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SYMPOSIUM ON TRANSITIONING TOWARDS SUSTAINABLE AND EQUITABLE CITIES

Towards a Science of Scaling for Urban Climate Action and Governance

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Abstract

The scaling of urban climate action and its governance is rapidly becoming a central focus in the urban climate governance literature and policy debates. Building on the broader scaling literature and inspired by related initiatives in other fields, this article calls for the development of a systematic "science of scaling" for urban climate governance. Such a science of scaling may help to give a better understanding of how well-performing urban climate action and its governance can be multiplied, accelerated and broadened (ie horizontal and vertical scaling and scaling out, up and down), and it may help to uncover scaling trajectories towards systemic change in cities (ie deep scaling).

Keywords: science of scaling; urban climate action; urban climate governance

I. Introduction

For a long time, cities, city regions, urban communities and other large human settlements (referred to here as "cities") have been lauded for taking climate action where nation states were seen to fail.[1] They have received praise for rapidly embracing new technologies and pursuing behavioural changes to reduce urban resource consumption and waste production.[2] Cities have also received accolades for experimenting with novel forms of urban climate action and its governance and for the dissemination of lessons from these experiments through city-to-city networks and other platforms.[3] Finally, high hopes have been expressed regarding the potential to scale these urban climate actions and their

[1] Y Gao, X Gao and X Zhang, "The 2 °C Global Temperature Target and the Evolution of the Long-Term Goal of Addressing Climate Change – From the United Nations Framework Convention on Climate Change to the Paris Agreement" (2017) 3 Engineering 272; UN, *Yearbook of Global Climate Action 2018* (Geneva, United Nations Climate Change Secretariat/Marrakech Partnership 2018).

[2] H Bulkeley, VC Broto and G Edwards, *An Urban Politics of Climate Change: Experimentation and the Governing of Socio-technical Transitions* (Abingdon-on-Thames, Routledge 2015); M Santamouris and D Kolokosta (eds), *Urban Climate Mitigation Techniques* (Abingdon-on-Thames, Routledge 2016).

[3] N Frantzeskaki, "How City-Networks are Shaping and Failing Innovations in Urban Institutions for Sustainability and Resilience" (2019) 10 Global Policy 712; M Keiner and A Kim, "Transnational City Networks for Sustainability" (2007) 15 European Planning Studies 1369.

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governance (locally, regionally, nationally and even globally) and to make a significant contribution to keeping global warming under 1.5°C.[4]

However, this narrative is rapidly shifting. Increasingly, scholars are pointing out that what we know about the scaling of urban climate action and its governance does not paint a hopeful picture. In this context, scaling is understood as: (1) the increased use of innovative forms of urban climate action and its governance beyond the individuals and collectives involved in their initial development and implementation; (2) transformative and systemic change achieved through innovative forms of urban climate action and its governance; or (3) a combination of both (1) and (2).[5] Scholars point out that innovative urban climate action and its governance are not resulting in fundamental changes across institutional levels[6]; that there is no buy-in from the global majority of cities and urban citizens to take action locally (through direct replication or adjustment to the local context of innovations from elsewhere)[7]; and that, at best, technological innovations have scaled but behavioural and institutional ones have not scaled so much.[8]

In sum, over recent years, scholars have begun to point out that, whilst the scaling of (innovations in) urban climate action and its governance is essential, it is not yet happening to the extent that it makes a significant contribution to keeping global warming under 1.5°C.[9] Related observations are made in policy debates and documents. For example, the recent European Green Deal is explicit regarding the need for large-scale changes and the difficulty of achieving these changes under a business-as-usual scenario in areas such as building retrofits and smart urban transport. The European Commission lauds what has been achieved in a piecemeal manner over recent decades in terms of, among other things, reductions in city-related greenhouse gas emissions, but it stresses that deep, mutually reinforcing transformations are required to achieve the European Union's climate ambitions.[10]

For these reasons, scholars of urban climate governance have begun to focus on scaling as a topic for scholarly inquiry in and of itself if we wish to know how the scaling of urban climate action and its governance can best be achieved.[11] This article seeks to contribute to

[4] S Sassen, "Bringing Cities into the Global Climate Framework" in C Johnson, N Toly and H Schroeder (eds), *The Urban Climate Challenge* (Abingdon-on-Thames, Routledge 2015); UNFCCC, *Adoption of the Paris Agreement, Draft Decision CP.21* (Rio de Janeiro, United Nations Framework Convention on Climate Change 2015).

[5] P Hofman et al, "Retrofitting at Scale: Comparing Transition Experiments in Scotland and The Netherlands" (2021) 2 Buildings and Cities 637; M Sartas et al, "Scaling Readiness: Science and Practice of an Approach to Enhance Impact of Research for Development" (2020) 183 Agricultural Systems Article 102874.

[6] E Smeds and M Acuto, "Networking Cities after Paris: Weighing the Ambition of Urban Climate Change Experimentation" (2018) 9 Global Policy 549.

[7] J van der Heijden, "From Leaders to Majority: A Frontrunner Paradox in Built-Environment Climate Governance Experimentation?" (2018) 61 Journal of Environmental Planning and Management 1383; K Kern, "Cities as Leaders in EU Multilevel Climate Governance: Embedded Upscaling of Local Experiments in Europe" (2019) 28 Environmental Politics 125.

[8] VC Broto and H Bulkeley, "A Survey of Urban Climate Change Experiments in 100 Cities" (2013) 23 Global Environmental Change 92; L Delina, "Climate Mobilizations and Democracy: The Promise of Scaling Community Energy Transitions in a Deliberative System" (2020) 22 Journal of Environmental Policy & Planning 30.

[9] UN, *World Urbanization Prospects: The 2018 Revision* (New York, United Nations 2018); R Sennet, R Burdett and S Sassen (eds), *The Quito Papers and the New Urban Agenda* (Abingdon-on-Thames, Routledge 2018); D Reckien et al, "How Are Cities Planning to Respond to Climate Change? Assessment of Local Climate Plans from 885 Cities in the EU-28" (2018) 191 Journal of Cleaner Production 207; VC Broto, "Urban Governance and the Politics of Climate Change" (2017) 93 World Development 1 Of course, not all of the literature presents as gloomy a picture as I do here. For example, some urban transition scholars have recently begun to point out that the energy transition is entering a new stage of acceleration: see J Markard, F Geels and R Raven, "Challenges in the Acceleration of Sustainability Transitions" (2020) 15 Environmental Research Letters 1.

[10] European Commission, *The European Green Deal* (Brussels, European Commission 2019).

[11] H van der Ven, S Bernstein and M Hoffmann, "Valuing the Contributions of Non-state and Subnational Actors to Climate Governance" (2017) 17 Global Environmental Politivs 1; Smeds and Acuto, supra, note 6.

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this rapidly emerging debate on the scaling of (innovations in) urban climate action and (innovations in) its governance. It does so by mapping, exploring and interrogating the scaling debate in the urban climate governance literature, and it delves into discussions on scaling in other policy areas to enrich this debate. This article builds on a narrative review of the literature on scaling urban climate action and governance. For the review, peer-reviewed journal articles were sourced from the Web of Science and Google Scholar databases using "urban AND scale AND climate AND (action OR govern*)" as keywords. In addition, the same databases were searched for the keywords "science of scaling" to identify broader debates on this topic.[12]

The aim of this article is to begin working towards a systematic "science of scaling" for urban climate governance, which seems necessary if we wish to increase the likelihood that urban climate action and its governance will achieve systemic change.[13] In what follows, following the broader scaling literature, some essential elements of such a science of scaling for urban climate governance are presented. But first, it is explained why a science of scaling has become so essential for this area of scholarship at the beginning of the 2020s and how, and with what results, insights from the scaling literature have been applied in this area to date.

II. How the scaling challenge has entered urban climate action and governance scholarship

For a long time, the development, use, maintenance and transformation of cities have been governed through laws and regulations introduced by national, regional and local governments.[14] Whilst such laws and regulations have served cities well in the past,[15] they face challenges in dealing with the urgently required climate change transformation of cities (mitigation *and* adaptation). The problems include, but are not limited to: a lag between the development of law and regulation and the growth of cities in low- and middle-income countries[16]; the slow replacement rate of existing buildings and infrastructure in cities in developed economies[17]; and the difficulty of changing or altering the existing property rights of the owners, users and other beneficiaries of buildings, infrastructure and land – meaning that new urban law and regulation often exempt from compliance existing buildings, infrastructure and land use in cities.[18]

Facing these challenges, governments have developed alternatives for law and regulation (sometimes in collaboration with non-governmental parties) to initiate urban climate

[12] H Cooper, L Hedges and J Valentine (eds), *The Handbook of Research Synthesis and Meta-analysis* (3rd edition, New York, Russel Sage Foundation 2019).

[13] Cf. J Gargani and R McLean, "Scaling Science" (2017) 2017 Stanford Social Innovation Review 34; H Price-Kelly, L van Haeren and R McLean, *The Scaling Playbook: A Practical Guide for Researchers* (Ottawa, International Development Research Centre 2020).

[14] P Taylor, *Extraordinary Cities: Millennia of Moral Syndromes, World-Systems and City/State Relations* (Cheltenham, Edward Elgar 2013).

[15] F Fukuyama, *The Origins of Political Order: From Prehuman Times to the French Revolution* (New York, Farrar, Straus, and Giroux 2012).

[16] World Bank, *Africa's Cities: Opening Doors to the World* (Washington, DC, World Bank 2017); C Rosenzweig et al, *Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network* (Cambridge, Cambridge University Press 2018).

[17] World Bank, *Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment* (Washington, DC, World Bank 2016).

[18] F van Straalen, T Hartmann and J Sheenan (eds), *Property Rights and Climate Change: Land Use under Changing Environmental Conditions* (Abingdon-on-Thames, Routledge 2018).

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action.[19] For example, in 2010, the City of Amsterdam introduced a Climate and Energy Fund. The Fund makes finance available for projects that, among other things, help to reduce the city's carbon emissions but that cannot find funding elsewhere. The Fund operates as a revolving loan fund, meaning that once a loan is paid back to it the funds are made available again to other projects. The Fund helps the City of Amsterdam to reduce the city's carbon emissions and to normalise the development of low- and even zero-carbon construction projects.[20]

Similarly, these challenges have spurred non-governmental parties to take voluntary urban climate action and to develop and implement strategies to govern this voluntary action. For example, around the globe, for-profits and not-for-profits have introduced building rating and certification programmes, with a dominant example in Europe being the Building Research Establishment Environmental Assessment Method (BREEAM).[21] These programmes allow the environmental impacts of existing and new buildings to be evaluated. Depending on its performance, a building will be given a higher or lower rating, typically represented by a certificate, to help (future) owners or tenants to distinguish between poor-performing and well-performing buildings. It is then expected that owners and tenants will increasingly call for buildings with a low environmental impact and that developers will begin building these.

Another response is represented by a mushrooming of city-to-city, city-to-citizen and city-to-firm climate networks. In such networks, cities can cooperate and share information on how to take and govern climate action (eg there are well-known municipal climate networks such as the Covenant of Mayors for Climate and Energy, which was launched in Europe in 2008); they can collaborate with citizens and firms within the same jurisdiction (an example here is the Transition Town Network); and they can even embrace the private-sector and non-governmental initiatives that provide "off-the-shelf" urban climate action (an example being the Rockefeller Foundation's 100 Resilient Cities programme, which has merged into the Resilient Cities Network).[22]

1. Unpacking and understanding the scaling challenge

The developments discussed should be understood within the context of at least three decades of exceptionally active debates about the role of cities in the global response to climate change. At the beginning, during the 1990s, cities were increasingly seen as the most promising level for governing climate action.[23] Arguably, Local Agenda 21, adopted at the Earth Summit in Rio de Janeiro in 1992, was a landmark and paradigm-shifting publication that recognises and explicitly mentions cities as important sites for climate action.[24] Local Agenda 21 gave (local) governments and policymakers legitimacy to put climate mitigation (and later adaptation) on the urban agenda, and it provided an

[19] H Bulkeley, *Cities and Climate Change* (Abingdon-on-Thames, Routledge 2013); J van der Heijden, "Cities and Sub-national Governance: High Ambitions, Innovative Instruments and Polycentric Collaborations" in A Jordan and D Huitema (eds), *Polycentricity in Action* (Oxford, Oxford University Press 2018).

[20] J van der Heijden, *Governance for Urban Sustainability and Resilience: Responding to Climate Change and the Relevance of the Built Environment* (Cheltenham, Edward Elgar 2014).

[21] A Sánchez Cordero, S Gómez Melgar and JM Andújar Márquez, "Green Building Rating Systems and the New Framework Level(s): A Critical Review of Sustainability Certification within Europe" (2020) 13 Energies 26.

[22] J van der Heijden, "Experimental Governance for Low-Carbon Buildings and Cities: Value and Limits of Local Action Networks" (2016) 53 Cities 1.

[23] R Stren, R White and J Whitney, *Sustainable Cities: Urbanization and the Environment in International Perspective* (Boulder, CO, Westview Press 1992); L Blassingame, "Sustainable Cities: Oxymoron, Utopia, or Inevitability?" (1998) 35 Social Science Journal 1.

[24] UNCED, *Agenda 21* (New York, United Nations 1992).

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impetus for academics to begin systematic and ongoing inquiries into the how, what, why and where of urban climate action and its governance.[25]

From the early 2000s onwards, the narrative of cities, climate change and urban climate action and its governance has grown rapidly. In a first storyline, cities are seen as one of the main victims of climate change. It is commonplace to acknowledge that the negative results of climate change will hit cities hardest because of their high population densities, their role in the global economy and function as capital sinks and their often-vulnerable locations.[26] A second storyline takes a different point of view and looks at cities as key sources of climate change. More than half of the world's population lives in cities (and that number will only rise), and most global carbon emissions and resource consumption can be attributed to urban lifestyles, whilst cities make up less than 5% of Earth's land surface.[27] A third storyline sees cities as sites of opportunity because their population densities and relative affluence mean that major reductions in energy, finite material use and greenhouse gas emissions could be realised relatively quickly in them.[28]

During the 2010s, the narrative grew thicker. In a fourth storyline, cities are lauded as saviours of the planet in the face of climate change.[29] Cities are reported to be rapidly embracing new technologies and behavioural changes to reduce city-related greenhouse gas emissions and to change urban lifestyles (in part by embracing alternatives to traditional, government-led direct regulation – as discussed previously).[30] Cities are also found to collaborate actively with citizens and businesses to develop tailored urban governance climate interventions and to operate in regional, national and international city networks, helping to build knowledge regarding urban climate action, disseminate best practice and, in international forums, raise the voice of cities as meaningful players in global climate governance (again, these tailored interventions are developed as alternatives to traditional, government-led direct regulation – as discussed previously).[31] This role of cities was, for example, underlined in 2015 in the lead-up to the signing of the Paris Agreement, in the New Urban Agenda in 2016 and in the European Union Strategy on Adaptation to Climate Change in 2021.[32]

However, in the early 2020s, the narrative has now begun to shift.[33] Increasingly, scholars are stressing that cities are not taking the necessary actions and making changes of the

[25] W Lafferty and K Eckerberg, *From the Earth Summit to Local Agenda 21: Working towards Sustainable Development* (London, Earthscan 1998); P Selman, "Local Agenda 21: Substance or Spin?" (1998) 41 Journal of Environmental Policy and Management 533.

[26] N Brenner, *New State Spaces: Urban Governance and the Rescaling of Statehood* (Oxford, Oxford University Press 2004); P Nijkamp and G Pepping, "A Meta-analytical Evaluation of Sustainable City Initiatives" (1998) 35 Urban Studies 1481.

[27] M Betsill and H Bulkeley, "Looking Back and Thinking Ahead: A Decade of Cities and Climate Change Research" (2007) 12 Local Environment 447; C Rosenzweig et al, "Cities Lead the Way in Climate-Change Action" (2010) 467 Nature 909.

[28] S Parnell, "Defining a Global Urban Development Agenda" (2016) 78 World Development 529; H Bulkeley and M Betsill, *Cities and Climate Change* (Abingdon-on-Thames, Routledge 2003).

[29] C Johnson, *The Power of Cities in Global Climate Politics: Saviours, Supplicants or Agents of Change?* (London, Palgrave Macmillan 2018); B Barber, *If Mayors Ruled the World* (New Haven, CT, Yale University Press 2013).

[30] P Newman, T Beatley and H Boyer, *Resilient Cities* (Washington, DC, Island Press 2009); R Brescia and J Marshall, *How Cities Will Save the World: Urban Innovation in the Face of Population Flows, Climate Change, and Economic Inequality* (Abingdon-on-Thames, Routledge 2016).

[31] K Kern and G Alber, "Governing Climate Change in Cities" in L Kamal-Chauoi (ed.), *Competitive Cities and Climate Change* (Paris, OECD 2010); C40 and Arup, *Deadline 2020: How Cities Will Get the Job Done* (C40 Cities 2017).

[32] United Nations, *New Urban Agenda* (New York, United Nations General Assembly 2016); C Streck, P Keenlyside and M von Unger, "The Paris Agreement: A New Beginning" (2016) 13 Journal for European Environmental & Planning Law 3; European Commission, *Forging a Climate-Resilient Europe – The New EU Strategy on Adaptation to Climate Change* (Brussels, European Commission 2021).

[33] To give credit where credit is due, the narrative of cities as saviours was already being challenged in the 2010s by some scholars: eg J Rogelj et al, "Paris Agreement Climate Proposals Need a Boost to Keep Warming Well

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magnitude and at the speed required to keep global warming to 1.5°C.[34] Their work hints at different challenges. Cities may have embraced new technologies, innovative forms of behavioural change and governance alternatives in too haphazard a way, and they may now be struggling to merge these into a coherent whole that is larger than the sum of its parts.[35] Some cities have managed to harvest the "low-hanging fruit" by such actions as increasing the building energy efficiency of new buildings, but they may have been less successful in tackling more complex problems such as energy retrofits of existing buildings,[36] whereas other cities may have found it difficult (or perhaps have been unwilling) to learn from and repeat each other's best practices.[37] Replicating best practices is often challenging because their performance and impact are strongly affected by local contexts and local actors.[38] As a result, the combined climate activities and governance interventions of cities have not (yet) accumulated to a point at which they trigger a fundamental change in norms, values and rules across cities globally.[39]

These issues have rapidly entered the urban climate governance research agenda and point to a common denominator: a scaling challenge. We have now reached a point where we need to think critically and systematically about *how* to stabilise and accelerate, *how* to broaden and grow and *how* to replicate and transfer the innovations in urban climate action and governance that have mushroomed around the world for more than three decades.[40] Equally importantly, we have reached a point where we need to think critically about *how* to achieve the systemic changes that are critical to the rapid transformation of our cities in a way that helps to keep global warming to 1.5°C.[41]

III. State of the art: urban climate governance scholarship embraces the scaling challenge

Increasingly, scholars of urban climate governance are embracing this scaling challenge and discussing the need for a better understanding of the scaling of urban climate action

Below 2 °C" (2016) 534 Nature 631; G Peters et al, "The Challenge to Keep Global Warming Below 2 °C" (2013) 3 Nature Climate Change 4. It is since 2020, however, that the shift in narrative described here has gained a foothold in the urban climate governance literature.

[34] A Hsu et al, "Performance Determinants Show European Cities Are Delivering on Climate Mitigation" (2020) 10 Nature Climate Change 1015; M Heikkinen et al, "Transnational Municipal Networks and Climate Change Adaptation: A Study of 377 Cities" (2020) 257 Journal of Cleaner Production 1.

[35] S Markolf et al, *Pledges and Progress: Steps toward Greenhouse Gas Emissions Reductions in the 100 Largest Cities across the United States* (Washington, DC, Brookings 2020); Ä Persson and H Runhaar, "Drawing Lessons for Environmental Policy Integration and Prospects for Future Research" (2018) 85 Environmental Science & Policy 141.

[36] G Trencher et al, "Innovative Policy Practices to Advance Building Energy Efficiency and Retrofitting: Approaches, Impacts and Challenges in Ten C40 Cities" (2016) 66 Environmental Science & Policy 353.

[37] M Guenard, *Key Learnings for Cities to Enable 1.5-Degree Lifestyles* (*CityTalk*, 2020) <https://talkofthecities.iclei.org/key-learnings-for-cities-to-enable-1-5-degree-lifestyles/> (last accessed 25 May 2022); VC Broto and L Westman, "Ten Years after Copenhagen: Reimagining Climate Change Governance in Urban Areas" (2020) 11 WIREs Climate Change 1.

[38] J van der Heijden, "Studying Urban Climate Governance: Where to Begin, What to Look for, and How to Make a Meaningful Contribution to Scholarship and Practice" (2019) 1 Earth System Governance Article 100005; D Gordon, *Cities on the World Stage: The Politics of Global Urban Climate Governance* (Cambridge, Cambridge University Press 2020).

[39] Delina, supra, note 8; VC Broto, "Climate Change Politics and the Urban Contexts of Messy Governmentalities" (2020) 8 Territory, Politics, Governance 241.

[40] H Bulkeley, "Climate Changed Urban Futures: Environmental Politics in the Anthropocene City" (2021) 30 Environmental Politics 266; S Bouzarovskim and H Haarstad, "Rescaling Low-Carbon Transformations: Towards a Relational Ontology" (2019) 44 Transactions of the Institute of British Geographers 256.

[41] A Karvonen, "The City of Permanent Experiments?" in B Turnheim, P Kivimaa and F Burkhout (eds), *Innovating Climate Governance: Moving Beyond Experiments* (Cambridge, Cambridge University Press 2018); S Hughes and M Hoffmann, "Just Urban Transitions: Toward a Research Agenda" (2020) 11 WIREs Climate Change 1.

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and its governance. When carrying out an overview of the literature, three different areas of focus stand out. First, scholars have begun to explore where we can expect to find scaling of urban climate action and its governance, resulting in a range of ideal types of scaling. Second, they have begun to explore the conditions that may contribute to or hamper this scaling, resulting in a broad set of (expected) drivers of and causal mechanisms for scaling. Third and finally, scholars have introduced different ways of looking at scaling by mapping, exploring and interrogating the urban climate actions that can be scaled (the "what" of scaling), the urban climate governance and other mechanisms required for such scaling (the "how" of scaling) and the interplay of these elements and other dynamics that make scaling processes context-specific or more generally applicable (the "replicability" of scaling).

1. Types of scaling

The area of focus that has received most attention is where scaling of urban climate action and its governance may be expected and what forms it may take. Despite some minor quibbles over terminology,[42] scholars largely agree on three ideal types of scaling. Of course, the boundaries of these types will not be as easy to define in real-world settings as they are when discussed in the literature, and there are likely to be interactions and interdependencies between the types.[43]

The first type of scaling is characterised by the multiplication (in time, space or both) of urban climate actions and their governance and parts thereof, the replication of (conceptually) similar actions and governance interventions to (conceptually) dissimilar contexts and the replication of the principles of actions and interventions to (conceptually) similar contexts.[44] The conventional terminology used for this ideal type is "horizontal scaling" and "scaling out".[45] This type of scaling is typically expected to occur voluntarily on the basis of learning and the exchange of experiences and knowledge.[46] For example, the BREEAM building certification programme (discussed earlier) was originally launched in the UK and has been replicated with local adaptations in countries such as Austria, Spain and Sweden.[47] Similarly, the principles of the Transition Town movement have been replicated in many European cities, leading to a variety of local actions – from urban

[42] For a narrative review of the broader scaling literature and arguments for and against using specific terminology, see D Lam et al, "Scaling the Impact of Sustainability Initiatives: A Typology of Amplification Processes" (2020) 2 Urban Transformations 1.

[43] D van Doren et al, "Scaling-up Low-Carbon Urban Initiatives: Towards a Better Understanding" (2018) 55 Urban Studies 175.

[44] H Fuhr, T Hickmann and K Kern, "The Role of Cities in Multi-level Climate Governance: Local Climate Policies and the 1.5 °C Target" (2018) 30 Current Opinion in Environmental Sustainability 1; M Schut, C Leeuwis and G Thiele, "Science of Scaling: Understanding and Guiding the Scaling of Innovation for Societal Outcomes" (2020) 184 Agricultural Systems 1.

[45] Some scholars have spent a long time explaining why "horizontal scaling" is different from "scaling out" and why "vertical scaling" is different from "scaling up". In my reading of the literature, however, we simply lack the level of (empirical) understanding of scaling of urban climate action and governance to allow for such detailed distinguishing of "difference in differences". See also M Reed and S Bruyneel, "Rescaling Environmental Governance, Rethinking the State: A Three-Dimensional Review" (2010) 34 Progress in Human Geography 646; A Cohen and J McCarthy, "Reviewing Rescaling: Strengthening the Case for Environmental Considerations" (2015) 39 Progress in Human Geography 3.

[46] Kern, supra, note 7; S Bernstein and M Hoffmann, "The Politics of Decarbonization and the Catalytic Impact of Subnational Climate Experiments" (2018) 51 Policy Sciences 189.

[47] Sánchez Cordero et al, supra, note 21.

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agriculture in Essen, Germany, to a community centre that raises awareness about environmental and social sustainability in Linda-A-Velha, Portugal.[48]

The second type of scaling is characterised by the transferring and spreading of urban climate actions and their governance and parts thereof through administrative or organisational levels other than the levels at which they originated. This type of scaling is seen as particularly promising in multi-level systems such as the European Union, where promising local initiatives (such as efficiency standards for buildings) can be made mandatory in a large geographical region.[49] It is likely that the conditions for such scaling – such as changes to laws, policies or institutions – will have to be created intentionally.[50] For example, an action or governance intervention may be integrated at a higher system or governance level (from local to national, from national to global or even from local to global) and, once integrated, the responsibility or accountability for it can be further redirected[51] – including to lower system or governance levels.[52] The conventional terminology used for this ideal type is "vertical scaling" and "scaling up". This type of scaling is typically expected to require some form of power[53] – whether this is a voluntary and self-organised pull mechanism or a forced and authoritarian push mechanism.[54] For example, in 2021, twenty Danish municipalities across five regions adopted development plans to reduce their greenhouse gas emissions by 2030 by up to 70% relative to 1990 levels and to become carbon neutral by 2050.[55] This is a direct implementation of the voluntary standards for urban climate planning that were developed by the C40 city-to-city climate network.[56]

The third type of scaling is concerned with systemic change rather than the directional multiplication, replication, transferring or spreading of urban climate actions and their governance (that is, horizontal or vertical scaling and scaling out, up and down).[57] Put differently, this type of scaling has a focus on improvement at scale rather than implementation at scale.[58] The conventional terminology used for this ideal type of scaling is "deep scaling".[59] It is conceptualised as a process of social transformation that occurs "when sustainable values and norms become culturally and institutionally embedded by individuals and institutions".[60] It seems unlikely that deep scaling is a process that can be

[48] M Fernandes-Jesu et al, "Community Engagement in the Transition Movement: Views and Practices in Portuguese Initiatives" (2017) 22 Local Environment 1546; C Miller and P Hammer, "Socially Driven Examples. Urban Gardening Projects in the City of Essen" in K Pallagst, J Vargas-Hernández and P Hammer (eds), *The Role of Green Innovation Areas in Revitalizing German and Mexican Cities* (Sant Antoni de Portmany, Fondo Editorial Universitario 2019).

[49] Fuhr et al, supra, note 44.

[50] I Omann et al, "Assessing Opportunities for Scaling Out, Up and Deep of Win–Win Solutions for a Sustainable World" (2020) 160 Climatic Change 753.

[51] E Ostrom, "A Multi-Scale Approach to Coping with Climate Change and Other Collective Action Problems" (2010) 1 Solutions Journal 27; J Hamilton et al, "Scaling Up Local Carbon Action: The Role of Partnerships, Networks and Policy" (2014) 5 Carbon Management 463.

[52] The latter is sometimes described as "scaling down" (eg see Fuhr et al, supra, note 44). However, the same term is used for scaling processes in which the introduction of alternatives reduces existing (undesirable) practices (eg see Schut et al, supra, note 44).

[53] Kern, supra, note 7; Bernstein and Hoffmann, supra, note 46.

[54] Schut et al, supra, note 44.

[55] "DK2020 - Klimaplaner for hele Danmark" <https://concito.dk/projekter/dk2020-klimaplaner-hele-danmark> (last accessed 10 January 2022).

[56] C40, *Climate Action Planning Framework* (C40 Cities 2020).

[57] L Woltering et al, "Scaling – From 'Reaching Many' to Sustainable Systems Change at Scale: A Critical Shift in Mindset" (2019) 176 Agricultural Systems Article 1026652; P Newell, F Daley and M Twena, "Scaling Behaviour Change for a 1.5-Degree World: Challenges and Opportunities" (2021) 4 Global Sustainability 1.

[58] M Cannata and S Rutledge, "Introduction to New Frontiers in Scaling Up Research" (2017) 92 Peabody Journal of Education 559.

[59] Omann et al, supra, note 50; Woltering et al, supra, note 57.

[60] Newell et al, supra, note 57.

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planned in a linear manner; rather, it requires multiple strategic interventions in different social, economic, political and cultural contexts.[61] The latter is indeed a point of departure in the transitions literature and is central to the multi-level perspective (MLP) that acknowledges that the scaling up and scaling out of innovative climate actions (innovations at the "niche" level in MLP jargon) could ultimately result in systemic change (change at the "regime" and "landscape" levels in that same jargon).[62]

2. Drivers and causal mechanisms of scaling

Considerably less attention is given in the literature to the conditions that contribute to or hamper the scaling of urban climate action and its governance. Identifying these conditions requires analytical scrutiny of real-world instances of such cases, but scaling is notoriously difficult to study empirically because of the long timespan that is often needed for something to scale and the many moving parts involved.[63] That being said, and as illustrated by the ideal types, the urban climate governance literature (obviously) touches on coercion and cooperation as important factors for the scaling of urban climate action and its governance. Coerced scaling involves, among other things, the changing of laws and regulations to scale urban climate action and its governance,[64] and cooperative scaling involves, among other things, the changing of institutions and power relationships to scale climate action and its governance, but without the force of law.[65]

Other broad conditions that drive scaling or otherwise affect it can be summed up under the headings of finance (ie the profitability of urban climate action for developers and end-users), confidence in the solution (ie the reliability of the technical, environmental and economic performance of urban climate action), complexity (ie the financial, human, information and technical resources required for developers and end-users), compatibility (ie the technical, geographical, cultural and normative alignment of urban climate action) and information (ie the communication between the instigators of urban climate action and its developers and end-users).[66]

Besides a focus on these institutional, structural and contextual conditions, there is an ongoing (niche) debate in the urban climate governance literature on the (assumed) role that frontrunners (also termed "leaders", "innovators", "pioneers", "trend-seekers" and "explorers") play in the process of scaling urban climate action and its governance.[67] This debate echoes a process of linear scaling described in the diffusion of innovations literature: urban climate action or its governance begins small with innovators, is then taken up by early adopters and via them makes the jump to the majority and laggards.[68]

[61] J Rotmans and D Loorbach, "Complexity and Transition Management" (2009) 13 Journal of Industrial Ecology 184; F Geels and J Schot, "Typology of Sociotechnical Transition Pathways" (2007) 36 Research Policy 399.

[62] R Naber et al, "Scaling Up Sustainable Energy Innovations" (2017) 110 Energy Policy 342.

[63] S Wigiboldus et al, "Systemic Perspectives on Scaling Agricultural Innovations. A Review" (2016) 36 Agronomy for Sustainable Development 46; Gargani and McLean, supra, note 13.

[64] S Hughes, "The Politics of Urban Climate Change Policy: Toward a Research Agenda" (2017) 53 Urban Affairs Review 362; S Jagers et al, "On the Preconditions for Large-Scale Collective Action" (2020) 49 AMBIO 1282.

[65] J van der Heijden, *Innovations in Urban Climate Governance: Voluntary Programs for Low Carbon Buildings and Cities* (Cambridge, Cambridge University Press 2017); M Acuto and S Rayner, "City Networks: Breaking Gridlocks or Forging (New) Lock-Ins?" (2016) 92 International Affairs 1147.

[66] van Doren et al, supra, note 43; Omann et al, supra, note 50.

[67] J Wittmayer and D Loorbach, "Governing Transitions in Cities: Fostering Alternative Ideas, Practices, and Social Relations through Transition Management" in D Loorbach et al (eds), *Governance of Urban Sustainability Transitions* (Berlin, Springer 2016); M Ye et al, "Collective Patterns of Social Diffusion Are Shaped by Individual Inertia and Trend-Seeking" (2021) 12 Nature Communications 1.

[68] EM Rogers, *Diffusion of Innovations* (New York, Free Press 1995); EM Rogers et al, "Complex Adaptive Systems and the Diffusion of Innovations" (2005) 10 Innovation Journal 1; G Moore, *Crossing the Chasm* (New York, HarperCollins Publishers 2002).

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Typically, large and affluent cities in the Global North are seen (and studied) as the innovators and early adopters in this debate, and the assumption is quite easily made that once these cities are on board cities elsewhere will follow.[69]

It remains to be seen, however, whether frontrunners play as strong a role in the process of scaling of urban climate action and its governance as is often assumed. In non-homogeneous environments (with large variety in those that make up the majority) such as the global pool of cities, city regions and urban communities (and, perhaps more importantly, the people that live, work and invest in them), there is a substantial risk that the majority (and laggards) are not convinced by the experiences and insights of the frontrunners because they do not consider them as their peers or equals[70] – a challenge that has indeed been flagged in the urban climate governance literature.[71]

3. Different ways of looking at scaling

Over the years, scholars have both embraced existing heuristics and analytical frameworks and developed novel ones that help to capture the scaling of urban climate action and urban climate governance.[72] For example, the diffusion of innovations framework presents a rather straightforward view on scaling: an innovation begins small and, if it scales, it does so by going through different phases of ever-larger adoption. To use the terminology introduced above, this first involves a scaling out of the innovation within a group of innovators before there is a scaling up to the group of early adopters. Once the innovation has scaled out far enough within that group of early adopters, it is expected to scale up again to the majority, and so on until it has become transformative.[73]

A different way of looking at scaling of urban climate action and its governance is the small-wins perspective.[74] Rooted in organisational psychology,[75] this holds that transformative change may result from the accumulation of small wins and occurs in a non-linear manner (contrary to the linear view taken by the diffusion of innovations perspective). To this end, targeted governance interventions are required to introduce a variety of propelling mechanisms that accelerate the application of innovations (the small wins) but within a larger vision of transformation. The central idea of this perspective is to "[stimulate] distributed innovation efforts to foster gradual, yet in-depth change in a desired direction".[76] The small-wins perspective calls for a shift away from seeking large-scale transformation through bold policy programmes (which may be too overwhelming for policymakers, practitioners and citizens) towards modest policy planning that cultivates small wins and governs them towards the desired outcome.[77]

[69] Kern, supra, note 7; Y Peng, Y Wei and X Bai, "Scaling Urban Sustainability Experiments: Contextualization as an Innovation" (2019) 227 Journal of Cleaner Production 302.

[70] B Clarysse et al, "Creating Value in Ecosystems: Crossing the Chasm between Knowledge and Business Ecosystems" (2014) 43 Research Policy 1164; S Jahanmir and LF Lages, "The Late-Adopter Scale: A Measure of Late Adopters of Technological Innovations" (2016) 69 Journal of Business Research 1701.

[71] van der Heijden, supra, note 7; Kern, supra, note 7.

[72] Because of space limitations, what follows are brief descriptions of only three of the many ways of looking at scaling discussed in the broader literature.

[73] Rogers, supra, note 68; Moore, supra, note 68.

[74] C Termeer et al, "The Regional Governance of Climate Adaptation: A Framework for Developing Legitimate, Effective, and Resilient Governance Arrangements" (2011) 2 Climate Law 159; C Termeer and T Metze, "More than Peanuts: Transformation towards a Circular Economy through a Small-Wins Governance Framework" (2019) 240 Journal of Cleaner Production 1.

[75] K Weick, "Small Wins: Redefining the Scale of Social Problems" (1984) 39 American Psychologist 40.

[76] S Bours, I Wanzenböck and K Frenken, "Small Wins for Grand Challenges. A Bottom-Up Governance Approach to Regional Innovation Policy" (2021) European Planning Studies (early view).

[77] Termeer et al, supra, note 74; Termeer and Metze, supra, note 74.

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Yet other ways of looking at scaling are provided in sustainability transition studies,[78] an area of scholarship concerned with "large-scale disruptive changes in societal systems that emerge over a long period of decades".[79] Among other things, sustainability transition studies are concerned with the mechanisms and driving forces that can accelerate the uptake of innovations and lead to urban climate transitions, such as contestation, competition and cooperation.[80] Acceleration is seen as an important phase of transitions in which innovations have scaled and are beginning to combine, and in doing so they cause regime change by affecting policy, business and consumer practices.[81] A central overlap with the small-wins perspective is the expectation that it is likely that large-scale change of technological systems, ecological systems and institutions will be a non-linear process; the major difference is that the focus of transition studies is on "radical, systemic, and accelerated change" (contrary to the incremental view taken by the small-wins perspective).[82]

IV. Looking forward: a science of scaling for urban climate governance scholarship

Scaling is rapidly becoming a central focus in urban climate governance scholarship, and the time seems ripe to pursue a science of scaling for urban climate governance – an endeavour that is also being undertaken in related academic and policy areas.[83] The overall aim of a science of scaling is "to contribute to building a culture of critical thinking on [scaling]"[84] and to increase the likelihood that (innovative) urban climate action and (innovations in) its governance will benefit society and make a meaningful contribution to keeping global warming to 1.5°C. Such a science of scaling should be systematic, and it essentially pursues four objectives.[85]

A first (obvious) objective of a science of scaling for urban climate governance is to *answer ontological questions*.[86] To take the extreme positivist and interpretivist positions: does the scaling of urban climate action and its governance exist as an objective, predictable phenomenon (ie a mechanism or process that will emerge once the "right" conditions are in place) or does such scaling only exist by virtue of its context and the subjects involved (which include the scholars who study scaling)? Considering the abovementioned typologies, conditions and perspectives, it is likely that the answer will lie somewhere between those extremes. Nevertheless, in order to understand whether and to what extent the scaling of urban climate action and its governance can be designed and nurtured, and thus governed and managed, answering such questions is essential.

A second objective is to *answer epistemological questions*. In other words, how can we know that the scaling of urban climate action and its governance exists (be that as an objective phenomenon, a subjective one or something in-between)? This calls for careful thinking about the methods and tools required to study such scaling.[87] Given the long

[78] It is beyond the scope of this article to map this broad area of research; for an extensive discussion, see J Köhler et al, "An Agenda for Sustainability Transitions Research: State of the Art and Future Directions" (2019) 31 Environmental Innovation and Societal Transitions 1.

[79] D Loorbach, N Frantzeskaki and F Avelino, "Sustainability Transitions Research: Transforming Science and Practice for Societal Change" (2027) 42 Annual Review of Environment and Resources 599.

[80] K Gorissen et al, "Moving towards Systemic Change? Investigating Acceleration Dynamics of Urban Sustainability Transitions in the Belgian City of Genk" (2018) 173 Journal of Cleaner Production 171.

[81] Markard et al, supra, note 9.

[82] Loorbach et al, supra, note 79.

[83] Schut et al, supra, note 44; Price-Kelly et al, supra, note 13.

[84] Gargani and McLean, supra, note 13.

[85] ibid.

[86] Bouzarovskim and Haarstad, supra, note 40.

[87] Schut et al, supra, note 44.

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timeframes and interdependencies between the many conditions involved in scaling, it is likely that careful case studies of a process-tracing type are required first in order to grasp the broad boundary conditions and mechanisms that recur across real-world observations of scaling.[88] From there, configurational comparative research may help us to uncover evidence-based scaling pathways that are broad enough to guide future urban climate action experiments (including innovative urban climate governance interventions) but are not oversimplified to the point where they are little more than the broad ideal types introduced earlier.[89]

A third objective is *theory building and testing*. Practically, this calls for a move away from studying "best practices" and "innovations" in urban climate action (including its governance) and their stabilisation, embedding, speeding up, growth, replication, transfer and so on to questioning and refining scaling pathways and trajectories. Ideally, such theory-building and testing will be undertaken with the ambition of informing real-world governance and policy initiatives that seek large-scale transformational change. Obviously, scholarship needs to cast a wider net beyond the typical "leading" cities and initiatives in the Global North and increasingly include cities and initiatives from the Global South as well as cities and initiatives from the Global North that currently operate in the shadow of the leaders.

A fourth objective is to reflect on the *practical application* of the existing knowledge of scaling and the different ways of looking at it. Is the work produced by the academic community of value to policymakers and practitioners? Does this work help them, ultimately, to implement policies and undertake urban climate action that help in keeping global warming to 1.5°C? It is likely that this will require closer collaboration between the academic, policy and practitioner communities to ensure that our academic work will have practical value. It may also ask for introspection by the academic community to understand whether and how decades of our collective work in this area have (or have not) contributed to the required scaling of urban climate action and its governance.

V. Conclusion: why a science of scaling for urban climate action and governance is essential

Scaling of urban climate action and its governance is rapidly becoming a central focus in the urban climate governance literature and policy debates. Building on the broader scaling literature, this article has called for the development of a systematic science of scaling for urban climate action and governance. Such a science of scaling is relevant not only to gaining a better understanding of the ideal types of scaling (such as scaling up and out and deep scaling) but also to producing practical and applicable lessons to aid governance and policy initiatives that seek large-scale transformational change. For example, for the European Green Deal to be successful, it seems that it will be essential to gain an understanding of how its various parts (such as the New European Bauhaus[90] and 100 Climate-neutral Cities by 2030[91]) can be designed and implemented to achieve, in cohorts, the large-scale transformation for which the European Commission is aiming.

[88] A Kay and P Baker, "What Can Causal Process Tracing Offer to Policy Studies? A Review of the Literature" (2015) 43 Policy Studies Journal 1.

[89] B Rihoux and C Ragin, *Configurational Comparative Analysis* (Thousand Oaks, CA, SAGE 2009).

[90] An initiative that seeks to generate ideas for and examples of future ways of living that are inclusive, sustainable and affordable. See further at <https://europa.eu/new-european-bauhaus/> (last accessed 12 January 2022).

[91] European Commission, *100 Climate-neutral Cities by 2030 – By and For the Citizens: Interim Report of the Mission Board for Climate-neutral and Smart Cities* (Brussels, European Commission, Directorate-General for Research and Innovation 2020).

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The call for a science of scaling made in this article is inspired by similar calls and advances made by scholars who study scaling in other policy areas. Put simply, a science of scaling for urban climate action and its governance aims to understand the essence of scaling. It questions whether scaling is something that can be designed and nurtured, and thus can be governed and managed, or whether it is something that emerges in a non-predictable manner – and it could question whether scaling is as desirable as is often claimed in the urban climate literature. Its ambition is to increase the likelihood that (innovations in) urban climate action and (innovations in) its governance will benefit society.[92] As Newell, Daley and Twena have recently illustrated, thinking systematically about scaling can break new ground for theory and practice – they suggest, among other things, the exploration of the dynamics that allow "shallow" forms of scaling (scaling up and out) to evolve into more transformational change over time (deep scaling).[93]

Equally importantly, by committing to (the development of) a systematic science of scaling for urban climate action and its governance, this area of research may avoid some of the challenges and pitfalls experienced by scholars who study scaling in related areas. These include, but are not limited to, a bias towards studying success stories of scaling (and not failure stories),[94] a bias towards conceptualising scaling as a linear process (rather than a dynamic, multiplicative or exponential one)[95] or a bias towards conceptualising scaling as a maximising (rather than a sufficing) process.[96] In short, a science of scaling may prevent us from ignoring the important trade-offs that are likely to be required when it comes to scaling urban climate action and its governance.[97] As this article has indicated, urban climate scholarship does not have to start from scratch in the development of a science of scaling. The building blocks are available in related areas of research and in the broad urban climate scholarship itself.

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[92] Cf. Price-Kelly et al, supra, note 13.
[93] Newell et al, supra, note 57.
[94] M Taylor, "Climate-Smart Agriculture: What Is It Good For?" (2018) 45 Journal of Peasant Studies 89.
[95] Wigiboldus et al, supra, note 63.
[96] Price-Kelly et al, supra, note 13.
[97] Gargani and McLean, supra, note 13.

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