energy at stations are expected to reduce operating costs and dependence on fossil fuels, as well as further reduce greenhouse gas emissions, lower noise levels, providing a cleaner, quieter, more comfortable service for users.[77]

**Bogotá.** The *TransMilenio* BRT has played a central role in Bogotá's urban transport network since its opening in December 2000. *TransMilenio* is a 114-kilometer full BRT system built around exclusive bus corridors, median stations with level boarding, off-board fare collection, and high-capacity articulated and bi-articulated buses. This configuration allows large passenger volumes to be moved efficiently using road-based infrastructure rather than rail. Serving over four million passenger trips per day, *TransMilenio* has substantially improved access to employment and urban services for residents who depend on public transport, particularly in lower-income areas located along major transit axes. Tsivanidis (2017) estimated the overall wider economic impact of the system to be a 3.5% increase in average welfare and 2.73% increase in output for Bogotá.[78] Environmentally, a study by Universidad de los Andes (Colombia) found that by switching to a low-emission diesel bus fleet (from Euro II standard to Euro V with filter and Euro VI) in 2019, there was substantial reduction of PM2.5 (78%) and soot (80%) along the corridor.[79] To minimize vehicle emission pollution, *TransMilenio* has been

[76] Antonio Vilela, "Lima Takes a Big Step Towards Electromobility in Public Transport," *Latamobility*, May 15, 2025, https://latamobility.com/en/lima-takes-a-big-step-towards-electromobility-in-public-transport/.
[77] Vilela, "Lima Takes a Big Step."
[78] Nick Tsivanidis, "Ticket to Ride? Building Efficient and Equitable Cities with Bus Rapid Transit: Guest Post by Nick Tsivanidis," *Development Impact* (blog), World Bank, November 29, 2017, https://blogs.worldbank.org/en/impactevaluations/ticket-ride-building-efficient-and-equitable-cities-bus-rapid-transit-guest-post-nick-tsivanidis.
[79] TransMilenio S.A., "Estudio de Universidad de los Andes ratifica mejora en calidad del aire en sistema

gradually building up its electric fleet since 2018. By early 2026, *TransMilenio* had approximately 1,486 electric buses in operation, making it the second-largest electric bus fleet in Latin America after Santiago, Chile.[80] The entire electric fleet has been acquired from Chinese manufacturers BYD and Yutong. With new electric buses scheduled to be delivered, Bogotá will reach approximately 1,850 electric buses in operation. The electric bus fleet is projected to reduce 18,378 tons of $CO_2$ annually compared to a diesel fleet, equivalent to planting 835,638 trees, while also reducing noise levels by 27-36% in the city.[81]

Speaking of BRT systems, the *Rede Integrada de Transporte* (RIT) in Curitiba, Brazil, which began operation in 1974, is recognized as the world's first full BRT system and remains one of the most influential examples of transit-oriented development.[82] Bogotá's *TransMilenio* adapted the Curitiba model but implemented it on a much larger scale and with higher capacity from the start, demonstrating its viability for mega-cities.[83]

### *2.3.3. Electric Vehicle*

The third approach for cities to enhance next generation mobility is through electric vehicle (EV) policies and infrastructure. In addition to the electrification of public transit fleet as

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TransMilenio," last updated December 2, 2025, https://www.transmilenio.gov.co/comunicaciones/publicaciones/2023/estudio-de-universidad-de-los-andes-ratifica-mejora-en-calidad-del-aire-en-sistema-transmilenio.

[80] César Mariño García, "(Multimedia) Especial: Tecnología china crucial para desarrollo de la movilidad en Bogotá, señalan asistentes a congreso internacional," Xinhua, March 7, 2026, https://spanish.xinhuanet.com/20260307/5a5e108e0a124f68a2d2d34c42b2bff6/c.html.

[81] ACIS, "TransMilenio se transforma con 364 nuevos buses eléctricos," June 27, 2025, https://www.acis.org.co/blog/noticias-2/transmilenio-se-transforma-con-364-nuevos-buses-electricos-1355.

[82] Development Asia, "What the World's First Bus Rapid Transit System Can Teach Us," Asian Development Bank, May 18, 2016, https://development.asia/case-study/what-worlds-first-bus-rapid-transit-system-can-teach-us.

[83] Emma Freedman, "Bus Rapid Transit Systems in Latin America," *Panoramas*, University of Pittsburgh, June 15, 2016, https://panoramas.secure.pitt.edu/economy-and-technology/bus-rapid-transit-systems-latin-america.

mentioned above, policy support for private EVs typically takes the form of financial incentives such as subsidies on vehicle registration costs, or tax credits, and is often accompanied by restrictions on internal combustion engine vehicles and the expansion of charging infrastructure. For instance, Singapore reduces the cost of EV purchase through EV Early Adoption Incentive (EEAI) and the Vehicular Emissions Scheme (VES). As of 2025, a buyer can save up to SGD 40,000 (approximately USD 31,000) on the car's upfront cost from these schemes.[84] At the same time, Singapore has been expanding public charging infrastructure, aiming to deploy 60,000 charging points by 2030, achieving a ratio of four EVs per charging point.[85]

**Paris EV sharing.** In addition to the financial incentives, restriction on internal combustion engine (ICE) vehicles and charging infrastructure expansions, there are other innovative measures governments have experimented with to promote EV adoption. One such example is Paris' EV sharing program *Autolib'*. Back in 2011, when bike sharing was booming around the world,[86] electric car sharing in a similar "free-floating" fashion was still a novelty. Paris pioneered the *Autolib'* electric car sharing service through a public-private partnership. It was operated by the Bolloré Group, which supplied the Bluecar, an all-electric car developed with the Italian design firm Pininfarina. *Autolib's* business model was modeled after *Velib*, a

[84] "Singapore Motor Dealers Expect COE Premiums to Surge in Response to Revised Vehicle Rebates," *The Star*, September 9, 2025, https://www.thestar.com.my/aseanplus/aseanplus-news/2025/09/09/singapore-motor-dealers-expect-coe-premiums-to-surge-in-response-to-revised-vehicle-rebates.

[85] Ministry of Transport, Singapore, "Written Reply to Parliamentary Question on the Projected Average Ratio of Electric Vehicle (EV) Charging Points," April 4, 2022, https://www.mot.gov.sg/news-resources/newsroom/written-reply-to-parliamentary-question-on-the-projected-average-ratio-of-electric-vehicle--ev--charging-points/.

[86] "From Amsterdam to Beijing: The Global Evolution of Bike Share," *Smart Cities Dive*, accessed April 13, 2026, https://www.smartcitiesdive.com/ex/sustainablecitiescollective/amsterdam-beijing-global-evolution-bike-share/1100421/.

bike-sharing service that had been successfully operating in Paris for many years and prompted the global spread of this model.[87] Revenue came from the paid subscription from its users. Subscribed users can enjoy electric vehicles, charging, parking in one service – a user can pick up a car, leave the car and charge it in designated areas around the city. *Autolib'*s charging stations can also charge other electric vehicles. The service was highly sought after at the outset and received subscriptions that far exceeded its EV supply, causing demand for its vehicles to outstrip supply.[88] However, over time, its popularity, usage rate, and number of users gradually declined. The main reasons for this include the increasing number of more convenient alternative modes of transportation (including ride-hailing services such as Uber), as well as poor vehicle maintenance, and the fact that empty cars were often occupied by homeless people as overnight shelters.[89] Finally, after years of losses, Paris and the other participating municipalities terminated the Autolib' contract in 2018, and the service was later replaced by Mobilib', run by several operators. The latter operates a mixed fleet of EVs, hybrid and ICE vehicles, and replaces *Autolib'*s "free-floating" service with a "roundtrip" model which requires users to return the car to its original station.[90] Despite its failure, *Autolib'* left behind one immense asset – its charging infrastructure. At the time, its network of over 6,000 charging stations made Paris the most EV-ready large city in the Western world, creating an asset that

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[87] "From Amsterdam to Beijing."
[88] "France's Car-Sharing System Autolib' Hits the End of the Road," *France 24*, June 21, 2018, https://www.france24.com/en/20180621-france-paris-end-road-car-sharing-system-autolib.
[89] "Autolib' Hits the End of the Road."
[90] "Paris lance Mobilib', un nouveau service d'autopartage électrique et thermique" [Paris launches Mobilib', a new electric and thermal car-sharing service], *Europe 1*, accessed April 11, 2026, https://www.europe1.fr/economie/paris-lance-mobilib-un-nouveau-service-dautopartage-electrique-et-thermique-3897052.

subsequent car-sharing services could use.[91] *Autolib'* demonstrated that bold, innovative projects require a solid financial foundation, robust operational planning, and a flexible governance structure that can adapt to unforeseen challenges. Its legacy serves as a valuable, real-world textbook for anyone planning large-scale urban mobility initiatives.

### *2.3.4. Active Mobility*

Lastly, active mobility such as walking and cycling is an essential part of sustainable urban mobility, integrated into transit-oriented development and smart densification, connecting residents to the various options of public transit. More importantly, active mobility is not only a zero-emission, low-carbon mode of transport, it also offers health benefits to commuters, most notably through a reduced risk of obesity.[92] An Australian study monetized the health benefits of active transport to be AUD 1.68 (USD 1.19) per kilometer for walking and AUD 1.12 (USD 0.79) per kilometer for cycling.[93] In addition to health benefits, the study also estimated the economic value of other benefits from active transport, including decongestion, noise and emissions reductions, as well as savings on vehicle operating cost, roadway provision cost and parking costs, albeit the per kilometer benefits are much smaller compared to health benefits.[94] Finally, a walkable and cyclable city could better support local businesses, as people can easily get from store to store.[95]

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[91] Xavier Boucherat, "Life after Autolib: Car-Sharing Continues in Paris," *Automotive World*, May 21, 2019, https://www.automotiveworld.com/articles/life-after-autolib-car-sharing-continues-in-paris/.
[92] Chris Rissel et al., *Key Health Benefits Associated with Public Transport: A Rapid Review*, Evidence Check (Sydney: Sax Institute for the NSW Ministry of Health, 2012)
[93] Rissel et al., *Key Health Benefits*, 27.
[94] Rissel et al., *Key Health Benefits*, 27.
[95] Norman, "Urban Planning in Copenhagen."

**Paris.** Active mobility is an integral part of the "15-minute city" model implemented by Paris. In 2021, Paris adopted a five-year cycling plan with a total investment of more than 250 million euros, aiming to make Paris a city that is safe and fully accessible by bicycle.[96] According to the plan, Paris will add 180 km of segregated bike lanes by 2026. Of these, 52 km will be converted from temporary bike lanes added during the pandemic to permanent bike lanes. These lanes will be complemented by a planned 180,000 additional bicycle parking spaces - three times the total number of current parking spaces. In addition, the construction of these bicycle-related infrastructures will focus on important transportation hubs and main roads connecting the neighboring suburbs and the city to create better integration across the wider metro area. Lastly, more comprehensive traffic regulations related to bicycles are in the pipeline to facilitate the city's transition to more sustainable commuting.[97] A GPS-based mobility survey by the Institut Paris Région, conducted between October 2022 and April 2023, found that 11.2 percent of trips within Paris were made by bicycle, against 4.3 percent by car.[98] In the 2025 Copenhagenize Index, a framework that assesses the safety and connectedness of infrastructure, usage and accessibility, and policy support, Paris ranked fifth among bicycle-friendly cities worldwide and was the only city in the top ten with a metropolitan population above ten million.[99]

**Copenhagen.** Copenhagen successfully underwent an urban transformation from a car-

[96] Feargus O'Sullivan, "Inside the New Plan to Make Paris '100% Cyclable,'" *Bloomberg*, October 22, 2021, https://www.bloomberg.com/news/articles/2021-10-22/how-paris-will-become-100-cyclable.
[97] O'Sullivan, "Paris '100% Cyclable.'"
[98] City of Paris, "Bicycles Outperform Cars in Paris and Its Inner Suburbs by Far," Paris.fr, April 4, 2024, https://paris.fr/en/pages/bicycles-outperform-cars-in-paris-and-its-inner-suburbs-by-far-28354.
[99] Copenhagenize, *The Copenhagenize Index 2025: EIT Urban Mobility Edition* (Copenhagenize, 2025), 22, https://copenhagenizeindex.eu/wp-content/uploads/2025/11/INDEXReport_VFLight.pdf.

centric city in the 1970s to a global leader of bicycle-oriented planning, with its robust cycling infrastructure forming the backbone of the city's transport network.[100] The city set a goal for at least 75% of all trips to be made on foot, by bicycle, or by public transport by 2025.[101] To that end, Copenhagen has continued to expand its cycling lanes, pedestrian infrastructure, and public transit systems, making sustainable mobility the most convenient and preferred mode of travel.

One of the city's most innovative cycling projects is the "Green Wave" (*Grøn Bølge*) Traffic Light System - an intelligent traffic management system that synchronizes traffic lights to prioritize cyclists.[102] On most major routes into the city center, synchronized traffic lights allow cyclists to ride non-stop during rush hours, by maintaining an optimal speed of 20 km/h (12.4 mph). On select routes, asphalt-embedded LED lights guide cyclists to maintain the proper speed for hitting green lights at upcoming intersections, while radar speed signs prompt riders to hold 20 km/h to "surf the green wave".[103] As of 2014, a second version of the system was being tested, using sensors to register groups of cyclists and automatically lengthen green lights as they approach.

Copenhagen's cycling infrastructure development pays equal attention to both macro- and micro-infrastructures, both hardware and software. In addition to the separated bike lanes and bike parking spots, footrests and railings at intersections allow cyclists to wait for traffic

[100] EBRD Green Cities, "Cycling Strategy: Copenhagen, Denmark," European Bank for Reconstruction and Development, 2020, https://www.ebrdgreencities.com/policy-tool/cycling-strategy-copenhagen-denmark-2/.
[101] City of Copenhagen, *CPH 2025 Climate Plan: A Green, Smart and Carbon Neutral City* (Copenhagen: Technical and Environmental Administration, 2012).
[102] Mikael Colville-Andersen, "Innovation In, Lycra Louts Out: What Copenhagen Can Teach Us about Cycling," *Guardian*, October 16, 2014, https://www.theguardian.com/cities/2014/oct/16/copenhagen-cycling-innovation-lycra-louts-green-wave-bike-bridges.
[103] Colville-Andersen, "Innovation In."

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light without hopping off or putting their foot down. Public bike pumps are available on roadside. Even trash bins are tilted so that cyclists can throw garbage without stopping.[104] Additionally, LED lights warn turning vehicle drivers of cyclists approaching from behind, rumble strips on bike lanes alert riders to curbs, and digital countdown timers positioned 100 meters before intersections inform cyclists whether to speed up or coast to catch the green light and maintain their momentum.[105]

As a result of these sustained efforts, about 40% of the city's residents commute by bicycle daily, a share that continues to grow.[106]

## 2.4. Waste

Cities can tackle waste emission at any level along the *Reduce, Reuse, Recycle, Recover,* and *Disposal* waste hierarchy.[107] Cities are developing initiatives to shift resource consumption from linear flows to circular, or continuous reuse, so that the last resort of disposing of waste at landfills without energy recovery can be avoided as far as possible.[108] This subsection highlights case studies on municipal solid waste (MSW) and wastewater management.

### *2.4.1. Municipal Solid Waste*

[104] Colville-Andersen, "Innovation In."
[105] Colville-Andersen, "Innovation In."
[106] Norman, "Urban Planning in Copenhagen."
[107] *Reduce*: avoid creating waste in the first place; *Reuse*: use products again for the same or different purpose; *Recycle*: convert waste materials into new products; *Recover*: extract energy from waste; *Disposal*: landfill or incineration without energy recovery. Adapted from Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste, art. 4, *Official Journal of the European Union* L 312 (November 22, 2008): 3-30.
[108] C40 Cities and McKinsey, *Focused Acceleration*.

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**New York.** Waste management and the circular economy fall under Green Economy, the third major objective of PlaNYC: Getting Sustainability Done. PlaNYC aims to divert 75% of its solid waste stream from landfills by 2030 through expanded recycling rules, organics collection, and circular-economy initiatives.[109]

In 2023, New York City's MSW diversion rate was just 20.2%.[110] The Zero Waste Act (Local Law 85 of 2023) officially made composting a requirement for all NYC residents, entrusting the New York City Department of Sanitation (DSNY) and New Yorkers with the largest curbside composting program in the nation.[111] Curbside composting became mandatory citywide in October 2024, and enforcement through fines began on April 1, 2025, although the city suspended most fines within three weeks, limiting penalties for the rest of 2025 to buildings with more than 30 units that had received more than four warnings.[112] Collected organic waste is directed to the Newtown Creek Wastewater Treatment Facility and the Staten Island Compost Facility for processing. Residential property owners are responsible for complying with regulations - source-separated compostable organics must be placed in a bin no larger than 55 gallons, lined with paper or plastic, and secured with a lid. Non-compliance will result in warnings and fines for each violation.[113]

[109] Mayor's Office of the City of New York, *PlaNYC*.

[110] New York City Department of Sanitation, *2023 NYC Waste Characterization Study* (New York: DSNY, 2023), https://www.nyc.gov/assets/dsny/downloads/resources/reports/waste-characterization-studies/2023/wcs-2023.pdf.

[111] Mayor's Office of the City of New York, "Mayor Adams Celebrates Completion of Roll Out of First-Ever, No-Cost, Pain-Free Citywide Curbside Composting Program," news release 738-24, October, 2024, https://nyc.gov/office-of-the-mayor/news/738-24/mayor-adams-completion-roll-out-first-ever-no-cost-pain-free-citywide-curbside.

[112] Mayor's Office of the City of New York, "Citywide Curbside Composting Program"; "NYC Suspends Most Composting Fines Just Weeks after Enforcement Began," *6sqft*, April 21, 2025, https://www.6sqft.com/nyc-suspends-most-composting-fines-just-weeks-after-enforcement-began/.

[113] New York City Department of Sanitation, "Curbside Composting," accessed April 11, 2026, https://www.nyc.gov/site/dsny/collection/residents/curbside-composting.page.

Curbside composting has existed in NYC for more than ten years, but no previous program served over 40 percent of the city or required mandatory participation.[114] Since April 2025, DSNY has witnessed a series of record-high weekly compost collected, from 3.6 million pounds in the second week of April, to 5.9 million pounds in November.[115] The program aims to divert one million tons of organic waste per year.

The two facilities that process the organic waste further *recycle* and *recover* the waste material. The Staten Island Compost Facility produces dry compost from organic waste. DSNY gives back part of finished compost to New York City residents for free. Each resident, upon online registration, can pick up ten 40-pound bags of finished compost from DSNY giveback sites across the five boroughs. In 2025, DSNY gave back over eight million pounds of compost to residents, nonprofits, and community gardens.[116] Newtown Creek Wastewater Treatment Facility produces renewable natural gas (RNG) from organic waste, and uses it on-site to heat the buildings, digesters, and to power the purification system. With the upcoming Newtown Creek Wastewater Resource Recovery Facility (WRRF) in operation, the facility will be connected to the grid system and able to generate renewable electricity from excess RNG to power nearly 5,200 homes in Brooklyn.[117]

**Singapore.** Reducing food waste is a key component of Singapore's waste reduction

[114] New York City Department of Sanitation, *Waste Characterization Study.*
[115] "New Yorkers Divert Record Amount of Food and Yard Waste from Landfills," *American Recycler*, January 2026, https://americanrecycler.com/waste/new-yorkers-divert-record-amount-of-food-and-yard-waste-from-landfills/.
[116] New York City Department of Sanitation, "High Five! It's Compost Giveback Season!" news release, March 20, 2026, https://www.nyc.gov/site/dsny/news/26-017/high-five-it-s-compost-giveback-season-.
[117] New York City Department of Environmental Protection, "DEP, EPA and National Grid Celebrate Innovative Project That Converts Wastewater into Renewable Energy," news release, June 14, 2023, https://www.nyc.gov/site/dep/news/23-026/dep-epa-national-grid-celebrate-innovative-project-converts-wastewater-renewable.

strategy, as food waste accounts for 20 percent of total waste disposed in the country.[118] According to a study by the National Environment Agency, households are the largest contributors, generating half of all food waste nationally. In 2017, each household produced an average of 2.5 kilograms of food waste per week. Despite these high volumes, only 17 percent of all food waste in Singapore is recycled.[119]

To support the Singapore Green Plan 2030 target of reducing per capita waste sent to landfill by 30 percent, Singapore introduced the Resource Sustainability Act in 2019. This legislation requires owners and operators of large commercial and industrial premises - which generate significant quantities of food waste - to segregate their food waste for treatment starting in 2024.[120]

Onsite food waste treatment systems that convert food waste into non-potable water, liquid nutrients, and compost will play a crucial role in achieving Singapore's food waste treatment and waste reduction targets. A clear example is the food waste digesters at Our Tampines Hub (OTH), a large integrated community and shopping center. The digesters have reduced food waste at OTH by over 65 percent while saving thousands of dollars.[121]

At OTH, approximately 1.4 tons of food waste from all retail food outlets are fed into the digester daily. Microbes within the digesters break down the waste into non-potable water, liquid nutrients, and organic fertilizer. The non-potable water is then used to clean the digester

[118] Ministry of the Environment and Water Resources, Singapore, *Zero Waste Masterplan* (Singapore: Ministry of the Environment and Water Resources, 2019), https://www.oneplanetnetwork.org/sites/default/files/from-crm/250-b8a3c3a36cfd24a102b6e8764bc8696f_zero-waste-masterplan-compressed.pdf.
[119] Ministry of the Environment and Water Resources, *Zero Waste Masterplan*
[120] Ministry of Sustainability and the Environment, Singapore, "The Resource Sustainability Act," July 30, 2020, https://www.mse.gov.sg/latest-news/resource-sustainability-act/.
[121] Singapore Green Plan, "Food Waste Is Not Really Just Waste," *Medium*, March 30, 2023, https://medium.com/greenplan/food-waste-is-not-really-just-waste-b5a851a2a32b.

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and bin center, while the liquid nutrients and organic fertilizer are applied to landscaping plants and community gardens at OTH. Any excess fertilizer is given away free of charge to OTH visitors and Tampines residents. By reducing the need for waste collection from OTH to incinerators, the food digesters save an estimated SGD 40,000 (USD 31,000) annually.[122]

Food waste digesters can also help reduce food waste in residential households. In Tampines - the neighborhood where OTH is located - successful pilot programs have collected food waste from residential households and sent it to OTH for recycling. Over three months, 380 households yielded more than 4,000 kilograms of food waste.[123] Given that households are the largest contributors to food waste in Singapore, closing the loop on residential food waste is essential to achieving the country's landfill waste reduction targets.

**Copenhagen.** The Amager Bakke Waste-to-Energy Plant (also known as CopenHill) is a flagship project in Copenhagen's waste management strategy, processing 600,000 tons of waste annually while generating district heating for 150,000 households and electricity for over 60,000 homes. The capacity of CopenHill is modest, especially compared with some of the mega Waste-to-Energy projects like Dubai's Warsan Waste-to-Energy Centre (1.9 million tons MSW annually).[124] However, the facility is known for its cutting-edge emissions control systems and its successful integration into urban space. The large, sloped roof of CopenHill houses a 500-meter ski slope and hiking trails that are open to the public, while one side of the building

[122] Samantha Boh, "Tampines Hub's Way to Cut Waste and Cost," *Straits Times*, June 18, 2017, archived June 23, 2017, at the Wayback Machine, https://web.archive.org/web/20170623232154/https://www.straitstimes.com/singapore/tampines-hubs-way-to-cut-waste-and-cost.

[123] Ministry of the Environment and Water Resources, *Zero Waste Masterplan.*

[124] "Dubai to Launch Phase 2 Expansion of Warsan Waste to Energy Plant This Year," *Zawya*, February 15, 2026, https://www.zawya.com/en/projects/utilities/dubai-to-launch-phase-2-expansion-of-warsan-waste-to-energy-plant-this-year-nzu46le4.

is equipped with an 85-meter climbing wall, the highest in the world. The combination of all these recreational features into a facility that recovers energy from waste highlights Copenhagen's ability to integrate sustainability with public spaces.[125]

A notable feature of these circular approaches is that they deliver co-benefits, reducing greenhouse gas emissions through diversion while also producing materials or recovering energy. Wastewater treatment plants with integrated biogas harvest capability, like the Newtown Creek of New York, can use the biogas to achieve energy self-reliance, or generate electricity for the grid, or in the case of Oslo, power the city's garbage truck fleet closing the loop of a circular waste management system.[126]

Taken together, the cases show both the range of instruments available to cities and the unevenness of the evidence behind them. Interventions backed by mandates or direct public investment, such as Bogotá's TransMilenio, Singapore's floating solar farm, and New York's mandatory composting, tend to come with reported, measured results, whereas several incentive-based programs, including Delhi's solar subsidies and Singapore's EV rebates, are documented mainly through targets and projections. This variation in what cities measure and disclose is precisely what the network-level accountability model examined in the next section sought to standardize.

## 3. The Role of City Networks

[125] Green Is You, "Copenhill: Transforming Waste into Energy and Recreation," January 12, 2026, https://www.greenisyou.com/en/post/copenhill-transforming-waste-into-energy-and-recreation.
[126] United for Smart Sustainable Cities, *Reducing Food Waste: Case Study of the U4SSC: A Guide to Circular Cities*(Geneva: International Telecommunication Union, 2020), https://www.itu.int/en/publications/Documents/tsb/2020-U4SSC-Case-study-Reducing-food-waste/files/basic-html/page14.html.

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All the cities examined in the case studies above are affiliated with C40: New York, Sydney, Paris, Copenhagen, Oslo, Tokyo, Rio de Janeiro, Bogotá, and Lima as active members, Delhi as a member currently classified as inactive, and Singapore as an observer city.[127] As discussed in the introduction, transnational city networks like C40 were established as cities and their leaders stepped forward, often ahead of regional and national governments, as key actors in implementing the sustainability agenda. Networks such as ICLEI - Local Governments for Sustainability's Cities for Climate Protection (ICLEI-CCP), the Climate Alliance, United Cities and Local Governments (UCLG), the Global Covenant of Mayors (GCoM), and C40 play an instrumental role in facilitating a city-led, bottom-up sustainable transition. They do so by sharing knowledge and best practices, setting agendas and aligning policy priorities, and enhancing recognition and accountability. The following subsections discuss these roles, using C40 as the principal example.

### 3.1. Knowledge and Best Practice Sharing

Beginning in 2008, then Chair Mayor David Miller established the network's peer-to-peer model through a series of summits held in Seoul, Berlin, Rotterdam, Tokyo and Hong Kong, allowing cities to share knowledge and exchange ideas on buildings, transport, energy and adaptation.[128] In addition to these live interactions at summits, the C40 Knowledge Hub provides archived and up-to-date research findings, best practices, and successful strategies from leading cities, all accessible to city practitioners for analysis and learning. Much of the

[127] C40 Cities, "Our Cities," https://www.c40.org/cities/.
[128] C40 Cities, "Our History."

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research curated in the Knowledge Hub involves the global consulting firm Arup. Since its initial collaboration with C40 in 2009, Arup, along with other research institutes, has been monitoring and analyzing cities' actions through comprehensive data collection and identifying implementation gaps and the priority areas with the largest sustainability potential.[129]

C40's dissemination of research findings and best practices is critical to cities' peer learning. According to a study on C40 cities' socialization, learning and collaboration,[130] between cities in the network, socialization activities are the most frequent interaction and are more likely to be accompanied by learning than collaboration. This is likely because collaborations require a bi-directional commitment, thus more demanding to take place, whereas learning and information seeking could be one-way.[131] The well-curated C40 Knowledge Hub makes such one-way learning highly feasible.

This one-way pattern, however, describes the diffusion of curated best practice more accurately than it captures the development of measurement methodology itself. The policy mobilities literature cautions that urban policy rarely travels as a finished template copied outward from a single origin, moving instead through reciprocal circuits in which cities adapt, revise, and feed innovations back to one another.[132] C40's technical work bears this out. For instance, New York, often cast as the exporter of the accountability model, drew on London in its treatment of aviation emissions before both cities contributed to the standardized Global

[129] Gordon, *Cities on the World Stage*, 161.
[130] Taedong Lee, "Network Comparison of Socialization, Learning and Collaboration in the C40 Cities Climate Group," *Journal of Environmental Policy & Planning* 21, no. 1 (2019): 104-15, https://doi.org/10.1080/1523908X.2018.1433998.
[131] Lee, "Network Comparison," 112.
[132] Eugene McCann and Kevin Ward, eds., *Mobile Urbanism: Cities and Policymaking in the Global Age* (Minneapolis: University of Minnesota Press, 2011); Cristina Temenos and Eugene McCann, "Geographies of Policy Mobilities," *Geography Compass* 7, no. 5 (2013): 344-57

Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).[133] Tokyo's building cap-and-trade program preceded New York's Local Law 97, and its officials describe C40's building-sector knowledge sharing as circulating both successes and failures, and reflections on their causes, making the learning genuinely reciprocal rather than one-directional.[134] The network's methodological core, in other words, was co-developed among a small group of leading cities even as its curated best practices diffused outward in the one-way fashion Lee describes.[135]

The result of the effort to facilitate peer learning is apparent. For instance, energy efficiency retrofit programs such as LED streetlights and smart lighting systems have been implemented in more than 20 cities; more than 10 cities have introduced BRT systems.[136] Furthermore, rooftop solar programs, building energy standards, electrification of public transport, cycling infrastructure development, various waste-to-energy facilities are widely implemented in cities of the Global North and South. More importantly, these knowledge and best practice sharing efforts overcome the tendency for cities to seek inspiration from others based on historical or cultural ties and geographic proximity, rather than by functional similarity in terms of government capacity, urban characteristics, or by evidence-based efficacy.[137]

### 3.2. Agenda-Setting and Policy Alignment

[133] Dickinson, Interview.
[134] Nishida, Interview.
[135] Lee, "Network Comparison," 112.
[136] Elif Colakoglu, "Climate Change and Urbanization in New York City during Bloomberg's Term of Mayor: Effects and Implications," *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi* 36, no. 2 (2018): 1-21, https://dergipark.org.tr/en/pub/huniibf/issue/38016/289018.
[137] Gordon, *Cities on the World Stage*, 148.

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Once priority areas are identified, C40 launches targeted programs to drive action on specific issues. These take the form of C40 Accelerators or initiatives. C40 Accelerators are time-bound, action-oriented campaigns that provide a structured framework for member cities to make measurable progress on specific climate challenges. As of April 2026, C40 listed 14 Accelerators, each focused on a single issue (such as extreme heat, water safety, or building emissions) and each requiring cities to make concrete, public pledges.[138] For instance, under the *C40 Renewable Energy Accelerator*, signatory cities commit to switching municipal electricity consumption to 100% renewable energy by 2025 or deploy renewable energy systems on all feasible municipal assets by 2030. Additionally, signatories choose one of three pathways based on local context and priorities, all leading to 100% renewable energy citywide by 2050.[139] Compared to the Accelerators, the C40 initiatives or programs are more numerous and diverse, each focusing on a smaller group of cities. For example, the "Breathe Cities" initiative is a USD 30 million global clean air program launched in 2023, by Bloomberg Philanthropies, the Clean Air Fund, and C40 Cities. Building on the success of London's Ultra Low Emission Zone (ULEZ), the initiative aims to help cities worldwide reduce air pollution, cut carbon emissions, and improve public health. It focuses on four key pillars: expanding local air quality data through innovative technologies, engaging communities most affected by pollution, providing technical policy assistance to local governments, and sharing lessons across cities. In 2023, the initiative supported the first global cohort of 11 cities.[140]

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[138] C40 Cities, "C40 Accelerators," https://www.c40.org/what-we-do/raising-climate-ambition/c40-accelerators/#our-accelerators.

[139] C40 Cities, "C40 Renewable Energy Accelerator," 2026, https://www.c40.org/accelerators/renewable-energy/.

[140] C40 Cities, *C40 Cities Annual Report 2023* (C40 Cities, 2023), https://www.c40.org/news/c40-annual-report-2023/; C40 Cities, "Michael R. Bloomberg and Sadiq Khan Launch US$30 Million Breathe Cities Initiative to Take Clean Air Global," news release, June 26, 2023, https://www.c40.org/news/bloomberg-khan-breathe-cities-launch-clean-

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These programs illustrate how C40 sets the urban climate agenda less by command than by orchestration: it steers cities indirectly through norms, targets, information, and recognition, and increasingly ties technical assistance and finance to standardized reporting and planning.[141] Aggarwala describes C40's theory of change evolving from awareness-raising and practice-sharing toward active capacity-building, including the mobilization of a global development fund to help lower-capacity cities complete the inventories that membership effectively required, a shift he characterizes as moving from hoping a city would produce an inventory to helping it produce one.[142] Freed locates the conditions of that alignment in partnership and leadership, noting that national-government support and external technical assistance are often what make compliance feasible rather than merely aspirational.[143] Agenda-setting, in this reading, works by turning the network's priorities into the conditions of recognition and support.

### 3.3. Accountability and Recognition

If the previous two roles of facilitating knowledge sharing and agenda-setting are common across most transnational networks of cities, the last role of enhancing accountability to and recognition by external audiences is arguably what distinguishes C40 from other networks. According to Gordon (2020), a key transformation of C40 happened with Bloomberg's tenure as the Chair. "Bloomberg projected onto the C40 the norm of global

air-global/.

[141] David J. Gordon and Craig A. Johnson, "The Orchestration of Global Urban Climate Governance: Conducting Power in the Post-Paris Climate Regime," *Environmental Politics* 26, no. 4 (2017): 694-714, https://doi.org/10.1080/09644016.2017.1320829.

[142] Aggarwala, Interview.

[143] Freed, Interview.

accountability," and shifted the organization to a data-driven operating model.[144] The common practices of measurement, benchmarking, evaluation and disclosure are derived from the same climate governance methodology that guided PlaNYC and built the foundation of C40 cities' accountability.

That methodology was institutionalized in New York before it was replicated elsewhere. Released on Earth Day 2007, *PlaNYC: A Greener, Greater New York* set out 127 initiatives across ten goal areas, and the city moved quickly to make its measurement commitments binding rather than discretionary.[145] Local Law 22 of 2008 codified a 30 percent reduction in citywide greenhouse gas emissions below 2005 levels by 2030, set a separate 30 percent target for municipal government operations by 2017, and required the city to publish annual citywide and municipal inventories documenting its progress.[146] Local Law 17 of 2008 required that PlaNYC be updated every four years and that progress be reported annually and tracked against a set of sustainability indicators.[147] The Greener, Greater Buildings Plan of 2009, including Local Law 84's requirement that large buildings benchmark and disclose their energy use, extended the same logic of measurement and disclosure from city government to private property.[148] The architecture also survived changes in administration, carried forward through *OneNYC* in 2015 and *PlaNYC: Getting Sustainability Done* in 2023. This combination of legally mandated

[144] Gordon, *Cities on the World Stage*, 148.
[145] City of New York, *PlaNYC: A Greener, Greater New York* (New York: City of New York, 2007), https://climate.cityofnewyork.us/reports/planyc-reports/; City of New York, *PlaNYC Progress Report 2010* (New York: Mayor's Office of Long-Term Planning and Sustainability, 2010), https://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_progress_report_2010.pdf.
[146] City of New York, *Inventory of New York City Greenhouse Gas Emissions, September 2010* (New York: Mayor's Office of Long-Term Planning and Sustainability, 2010), https://climate.cityofnewyork.us/wp-content/uploads/2022/10/greenhousegas_2010.pdf.
[147] City of New York, *PlaNYC Progress Report 2010*.
[148] City of New York, *PlaNYC Progress Report 2010*; New York City Local Law No. 84 of 2009.

measurement, recurring public reporting, and continuity across mayoralties is what Bloomberg carried into C40 as a norm of membership.

Measurement itself was not New York's invention. ICLEI's Cities for Climate Protection campaign, established in 1993, had already organized participating municipalities around a sequence of milestones beginning with a baseline emissions inventory, and the European Covenant of Mayors, launched in 2008, likewise required signatories to submit baseline emission inventories.[149] What distinguished the PlaNYC model as it moved into C40 was therefore less the practice of counting emissions than the coupling of standardized, public, recurring disclosure to network membership, peer recognition, and access to philanthropic and institutional capital. It is this coupling, rather than measurement as such, that the remainder of this section examines.

With accountability comes recognition: peer cities, external audiences from capital markets, national governments and international organizations can easily identify whether cities' pledges are met by their actions and outcomes. Bloomberg further enhanced the recognition of cities by actively bringing in non-state actors such as the World Bank, Arup, Siemens, CDP, as well as media organizations including National Geographic and CNN, and by hosting events like the Climate Leadership Awards.[150]

Recognition, however, is only one of the forms of accountability the network produces. Gordon (2016) identifies a second, a network politics of ordering, in which benchmarking and

[149] Michele M. Betsill and Harriet Bulkeley, "Transnational Networks and Global Environmental Governance: The Cities for Climate Protection Program," *International Studies Quarterly* 48, no. 2 (2004): 471-93.; European Commission Joint Research Centre, *How to Develop a Sustainable Energy Action Plan (SEAP): Guidebook* (Luxembourg: Publications Office of the European Union, 2010).
[150] Gordon, *Cities on the World Stage*, 163.

disclosure rank cities against one another and generate soft hierarchy, peer pressure, and emulation.[151] Benchmarking here operates as a technique of governing at a distance, defining best practice and disciplining conduct without formal compulsion.[152] Aggarwala, who carried PlaNYC's apparatus into C40, describes membership as voluntary in form but reputationally binding in practice: cities performed a series of measurement gestures to gain and retain admittance, and the prospect of reputational loss or removal incentivized compliance more effectively than any enforcement mechanism, with cities such as Auckland undertaking additional work specifically to avoid being dropped from the network.[153]

According to Gordon (2020), accountability (legitimacy) and visibility (legibility), together with the capital alliance formed by Bloomberg, created a positive feedback loop in which cities that are accountable for their commitment and actions are more recognized by external audiences; such cities could further enjoy the benefit of access to public and private capital which allows them to achieve more ambitious sustainability targets.[154] Transnational city networks like C40 are voluntary and have low barriers to exit. Any positive climate outcomes are effectively public goods that are non-excludable. Furthermore, cities outside the network can freely interact and conduct learning from other peer cities (C40 member or not). Therefore, the incentive linking accountability to capital gives C40 the authority to "govern in the absence of explicit coercion", achieve coordinated actions and meaningful effects on global climate change.[155]

[151] Gordon, "Politics of Accountability."
[152] André Broome and Joel Quirk, "Governing the World at a Distance: The Practice of Global Benchmarking," *Review of International Studies* 41, no. 5 (2015): 819-41.
[153] Aggarwala, Interview.
[154] Gordon, *Cities on the World Stage.*
[155] Gordon, *Cities on the World Stage*.

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The strength of this feedback loop, however, appears more uneven in practice than its formulation suggests, and the interviews conducted for this study allow the mechanism to be examined from the vantage of those who built and replicated it. Aggarwala confirms that the measurement architecture was consciously built to serve external legibility to funders alongside internal management, treating metrics as both a management tool and a tool of communication.[156] Yet the direct pipeline from disclosure to capital is weaker and takes longer than the loop implies. Dickinson, who authored New York's inventories, reports no clear or direct connection between completing an inventory and securing capital or climate finance, and describes the credential function as one that accreted over time.[157] The contingency is also geographic. In Tokyo, Nishida reports that finance was not a strong driver of the city's accountability practices at all, and that where certification carried financial value it did so as an international business credential attractive to overseas financiers and clients rather than as a domestic political or capital-market signal.[158] Read together, the interviews suggest that the feedback loop linking accountability, legibility, and access to finance, although intentionally designed, is best understood as a conditional route to finance: strongest where a network deliberately couples recognition to creditworthiness[159] and attenuated where local institutions do not. This unevenness anticipates a distributive concern, where recognition and finance flow most readily to cities that are more capable of reporting and exhibiting creditworthiness, which tend to be the cities with more resources.

[156] Aggarwala, Interview.
[157] Dickinson, Interview.
[158] Nishida, Interview.
[159] World Bank, (Washington, DC: World Bank, 2014).; Cities Climate Finance Leadership Alliance, *The State of City Climate Finance 2015* (New York: CCFLA, 2015).; Gordon and Johnson, "Orchestration."

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### 3.4. Standardization, Local Relevance, and Equity

The third of Gordon's forms of accountability, the internal politics of translation, is where the model's tensions with equity concentrate, since globally legible metrics must be translated into local administrative routines, budgets, and priorities.[160] The difficulty begins with comparability itself. The GPC deliberately permits methodological flexibility in emission factors and system boundaries so that cities with different data realities can participate, but that same flexibility undermines the strict cross-city comparison the framework promises,[161] and studies comparing self-reported inventories against independent gridded datasets reveal significant discrepancies driven by jurisdictional versus metropolitan boundaries.[162] Dickinson notes that even under shared protocols, inventories differed in boundaries, emission factors, treatment of transportation and aviation, and baseline years, and that these differences were rarely visible to policymakers or the public, which makes transparent documentation as consequential as the headline figure.[163] Nishida draws the corollary for practice: cities must measure different things according to their own boundary conditions, and comparison is meaningful only when conditioned on shared criteria such as climate and economic profile, so that similar cities are grouped rather than forced to a common starting point.[164]

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[160] Gordon, "Politics of Accountability."
[161] World Resources Institute, C40 Cities Climate Leadership Group, and ICLEI Local Governments for Sustainability, *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities* (Washington, DC: World Resources Institute, 2014), https://ghgprotocol.org/ghg-protocol-cities.
[162] Cathy Nangini et al., "A Global Dataset of CO2 Emissions and Ancillary Data Related to Emissions for 343 Cities," *Scientific Data* 6 (2019): 180280.
[163] Dickinson, Interview
[164] Nishida, Interview.

Beyond comparability lies a deeper question of what the standard makes visible. Because C40's inventories are territorial, capturing emissions produced within a city's boundaries, they omit the emissions embedded in urban consumption, a blind spot the network has itself begun to address through consumption-based accounting.[165] Dickinson regards New York's decision not to pursue consumption-based accounting as a missed opportunity, observing that pairing localized energy data with demographic sources such as the American Community Survey could have surfaced neighborhood-level equity patterns, with preliminary work suggesting Staten Island carried a more carbon-intensive profile than Manhattan.[166] This is the mechanism by which a standardized, production-based framework reinforces equity blind spots: by rendering legible what is easy to count and to finance while sidelining distributive questions, community-led approaches, and consumption.[167] Freed suggests one practical way to address this issue is pairing a universal standard for comparability with locally selected metrics that reflect a city's most significant challenges.[168]

The tradeoff between comparability and local relevance is most visible among Global South cities. Aggarwala observes that lower-income cities in the Global South were often more engaged with the accountability model precisely because they were more exposed to climate risk, yet that adaptation, the domain most consequential for vulnerable populations, proved far

[165] C40 Cities, Arup, and University of Leeds, *The Future of Urban Consumption in a 1.5°C World* (London: C40 Cities, 2019), https://www.c40.org/news/new-research-shows-how-urban-consumption-drives-global-emissions/.
[166] Dickinson, Interview.
[167] Linda Westman et al., "The Homogenization of Urban Climate Action Discourses," *Global Environmental Politics* 23, no. 2 (2023): 102-24, https://direct.mit.edu/glep/article-abstract/23/2/102/114257/The-Homogenization-of-Urban-Climate-Action?redirectedFrom=fulltext.; Sara Hughes et al., "Accountability and Data-Driven Urban Climate Governance," *Nature Climate Change* 10, no. 12 (2020): 1085-90, https://www.nature.com/articles/s41558-020-00953-z.
[168] Freed, Interview.

harder to measure and to finance than greenhouse gas accounting.[169] The standard travels most easily where the underlying problem is one of mitigation accounting, and least easily where it is one of adaptation, capacity, and distribution.

## 4. Limitations and What the Accountability Regime Has Not Achieved

Twenty years after the launch of *PlaNYC: A Greener, Greater New York*, the accountability regime it seeded has demonstrably coordinated action across a voluntary network of cities. Yet three limitations underlie any account of its success, each visible both in the literature and in practitioners' accounts.

The first is democracy. The regime's accountability runs upward and outward, to networks, financial institutions, and investors, more than downward to residents, producing a technocratic drift in which those in whose name climate action proceeds have little role in designing the indicators or enforcing the commitments.[170] Digital engagement experiments have expanded consultation without redistributing decision-making power. Practitioners from our interviews shared this concern. Freed insists that reporting should strengthen accountability toward residents first, and that measurements which orient a city toward external audiences at the expense of immediate resident priorities such as safety and housing affordability would represent a failure of the framework.[171] Dickinson identifies a subtler democratic problem, namely that because the methodological choices inside an inventory are invisible to the public, a

[169] Aggarwala, Interview.
[170] Karin Bäckstrand and Jonathan W. Kuyper, "The Democratic Legitimacy of Orchestration: The UNFCCC, Non-State Actors, and Transnational Climate Governance," *Environmental Politics* 26, no. 4 (2017): 764-88.
[171] Freed, Interview.

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transparent-looking, comparable number can itself obscure the judgments embedded in it.[172] Bäckstrand and Kuyper distinguish three sources of democratic legitimacy in transnational climate governance: input legitimacy, which turns on whether affected publics participate in and are represented in decision-making; throughput legitimacy, which concerns the transparency and accountability of the governing process itself; and output legitimacy, which rests on whether governance delivers effective results. Measured against this distinction, C40's accountability regime is comparatively strong on throughput legitimacy, because standardized public reporting makes its processes visible to peers and funders, and plausibly on output legitimacy, given the coordinated action documented in Sections 2 and 3. It is weak on input legitimacy, because residents have little formal role in setting the indicators by which their cities are judged.[173]

The second limitation is distributive and follows directly from the uneven feedback loop mentioned previously. Where recognition and climate finance flow most readily to cities that already possess reporting capacity and creditworthiness, the framework is partly regressive. It tends to document needs and generate project pipelines without necessarily overcoming the structural barriers, such as low creditworthiness, high perceived risk, and weak enabling environments, that keep finance from reaching the cities that need it most.[174] From our interviews, Dickinson's absent inventory-to-finance link and Nishida's account of finance as a weak domestic driver both suggest that disclosure does not automatically convert into capital and does so least where institutions are weakest.

The same tension appears at the model's point of origin. Local Law 97 recognized that

[172] Dickinson, Interview.
[173] Bäckstrand and Kuyper, "Democratic Legitimacy."
[174] World Bank.; CCFLA, *State of City Climate Finance 2015*; Global Green Growth Institute, (Seoul: GGGI, 2025).

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uniform emissions caps could fall hardest on affordable housing: buildings in which more than 35 percent of units are rent regulated were placed on a separate pathway under Article 321, permitted to complete a prescribed list of energy conservation measures by the end of 2024 instead of meeting emissions limits.[175] The carve-out shields tenants from near-term pass-through costs, but it also holds the buildings that house many lower-income New Yorkers to a prescriptive rather than a performance-based standard. In 2024 the city released *Environmental Justice NYC*, its first comprehensive study of systemic environmental inequity across the five boroughs[176]; that analysis sits alongside, rather than within, the greenhouse gas accounting at the core of PlaNYC's accountability regime. Even in New York, then, the standardized regime has had to be adapted to distributive realities it was not designed to see.

The third limitation is homogenization. Standardized accountability aligns city narratives around a common, finance-oriented script of multi-actor coordination, integrated planning, and co-benefits, at the expense of more radical or locally specific alternatives.[177] The same features that make cities legible to one another and to capital narrow the range of imaginable climate policies.

These limits are best read not as failures of implementation but as structural features of an accountability regime built to make municipal effort legible, comparable, and financeable. They frame three propositions for a future research agenda: that the framework has narrowed urban climate politics around a standardized script; that it privileges measurable, financeable,

[175] NYC Accelerator, "Local Law 97: Article 321," compliance pathways handout, September 2022, https://accelerator.nyc/sites/default/files/2022-09/NYCA_LL97_Prescriptive_Pathways_Handout.pdf.
[176] Mayor's Office of Climate and Environmental Justice, *EJNYC,* (New York: City of New York, 2024), https://www.nyc.gov/assets/climate/downloads/pdfs/EJNYC_Report.pdf.
[177] Westman et al., "Homogenization"; Vanesa Castán Broto and Linda Westman, "Ten Years after Copenhagen: Reimagining Climate Change Governance in Urban Areas," *WIREs Climate Change* 11, no. 4 (2020): e643.

asset-protecting action over distributive and procedural justice; and that recognition and finance flow disproportionately to cities with prior capacity and creditworthiness, making the regime partly regressive across the network's economic divide.

This study has limitations of its own. Its interview evidence rests on four practitioners, three of whom helped build or export the New York model and may view it more favorably than outside observers would, and none of whom represents a Global South city, although several of the paper's distributive claims concern such cities. The paper also cannot establish that C40 membership or PlaNYC-style accountability caused the outcomes it describes. Cities that join C40 and adopt rigorous disclosure may already be more ambitious, better resourced, and more politically committed to climate action, so that membership may reflect ambition as much as produce it. Much of the outcome evidence in Section 2 is self-reported by cities or drawn from secondary reporting rather than independent evaluation, and the C40 and McKinsey framework that organizes it leaves adaptation outside its scope. Future research should extend interviews to practitioners in Global South member cities, compare the emissions and policy trajectories of C40 and comparable non-member cities over time, and draw on independently verified data where it exists.

## 5. Conclusion

Across four strategic areas and eleven cities, this paper has shown that municipal governments, coordinating through networks such as C40, have become central and capable actors in the global sustainability transition, and that the data-driven accountability model inherited from PlaNYC has been instrumental in coordinating that effort. That accomplishment is

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real and should not be understated. Yet the practitioner testimony gathered here also locates its influence more precisely. The accountability model traveled as a set of principles more than as a fixed template, and it changed practice most where political leadership converted measurement into binding mandates and budgets. Its coupling to climate finance was a deliberate design feature that strengthened the network's coordinating power, but an uneven route to capital that favored cities already able to report and already creditworthy. Its recognition ran outward and upward more than downward toward residents, and its standardized, production-based form rendered distributive and consumption-based questions difficult to see. These conclusions rest on a small set of practitioner interviews and largely self-reported city data, and testing them across a wider set of cities is the natural next step. City-led sustainability transitions are, on this evidence, both viable and essential. The task for the next twenty years is to build an accountability regime that keeps their coordinating power while answering more fully to the residents, and to the equity concerns, in whose name cities act.

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