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Decarbonising cities: Assessing governance approaches for transformative change

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Bonn, July 2022

Michael Roll, Christian von Haldenwang, Christina Grohmann, Maria Elisabeth Gronen, Anne Laible, Johanna Orth, Florian Wengel, Lisa Zumegen

Contents

Tables

Figures

Annex tables

Annex figures

Abbreviations

ACC	African Centre for Cities
BISKO	Bilanzierungs-Systematik Kommunal (municipal CO2 accounting system)
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development)
C40	C40 is a global network of mayors of nearly 100 cities that address the climate crisis
CDP	Carbon Disclosure Project
CDU	Christlich Demokratische Union Deutschlands (Christian Democratic Union of Germany)
CIVITAS	City Vitality and Sustainability network
CO2e	CO2 equivalents
DeLoG	Decentralisation & Local Governance
DIE	German Development Institute / Deutsches Institut für Entwicklungspolitik (now German Institute of Development and Sustainability, IDOS)
DMQ	Distrito Metropolitano de Quito
EEA	European Energy Award
EEA	European Environment Agency
EGCA	European Green Capital Award
EGLA	European Green Leaf Award
EUR	euro
FONAG	Fondo de Agua (water fund)
FUA	functional urban area
GCoM	Global Covenant of Mayors for Climate & Energy
GDP	gross domestic product
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GVA	gross value added
GWP	Global Warming Potential
ICAT	Initiative for Climate Action Transparency
ICLEI	Local Governments for Sustainability
IDOS	German Institute of Development and Sustainability
IDP	Integrated Development Plan (Cape Town)
IPP	independent power provider
IKI	Internationale Klimaschutzinitiative (International Climate Initiative)
IKI-TUC	International Climate Initiative – Transformative Urban Coalitions
IT.NRW	Information und Technik Nordrhein-Westfalen
LAG 21 NRW	Landesarbeitsgemeinschaft Agenda 21 Nordrhein-Westfalen

LG	local government
LSK	Leitstelle Klimaschutz (Climate Office, Bonn)
MIT	motorised individual traffic
NDC	Nationally Determined Contributions (Paris Agreement)
NGO	non-governmental organisation
NRW	North Rhine-Westphalia
OECD	Organisation for Economic Co-operation and Development
SDG	Sustainable Development Goal
SEA	Sustainable Energy Africa
SNG-WOFI	World Observatory on Subnational Government Finance and Investment
SPD	Sozialdemokratische Partei Deutschlands (Social Democratic Party of Germany)
SWB	Stadtwerke Bonn (public utility company)
SWB EnW	Stadtwerke Bonn Energie und Wasser (public utility company for energy and water)
UCT	University of Cape Town
UNECE	United Nations Economic Commission for Europe
USD	United States dollar
WBGU	Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (German Advisory Council on Global Change)
WRI	World Resources Institute

Executive summary

Cities are important emitters of greenhouse gases (GHGs) and are at the same time vulnerable to the impact of climate change. However, cities are also hubs for innovation and experimentation with green solutions and technologies. It is therefore essential to make cities an integral part of reducing global GHG emissions and meeting the goals of the Paris Agreement.

If cities are to fulfil their potential in contributing to global climate action, this requires a thorough understanding of the governance that underlies planning, financing and management of urban areas and climate action. Transforming cities toward zero carbon is a highly complex endeavour. Transformative urban governance hence plays a crucial role in determining the strategic facilitation and successful outcome of the ambition to achieve carbon neutrality in cities.

While cities are places of dynamic change and innovative policy action, conceptual gaps and a critical shortage of empirical data in this particular field remain. With some exceptions, academic research at the interface of sustainable urban transformation and urban governance has suffered from siloed approaches and fragmentation among different scientific disciplines. Against this background, the present study aims at generating new insights into governance qualities that shape the transformation of cities.

The study explores the following principal research question: Which governance approaches facilitate successful transformative change towards zero carbon in cities? While “urban governance” is the planning, financing, and management of urban areas by both government (at different levels) and non-government stakeholders, “transformative urban governance” refers to governance aimed at bringing about fundamental systemic change that ultimately leads to zero-carbon emissions within a city. The study specifically addresses three key aspects of transformative urban governance: **stakeholder involvement**, **financing**, and **impact assessment**. While these three aspects do not cover the full range of urban governance, they refer to core areas that are frequently discussed in academic and policy debates.

To relate these governance aspects to transformative urban change, the study distinguishes three dimensions of transformation. **CO2 reduction** is a necessary ingredient of any effort towards zero emissions. **Dynamics of transformation** refers to the need to accelerate the process and move from individual projects to broad, systemic change. Finally, **acceptance** marks the need to gain the approval and support of citizens to make fundamental change both possible and sustainable.

The empirical analysis is based on a mixed methods approach. An international survey involving city government officials of cities that are proactive in the fight against climate change was conducted to get an overview of socio-ecological transformation paths. In addition to this macro-level approach, in-depth case studies of three cities that are widely regarded as proactive on climate issues in their respective world regions – Bonn, Quito and Cape Town – provide insights that help to contextualise the findings from the survey.

The 54 survey responses show a generally positive tendency in the way local governments approach GHG emission reduction activities. They reveal that these cities engage in strategic planning and mainstreaming of policies to address climate change in local decision-making. Climate action plans and emission reduction targets have either been established or are currently being developed in most cities. Climate action seems to be being gradually institutionalised. Survey responses show a trend of decreasing per capita urban GHG emission levels between 2013 and 2018 but a mixed picture when it comes to total emissions. Mitigation activities generally enjoy support from local stakeholders and face only limited opposition, some of which is driven by demands for more ambitious goals and faster action. Most cities in the survey have been actively promoting the adoption of their approaches and solutions in other

cities or regions in the same country. The promotion of activities across countries is less pronounced, indicating potential for more international cooperation.

Stakeholder involvement: The survey provides descriptive evidence for a positive relationship between the inclusion of broad coalitions of stakeholders and an acceleration of CO2 emission reduction planning and implementation procedures. Stakeholder involvement is also considered a key success factor in the three case study cities Bonn, Quito and Cape Town. However, only few cities involved stakeholders in a truly inclusive and cooperative way. Moreover, the way cities approach this issue is rather different. In Bonn, stakeholder involvement used to be limited at the beginning of the process in the mid-1990s but now frequently takes place and is a highly institutionalised and/or common practice. To achieve carbon neutrality by 2035, Bonn places great hope in the innovative potential of broad citizen engagement. Nevertheless, involving the private sector and marginalised groups remains a challenge as participating citizens mostly belong to the better-educated and well-situated middle class. In Quito, relations between the local government and stakeholder groups are often rather short-term and project-bound. Lack of trust and lack of continuity seem to be factors that operate against longer-term forms of collaboration. In Cape Town, the process has been driven by a close connection between city government and academic institutions, based on individual experts who moved from one sphere to the other. The strong involvement of academia is an interesting approach that sets Cape Town apart from the other case studies. However, the inclusion of broader civil society and especially lower-income groups is a challenge that all three cities share.

Finance: Findings from the survey further show that additional funding for emission mitigation is associated with reduced GHG emissions over time. However, it remains open whether this means that additional funding leads to more emission reduction or that emission reductions enable the generation of additional funding (or both). Fiscal systems shape the capacities of cities to raise funds for transformative projects. Many cities rely mainly on traditional financing sources: intergovernmental transfers, local taxes and fees, and international grants in cities of the Global South. Additional funding through local revenue generation or market-based finance mechanisms is less widespread. Both Quito and Cape Town depend heavily on external funding by international organisations and donors, along with central government transfers, the latter of which is less relevant in Bonn. Internal revenue and central government transfers, however, are important financing sources for all three cities. The availability of funding presents a key challenge to Quito's climate action, as central government transfers tend to oscillate with the world price of oil (a main source of public income in Ecuador) and own local revenues prove to be insufficient. There is, however, an interesting difference between Quito's pathway of constructing a costly metro and Bonn's initial strategy to focus on fairly inexpensive measures. The case of Quito shows how a major infrastructure project, even though highly relevant in terms of (future) GHG emission reductions, may absorb fiscal space and administrative capacities to such an extent that it limits the space for other activities. In Cape Town, a key lesson is the perverse incentives associated with the composition of local revenues: as South African cities receive revenues from re-selling (fossil fuel-based) energy to consumers, they limit their own income when they replace grey with renewable energy production. In Bonn, limited fiscal space is an obstacle to fostering climate action. However, the city has recently introduced a sustainability budget to align policymaking and budgeting with sustainability and climate goals.

Impact assessment: Most cities in the survey collect relevant data but lessons learned from monitoring and evaluation are not always incorporated into ongoing or future projects. Based on the survey, we find descriptive evidence that cities that apply more rigorous methods of impact assessment have more frequently expanded or replicated mitigation activities within the city or are in the process of doing so. However, the use of impact assessment frameworks that link climate actions to specific outcomes such as emission reduction in cities is still a fairly recent development. Bonn is planning to set up such a system, since monitoring and reporting are considered crucial for public communication and accountability. Like most other cities, neither

Quito nor Cape Town have developed such frameworks but are focusing on improving data collection, the quality of data and the development of more general monitoring and evaluation systems. While data from Cape Town allows for the identification of basic emission tendencies over time, Quito has yet to conduct the respective measurements. Overall, it appears that the international acknowledgement that both cities have received in recent years is primarily based on ambitious goals, comprehensive plans, and ongoing projects and less on current achievements. In general, it seems as if in the early stages of transformative change, the added value of impact assessment is perceived as fairly low as resources are scarce and it is mostly committed people working on the topic who do not question the positive outcomes of emission reduction activities. Thus, scarce resources tend to be allocated elsewhere. In later stages however, awareness for emission reduction activities in the general population might be higher, as well as the amount of capital invested, and there might be a greater need to generate acceptance of stakeholders if more profound, transformational changes are to be introduced. Thus, accountability and learning become more relevant.

It is important to note that the research presented here suffers from limitations because of time constraints and the inability to travel to the respective cities. For instance, focusing on mitigation alone without accounting for adaptation means forgoing potential insights stemming from the analysis of interlinkages between both areas. Also, the conceptualisation of successful transformation (dependent variable) and the focus on just three governance approaches implies simplifications for the sake of feasibility. Not least, the realisation of the project was overshadowed by the COVID-19 pandemic, which made physical field research impossible.

Being mindful of these limitations, we trust that this study nevertheless contributes to the theoretical and empirical discussions in the field of transformative change and transformative urban governance in multiple respects. First, the conceptual framework of success dimensions for transformative change adds value to the ongoing theoretical development in this field. Second, combining a macro and a micro perspective by assessing survey responses and case study interviews contributes to tackling the persistent data challenge in the field of urban governance and sustainability. Third, financial resources and impact assessment are two crucial governance dimensions that have however not previously been studied in detail.

1 Introduction

Cities have a unique role to play in our time of climate crisis. Not only do they account for about 75 per cent of greenhouse gas (GHG) emissions worldwide and 70 per cent of energy use (EBRD [European Bank for Reconstruction and Development], 2020), but in many places, urban populations and infrastructures are also at a particularly high risk due to climate change (IPCC [Intergovernmental Panel on Climate Change], 2014). Still, by 2050 about two-thirds of the global population will foreseeably be living in cities (WBGU [Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen], 2016). Therefore, the 21st century is predicted to be the century of the cities. This label is meaningful in many ways, not least because whether the world will achieve the 1.5°C goal agreed upon in the Paris Agreement of 2015 or not will to a large degree depend on the ways in which cities evolve in the future.

As a result, local governments are increasingly involved in adaptive policies to reduce GHG emissions in order to protect people and the planet (Aylett, 2014). Many scholars agree that incremental reforms are not enough to slow down climate change. Instead, more profound and comprehensive changes in the institutional, social, and economic sphere are needed – transformative change (Brand, 2016; Eichhorn, Lindenthal, Hanke, & Kristof, 2019). Our research puts city governments at the centre of analysis, arguing that they take on important leading and facilitating roles in the process of creating a more sustainable future (Aylett, 2014; Wittmayer, Avelino, van Steenbergen, & Loorbach, 2017).

Governance is key in determining the successful outcome of transformation in cities, and in the strategic facilitation of this process. While “urban governance” refers to the planning, financing, and management of urban areas by both government (at different levels) and non-government stakeholders, “transformative urban governance” is governance aimed at bringing about fundamental systemic change that ultimately leads to zero-carbon emissions within a city. For a city to address changes that affect the lives of large parts of the population, effective urban governance is needed (Hernandez, 2021a, 2021b; Hölscher, Frantzeskaki, McPhearson, & Loorbach, 2019; WBGU, 2016). For instance, a frequent premise in the scientific debate about urban transformation is that it can only be achieved by collaborative governance approaches (WBGU, 2016). Further, the lack of financial resources is often pointed out as being a prime challenge to cities when implementing projects and programmes (Aylett, 2015). Other scholars argue that monitoring, assessment, and evaluation of policies are crucial ingredients in the governance of societal change (Holtz et al., 2018). The project presented here puts these beliefs to the test and analyses approaches that city governments employ to successfully facilitate urban transformation.

Based on current debates and theoretical considerations, our research aimed at identifying governance aspects that characterise successful transformative change in cities. Although we recognise the importance of adaptation of cities to climate change, we set a specific focus on mitigation of GHG and carbon dioxide (CO2) emissions in particular. The main research question we wanted to address was: Which governance approaches facilitate successful transformative change towards zero carbon in cities?

We focused on three key aspects that are closely related to the IKI-TUC (International Climate Initiative – Transformative Urban Coalitions) framework: stakeholder involvement, financing, and impact assessment.

In order to relate these governance aspects to transformative change in cities, we identified three dimensions of successful transformation. Our main dimension of success is CO2 reduction, which

is a necessary ingredient of any effort towards zero emissions.[1] In addition, we analysed two other success dimensions widely discussed in the literature: the dynamics of transformation, and acceptance. The dynamics of transformation addresses the need to accelerate the process and move from individual projects to broad, systemic change. Acceptance refers to the need to gain the approval and support of citizens to make fundamental change possible and sustainable. While many approaches to transformation see these two dimensions as relevant goals in their own right, we assume that at the same time they work as magnifiers for the main goal, CO2 reduction. Based on this framework, we analysed which governance approaches facilitate successful transformative change towards zero carbon in cities.

The study used a mixed methods approach. First, we compiled a database of cities worldwide that are active in international sustainability networks or have participated in international sustainability awards. Building on this database and based on a collaboration with one of the biggest city networks, ICLEI (Local Governments for Sustainability), we conducted a survey with city government officials worldwide to gain an overview of socio-ecological transformation paths. In addition to this macro-level approach, we prepared in-depth case studies on the towns of Bonn, Quito and Cape Town. These case studies provided additional insights into the dynamics and mechanisms of stakeholder involvement and acceptance, among other aspects.

Our research contributes to the ongoing academic debate on transformative change and transformative urban governance by providing conceptual as well as empirical inputs. Regarding concepts, we engage in an in-depth discussion of success dimensions of urban transformative change. Most contributions to the debate deal with this aspect implicitly or narrow the scope to emission reductions alone. We also focus on financing and impact assessment, two governance dimensions that are important but often neglected in studies.

The report proceeds as follows: The next section illustrates the concept of transformative change by discussing the main characteristics and by introducing basic terms and definitions. It further summarises recent trends towards transformation by giving an overview of city networks and awards and their role in initiating change, as well as available datasets on local GHG emissions and related issues. Section 3 introduces the way the research was designed, starting with our definition of success and introducing our explanatory variables: stakeholder involvement, financial resources, and impact assessment. It also presents our empirical strategy and the data. Section 4 presents the empirical findings from the survey along with the case studies. Section 5 summarises and contextualises our findings and contributions to ongoing academic and policy debates.

2 Transformative change in cities

Many authors agree that climate change and the resulting ecological crises require a (global) transformation towards a carbon-neutral society (Brand, 2016; Eichhorn et al., 2019). Most contributions understand transformation as a process that is characterised by deep, disruptive changes, which in turn produce irreversible outcomes and affect societies as a whole. The transformation towards carbon neutrality thus requires fundamental changes in the institutional, social, and economic spheres. The need for transformative change has become a core element of many political and environmental debates over the last few years (Wittmayer & Hölscher, 2017, p. 5). With regard to cities, the “World in Transition” report of WBGU, the German Advisory Council on Global Change, marked an important milestone in this debate in Germany (Brand, 2016; WBGU, 2011).

1 The terms “carbon neutrality” and “zero (GHG/CO2) emissions” refer to “net zero (GHG/CO2) emissions”, following the definitions of the IPCC. For more information on this, please consult https://www.ipcc.ch/sr15/chapter/glossary/.

Interactions between urban systems and climate change are complex and face trade-offs. As a result, initiatives for climate change compete with seemingly more pressing urban needs, which results in "short-term and optimisation-focused mainstream policy and planning practices" (Hölscher et al., 2019, p. 844). The quest for zero carbon, however, requires long-term and fundamental changes in urban governance systems under contested and uncertain dynamics.

This section provides an overview of the concept of transformation before focusing on the practice of transformative change in cities. Subsection 2.1 discusses definitions and models of transformative change in more detail. Subsection 2.2 highlights recent trends in urban decarbonisation efforts as well as the question of how to measure progress in emission reductions.

2.1 Conceptualisation

Even if scholars often provide a definition of transformation, no universal conceptualisation exists. For instance, there is no common understanding about what sets transformative change apart from "ordinary" change and incremental sustainable development. Typically, however, transformation refers to a non-linear process aimed at a fundamental change in the system. A certain durability and depth of the changes is necessary to ensure that the achievements are not easily reversible – and thus truly transformative (Brand, 2016). Such changes involve (or aim at involving) society as a whole, in our case the urban population, and ideally also affect groups in a city's vicinity. Transformative change thus implies a profound, comprehensive change of direction in the way we live, trade, move, eat – to mention only a few aspects.[2] Transformative change is a multidimensional process as "problems […] are in most cases linked and interconnected with one another" (DIE [German Development Institute / Deutsches Institut für Entwicklungspolitik], 2018, p. 15).

However, there are contesting beliefs regarding how deep such systemic changes should reach – and how fundamentally existing societal structures and practices would have to be challenged (Eichhorn et al., 2019). Some cities may envision their carbon-reducing activities as radical transformative change, while other cities might understand similar measures as incremental change.[3]

While the topic is being treated in political science and sociology, other disciplines such as psychology or economics are also becoming more involved in the debate.[4] Research strands such as transition studies, sustainability science, or resilience research lead the field, but many others follow (Wittmayer & Hölscher, 2017). Transformative research covers societal issues such as consumption, energy, mobility, or even the economy as a whole. Brandt (2016) calls socio-ecological transformation an "umbrella term", which puts "the ecological crisis into a larger context" and unites "different fields of thinking and action against business-as-usual strategies" (Brand, 2016, p. 23). The notion of transformative change can thus be seen as "conceptual glue" that offers opportunities for synergies but also the risk of trade-offs (Wittmayer & Hölscher, 2017, p. 13). In fact, transformative processes are likely to affect existing power dynamics, which results in winners and losers (Eichhorn et al., 2019).

2 A related concept to transformation is transition. In the literature, both concepts often describe similar processes or are even used synonymously. According to Wittmayer and Hölscher (2017) and Eichhorn et al. (2019), transformation refers to comprehensive change processes that affect the entire population whereas transition refers to political-institutional changes within existing socio-economic systems. These definitions attribute a broader reach and focus to transformation in comparison to transition. We thus argue that the systemic and groundbreaking change required for decarbonisation should be labelled transformation.

3 In fact, most cities tend to talk about climate change mitigation activities, instead of referring to such efforts as being transformative.

4 See Wittmayer and Hölscher (2017) for an overview of the literature in the different strands of research.

Transformative change, as it is understood here, acts upon the imminent climate crisis by actively contributing to societal change towards a zero-carbon urban society (Brand, 2016; Wittmayer & Hölscher, 2017), or to "enable equitable human development within planetary boundaries" (Wolfram & Frantzeskaki, 2016, p. 144). As such, it is often affected by normative ideas (Hernandez, 2021b), such as the idea that disruptive change is key to ensure that processes are truly transformative and do not remain in an "insufficient corridor of ecological modernisation" (Brand, 2016, p. 26). For this to be the case, incremental changes "need to be linked to the structural (including institutional) political, economic and cultural conditions – and related power relations – under which they take place" (Brand, 2016, p. 26). To break with path-dependencies, it is not enough to focus on sustainability innovations. Instead, it is key to also "exnovate" and abandon old, overcome approaches and technologies that work against the transformative path (Eichhorn et al., 2019; Wolfram & Frantzeskaki, 2016).

This complexity suggests that there is no one typical transformative path. Various models have been developed to describe different transformative paths. The multi-phase model describes a successful transformation as a shift from one dynamic equilibrium to another, by passing through an acceleration and stabilisation phase (Eichhorn et al., 2019). The multi-level model divides transformation into three different scale levels, whereby changes to the status quo start in niches "as a result of new ideas and new initiatives such as new techniques, alternative technologies and different social practices" and then, ideally, expand into norms and rules (regimes) and society as a whole (landscapes) (Loorbach & Rotmans, 2006, p. 4).

From a research perspective, there is an ongoing debate on methods, frameworks, and foci of transformation research (Wittmayer & Hölscher, 2017), but important empirical gaps remain (Wolfram & Frantzeskaki, 2016). Although information on institutional arrangements in individual cities is increasingly available, research on urban transformation towards zero carbon is confronted with a lack of comparative data on urban governance. Only a small number of sources systematically compile data on urban governance characteristics at a larger scale (Aylett, 2014, 2015; CDP [Carbon Disclosure Project], 2021).

In terms of methods, case studies have been frequently used (Aylett, 2015; Hölscher et al., 2019; Wolfram & Frantzeskaki, 2016). For a long time, in-depth case studies mostly focused on cities located in industrialised countries, so that insights were often based on or biased towards Western cultural, socio-economic and political realities. In recent years, however, the number of case studies on cities in the Global South has increased – among other reasons due to the growing engagement of cities in – and the technical and financial support from – international city networks such as C40.

Another methodological approach are surveys. Our research only identified a small number of surveys on urban transformation and decarbonisation efforts. For instance, Aylett (2015) conducted a worldwide survey with members of ICLEI. According to the author, this study provides the "first quantitative data on urban adaptation governance" (Aylett, 2015, p. 14). The survey emphasises the institutional context of climate change planning related to adaptation and mitigation. It largely ignores, however, the urgency of transformative action, and does not cover aspects related to systemic, ground-breaking change.

Generally, a combination of the two aforementioned methods – surveys and case studies – is rare.

2.2 Transformative cities: recent trends

Cities play an increasingly important role in transformative change towards zero carbon. Many cities engage in municipal networks to share experiences and display best practices or compete in international awards on particularly successful or innovative solutions. This subsection gives an exemplary overview of recent international trends.

2.2.1 Cities

Although no city has achieved zero carbon so far, more and more cities are setting targets, developing strategic plans, measuring emissions, and implementing policy interventions with the aim of reducing carbon emissions (Gordon & Johnson, 2017). According to the Coalition for Urban Transitions (2019), almost 10,000 cities and local governments all over the world are committed to such action. These cities are highly diverse in terms of their geographical location, their population, their history, and their environmental, political, economic and socio-cultural characteristics (WBGU, 2016).

After decades of industrialisation, high levels of pollution and environmental damage, European cities were at the forefront of climate action in the 1990s. These pioneering cities took early action against climate change, established municipal climate networks, and branded themselves as green cities (Kern, 2019, p. 126). Later, cities such as Copenhagen and Amsterdam developed from being pioneering cities to global frontrunners. Since the 1990s, cities engaging in climate action have become more diverse. First, climate change has become a crucial issue for capital cities and metropolitan areas, and many of the leading global cities[5] are now engaged in reducing carbon emissions (Bulkeley, 2010). Second, many smaller cities such as Växjö in Sweden or Sønderborg in Denmark have become internationally renowned leaders as well (Kern, 2019). Third, cities in the Global South are also increasingly active in the fight against climate change (Bulkeley, 2010).

Nevertheless, research on frontrunner cities still focuses on Europe. Cities that are the object of academic scrutiny are often located in Scandinavia (Copenhagen or Stockholm), continental Europe (Amsterdam), or the United Kingdom (Bristol). Only a few Southern European cities (Barcelona or Vitoria-Gasteiz) are mentioned as leading cities, while Eastern European cities tend to be less visible with regard to decarbonisation (with a few exceptions, such as Ljubljana) (Kern, 2019). In Latin America, Rio de Janeiro, Curitiba, Belo Horizonte, and Bogotá are often mentioned as frontrunners. In Africa, the most renowned frontrunners are Accra, Addis Ababa and Cape Town.[6]

2.2.2 Networks

In recent years, cities have joined forces in a multitude of city networks to pool their efforts in climate action. Overall, there is a large variety of city networks at the national, regional, and global levels. While several international networks emerged from Europe, cities in the Global South increasingly engage in municipal networks as well (Acuto & Leffel, 2020). The most obvious difference between networks is their size: while some networks only have a few members, others provide platforms for thousands of cities. Moreover, networks vary with regard to the type of membership, from traditional networks composed of cities only, to networks with a mixed membership of cities and associations of cities, and networks with an even larger variety of public and private actors from non-governmental organisations (NGOs), business and academia. Many networks also attract cities of very different types and sizes ranging from global cities to mid- and even small-sized cities (Acuto & Leffel, 2020; Acuto & Rayner, 2016). Lastly, networks vary in their thematic focus. While some networks focus on a single topic such as zero carbon, others engage in a variety of topics associated with sustainable development, or treat sustainability and climate change as one topic among many.

5 Global cities are defined as cities of "particular strategic economic or political importance" (Bulkeley, 2010, p. 233).

6 Information on Latin American and African cities is drawn from our expert survey conducted to identify possible case study cities.

Generally, city networks have a variety of functions. A key function is the transfer of knowledge, the exchange of experiences, and the facilitation of learning among members. Participating in networks allows cities to share and replicate best practices, which is highly important to scale experiments and achieve a zero-carbon transformation (Bai et al., 2019; Kern & Bulkeley, 2009; Smeds & Acuto, 2018). Another function is to form transnational alliances and strengthen cities' voices in global climate governance (Smeds & Acuto, 2018). Additionally, networks engage in a variety of other activities such as reporting emission reductions, providing benchmarking and recognition to members, or certifying cities that achieve certain climate goals (Gordon & Johnson, 2018; Kern & Bulkeley, 2009). To get a better impression of the diversity of networks, we will briefly introduce three of them as examples: ICLEI; the C40 Cities Climate Leadership Group; and the Global Covenant of Mayors for Climate & Energy (GCoM).[7]

ICLEI is one of the first municipal networks on climate change that was founded in 1990 by a group of pioneering municipalities with the aim of creating and sharing knowledge on technological solutions for the fight against climate change. Further activities of the network include training, workshops, study visits, reports, and handbooks on local climate solutions as well as advocacy work to "shape the debate on urban sustainability politics" (EEA [European Environment Agency], 2019, p. 86). Its members are more than 1,500 cities, towns, and regions from all over the world (van der Heijden, 2018).

The C40 Cities Climate Leadership Group is a network of 80 of the world's largest cities (van der Heijden, 2018). Its members are megacities with a population of more than three million inhabitants and a group of selected innovator cities with an exceptional record of accomplishment in the field of climate action (Pinault, 2019). The main aim of this network is to provide a platform for cities to display their climate action, inspire other cities, and learn from one another (C40 Cities Climate Leadership Group, 2021). The network considers insufficient access to finance for green and innovative projects one of the most critical barriers hindering sustainable urban development and thus established an in-house C40 Cities Finance Facility in 2016. C40 plays an important role in selecting best practices and providing relevant information to other cities around the world to apply and scale these projects (Nguyen, Davidson, & Coenen, 2020).

The Global Covenant of Mayors for Climate & Energy is the largest international network committed to climate action, involving more than 10,000 cities and local governments all over the world. Signatories pledge to develop a GHG emissions inventory, define ambitious climate-mitigation targets, create climate action plans, and track their progress on a regular basis (Global Covenant of Mayors for Climate & Energy, 2021).

2.2.3 Awards

In addition to networks, there is a large number of climate-related competitions and awards (Maassen & Galvin, 2019). Many local governments participate in these competitions to brand their cities as sustainable or green and to display best practices (Kern, 2019). Winning a prestigious award may also raise awareness for climate change, thereby motivating cities to continue, or even strengthen, their efforts (European Commission DG Research and Innovation, 2020).

Overall, there is a broad variety of awards at the national and international level, although many regional awards focus on Europe. Whereas some awards only consider applications from city governments, others are open to submissions from NGOs, community groups, or individuals. City governments usually have to apply for awards themselves. In the following, we will briefly introduce three such awards as examples: the World Resources Institute (WRI) Ross Prize for

7 A detailed list of networks can be found in Table A1 in the Appendix.

Sustainable Cities; the European Green Capital Award; and the C40 Cities Bloomberg Philanthropies Awards.[8]

The WRI Ross Prize for Cities is a global award for transformative urban projects, not necessarily with a climate focus. The objective of the award is to highlight cases of deep urban transformation, to identify the success factors behind them, and to inspire similar projects (Maassen & Galvin, 2019). The winner of the 2020/2021 prize was the Sustainable Food Production for Rosario project (Argentina) (World Resources Institute Ross Center, 2021).

The objective of the European Green Capital Award (EGCA) is to reward cities with more than 100,000 inhabitants for high environmental standards, to encourage cities to commit to ambitious climate goals, and to provide a role model for other cities. So far, 13 cities have won the EGCA, most recently Lisbon (2020), Lahti (2021), and Grenoble (2022). Following the success of the EGCA, the European Green Leaf Award (EGLA) was established in 2015 to recognise the environmental achievements of cities with less than 100,000 inhabitants. Recent winners of the EGLA are Limerick (Ireland) and Mechelen (Belgium) (2020), and Gabrovo (Bulgaria) and Lappeenranta (Finland) (2021) (European Commission DG Environment, 2020).

The C40 Cities Bloomberg Philanthropies Awards rewards cities for outstanding climate action leadership. An objective of the award is to ensure that leading cities in the fight against climate change are globally recognised, and to share replicable best practices across cities (C40 Cities Climate Leadership Group, Realdania, & Nordic Sustainability, 2019). Among the winning cities in 2019 are Kolkata (India: Low Carbon Commute Transition), Guangzhou (China: Expansive Bus Electrification), Seoul (South Korea: Solar City Expansion) and London (United Kingdom: Ultra-Low Emission Zone) (C40 Cities Climate Leadership Group, 2021).

2.2.4 Datasets

Reliable, up-to-date, and comparative data is a key feature of any attempt to measure cities' progress in their journey towards transformation. This is above all true for quantifying achievements in reducing GHG emissions. As national governments commit themselves to Nationally Determined Contributions (NDCs) under the Paris Agreement, cities are increasingly required to map their own activities in a way that allows for aggregated or comparative views on national efforts.

There are various different approaches to measuring GHG. The most common method is to measure carbon dioxide equivalents (CO2e). This method compares the emissions from various GHGs based on their Global Warming Potential (GWP)[9] (Eurostat, 2017b) and in relation to carbon dioxide (GWP of 1) (Chamberlain, 2017). Another common approach is to measure the release of carbon dioxide (CO2) and/or their precursors into the atmosphere over a specified area and period of time (Eurostat, 2017a).

At an international level, several organisations such as the Carbon Disclosure Project,[10] and ICLEI[11] (see subsection 2.2.2) have developed approaches and standards for local governments to measure GHG emissions and their reduction over time across different sectors.

8 A detailed list of awards can be found in Table A1.

9 The GWP measures how much heat the GHGs can trap within the atmosphere and the environmental impact it is expected to have (Chamberlain, 2017).

10 The Carbon Disclosure Project: A not-for-profit charity that runs the world's largest environmental reporting system to drive meaningful change. It is recognised by the largest city networks which means that it is possible as a city to report climate action data to these networks via CDP.

11 Through partnering with CDP, the platform Carbonn, a unified process for subnational climate action reporting emerged. See https://carbonn.org/.

Other initiatives such as the World Observatory on Subnational Government Finance and Investment (SNG-WOFI)[12] aspire at producing comparative data on governance dimensions or local public finance.

Overall, however, currently there are only a few datasets with a large number of cities on a truly global scale.[13] As a result, it was not possible for us to rely on external datasets that would match the sample of cities that we collected ourselves. Lack of coverage is thus a key issue for any attempt to assess transformative change of cities at an international scale. Another aspect worth noting is that geocoded datasets are increasingly gaining importance as there is a growing amount of open data available (Winchester, 2016).

3 Research design

Our research examined governance approaches that facilitate successful transformative change towards zero carbon in cities. Accordingly, the dependent variable in our research was successful transformative change. Here, we looked at three dimensions of success: CO2 reduction, dynamics of transformation, and acceptance. As explanatory variables, we focused on three governance approaches to urban transformation: stakeholder involvement, finance, and impact assessment.

To investigate our hypotheses, we employed a two-stage empirical strategy consisting of a survey and three case studies. At the first stage, we conducted an international survey with city government officials. For the distribution of this survey, we built a global database of cities that were members of international sustainability networks or participated in international sustainability awards. Further, we cooperated with international city networks to reach out to cities worldwide that were active in socio-ecological change. At the second stage, we conducted case studies in Bonn, Quito, and Cape Town. Interviews with government officials and other stakeholders such as NGOs, universities, think tanks, and consultancies, allowed us to examine transformation processes in these cities in more detail.

This section describes how our research was designed. Subsection 3.1 introduces our dependent variable. Subsection 3.2 presents our explanatory variables, before deriving our hypotheses on the relationships between urban governance and transformative change towards carbon neutrality. Our use of the concept “carbon neutrality” focuses on reducing GHG emissions rather than using technologies for offsetting emissions. Finally, subsection 3.3 summarises our hypothesis framework, empirical strategy, and data.

3.1 Dependent variables: success dimensions of transformative change

The dependent variable in our research is successful transformative change towards carbon neutrality in cities. But what exactly do we mean by successful transformative change, and what does a successful transformation entail?

There are no universal methodologies or academic standards to evaluate and quantify urban transformation (Maassen & Galvin, 2019). Different scientific disciplines and international sustainability awards understand success or successful transformation in different ways. Very

12 World Observatory on Subnational Government Finance and Investment, collecting data on subnational governance, finance and investment across over 120 countries in the world (see OECD/UCLG, 2019).

13 Please refer to Table A2 for a list of international datasets covering aspects of transformative change in cities.

often, they do not define these terms at all. In this subsection, we therefore give an overview of different understandings of success. Subsection 3.1.1 provides a short literature overview of successful transformation, while subsection 3.1.2 introduces the success criteria of international sustainability awards. Based on this overview, we introduce in subsection 3.1.3 three dimensions of success that we consider particularly relevant for our research.

3.1.1 Literature overview on success

There is general agreement in the literature that the reduction of CO2 emissions is at the heart of successful transformative change towards zero carbon (Rockstrom et al., 2009). According to Clarke et al. (2014, p. 420), “emission reductions of this magnitude will require large-scale transformations in human societies”. The WBGU (2011, p. 265) argues that we “need fast, transformative counteraction” to decarbonise global energy systems by the middle of the century. In its transformational change methodology, the Initiative for Climate Transparency (ICAT, 2019, p. 17) argues that the overall transformational impact of a project, policy or action is assessed through its “contribution to a system change towards zero carbon and sustainable development goals”. The mission “100 Climate neutral Cities by 2030” of the European Commission defines the target of the mission as “carbon neutrality, namely mitigating and offsetting all greenhouse gas emissions […] within a city” (European Commission DG Research and Innovation, 2020, p. 22).

As explained in Section 2, transformative change is a “change of systems” and goes beyond an accumulation of individual projects (ICAT, 2019, p. 14). To be successful, transformative change therefore requires an “intentional, long-term change strategy” (ICAT, 2019, p. 16) as well as “long-term oriented visions, target systems and ‘road maps’ until 2050 and beyond” (WBGU, 2011, p. 273). Niche innovations must extend “beyond the experimentation phase and diffuse more widely into markets and wider society” (EEA [European Environment Agency], 2019, p. 54). Public policies must have a long-term focus and be valid for years or decades to traverse government changes and swings in political opinions.

Another important dimension of successful transformation is the speed of implementation: In the short and medium term, political decision-makers must accelerate the transformation to “retain the chance of compliance with the planetary guard rails” (WBGU, 2011, p. 318). Similarly, the European Environment Agency identifies a need to “accelerate the development and diffusion” of innovations and sustainable alternatives to traditional technologies (EEA [European Environment Agency], 2019, p. 44).

Moreover, transformative change must be accepted by those who are affected by it. According to the WBGU (2011, p. 67), an effective environmental and climate policy “must make the intended transition agreeable to large majorities”. Hernandez (2021b, p. 8) argues that although a transformation “is always negotiated in nature”, the terms of the transformation must remain “acceptable or at least tolerable for all”. To achieve this goal, a transformation strategy should not solely rely on relinquishment and external force, which may trigger anxiety and aversion against the stipulated measures. Instead, a promising strategy matches “perceptions of what a good and successful life is” and demonstrates that it can improve life satisfaction and wellbeing for the population (WBGU, 2011, p. 67). This dimension thus relies on the idea that transformation towards zero carbon in cities can only be successful if cities at the same time secure economic prosperity, provide employment, improve service delivery, and protect the population and the economy from environmental risks (Ahmad, Dowling, Chan, Colenbrander, & Godfrey, 2019).

3.1.2 Award criteria of success

International sustainability awards reward cities for their efforts and achievements in transformative action based on specific selection criteria. These criteria provide insights into what constitutes a successful transformation in cities from a policy perspective. They cover various topics and are framed in very different ways. While drawing general conclusions from them is difficult, it is possible to derive interesting insights and some common ground from them.

A first important criterion of many awards is the environmental impact of a transformative project or a city's overall efforts to advance towards zero carbon. For example, the C40 Bloomberg Philanthropies Award lists "climate action" and the "expected or achieved CO2 reduction and/or climate risk mitigation and/or air pollution reduction of the project" as first selection criterion (C40 Cities Climate Leadership Group, 2021). The EGCA is given to cities that achieve "high environmental standards" and are committed to "further environmental improvement" (European Commission DG Environment, 2020, p. 4). The One Planet City Challenge selects national winners based on the most ambitious commitments and actions for emission reduction with the aim of limiting global warming to 1.5° C or less (World Wide Fund for Nature, 2021).

Second, some awards focus on the overall impact of a transformative project. One selection criterion of the WRI Ross Prize for Sustainable Cities is, for example, the "life-changing impact" of a project, meaning the extent to which a project has changed lives, mindsets, and behaviours of people and communities (World Resources Institute Ross Center, 2021). In addition, the award attaches particular importance to the "balance of impacts" by evaluating whether a project has a positive environmental, social, and economic impact at the same time (Maassen & Galvin, 2019, p. 18).

A third important selection criterion of many awards is the scaling of projects and the sharing of experiences with other cities. The C40 Bloomberg Philanthropies Award, for example, puts forward "sharing and scaling" as one criterion (C40 Cities Climate Leadership Group, 2021). On the one hand, this criterion entails the extent to which a city shares a successful project experience with other cities, thus reaching an impact beyond the city. On the other hand, the criterion evaluates the city's potential to scale a project within the city and to increase the project's spatial scope. The EGCA and the EGLA are particularly interested in the aspect of sharing experiences and having an impact beyond the city: both awards assess a city's capacity to act as "role model" or "green ambassador" to inspire other cities, and to promote best practices (European Commission DG Environment, 2020, p. 4). The WRI Ross Prize for Sustainable Cities puts a strong emphasis on both the spatial scope of a project and on having an impact beyond the city. The award assesses the "spatial extent of impact" by evaluating whether the impact of a transformative project reaches beyond the project site; it also accounts for the extent to which a project can be replicated in other cities or in other parts of the same city (Maassen & Galvin, 2019, p. 18).

A fourth criterion is the systemic extent of a transformative project, meaning the extent to which it triggers long-term and sustained institutional changes. The WRI Ross Prize for Sustainable Cities, for example, takes into account the "ripple effects" of a project, which describes the extent to which a project has a systemic impact on institutions within or beyond the city (World Resources Institute Ross Center, 2021). The award is especially interested in measuring a project's temporal reach and therefore evaluates its "duration of impact" to see if the impact of a transformative project extends beyond political and budgetary cycles and is sustained over time (Maassen & Galvin, 2019, p. 19).

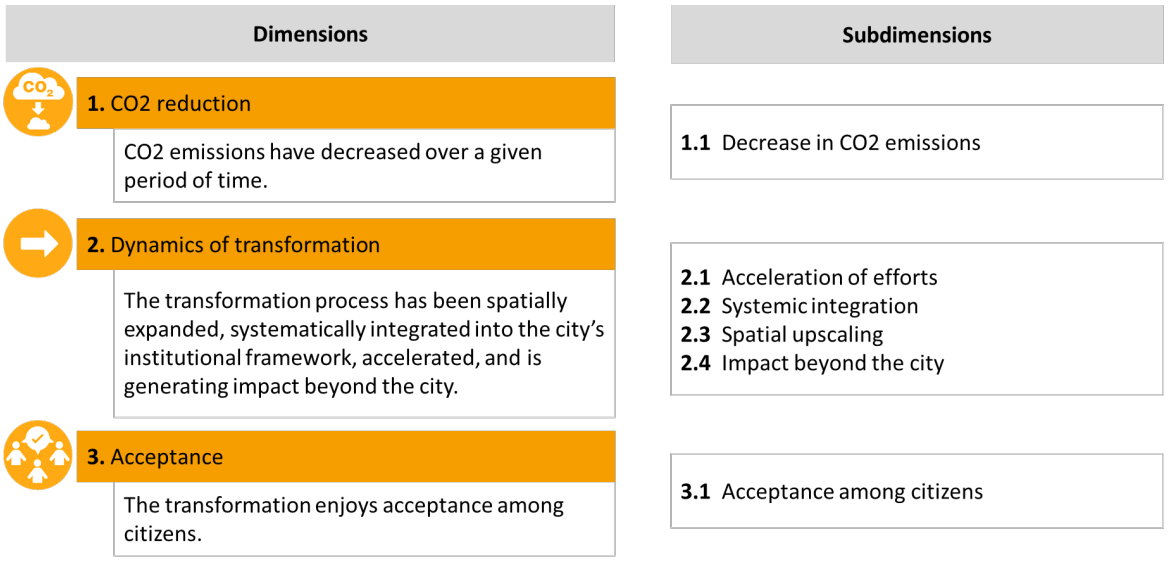
Moreover, the WRI emphasises that successful transformation must take the needs of different population groups into account. A key element of transformation is to identify how transformative projects affect different parts of the population, especially vulnerable groups, and to mitigate potential conflicts from the beginning (Li, Gray, & Dennis, 2020). Another selection criterion of

certain awards is the innovativeness of a project (for example in the C40 Cities Bloomberg Philanthropies Award and the European Green Cities Award).

3.1.3 Our definition of success

Based on the discussions in the previous paragraphs, we introduce three success dimensions (see Figure 1) that we consider particularly relevant for our research. They represent our dependent variables. Our main dimension is the CO2 reduction that a city has achieved in a given period of time. Dynamics of transformation and acceptance are secondary or supportive success dimensions.

Figure 1: Dependent variables: success dimensions for transformative change



Source: Authors

A reduction in CO2 emissions is essential for the transformation towards carbon neutrality in a city. Therefore, our first and pivotal success dimension is CO2 reduction. This reduction can be measured as a relative or per capita decrease in the CO2 emissions of a city over a given period of time.

The second success dimension looks at the dynamics of transformation in a city. This dimension serves to distinguish the transformative nature of change that is needed to achieve carbon neutrality from "ordinary" change or incremental sustainable development. We display the dynamics of transformation in four subdimensions: acceleration of efforts, systemic integration, spatial upscaling, and impact beyond city. These dynamics may influence the extent of CO2 reduction by increasing the scope as well as the speed of emission reduction activities in a city.

Acceleration of efforts refers to the speed at which transformative projects are developed and implemented: Accelerating the transformation towards carbon neutrality is needed to remain within the planetary boundaries (Rockstrom et al., 2009; WBGU, 2011). Systemic integration refers to the extent to which new sustainable procedures, policies and guidelines are integrated into the city's institutional framework: An integration into the policy framework is crucial to ensure the longevity of transformative processes in the face of electoral cycles and political change (WBGU, 2011). Spatial upscaling refers to the extent to which a city has replicated or scaled successful projects within the city: As pointed out above, upscaling is of major importance to achieve transformative change (EEA [European Environment Agency], 2019). Impact beyond

city captures the extent to which activities have been replicated or scaled to a regional, national, or international level.

Our third success dimension is the acceptance of transformative change among citizens. For a city to succeed in its transformation towards carbon neutrality, widespread acceptance among various different groups of citizens is essential. This dimension relies on the idea that transformation can only be successful if cities foster economic development and provide high-quality services to their citizens while reducing their CO2 emissions. Accordingly, acceptance may not only influence the extent of CO2 reduction but also the dynamics of transformation, as lower levels of opposition and conflict tend to smoothen the implementation of projects and facilitate systemic approaches to change.

By introducing these success dimensions, we do not want to depict a system of success in which the different dimensions outweigh one another. In our approach, each dimension is valid on its own. Lack of success in one dimension cannot be compensated by success in another dimension. Although we assume that the three dimensions reinforce one another, we are aware that tensions or trade-offs may arise.

3.2 Explanatory variables: three governance dimensions for urban transformation

Urban transformation must be governed. We have selected three governance approaches as our explanatory variables. Broadly, governance can be defined as “an effort to craft order, thereby to mitigate conflicts and realise mutual gains” (Williamson, 2000, p. 599). More specifically, the term entails which forms of coordination (hierarchical, horizontal or hybrid) are being applied to steer processes, implement decisions, or solve problems. While a narrow understanding is sometimes limited to the actions of government agents (at a national or local level), this report adopts a broader view which includes non-state actors such as civil society, academia, and the private sector (Hernandez, 2021b; WBGU, 2016). “Urban governance” then is the planning, financing, and management of urban areas by both government (at different levels) and non-government stakeholders. It is a continuous process of negotiating conflicting and common interests, in which different actors and institutions ultimately decide over the allocation of resources and power, relying on both formal and informal institutions (UN-Habitat [United Nations Human Settlement Programme], 2002). “Transformative governance” and especially “transformative urban governance” therefore refer to governance aimed at bringing about the aforementioned fundamental systemic change that ultimately leads to zero-carbon emission within a city.

Local actors, including city governments, increasingly engage in actively changing their practices and bringing about sustainable change. Hoff, Gausset, and Lex (2020) observe this to be a reaction to the failure of national and international governments to satisfactorily tackle environmental challenges on their own. This observation draws attention to the will and ability of city governments to develop and adopt good practices for urban transformation.

Our research places city governments at the centre of analysis, arguing that they play an important leading and facilitating role in urban transformation (Aylett, 2014; Wittmayer et al., 2017). Among urban governance actors, city governments are often the most visible, though not necessarily the most powerful actors. Private businesses and central state agencies determine much of what actually happens in a city. In low- and middle-income countries, external actors such as development partners or international organisations are often active and powerful in shaping transformative change. Furthermore, city politics can be the place of significant opposition against climate action – especially when other development priorities are at stake or parts of the society stand to lose from certain measures. Political factors like these can thus

have a decisive influence on whether local politicians engage in transformative change in the first place (Bulkeley, 2010).

The analysis of actor constellations in the governance of urban transformative change is therefore important, and especially so, as power relations are likely to be significantly affected and altered throughout the process (Hernandez, 2021b; Knappe, Holfelder, Beer, & Nanz, 2019). Nevertheless, local governments can also shape transformation processes by involving stakeholders. Literature such as the WBGU report favours inclusive forms of involvement whereby all stakeholders are involved in the entire cycle of transformative change projects or processes (WBGU, 2016, p. 17). We will provide further insight into stakeholder involvement as our first explanatory variable in subsection 3.2.1.

To grasp the role that city governments can play in the governance of urban transformation, their position in the multi-level governance system has to be understood because it determines their rights and responsibilities and affects their capacities and resources. Quite often, cities provide goods and services that are key for carbon reductions (covering transport, infrastructure development, land-use planning, waste management, and so on). However, to be able to make meaningful changes, they require specific competencies and powers in the respective sectors, which they do not always have. Some urban governance issues are dealt with at higher levels of government. Regional transport or energy supply, for example, are usually more effectively addressed at a regional level (Bulkeley, 2010).

The degree of decentralisation varies greatly across countries (OECD [Organisation for Economic Co-operation and Development]/UCLG [United Cities and Local Governments], 2019), which means that cities around the globe are in very different positions to shape urban transformation toward zero carbon. Integration and coordination between levels of government are especially important in cross-cutting policy areas such as sustainable development or environmental policy, where goals and policies often interact and can be in conflict with each other (Howlett, Vince, & del Río, 2017).

A central area affected by the multi-level governance system is the urban finance system. Financing the urban transformation often poses severe challenges (Floater, Dowling, Chan, Ulterino, Braunstein, & McMinn, 2017). Local governments often lack both human and financial resources to meet their responsibilities (Bulkeley, 2010). In fact, global survey data presented by Aylett (2015) indicate that a lack of funding for implementing climate change projects and programmes is a significant challenge for more than two-thirds of the cities that took part in the survey. We will provide further insight into financial resources as our second explanatory variable in subsection 3.2.2.

As laid out above, the governance of urban transformation is highly complex and neither its exact outcomes nor the pathways to achieve them are clear from the outset. Instead, the process is often described as one of searching, learning, and adapting. Several scholars have stressed the importance of thoroughly assessing the impact of interventions and activities (Holtz et al., 2018; Loorbach, 2009). Different methods range from generating anecdotal evidence to rigorous approaches based on scientific inquiry, and from continuous accompanying research to single ex post evaluations. We will provide further insight into impact assessment as our third explanatory variable in subsection 3.2.3.

3.2.1 Stakeholder involvement

As pointed out above, urban transformation affects and depends on many different stakeholders and actors. How exactly they should be involved in the process, however, remains a debated issue. This subsection gives an overview of how stakeholders and other actors in the governance of urban transformation are conceptualised. It summarises normative and functional

arguments in favour of stakeholder involvement and presents different forms of participation, along with their limitations. Based on this discussion, we will then lay out our hypotheses on stakeholder involvement.

Stakeholders of urban transformation are all people, groups and organisations that are directly or indirectly affected by the process. The concept differs from the term “actors” in that the latter implies activity and agency and thus refers to those groups and individuals that *actively* engage in urban transformation. While the status of stakeholder is often restricted to groups that are locally present, this would exclude groups such as farmers who live outside the city but may be directly affected by its water management, for example, without being involved decision-making processes.

Stakeholders are often grouped into state, market, and civil society sectors. Although these sectors are sometimes presented as if they were homogenous actors in themselves, it is in fact much more accurate to think about them as specific contexts of transformation. Also, stakeholders appear at different levels of aggregation. Organisational stakeholders can be governmental agencies, large corporations, community groups, clubs, universities, NGOs, and so on. Individuals, on the other hand, can act as politicians and citizens, employers and customers, residents and relatives, or club members and volunteers, to name but a few roles. Stakeholders can also be framed according to their role in the transformation process (including descriptions such as change agents, or pioneers). Depending on these conceptualisations, different rights, powers, needs, and abilities of stakeholders become apparent that are likely to affect their (changing) relations and roles in urban transformation.

The literature cites many arguments for stakeholder involvement that are based on different normative or functional reasons. Some authors see the involvement of stakeholders as a democratic right and duty. The WBGU, for instance, argues that the involvement of all stakeholders is needed to ensure “universal minimum standards for substantive, political and economic inclusion” in all cities (WBGU, 2016, p. 371). The assumption is that participation can contribute to detecting unintended consequences of potentially harmful measures. This line of reasoning often attributes an inherent value to participation. Some schools of thought see an inseparable link between the transformation toward carbon neutrality and the creation of a more democratic and egalitarian (world) society (Adloff & Neckel, 2019; Knappe et al., 2019). However, as sustainability has become part of a scientific (often apolitical) expert discourse in the past years, Adloff and Neckel (2019) observed that goals of democratisation are no longer as relevant as they used to be for the early movements in the 1970s and 1980s.

Accordingly, there has been an upsurge of rather functional arguments for the involvement of stakeholders. A common argument is that the mere scope of the transformational endeavour exceeds the abilities of (city) government actors, which is why they rely on the support and resources of community groups, civil society organisations, and private-sector actors. However, stakeholders are not only relevant because they can potentially become important partners in designing and implementing meaningful transformative projects and policies (which they sometimes already do on their own), but also because they might resist changes and thus hinder process (Aylett, 2014; Hoff et al., 2020; WBGU, 2016).

Based on these arguments, participation has become a central notion in urban governance. It describes “the inclusion of people in the conduct of common affairs” (WBGU, 2016, p. 107) and is frequently used as a reference for city governments’ actions to involve citizens or stakeholder groups in political decision-making processes. Forms and degrees of participation vary widely. They can range from being merely informative, or consultative, to various types of joint decision-making or independent and autonomous action (Arnstein, 1969). Typical forms of informative participation are public events or campaigns where citizens are informed ex post about decisions taken by local authorities. Consultative participation instruments include citizen surveys or report cards. Such instruments aim to guide future decisions by finding out about residents’ needs and

priorities, or to give feedback on existing public services without being binding. Participatory decision-making then gives more space for government-citizen interaction or even policy co-creation. This form of participation includes referenda, where citizens can decide between various proposals but also instruments such as community action planning or citizen planning cells, where solutions are developed together with (selected representatives of) the population (WBGU, 2016).

> The WBGU recommends adopting collaborative governance approaches in urban transformation. According to this concept, affected population groups and civil society initiatives (stakeholders) should be regarded as equals in the transformation process and therefore be included into the entire project cycle of transformative change initiatives, including their initiation, design, implementation, evaluation and maintenance. City governments should strengthen formal (transparent and inclusive) participation structures (incl. so-called arenas for public discourse) and create space for experimentation. (WBGU, 2016, pp. 17 and 371)

Taking up this perspective, we hypothesise that:

H1 – **Inclusiveness**: Cities that employ inclusive governance approaches are more successful in their transformative change towards zero carbon than those that rely on less comprehensive forms of stakeholder involvement.

For a more fine-grained analysis, we further divide **H1** into two sub-hypotheses, focusing on the range of actors involved and the modes of their involvement or, in other words, on the width and depth of stakeholder involvement:

H1.1 – **Range of actors**: Cities in which broader coalitions of stakeholders are built are more successful in their transformative change towards zero carbon than those in which more narrow coalitions are built.

H.1.2 – **Modes of involvement**: Cities that employ collaborative modes of stakeholder involvement are more successful in their transformative change towards zero carbon than those that solely employ consultative (or no) modes of involvement.

We foresee the strongest connection between stakeholder involvement and the success dimension of acceptance. Research shows that people tend to have higher levels of acceptance when they understand what is happening, see a personal benefit, are included, and feel a sense of self-efficacy. Furthermore, platforms for public deliberation and joint action can help to identify synergies and potential challenges, overcome trade-offs, and prevent and settle conflicts. Participation can therefore help to increase the legitimacy of both governments and change processes (Cornwall, 2008; Loorbach, 2009; WBGU, 2016).

However, participation does not necessarily lead to increased acceptance. On the contrary, it can also result in more citizens rejecting and criticising the measures. Even if stakeholders are included, their expectations about how far they can influence processes and the actual outcomes might not match. Expectations and frustrations might be especially high in contexts “where a population experiences an expansion of participation opportunities as something new” (WBGU, 2016, p. 371). As governance is always context-dependent, so might be suitable approaches to stakeholder involvement (Loorbach, 2009). Investigating them in different geographical and cultural locations seems especially relevant in this regard.

Beyond increasing acceptance, more comprehensive forms of participation (like participatory decision-making, co-creation, and autonomous action) are directed toward learning, empowerment, and the generation of innovative, agile, and even radical solutions which fit the local context and can challenge (or even replace) the status quo (Cornwall, 2008; Hoff et al., 2020; WBGU, 2016). Therefore, we see a connection between such modes of stakeholder involvement and the success dimension of CO2 reduction. While many niche innovations evolve

independently of – and sometimes even against – city authorities' actions, local governments can also strategically promote them, for example by funding pilot projects or creating protected environments that incentivise experimentation (Holtz et al., 2018; Loorbach, 2009).

Furthermore, joint stakeholder action may also affect the dynamics of transformation, as it may not only be crucial to develop innovative solutions but also to transfer them from the niche to the regime level (Holtz et al., 2018; Khan, 2013). Public deliberation and joint action may not only increase acceptance but also contribute to the upscaling of activities within and beyond the city, as they involve many different stakeholders and, among them, can help to develop a common understanding and a long-term vision for the transformation. Hence, stakeholder participation, while taking up more time at the beginning, can ultimately accelerate the transformation because the developed approaches are more viable and less prone to conflict-related delays (WBGU, 2016). In terms of joint decision-making, however, selection and exclusion are important issues. If representative structures are formed, a careful selection of participants is important – especially when a city intends to empower marginalised groups to participate in shaping urban transformation (WBGU, 2016). Effective participation, however, depends on a broad range of competencies, quite apart from time and energy (Loorbach, 2009), which is why the real inclusiveness of such approaches can often be questioned. Pointing in a similar direction, Khan (2013, p. 138) warns against the "elitist character" of network governance approaches to urban climate politics. A focus on achieving results rather than increasing democratic legitimacy could lead to the exclusion of alternative voices.

3.2.2 Urban finance

As has been laid out above, financial resources remain a bottleneck of urban transformative change in many cities and especially so in the field of sustainable infrastructure development. This subsection gives an overview of the requirements, obstacles and potentials in financing urban transformation that leads us to our hypotheses on urban finance.

Transformation towards carbon-neutral cities requires a profound reorganisation of urban systems. Many of the measures needed to reorient current consumption and production patterns depend on large-scale capital spending. Examples include innovations for mass transit, renewable energy production and distribution, energy and resource-efficient buildings, and water management or waste reduction, which create a real potential for green urban transformation.

In many industrialised cities in the Global North, urban transformation requires substantial investments to upgrade and replace ageing and increasingly outdated infrastructure. Clean solutions in environmental technology enable and support more sustainable urban lifestyles and modes of production. Urban forms and urban structures that were evolving over centuries must be swiftly adapted to a greener reality by escaping historical path dependencies.

In low- and middle-income countries, urban transformation often requires new and extended infrastructure to meet the demands of growing urban populations and the rising middle class. If the infrastructure gap is not closed during this period of rapid urbanisation, millions of urban dwellers may end up living in informal settlements without basic services such as drinking water and electricity. Without adequate shelter, public transport systems, and accessible infrastructure for active transport (walking and cycling), people's mobility for employment, livelihood and quality of life will be inhibited. Moreover, urban sprawl and the (uncontrolled) growth of informal settlements will complicate efforts towards carbon-neutral cities. The introduction of alternative clean infrastructure solutions in these cities would lock economic and climate benefits for decades to come (Floater et al., 2017).

Low-carbon infrastructure assets and projects are not by default costlier than high carbon choices (Godfrey & Zhao, 2016). Whereas certain types of sustainable urban infrastructure projects have longer timelines and require larger amounts of capital in the initial stages than

conventional infrastructure projects, the opposite can also be true. An important factor that provokes higher costs for lower-carbon options are the perceived risks associated with them (Ahmad et al., 2019). Although the potential of cost-cutting through economies of scale and a decrease in the perceived risk may result in the reduction of the costs of certain low-carbon assets, the short-term financing costs for sustainable urban infrastructure are likely to be larger than for conventional infrastructure. The urgency for action and the scope of transformation of urban infrastructure systems aggravate the cost pressure on cities (Floater et al., 2017).

Many cities do not exhaust the potential of new infrastructure due to significant fiscal constraints at the local level. Often, financing conventional infrastructure is already a challenge. Market and non-market barriers to financing sustainable infrastructure in urban areas hence result in a considerable shortage in infrastructure investments (Godfrey & Zhao, 2016). When balancing supply and demand for sustainable urban infrastructure investment globally, the financing gap amounts to USD1 trillion per year (Ahmad et al., 2019). This investment gap is particularly acute in developing countries and emerging economies. The largest funding needs associated with financing the Sustainable Development Goals (SDGs) are related to economic infrastructure, especially energy, transport and telecommunication systems (Doumbia & Lauridsen, 2019). Consequently, the sustainable transformation of cities is often held back by the high short-term financing costs of sustainable projects and the lack of funding of cities.

This observation leads us to the introduction of our second hypothesis:

H2 – **Financial scope**: Cities with larger fiscal space[14] for sustainable transformation are more successful in transformative change towards zero carbon than those that rely solely on existing flows of funds.

Larger fiscal space through the mobilisation of additional funding can facilitate cities' transformative change towards zero carbon in multiple ways. To begin with, it enables cities to scale up investment into low-carbon infrastructure projects. Such investment will have a positive impact on the city's carbon footprint in the medium to long term. Additional funding also allows cities to invest in human resources which is needed to develop strategies for sustainable transformation, elaborate regulations, and implement transformative projects. It also allows cities to engage in networks to exchange solutions. Furthermore, more fiscal space provides a basis for compensations to accompany transformative change. Transformation can incur losses for certain social groups while cities may facilitate the acceptance of these activities through targeted compensations.

The role that financial resources can play in transformative change depends to a considerable degree on the financing sources and mechanisms. The following paragraphs give an overview of common financing sources and mechanisms for cities. We will then identify major barriers that discourage investment in infrastructure and discuss innovative ways to finance the demand for clean infrastructure.

Cities can rely on public as well as private funding to finance their expenses. Sources of finance vary between countries, most notably as a result of different levels of fiscal decentralisation (Bahl & Linn, 1992). However, within countries, cities can also have highly diverse finance structures based on different size, levels of endowments of natural resources, or levels of local economic development (Ardanaz, Leiras, & Tommasi, 2014).

Most cities rely mainly on public funds (OECD, 2020). Intergovernmental transfers from central or intermediate governments are a core component of most city budgets (Godfrey & Zhao, 2016). In

14 Heller defines fiscal space as "the availability of budgetary room that allows a government to provide resources for a desired purpose without any prejudice to the sustainability of a government's financial position" (Heller, 2005, p. 3). The desired purpose in our case is urban transformation towards carbon neutrality.

addition, cities generate own revenue based on local taxes or non-tax sources, such as charges or fees. Furthermore, national or international development banks can provide cities with guarantees or direct liquidity through grants or loans. Not least, cities can benefit from bilateral development assistance through public agencies or NGOs (Platz, Hilger, Intini, & Santoro, 2017).

Market-based finance mechanisms allow cities to access private finance. The most traditional form is to take on private-sector (usually commercial bank) loans. However, advanced options may allow cities to tap the trillions of US dollars managed by institutional investors such as commercial banks, insurance companies, or pension funds (Ahmad et al., 2019). These include debt instruments, for instance the issuance of bonds, and equity instruments, for example public infrastructure companies, public-private partnerships, or privatisation (Croce, Paula, & Laboul, 2015; Lindfield & Teipelke, 2017). While there is no “one-size-fits-all” financing model for sustainable urban transformation, there *are* a number of potential approaches to scale up finance and to improve necessary preconditions (KPMG, 2012).

Eventually, national legislation defines the range of possible sources of city income. Some cities are not entitled to collect taxes or to receive direct financial assistance from international organisations and donors. More frequently, they are not allowed to engage in financial markets. These restrictions suggest that efforts to scale up finance for transformative change at the city level require close coordination with central governments (Floater et al., 2017). Beyond the legal frameworks, however, institutional failures such as local officials’ lack of capacities and expertise hinder the process of raising revenues. Regulatory inconsistency and uncertainty discourage private investors. Lastly, wider price distortions triggered by specific government interventions like certain subsidies or taxes often discourage the deployment of modern, energy-efficient technologies (Godfrey & Zhao, 2016).

Local revenue mobilisation is critical in establishing accountability and decision-making autonomy for the delivery of local services (Ahmad et al., 2019). Fiscal contract theory states that public funds are spent more deliberately and more effectively if they are sourced locally because local stakeholders demand higher levels of accountability from local authorities (Gadenne, 2017). Clearly, linking taxes to service delivery is also a way to offset political resistance to locally collected sources. Local revenue mobilisation can accelerate local activities that can be implemented more independently (von Haldenwang, 2008). Equally important is the role that own-source revenues play in directly providing capital and in unlocking additional financing mechanisms (Ahmad et al., 2019). In practice, however, legal or economic conditions often constrain local revenue mobilisation. Many cities have only limited powers with regard to developing own revenue sources (Lindfield & Teipelke, 2017). Cities must also consider the economic context when tapping local revenue sources, in order to avoid negative effects on poverty, inequality or economic development.

Market-based mechanisms to tap private capital are another potential solution to drive transformative change. Given the financial pressures that most governments are facing, private financing for project development has become ever more important (KPMG, 2012). Several instruments have the potential to leverage long-term private capital. Among these are different types of bonds issued at the local level (municipal bonds, green bonds, project bonds, and so on), different forms of public-private partnerships (such as lease arrangements, concessions) or the creation of special purpose vehicles to enable private investors to invest into infrastructure such as investment platforms or funds (Croce et al., 2015). Unlocking private capital through market-based finance sources represents a real potential to reduce the existing financing gap. Moreover, involving the private sector in public urban infrastructure investment can secure management and technical expertise. The profit motive can incentivise greater efficiency and innovation and improve the viability of projects. Engaging private partners may also lead to mutual learning and spillovers into other plans, projects, or cities (Ahmad et al., 2019).

Despite the benefits of market-based finance sources, urban development that is purely market-based cannot ensure a sustainable transformation towards carbon neutrality, due to multiple

market failures. In addition, without a sufficient supply of revenues, debt finance instruments can risk cities' default (Floater et al., 2017). If economic motivations and private corporations heavily dominate the process of urban transformation, relevant dimensions (such as acceptance and public support for transformative change) might be undermined.

Finally, the variety of funding sources tapped by local actors seems to be positively associated with the scope and pace of transformative action. As described above, cities can develop a diverse portfolio of public and private capital from local, national and international sources. The diversification of funding sources increases financial stability. This stability in turn may help to attract private capital due to diminished risk. Increased financial stability can also facilitate cities to adopt a long-term perspective in their decision-making and investment behaviour. Multiple funding sources also increase local discretion and facilitates upscaling because they promote capacity building in financial management and improve a city's financial records and reputation (Platz et al., 2017). On the other hand, expanding the resource envelope also creates additional transaction costs and can slow down processes because of additional coordination, reporting, and monitoring needs. If poorly managed and monitored, an increased number of finance mechanisms may increase risks relating to the misuse of funds.

3.2.3 Impact assessment

Impact assessment refers to processes geared to determine and measure the impact of project interventions. Successful impact assessment should help to speed up processes and facilitate the replication and expansion of projects through the possibility of applying lessons learned to other contexts. In this sense, impact assessment can facilitate successful transformative change towards zero emissions in cities. Hence, a basic assumption underlying our research is that good impact assessment increases the success of transformative change processes. This subsection provides answers to the question of how impact can be assessed. It also explains our hypotheses on impact assessment.

The need to know if an intervention has caused the desired impact is nothing new. For decades, monitoring and evaluation have been considered essential elements of the project cycle (Funk, Groß, Leininger, & von Schiller, 2019). Nevertheless, rigorous forms of impact assessment still lack broad implementation – particularly in the field of governance interventions (Garcia, 2011). Accompanying research can provide important tools to assess impact, as will be discussed in more detail below. Yet, there are many other approaches, ranging from informal short-term interviews to obtain anecdotal evidence to long-term approaches with a high degree of scientific rigour. Impact assessment, accompanying research, and evaluation are interrelated concepts with important overlaps, but it is still important to define and delimit these terms. This will be done in the following.

To start with, impact assessment can be categorised according to the scientific quality and the frequency of interaction. Scientific quality ranges from anecdotal evidence to systematic and scientific approaches. Frequency increases from one-off operations to continuous and long-term processes. While most projects are assessed by means of ex post evaluations once the project is concluded, more continuous approaches such as accompanying research have recently gained relevance (Funk, Leininger, & von Schiller, 2020; Kromrey, 2007).

Accompanying research is characterised by a long-term orientation and continuity throughout the entire project cycle, combined with a systematic, scientific approach. Research is being conducted in close cooperation with practitioners and target groups. This cooperation ideally starts before project implementation. Accompanying research does not necessarily cover aspects of impact assessment. In line with Funk et al. (2019), however, our understanding of the concept refers to research that does, in fact, focus on the impact achieved by interventions, applying mixed methods approaches that combine theory-based analyses and rigorous impact assessment (Funk

et al., 2019; Funk et al., 2020). More specifically, accompanying research not only answers the question of whether an intervention has caused an impact but also *why* and *how* this impact has been achieved. It aims at identifying underlying mechanisms, enabling strategic and operational learning as well as capacity building, and creating possibilities to upscale and accelerate projects. Scientific rigour contributes to the external validity of findings, even if the research design is highly context-specific. This helps to legitimise the respective activities and allows one to share insights within impact-related debates (Funk et al., 2019; Funk et al., 2020).

Beyond project-specific and academic outcomes, accompanying research can influence the political economy of transformation. By changing the decision-making culture, policy choices can be improved in the long run (The Transfer Project, 2020). Among other factors, this improvement depends on how engrained the practice of impact assessments becomes in a city. A systematic approach with a high degree of involvement of the evaluating entity in policymaking makes sure that the results eventually reach the policy process and that recommendations are implemented within the political process.

Despite the potential benefits outlined above, there is still resistance to more rigorous impact assessment, especially if embedded in accompanying research. Why is this the case? First, accompanying research is resource-intensive, especially in the early phase of a project. Standard evaluations are mostly conducted ex post and within a rather short time span (often no more than 5 to 10 days). In contrast, accompanying research is based on a sustained cooperation between practitioners and researchers. This requires frequent interaction and the involvement of researchers in planning and project formulation. The benefits of accompanying research tend to present themselves primarily in the medium term. Inefficiencies can be tackled on an ongoing basis and optimisation takes place continuously, thereby increasing project implementation efficiency.

Second, limited external validity may be an issue. Lessons learned in a project or country context cannot easily be transferred to another context. Especially within the governance context, measuring impact can be challenging, as processes are characterised by a high degree of complexity. This complexity is seen in projects being implemented at different levels and often applying a multi-stakeholder approach. Additionally, context specificity is key and multi-causality may lead to complex interconnections and trade-offs. Further, governance programmes often aim at rather abstract and long-term outcomes such as systemic change, which cannot be measured or quantified easily. This is further hindered by time lags between intervention and outcome. Finally, interventions may cause undesired results, which are not apparent at first sight (Funk et al., 2019; Kromrey, 2007). While this complex nature makes impact assessment more difficult, it also makes it *even more* necessary.

Against this background, one of the main questions that guide our research is how cities measure impact. We want to test the assumption that the incorporation of impact assessment into the project cycle is a key success factor for transformative change. As outlined, more rigorous and more continuous approaches to impact assessment take more time and are more expensive. Our aim is to put this assumption to test.

Therefore, we hypothesise that:

H3 – **Comprehensive impact assessment**: Cities that implement more comprehensive impact assessment are more successful in their transformative change towards zero carbon than those that conduct less comprehensive assessments or do not assess the impact of their interventions at all.

In our understanding, comprehensive impact assessment is characterised by the use of rigorous methods, its continuity, as well as the involvement of external entities. Rigorous impact assessment implies a systematic and methodological approach to measuring impact. It forces cities to define their goals and frequently check whether the approaches and resources

employed are appropriate to attain these goals. In addition, rigorous impact assessment facilitates reporting project progress and outcomes, and building a reputation that facilitates the acquisition of additional funds. These funds create additional possibilities to upscale projects within cities and to expand projects beyond a city's borders. Not least, more rigorous data might facilitate learning processes. These assumptions point towards a strong and predominantly positive connection between **H3** and the success dimension on the dynamics of transformation. Further, we expect a strong and predominantly positive impact of rigorous impact assessment on success dimension Three, acceptance: It is likely that robust evidence on the impact and achievements of an intervention facilitates the acceptance of such measures. Nevertheless, rigorous impact assessment might bear trade-offs with regard to efficiency and speed. By including feedback loops throughout the entire project cycle and employing scientific methods, some processes could turn out to be more time-intensive. Also, there are some endogeneity concerns, since proof of successful CO2 reduction lies in the demonstration of impact, which implies that causality can also be reversed.

Second, the time dimension is key when talking about the success of impact assessment. We assume that continuous impact assessment extends the time span in which learning and adaptation of project interventions are taking place, thus increasing project efficiency. In this way, continuity in impact assessment might especially facilitate the acceleration of processes. Further, potentially costly inefficiencies can be identified and corrected early in the project cycle. Additionally, efficiency is assumed to be higher as continuity in impact assessment enables better responsiveness to the interests of local stakeholders and thus a better fit to local problems. This has a potentially positive impact on the acceptance of interventions. We also expect the success dimension "systemic scope" to benefit from continuous impact assessment as continuity facilitates the integration of transformative change in everyday operations. Lastly, continuity of impact assessment facilitates upscaling, as insights from project planning and implementation can be gathered and shared early on, allowing other projects to benefit from lessons learned throughout the entire project cycle. As a counterargument, time and cost intensity of continuous impact assessments can be higher. This might counteract the positive effect on acceptance and the acceleration of interventions.

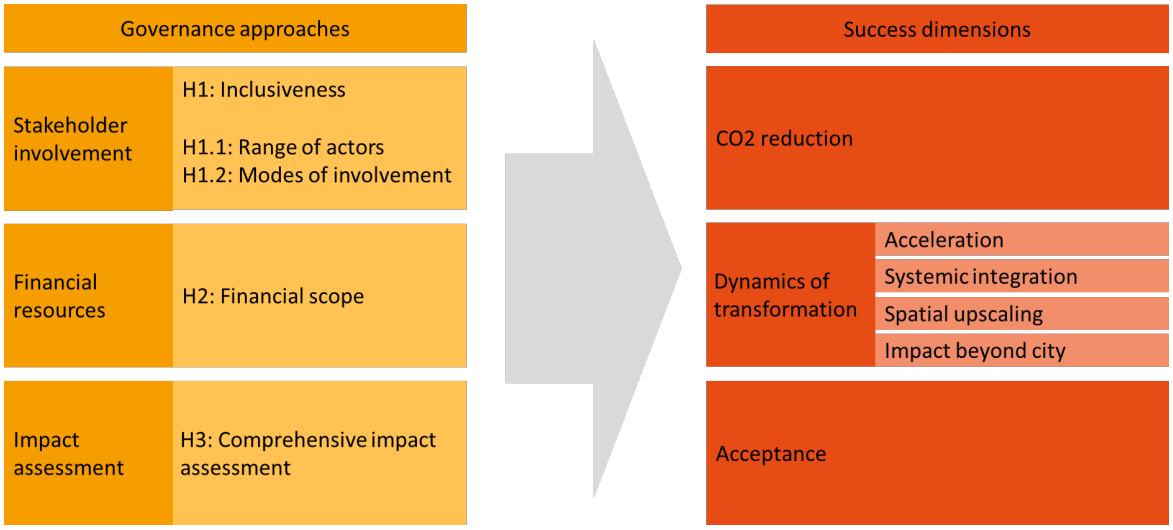
Another key factor of impact assessment is related to the entity that is in charge of the process. The assumption here is that conducting impact assessments in cities in collaboration with external partners such as universities, research institutes, think tanks, or private consultancies ensures that interventions are based on a joint consideration of theoretical and practical insights. Incorporating external expertise increases the knowledge base of local actors involved in the impact assessment. While internal actors are above all aware of the city- or project-specific context, external actors may bring in experiences from other cities and projects, thus putting the impact assessment in a broader context. By relying on external expertise, city governments can therefore take decisions based on enhanced knowledge on technical or financial aspects of sustainable transformation, and an improved understanding of good practice in other cities. This way of decision-making is expected to positively contribute to the acceptance of measures as well as the systemic scope by creating more credible results. On the other hand, however, a lack of city- or project-specific insights could affect the work of external experts. Also, lack of trust by local stakeholders might undermine the efficiency of external experts. These negative effects could counteract the positive effect on the systemic scope and would be an argument in favour of internal assessments.

Having laid out our dependent variables, the success dimensions for transformative change, and the three governance approaches (stakeholder involvement, urban finance, and impact assessment) that constitute the explanatory variables, the next subsection combines these and elaborates the empirical strategy that was adopted to answer our research question.

3.3 Empirical strategy and data

Subsection 3.1 presented three success dimensions of transformative change: CO2 reduction, dynamics of transformation, and acceptance. Based on current literature debates and own theoretical considerations, Subsection 3.2 formulated hypotheses on the relationship of governance approaches and successful transformation (see Figure 2). Figure 2 summarises our hypotheses framework.

Figure 2: Hypotheses framework



Source: Authors

We consider the different governance aspects as explanatory variables and the three success dimensions as dependent variables. Taking into account all possible combinations of governance approaches and success dimensions would be impossible within the scope of this study. In our empirical analysis, we therefore focus on relationships that we consider particularly relevant because of their strong theoretical foundation or their practical relevance. For instance, we expect a strong, direct and positive relationship between the range of actors involved (**H1.1**) and the acceptance of change (see subsection 3.2). Not all relevant relationships can be assumed to be unambiguously positive, however. For instance, a higher degree of stakeholder involvement may speed up the transformation process (acceleration): once the project design has been discussed and decided in a participatory process, implementation may be less conflictive and thus run more smoothly and quickly. On the other hand, if more actors are involved, this may slow down decision-making.

Employing a two-stage empirical strategy, we use this conceptual framework for our study. At the first stage, we take on a macro perspective to gain an overview of urban transformation. To this end, we conducted an international survey with city government officials. This survey of cities from all over the world was set up in order to identify general patterns as well as differences between subgroups of cities, for instance, based on world regions or funding structures.

At the second stage, we analysed transformative change from a micro perspective based on insights from three case studies: Bonn (Germany), Quito (Ecuador), and Cape Town (South Africa). The case study approach was chosen in order to zoom in on transformation processes, examine impact chains, and go beyond the city government officials' view. The following subsections describe our survey and case study approach in more detail.

3.3.1 Survey approach

In March 2021 we invited cities around the world to participate in a survey. We developed the survey based on our theoretical framework, inspired by earlier surveys, such as Aylett (2014), and with feedback from partners working on urban transformation and decarbonisation. The survey was addressed to city government officials with knowledge about CO2 emission reduction activities in their respective cities.

In preparation for our survey, we created a database covering cities worldwide that were active in international sustainability networks or had participated in international sustainability awards.[15] Our focus on international networks and awards was based on the assumption that cities that engaged in settings beyond the domestic scale could be considered more active, more confident about their own approaches, and more interested in engaging with like-minded partners against a background of international sustainability standards and best practices.[16]

We applied the following criteria for networks and awards during our screening process:

The network

- operates on a global or at least regional level,
- comprises cities as members,
- lists member cities on its website,
- focuses on sustainability-related themes,
- offers a range of activities beyond single events such as conferences, and
- has been active after 2015.

The award

- operates on a global or at least regional level,
- targets cities or projects in cities,
- focuses on sustainability-related themes, and
- has been granted after 2015.

These criteria ensure that our city database includes those cities that are, through their own initiative, particularly involved in promoting socio-ecological change.[17] In total, we identified 43 city networks[18] and 18 awards that fulfil these criteria, including the networks and awards presented in subsection 2.2.[19] We then employed a twin-track contact strategy: First, we collected the publicly available email addresses of city officials for those cities in our database that had taken part in the above-mentioned awards, or were members of networks with up to 100 members. Building on this collection, we directly invited 587 cities to participate in the survey. The majority of the recipients were mayors or staff in sustainability, environmental, or urban planning departments. Second, to reach cities in sustainability networks with more than 100 members, we collaborated with international city networks, namely ICLEI and CIVITAS (City Vitality and Sustainability network). The ICLEI Secretariat invited 954 cities around the world to participate

15 To our knowledge, no comprehensive database or listing of such cities exists beyond individual networks.

16 From a practical perspective, including hundreds of national networks and initiatives would have exceeded the capacities of the research team.

17 See Acuto and Rayner (2016) and Keiner and Kim (2007) for definitions of an active city network based on regular procedures and direct involvement.

18 Twelve of those major city networks have more than 100 (in some case, several thousand) member cities. In these 12 cases, we could not screen cities individually due to our limited resources.

19 Please refer to Table A1 for a full list of networks and awards.

in the survey. CIVITAS sent the invitation to 188 member cities. The invitations sent to our own database and the ones sent through city networks added up to a total of 1,730 invited cities.

All direct communication with respondents was conducted by email or through online contact forms on city websites in those cases where we could not obtain an email address. ICLEI provided supporting publicity for the survey by promoting the survey in its global newsletter, the Carbonn Center's newsletter and on social media platforms. Cities were asked to submit their answers to the self-administered online questionnaire within a time window of around one month. Non-respondents or respondents who had not completed the survey, were sent two reminder emails at one-week intervals.

The questionnaire was composed of 58 questions in 6 sections: i) basic characteristics of the city and its GHG emission reduction ambitions; ii) local government's GHG emission reduction activities; iii) stakeholder involvement in GHG emission reduction activities; iv) financing GHG emission reduction activities; v) assessing the impact of GHG emission reduction activities, and; vi) COVID-19 impact and general information. Questions asked for both facts and personal assessments.

The survey questionnaire was reviewed for content and clarity by ICLEI headquarters staff members, city administrators of the city of Bonn, urban climate change researchers at the Wuppertal Institute for Climate, Environment and Energy, and colleagues at IDOS. The final questionnaire was translated into French, Spanish, Portuguese, German and Mandarin.

In total, 56 cities of the 1,730 invited cities (3.2 per cent) responded to the survey,[20] and 42 (2.5 per cent) completed the entire survey. Two responses had to be excluded, which left us with a sample size of 54 responses.

Most cities in our sample are in the Global North. Only around one-third (34.9 per cent) is in the Global South (see Table A3). In particular, African cities are underrepresented. European cities account for the largest number of survey responses (see Table A3). This Global North bias reflects the large number of European cities in our database and the Global North bias in the memberships of our partner city networks. Figure 3 shows a world map of the source countries. The cities in our sample represent a great variety regarding their population size, ranging from 2,600 to more than 10 million inhabitants. In terms of sectoral composition of the local economy, we can also observe a great variety in the city sample. Wholesale and retail trade (39 per cent), business or professional services (33 per cent) and light industry and manufacturing (32 per cent) are indicated most frequently among the three most meaningful sectors in the local economy.

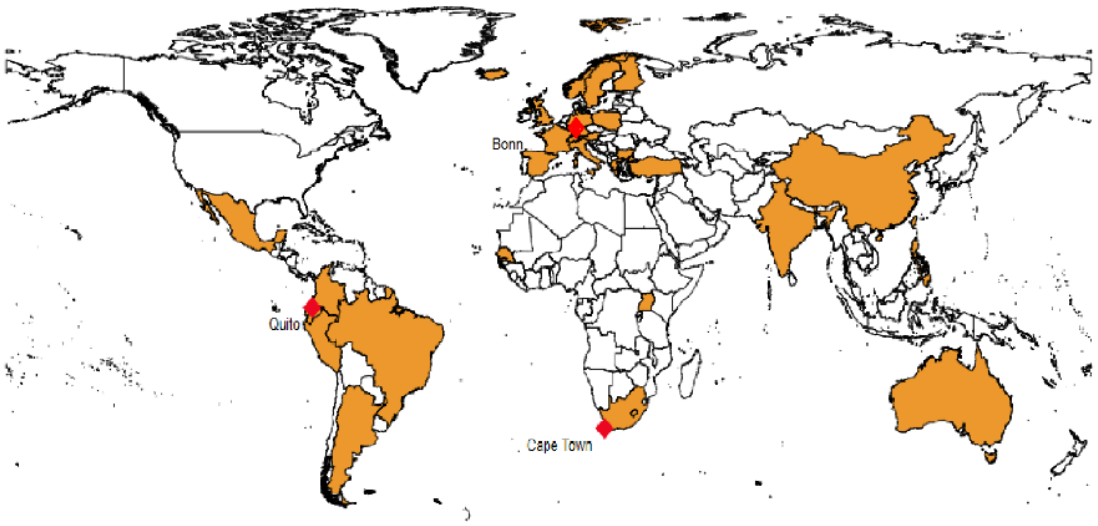
We employed descriptive statistics including cross-tabulations and differentiating between different subsamples to analyse the survey data (see subsection 4.1 for results). Given the small sample size and the broad variety of confounding factors, which we were neither able to cover in our survey nor retrieve from external data sources, we were not able to draw causal inferences based on statistical operations. While we expected effects to run in one direction (choice of governance approach affecting the transformation success), we were aware of various reverse causality issues.[21] It also needs to be noted that the external validity of our results is limited, due to our sampling procedure. Rather than covering all cities worldwide, our city sample only contains cities that are active in networks or have participated in awards. Additionally, representativeness is limited due to the low survey response rate, which may partly be explained by the ongoing COVID-19 pandemic and the ensuing overexposure of local government officials

20 We included all responses that completed at least 30 per cent of the questions in our final sample.

21 For example, it is possible that cities that have been more successful in reducing their CO2 emissions are also more successful in mobilising financial resources because investors are drawn towards successful cities.

to virtual formats. Moreover, especially concerning cities in the Global South, the lack of an incentive has been raised as a potential explanation.[22]

Figure 3: Map of case study cities and source countries of city survey responses



Source: Authors

3.3.2 Case study approach

To complement and deepen the insights from the survey, we conducted case studies in Bonn (Germany), Quito (Ecuador) and Cape Town (South Africa). Bonn was chosen because of its local proximity to IDOS, existing contacts between IDOS and city officials and its active participation in several international urban transformation initiatives, such as the Territorial Approach to the SDGs' project run by the Organisation for Economic Co-operation and Development (OECD). Quito and Cape Town were selected based on an expert survey: urban sustainability experts were asked to identify cities that were successful in transformative change towards carbon neutrality. Drawing from those recommendations, we looked for two cities from different continents. Also, accounting for the team's language skills, English and Spanish were identified as possible interview languages.

Given the restrictions for mobility and physical gatherings due to COVID-19, all interviews were conducted online via Zoom. We conducted seven interviews with stakeholders in Cape Town, ten interviews with stakeholders in Quito, and four interviews within the framework of our pilot case study in Bonn. Interviews took place between 26 March and 23 April 2021 and in a second phase between 30 July and 17 August 2021. An interview lasted approximately one hour.

The composition of stakeholders interviewed in each city depended on the respective city's context and projects. In contrast to the survey, the case studies were intended to go beyond the view of city officials and cover a broader range of stakeholder perspectives. To this end, we also interviewed representatives from sustainability networks, NGOs, research institutes and think tanks, consultancies, and international organisations. A list of interview partners can be found in the Annex (see Table A4).

22 We hope to address these challenges in a possible second survey round in the future. With an increased sample size, an analysis of correlations or even regressions might become possible.

We conducted semi-structured interviews based on previously prepared question guidelines. For each interview, the questionnaire was adjusted to the interviewee's context and knowledge. A special focus was laid on aspects that could not be fully covered by the survey (such as success dimension acceptance) and those that deserved to be studied in more detail (such as stakeholder involvement), in particular to examine possible impact chains. In designing the questionnaire and selecting stakeholders for interviews, we followed the triangulation principle for qualitative analysis.

Qualitative coding and analysis were carried out, using the software ATLAS.ti. Insights from our own interviews were complemented by existing literature and official documents (see subsections 4.2, 4.3 and 4.4 for results).

Our case studies are limited by the number of interviews conducted, the range of voices included, and – due to the inability to travel to the cities – the lack of immersion in the city for a couple of weeks which would have provided more context. While we did cover a number of issues in the interviews we conducted, more interviews with a broader variety of actors would certainly have helped to work out some of the details. Also, since we only conducted virtual interviews and primarily talked to expert stakeholders who were or are directly involved in the climate debate in the respective cities, we did not talk to community-based organisations or trade unions which probably would have provided another perspective on the topic.

4 Findings

In line with the research design and the data collection methods introduced above, this section on findings is divided into four subsections: insights from the survey (subsection 4.1) and presentation of the pilot case studies Bonn (subsection 4.2), Quito (subsection 4.3), and Cape Town (subsection 4.4).

Fifty-four cities across six continents participated in the survey. It provides a look at urban transformation towards carbon neutrality and governance approaches that cities use to address climate change. Drawing from these results, subsection 4.1 presents descriptive statistics of the governance that characterises local governments' efforts to mitigate climate change and advance towards the sustainable transformation of cities.

The case studies contextualise and complement the survey results by providing more detailed insights into transformative dynamics towards carbon neutrality in the three cities. Drawing on interviews with a variety of stakeholders and additional literature research, subsections 4.2, 4.3 and 4.4 present the case study findings. Each case study section begins with an introduction to the local context and climate action in the respective city, followed by a description of the current status of transformation. The sections then analyse the effect of stakeholder involvement, urban finance, and impact assessment, as well as other key factors in explaining transformative change towards carbon neutrality in Bonn, Quito and Cape Town.

4.1 Survey

The survey covers a broad range of issues related to the status quo and progress of cities' climate change mitigation activities along with governance characteristics that surround local government climate change planning.[23] The basic way that the survey has been structured was introduced in subsection 3.3.1. Based on the survey responses, the present subsection offers an overview of the state of the art in local government climate-mitigation action and the three

23 The survey questionnaire can be provided upon request.

urban governance dimensions our research is focusing on, namely stakeholder involvement, financing, and impact assessment. This subsection will first introduce descriptive statistics on mitigation activities and governance approaches and then, based on our research hypotheses, relate the governance approaches to the success dimensions. For reasons of time and space, we will focus on a limited set of success dimensions within each subsection to outline possible relationships in an exemplary manner. The selection will focus on relationships that have been identified as particularly interesting because of their strong theoretical foundation or practical relevance in the preparatory phase of the project.

4.1.1 Status quo of local government mitigation action

The unweighted mean of per capita GHG emissions in 2018 of the cities surveyed in the survey amounted to 5.6 tonnes CO2e[24] – considerably above the annual personal carbon budget of 1.5 tonnes CO2e allowed[25] to achieve the 1.5°C goal of the Paris Agreement. Per capita GHG emission levels in 2018 were reported to range between 1 to 11.7 tonnes CO2e with a high variance within the survey sample. The sample captured cities with overall GHG emission levels ranging from 0.08 to 32.37 million tonnes CO2e, which again illustrates the variety of cities contained in the sample.

69 per cent of local governments (37 out of 53 responses) reported that they conducted GHG or CO2 emission inventories regularly. This finding increases the credibility of the indicated data on GHG emissions. It also reveals that most cities in the sample have mainstreamed GHG accounting, which constitutes an important cornerstone for any climate-mitigation action.

In general, there is no one inventory standard that most cities use but we observed a variety of standards, protocols and methodologies that were used by cities. Symptomatic for this observation was that 26 per cent of the cities reported that they used a regional or country-specific inventory standard and 9 per cent a city-specific inventory standard. The most frequently used protocol was the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) (24 per cent). Other tools that where reported were the IPCC guidelines (7 per cent); the Carbon Disclosure Project (CDP, 4 per cent); Bilanzierungs-Systematik für Kommunen (BISCO, municipal CO2 accounting system, 4 per cent); and the Common Standard for Measuring Greenhouse Gas Emissions by UNDP, UN-Habitat and the World Bank (2 per cent) among other less frequently used ones.

When it came to the availability of external data about cities' CO2 emissions, the picture is mixed. While 53 per cent of cities have access to external data, 44 per cent cannot rely on data that is provided from external sources. Around half of the cities that have no access to external data conduct their own emission inventory. This leaves us with a significant share of 17 per cent of cities in the sample that cannot track their emissions levels and changes due a lack of data collection.

Depending on the city, the leading department or office on emission reduction efforts can vary. By asking cities which departments or offices within their local government led the CO2 reduction activities we found that in 67 per cent of the cities the main leader of CO2 emission reduction efforts was the environmental department. Other offices playing a leading role in these efforts were reported to be the planning offices and the offices of the mayors or city (30 per cent), followed by the dedicated climate change/GHG emission office or agency (28 per cent)

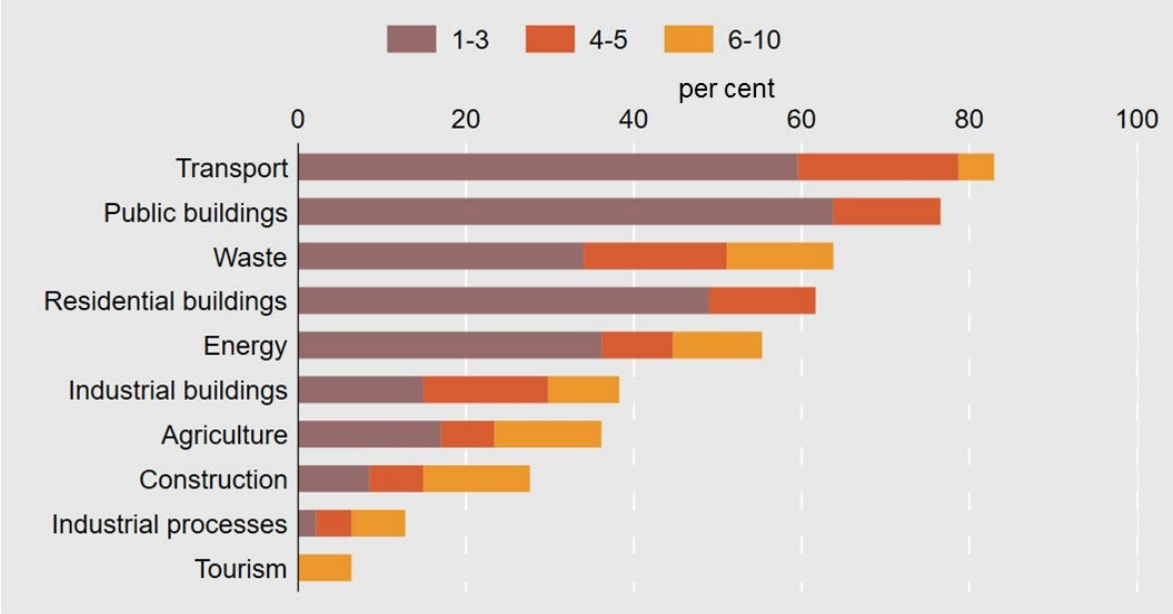
24 The survey asked respondents to either indicate total GHG emissions or mere CO2 emissions, based on their data availability. Since most respondents indicated GHG emissions, we will consistently refer to GHG rather than CO2 here. This might result in a small underestimation of total GHG gases.

25 The given personal carbon budget is based on an equal sharing of emissions across the global population (see Wilson, 2017). Equity concerns and historical emissions are not taken into account.

and the inter-departmental steering groups on climate change (26 per cent). In general, the finance and budget or treasury (7 per cent) and the economic affairs department (7 per cent) seemed to play a minor role in leading these efforts. Interestingly, we did not find a connection between the size or region of a city and the department or office in charge.

To gain a general understanding about the evolution and scope of local government action to mitigate climate change, including all policies and projects that either directly or indirectly reduced urban GHG emissions, the survey asked respondents about the actions' origins and concrete measures. The majority of cities reported that they had started their first climate activity between 2000 and 2015. Occasionally, cities introduced climate activities earlier. The earliest climate activity reported in the sample took place in 1983, while one city stated that it would only start activities in 2022. At a sector level, most urban climate activities had been conducted in sectors related to public services (see Figure 4). More than half of the cities had initiated climate activities in the public and residential buildings sector, in the transport sector, as well as energy and waste. These are also the most relevant GHG emitters. Sectors that are dominated by private firms, such as agriculture, construction or tourism, are less frequently subject to climate activities initiated by the local government.

Figure 4: Emission reduction activities by sector (ranking)



Notes: Ranking from most active in this sector (1) to least active (10). All percentages refer to the total of cities that responded to this survey question.

Source: Authors

In terms of policy design, most of the cities (61 per cent) had formulated a long-term strategic agenda (seven years or more) for GHG or CO2 emission reduction such as a climate action plan. 31 per cent were preparing or intended to introduce such a plan. Another indicator for climate ambition was the introduction of a GHG emission reduction target at the city-wide level.[26] 80 per cent of cities were working towards a concrete goal to cut their emissions within the next years. Around 50 per cent of cities had introduced a base year (intensity) target. On average,

26 GHG mitigation targets can be designed in multiple ways. Commonly used types of mitigation targets include the pledge to reduce, or control the increase of, GHG emissions by a specified quantity relative to a base year (base year emission target); to reduce emissions intensity (emissions per capita, etc.) by a specified quantity relative to a base year (base year intensity target); or to reduce emissions to an absolute level in a target year, most ambitiously to carbon neutrality (fixed-level or absolute targets) (compare with the standards put forward by the GHG Protocol developed by the WRI).

they were planning to reduce their (per capita) GHG emissions by around 54 per cent in around 29 years (while representing a great variance in their definition of base and target years and reduction levels). This was equal to a mean of envisaged yearly emission reductions of around 1.8 per cent. We were not able to find common social or economic characteristics shared by cities with higher emission reduction ambitions.

In addition, more than one-third of the cities had introduced a carbon neutrality target. The mean for the envisaged target year in our sample was 2042, which is encouraging, as carbon neutrality should be aimed for until 2050 to achieve the 1.5° goal (IPCC, 2018). While only a few cities aimed at achieving carbon neutrality in the years between 2025 and 2040 (mainly cities in high-income countries with a population size smaller than 400 thousand inhabitants), most cities wanted to achieve a climate neutral community by 2050. It seems characteristic for cities with carbon neutrality targets that they had largely recorded reduced GHG emissions over the last years. Interestingly, the composition of the local economy did not seem to affect the climate ambitions reflected in cities' target years. In addition, only a small number of cities set fixed-level targets (13 per cent). They envisaged target levels for annual emissions ranging between 1 and 2.5 tons per capita CO2e in 2050.

Another 20 per cent indicated that they did not have a reduction target for their cities. This mainly concerned cities in low- or middle-income countries. Cities without emission targets tended to have no access to emission data for their cities due to the absence of GHG inventories or external data sources. We can hence reiterate that the existence of GHG inventories seemed to be a crucial prerequisite for cities to introduce reduction targets. Reliable GHG inventories and the improvement of measurements should therefore be a priority for cities.

Only 28 per cent reported that their local government was required by national or subnational regulations or policies to set a GHG or CO2 emission reduction target or formulate such a policy. The majority (63 per cent) was not required to do so and hence set targets of their own accords. The fact that so many cities in our sample did so on their own accord could also be a sign that it was above all cities that belong to the group of worldwide frontrunners in urban transformation that responded to the survey.

We further found that the top policy priority of cities in our sample was by far the improvement of mobility and transport. This was followed by the priority to improve healthcare and social services. 61 per cent indicated that the reduction of CO2 and other GHG emissions was currently among the top five policy priorities of the local government (on average ranked as third top priority). A lower percentage of 39 per cent classified adaptation to climate change as a top priority (on average ranked as fourth top priority). It is concerning, though, that one-third of the cities – even in this sample of proactive cities – considered *neither* mitigation *nor* adaption efforts as major policy priorities.

4.1.2 Success dimensions of transformative change

Subsection 3.1 illustrated our concept of successful transformation of cities. It consists of three dimensions: CO2 reduction, dynamics of transformation, and acceptance. To provide a clear picture of the recent success of urban climate action, the survey gathered information on the change in GHG emissions; upscaling of mitigation activities within the city and beyond; the mainstreaming of GHG-emissions related aspects in government decision-making; the pace of mitigation activities; and the population's level of acceptance. Taken together, these responses created a detailed portrait of the success of emission mitigation activities in the cities surveyed.

When asked about the pivotal dimension of successful transformation – GHG emission reduction – 37 per cent of the cities reported that per capita GHG emissions had decreased "a

little" between 2013 and 2018 while 8 per cent reported that they had even decreased "a lot".[27] In contrast, 8 per cent of the cities reported that per capita GHG or CO2 emissions had increased "a little". The number of cities with decreasing per capita GHG emissions clearly outweighed those that reported increasing levels.

When comparing the pace of planning, approval, and implementation of mitigation activities in 2018 to the pace of 2013, 60 per cent of the cities confirmed that the speed had increased (see Figure A1). Especially the planning of such activities seems to have sped up. Moreover, the number of staff working on emission reduction in local government has increased since 2013. 38 per cent indicated that the staff number had increased by more than 20 per cent and 19 per cent said that it had increased by up to 20 per cent, while 23 per cent indicated that the number of staff remained the same. This suggests that the speed of implementing new plans and activities might increase in the near future.[28]

The systemic integration of climate change mitigation into local institutional regulations and standards was covered by asking whether GHG emission reduction goals were reflected in departmental plans or policies; whether GHG emission reduction criteria were considered in regular government procedures such as investment or procurement decisions; and how likely it was that a new local government would end current GHG emission reduction activities. 37 per cent of the cities reported that integrating GHG emission reduction goals into departmental plans or policies was common practice, followed by 33 per cent which were currently in the process of introducing such standards. The situation was less clear-cut when asked about government procedures such as investment or procurement decisions. A majority of 52 per cent indicated that they considered GHG emission reduction criteria only sometimes in their decision-making. 17 per cent reported that they did not consider them at all. At this level of local governance, climate-mitigation considerations did not yet seem to be firmly established. Equally interesting was the respondents' assessment to how closely GHG emission reduction goals were intertwined with the current political leadership. 61 per cent said that it was extremely or somewhat unlikely that a new local government would end current activities. This finding suggests that climate change activities had been mainstreamed in most cases.

With respect to the spatial dimension, 50 per cent indicated that local governments expanded their GHG emission reduction activities to other parts of the city or replicated them several times. Another 20 per cent were in the process of upscaling and replicating such activities or intended to do so in the future.

To understand whether cities had had a wider impact on climate action beyond their own borders, respondents were asked to indicate whether their climate-mitigation activities were adopted in other cities or on a higher administrative level. Figure 5 illustrates the fact that many cities had successfully promoted the adoption of their activities in other cities in the same country (63 per cent) while replication in cities abroad was rare. When it came to the transfer of climate-mitigation activities to higher levels of administration, there was a similar divide between the national and international scale. 38 per cent indicated that their activities were incorporated in subnational policy programmes which had been the case for only 21 per cent internationally.

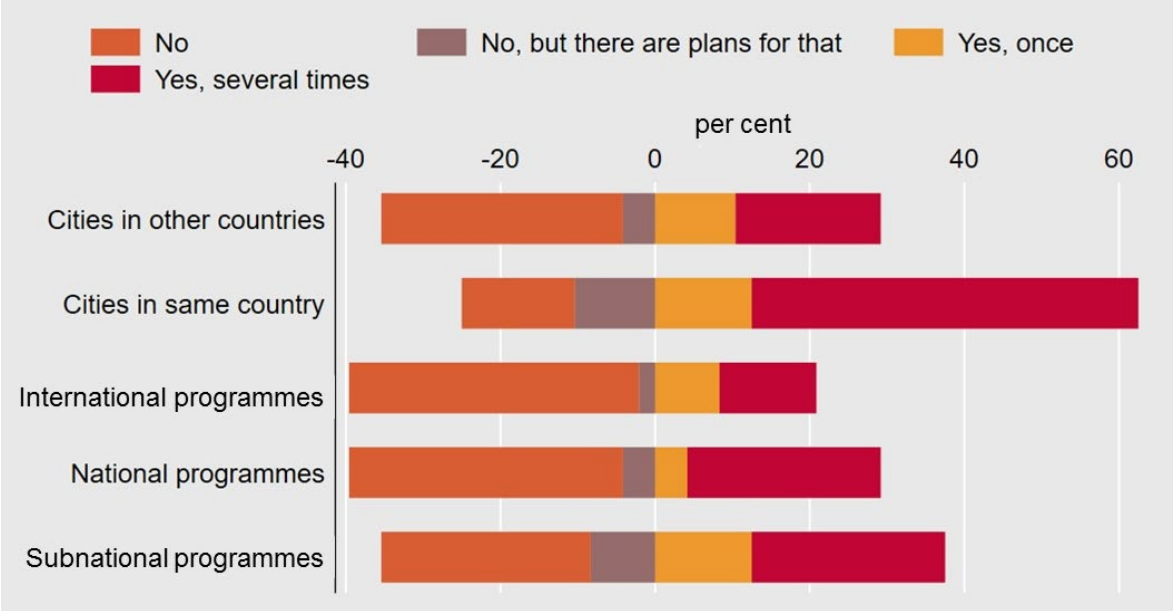
The acceptance of local government's climate activities by large parts of the population is another key element of successful urban transformation towards carbon neutrality. City government officials paint a mixed picture of the support that the local government is enjoying in the urban population (see Table 1). While roughly 20 per cent of the respondents indicate that

27 This period was chosen because some cities tended to finalise their GHG accounting with a time lag of several years and did not have data beyond 2018. We therefore excluded any effects of the global Covid-19 pandemic that started in early 2020.

28 In general, between 0.5 and 80 people work in the local government on emission reduction with the average staff number being 18 people.

more than 75 per cent of the city's population support the mitigation activities, another 20 per cent indicate that less than a quarter of the population support them. Differentiating between different stakeholder groups, city officials report that research entities, national and local NGOs as well as community groups are mostly supportive towards emission reduction activities (see Figure 6). Residents, who are often directly affected by mitigation activities, are also reported to predominantly support climate activities. From the perspective of local governments, opposition to mitigation action is rare. Trade unions, transport operators and the private sector are mentioned as opposing forces, albeit only at a very low level.[29]

Figure 5: Upscaling of mitigation activities beyond the city



Notes: All percentages refer to the total number of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose "Cannot answer".

Source: Authors

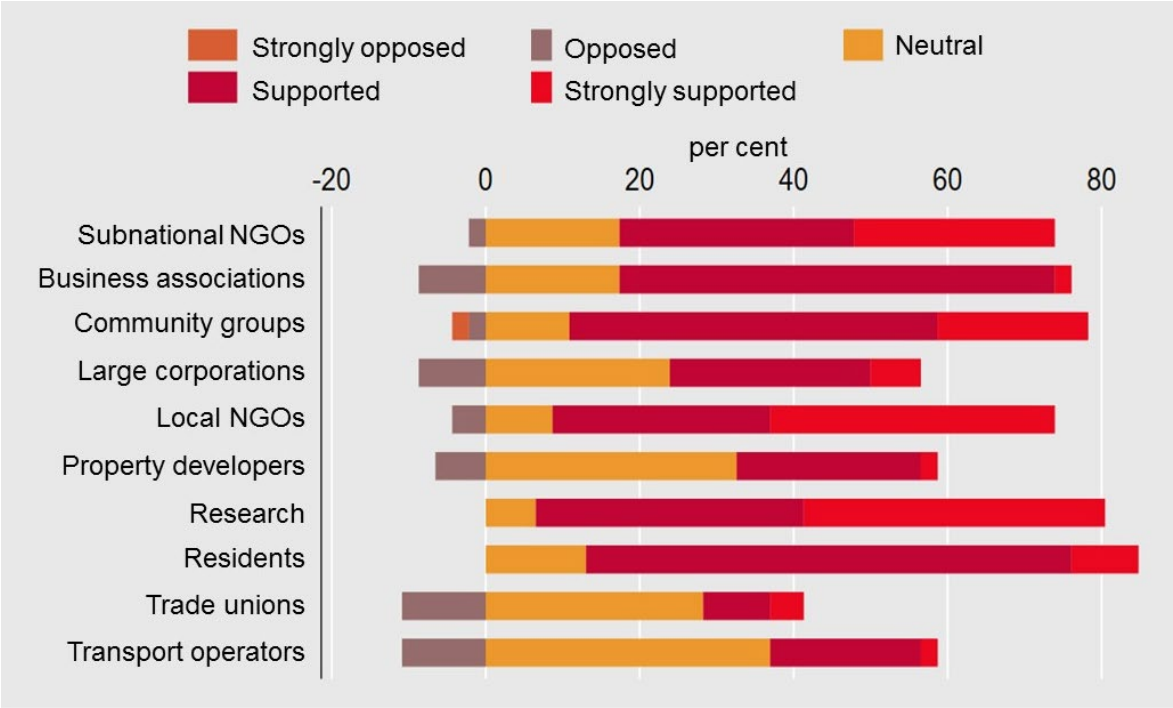
Table 1: Percentage of population supporting local government (LG) mitigation activities

Percentage of population supporting LG mitigation activities	Frequency	Per cent
0% - 25%	9	19.54
25% - 50%	8	17.39
50% - 75%	9	19.57
75% - 85%	4	8.70
85% or more	5	10.87
Cannot answer	11	23.91
Total	46	100

Source: Authors

29 This result provides further insight into Aylett (2014, 2015) questioning the engagement of different stakeholder groups and finding that local NGOs and the general public are highly supportive and engaged, whereas this was only the case for 26 per cent in the private sector.

Figure 6: Responses towards local government mitigation activities



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Questioning city government officials about public expressions of discontent (that is, demonstrations, protests, and so on) against the city’s mitigation activities confirms that local governments seldom meet strong opposition. Almost 50 per cent of the respondents indicate that no public expressions of discontent had taken place between 2013 and 2018 and that only 4 per cent of the local governments surveyed had experienced frequent public opposition to their GHG emission reduction activities. The main reason for protest mentioned is the fear of higher personal financial burden due to mitigation measures (see Figure A2). Almost 20 per cent of the respondents indicated that protestors were dissatisfied with the limited range of climate actions proposed and implemented by local governments, pushing for more and faster mitigation action.

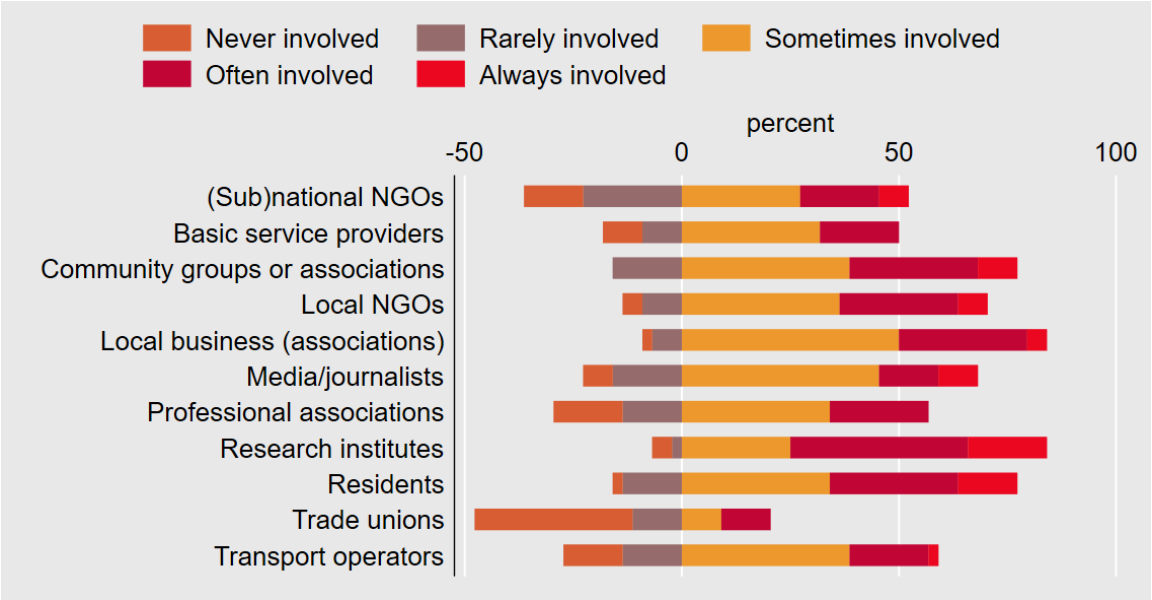
4.1.3 Stakeholder involvement

We asked respondents about the frequency of stakeholder involvement in mitigation activities. The stakeholder groups most often involved were local business (associations), research institutes, local community groups or associations as well as residents (see Figure 7). While 22 per cent of the cities reported that they did not involve stakeholders at all, 20 per cent stated that all 11 stakeholder groups had been involved to some degree (average of 6.8).

When asked whose guidance they relied on in their mitigation activities, differences between cities in the Global North and the Global South were noticeable (see Figure A3). Cities in the Global South showed a higher degree of reliance on the guidance of other stakeholders compared to cities in the Global North. Noticeably, NGOs as well as international organisations, development agencies, and international consultants appeared to play a limited role in the Global North, whereas most cities in the Global South relied on their guidance. Moreover, all cities in the Global South relied on guidance from local civil society.

We distinguished different degrees of stakeholder involvement, ranging from information to joint decision-making. Figure 8 shows that the degree of collaboration is inversely related to the frequency of use. In other words, the more far-reaching the involvement of stakeholders, the less was the approach applied by cities. Most cities at least informed stakeholders about their mitigation activities, but 50 per cent said that stakeholders did not play a role in monitoring activities.

Figure 7: Frequency of stakeholder involvement in mitigation activities



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Taking a look at the tools used to involve stakeholders, a similar picture emerges (see Figure A4). The more inclusive and cooperative the tool, the fewer cities applied them. Around 80 per cent of cities made use of public announcements, information events, workshops or roundtables to involve stakeholders. More than 50 per cent of the cities reported that they implemented activities that were originally initiated by local stakeholders outside local government such as civil society groups, or private businesses. On the other hand, only around 30 per cent of cities organise public ideas competitions or urban labs.

To test our hypothesis **H1.1**, that cities in which broader coalitions of stakeholders are built are more successful, we created an indicator based on the survey responses that not only took the number of different stakeholder groups involved into account but also additionally considered how frequently these groups were involved. The indicator was based on a weighted calculation, where the response options for the frequency of involvement were valued from 1 point for “Rarely involved” up to 4 points for “Always involved”. Thus, the higher the score of a city, the more and the more often stakeholders are involved in the city’s mitigation activities. Given that, in the survey, respondents had to choose among eleven stakeholder groups, the top indicator score would be 44.[30] We then split the city sample at the sample mean score (16), resulting in a third of the cities being classified as having “Narrower coalitions” and two-thirds as having “Broader coalitions”.

30 The highest score achieved was 36 by one city.

Figure 8: Frequency of involving stakeholders

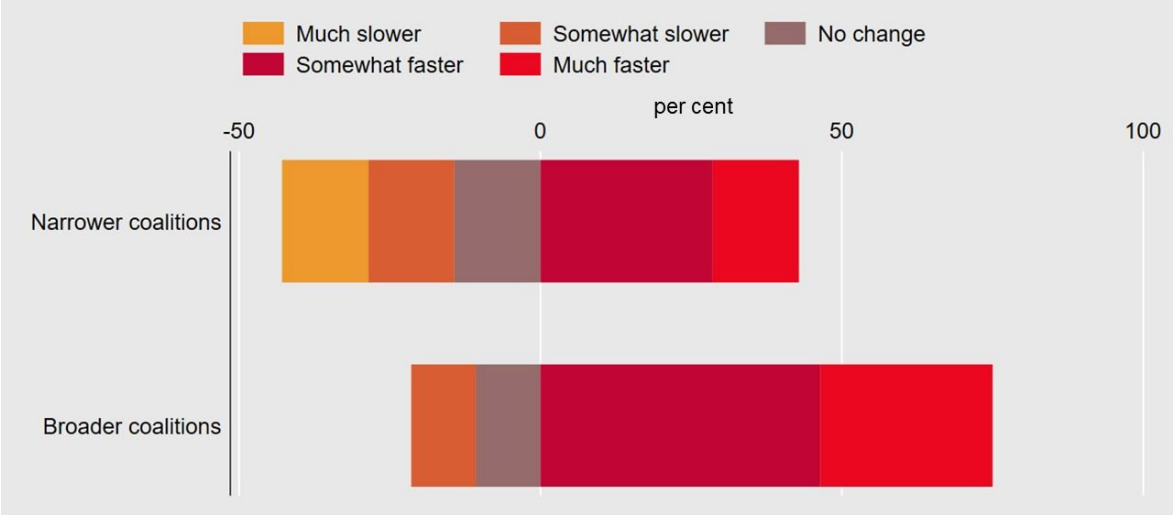
Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

While the two groups did not differ in terms of changing per capita GHG emissions (see Figure A5), there was a clear difference when analysing the success dimension “Acceleration of efforts”. Roughly 30 per cent of cities with narrower coalitions reported that planning of emission reduction activities was “Much slower” or “Somewhat slower” today compared to 5 years ago (see Figure 9). 14 per cent of those cities indicated no change in the speed of planning, and 43 per cent stated that planning was nowadays “Somewhat faster” or “Much faster”. In contrast, only 11 per cent of cities with broader coalitions reported that planning was “Somewhat slower” today and 75 per cent indicated a “Somewhat faster” or “Much faster” speed of planning. A similar picture emerged when looking at the speed of implementation of mitigation activities (Figure 10). More than 70 per cent of cities with broader coalitions reported a faster implementation of mitigation activities, while cities with narrower coalitions mainly reported a slower speed of implementation or no change in speed. Hence, broader coalitions did not seem to slow down the planning or implementation of emission reduction activities in cities – on the contrary: broader coalitions seemed to accelerate the processes.[31] A possible explanation could be that frequent interaction reduces conflict-related delays further down the process.

31 Just taking the number of different stakeholders into account and splitting the sample at the sample mean of the amount of stakeholder groups involved, the percentage distributions for speed of planning and speed of implementation were similar, leading to similar conclusions.

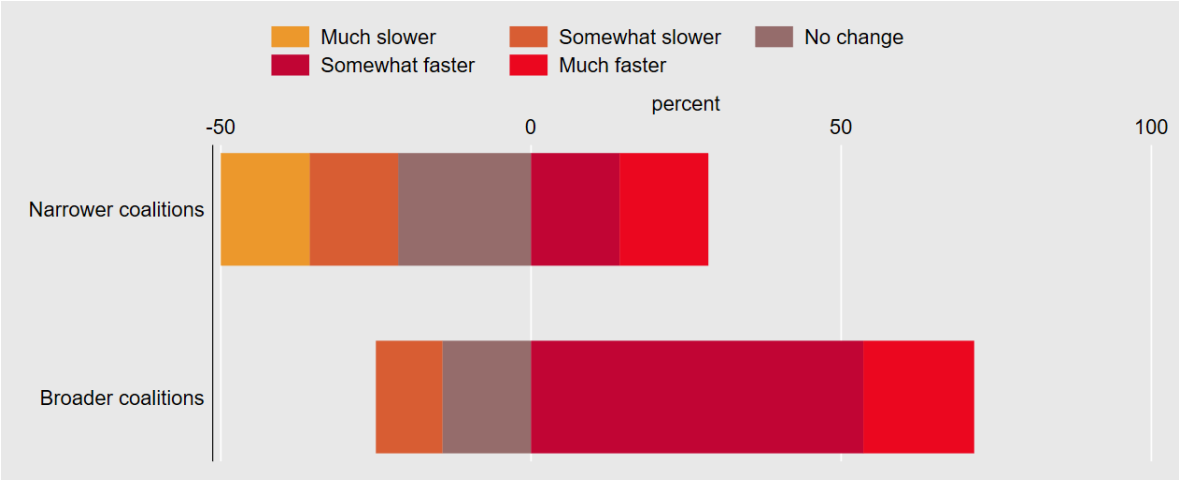
Figure 9: Cross-tabulation: change in speed of planning (2013-2018) and stakeholder involvement



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Figure 10: Cross-tabulation: change in speed of implementation (2013-2018) and stakeholder involvement



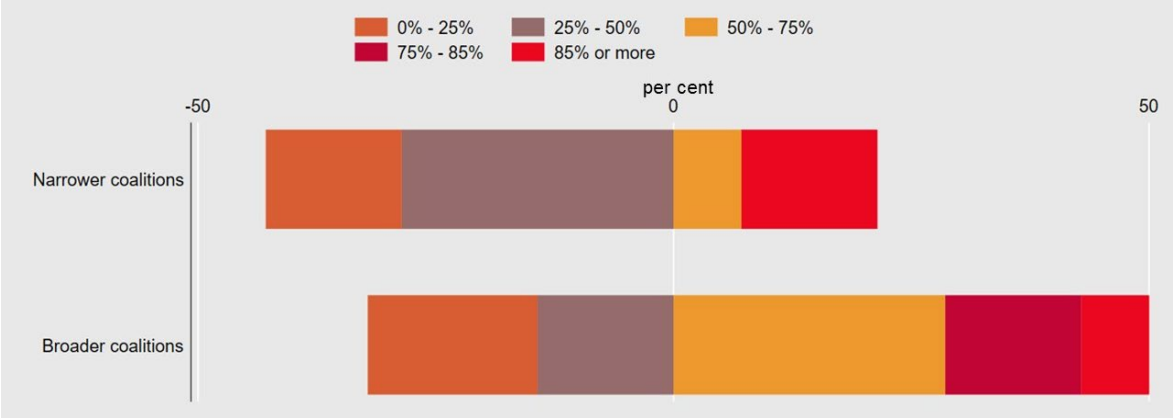
Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Figure 11 supports this explanation. Many more respondents from cities with broader coalitions reported that more than 50 per cent of the city’s population supported the mitigation activities. However, as these cross-tabulations did not capture any causal directions, it might also be the case that cities with a wider range of acceptance among the population were more likely to form broader coalitions. Besides, it was interesting to note that when only looking at the number of stakeholders and splitting the sample at the sample mean of the amount of stakeholder groups involved, no difference in the percentage distribution of population supports became apparent between the two subsamples. Therefore, it seems that the frequency of stakeholder involvement was crucial for population support. This seems to support our hypotheses **H1.2** that assumed a

positive relationship between more comprehensive forms of involvement and successful transformative change.

Figure 11: Cross-tabulation: city population support and stakeholder involvement



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

4.1.4 Urban finance

Local governments use various financing options to raise funds. 78 per cent of the cities surveyed reported that they were entitled to collect and keep own taxes, 39 per cent that they could modify existing taxes, and only 28 per cent had the right to introduce new taxes (see Figure A6).[32] This reveals the limited potential for additional finance for climate action through local taxes. 58 per cent of local governments were entitled to receive assistance through international organisations and 50 per cent were able to borrow from commercial banks. Only 31 per cent were entitled to use financial market financing instruments to raise finance such as issuing bonds or selling equity of public companies or funds.[33] The reluctance of national policymakers to authorise cities to employ financial market financing instruments seems to prevent financial markets from engaging more at the city level.

We observed differences between the Global North and the Global South. Cities in the Global South mentioned financial assistance from international organisations twice as frequently as cities in the Global North. Cities in the Global South also engaged in financial markets more often than those in the Global North. This might reflect their stronger need to complement restricted public revenues with private investments.

Further, respondents were asked to identify important financing sources for their GHG emission reduction activities by creating a ranking from a list of various public and private sources. As shown in Figure 12 the most significant sources were revenues from local taxes (ranked first or second by 49 per cent) and intergovernmental transfers (ranked first or second by 30 per cent).[34]

32 The Urban Governance Survey (LSE Cities, 2021) reports slightly different responses to their global survey with more than half of the local governments being entitled to introduce new local taxes.

33 Many of the financing instruments that are employed to attract private capital have been used mainly in the Americas, particularly the United States. In part this is due to the United States capital markets being the deepest and most liquid in the world (Siemens, PwC, & Berwin Leighton Paisner, 2014). This shows that certain macroeconomic criteria must be met before cities can seriously consider financial market financing instruments.

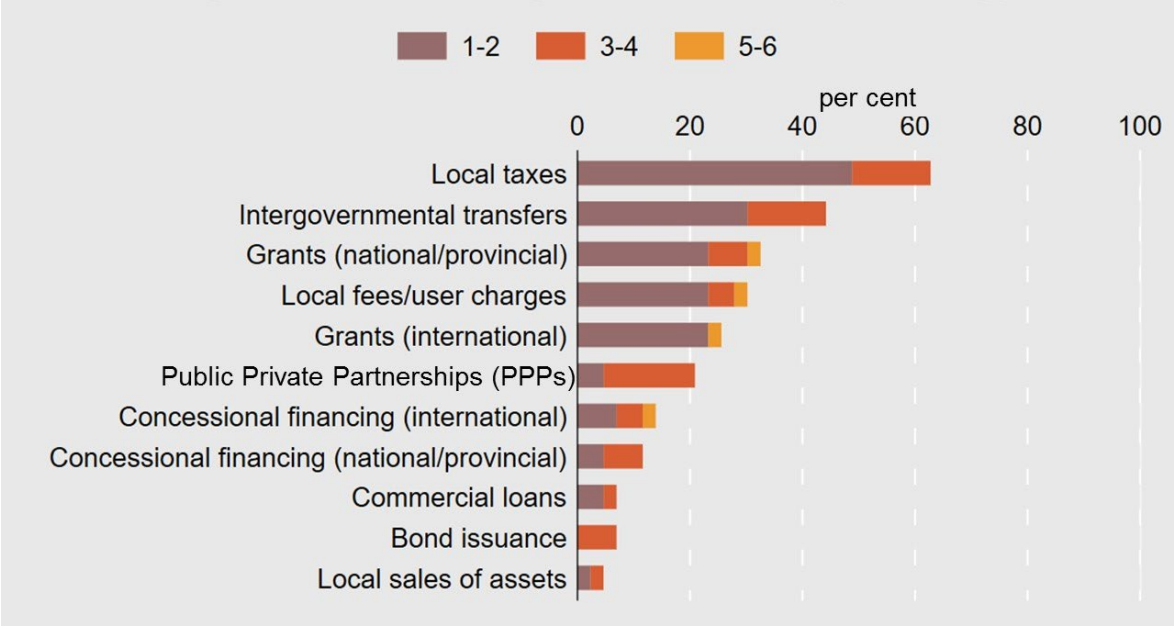
34 This mainly coincides with the results of the global survey conducted by Aylett (2014, p. 29) with 350 cities where local government own-source revenue and funding from national or state/regional governments were identified as the most common source of financing.

Many cities also relied on grant financing from either (sub-)national or international development banks or agencies (ranked first or second by 23 per cent). Revenue from local fees or user charges represented another essential source for many cities. Public-private partnerships figured prominently in the ranks three and four (16 per cent). Debt financing was less commonly used[35] and local sales of assets as a financing source were also rare. In terms of diversification of financing sources, the most frequent response was that local governments employed between two and four different financing sources.

The results show that most cities relied on a relatively small selection of traditional financing sources to finance their climate action, mainly local taxes and intergovernmental transfers. Although 53 per cent reported that local government was actively mobilising additional financing specifically for GHG emission reduction, only a few cities employed innovative instruments such as public-private partnerships or asset-based financing instruments.

When asked to indicate how much of the local government's annual budget was dedicated to GHG emission reduction in 2018 (including policy development, planning, implementation, stakeholder engagement, monitoring, and so on), most respondents (33 per cent) indicated that only a share of 0-3 per cent of the total budget was used to finance mitigation activities. 47 per cent reported that they could not answer the question at all. This might reflect the fact that city budgeting is often not well interlinked with cities' climate action while different departments are poorly interconnected. However, it must be acknowledged that 44 per cent indicated that the proportion of the local government's budget dedicated to GHG emission reduction increased slightly between 2013 and 2018 while 16 per cent even reported a significant increase.

Figure 12: Financing sources for mitigation activities (ranking)



Notes: Ranking from most important source (1) to least important (6). All percentages refer to the total of cities that responded to this survey question.

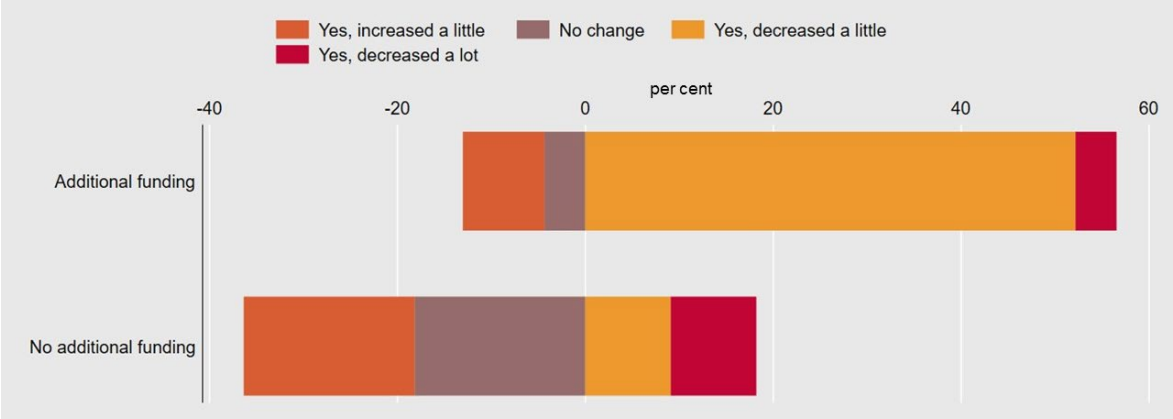
Source: Authors

The limited use of innovative market-based financing and local resource mobilisation, and the relatively low level of diversification of financing sources could help to explain why the lack of funding remains a significant challenge for cities in their ambitions to mitigate climate change

35 This contradicts LSE Cities (2021), which reports that almost all cities in their sample borrowed money and were able to do so.

(as reported by Aylett, 2015, p. 40). Considering the increased budget proportion that cities invested into climate action and the plans to mobilise additional financing, diversification and innovative financing solutions could further help lower the burden on public budgets.

Figure 13: Cross-tabulation: change in GHG emissions (2013-2018) and mobilisation of additional funding



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

When splitting the sample into cities that actively mobilised additional funding specifically for GHG activities (53 per cent) and cities that did not do so (26 per cent), the data seem to support hypothesis **H2** (see Figure 13): Almost 60 per cent of the respondents that stated that their local government mobilised additional funding for mitigation also indicated that per capita GHG emissions decreased in their city between 2013 and 2018. In comparison, those cities that solely relied on existing flows of funds mainly reported no change or even an increase in per capita GHG emissions over the same period.

As stated above, cross-tabulations do not show any causal effects or directions of impact. In particular, when examining GHG emissions, there are many confounding factors that we are not taking into account here. In this sense, a potential reasoning for this finding might be that additional funding facilitates the construction of low-carbon infrastructure, but it might also be true that cities that are more successful in reducing their GHG emissions get better access to additional financing sources.

4.1.5 Impact assessment

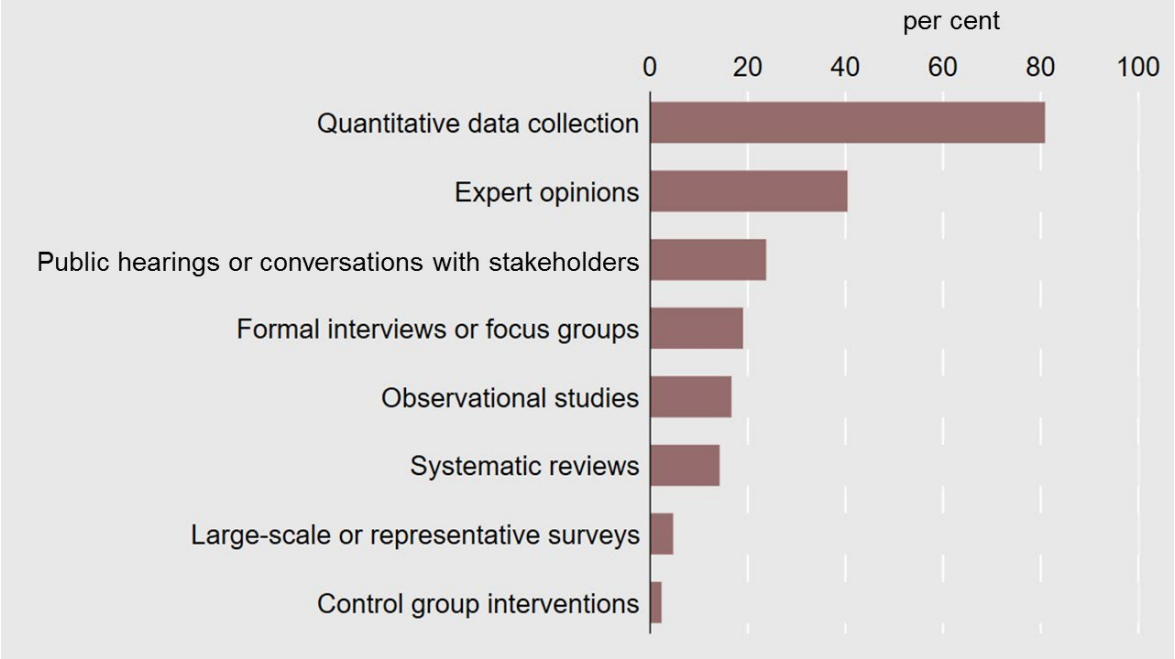
Turning to impact assessment in the urban context, the survey first asked local government officials how impact was assessed in their cities. 86 per cent of cities assessed impact at least sometimes. Regarding the methods applied, 81 per cent of cities stated that they collected quantitative data. Expert opinions were used by 40 per cent of cities (see Figure 14).

Regarding actors involved in impact assessments, Figure 15 reveals that such assessments are most often conducted by local governments, closely followed by universities and research institutes. Noticeably, 58 per cent of cities responded that impact was at least sometimes assessed in a collaborative manner, involving a combination of stakeholders listed in Figure 15. NGOs turned out to be least involved in assessing impact as 30 per cent stated that NGOs were never involved.

Another important aspect is the question at which point in time cities assess the impact of their mitigation activities. 51 per cent of cities responded that they did so once projects were concluded (ex post) whereas 12 per cent assessed impact mid-term while 19 per cent of cities responded

that they did so continuously. This shows that most cities looked at the impact of their projects at a specific point in time within the project cycle – mostly at the end.

Figure 14: Methods of impact assessment



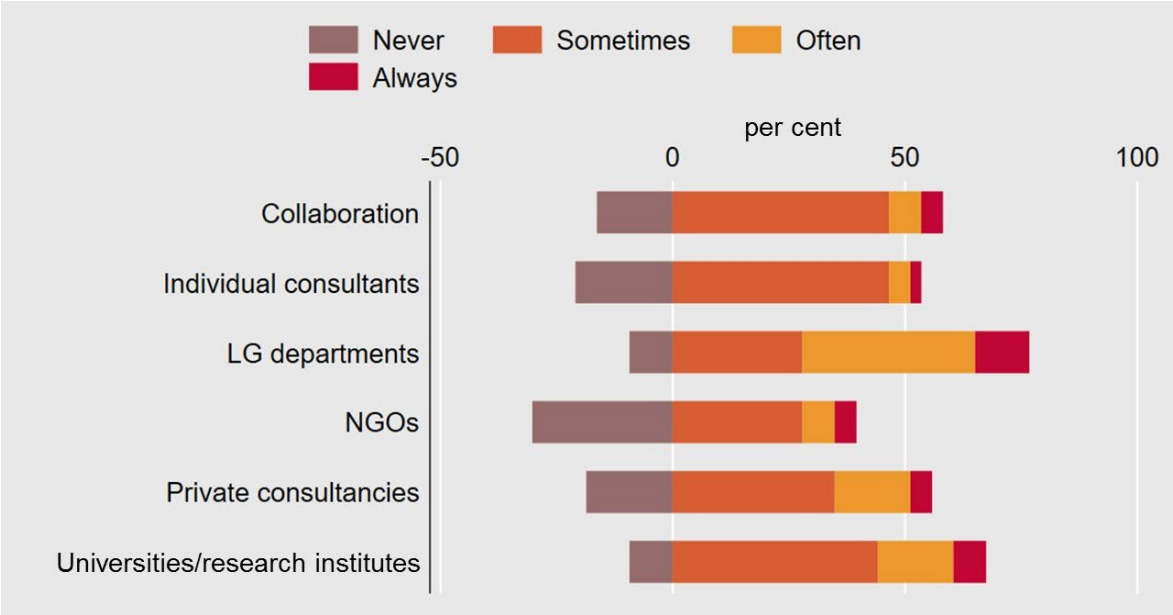
All percentages refer to the total of cities that responded to this survey question.

Source: Authors

Having determined that most cities assessed impact at least at certain points during or after projects, this leads to the question of what happened with the results and whether the results fed into ongoing or future projects. Out of the sample of cities which indicated that they assessed impact continuously or mid-term, 38 per cent responded that further project planning was “always” or “often” influenced by the results of such assessments. In the sample of cities conducting ex post impact assessments, almost 60 per cent indicated that the insights obtained influenced future project planning.

To test hypothesis **H3**, namely that cities that implement comprehensive impact assessment are more successful in transformative change, we concentrated on the success dimension “spatial scope”. Figure 16 shows the relationship between the methods used in impact assessment and the survey responses regarding the expansion or replication of mitigation activities in the same city. Methods used in impact assessments range from anecdotal evidence through public hearings or conversations with stakeholders to rigorous scientific methods including representative surveys, observational studies, and control group interventions. Since most cities applied a mix of methods, for the purpose of analysis cities are assigned to the most comprehensive method they use. As no city solely relied on anecdotal evidence, the least comprehensive method shown in Figure 16 is “Expert opinions”. It can be noted that cities that applied more rigorous methods in their impact assessments more frequently stated that mitigation activities had been expanded or replicated within the city or that they at least had the intention to do this. In particular, we observed that almost 90 per cent of cities using scientific methods in assessing impact reported that mitigation activities had been replicated several times or such replications were currently in progress.

Figure 15: Frequency of impact assessment by stakeholder groups

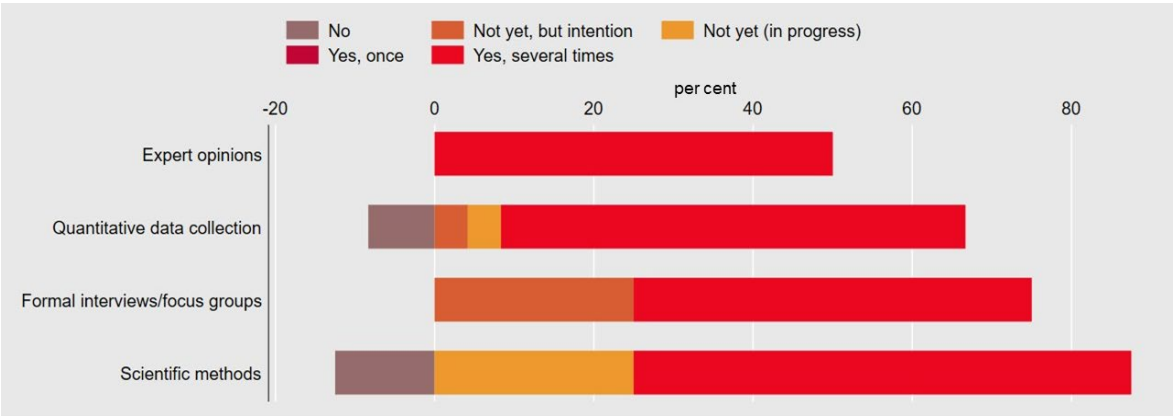


All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

When it came to upscaling beyond the city, our survey data suggests that external expertise from actors outside local government was fairly important for upscaling to cities in other countries. In contrast, impact assessment conducted internally by the local government seemed rather to be important for upscaling to national programmes or policies.

Figure 16: Cross-tabulation: spatial scope and methods used in impact assessment



All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

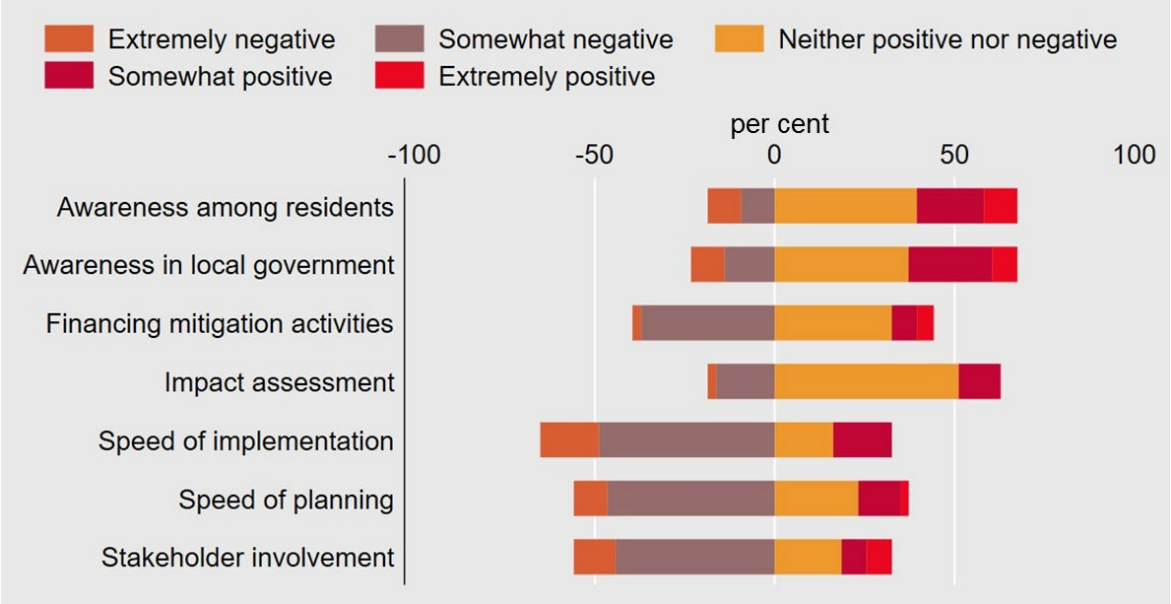
Source: Authors

4.1.6 Impact of the COVID-19 pandemic

Finally, we asked respondents in the survey about the impact of the COVID-19 pandemic on their local government's CO2 emission reduction efforts.

As Figure 17 shows, the pandemic seems to have had a negative impact on the speed of planning and implementation of mitigation activities. 65 per cent of respondents stated that the pandemic had an extremely or somewhat negative impact on the speed of implementation, while more than 50 per cent mentioned a negative impact on the speed of planning. Efforts to involve stakeholders were mainly indicated to be negatively affected by the pandemic. Also, roughly 40 per cent of respondents reported that financial resources for mitigation activities were negatively affected. In contrast, awareness of the importance of mitigation efforts seemed to be positively affected, both among residents and among employees of the local government.

Figure 17: Impact of COVID-19 pandemic



All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose "Cannot answer".

Source: Authors

4.1.7 Networks

As we used city networks as an important entry point to create our data set of proactive cities as well as for the distribution of our survey, we also wanted to paint a clearer picture of local governments engagement in city networks. What we found was that cities responding to this part of the survey (37 respondents) were on average active in around 2.6 of the biggest networks.[36] This meant that an active city usually participated in more than only one network and was therefore likely well connected with other proactive cities. Among the networks most cities claimed to be a member of was the Global Covenant of Mayors for Climate and Energy (70.27 per cent), closely followed by ICLEI – Local Government for Sustainability with 62.16 per cent. This is not surprising as the Global Covenant of Mayors for Climate and Energy is the

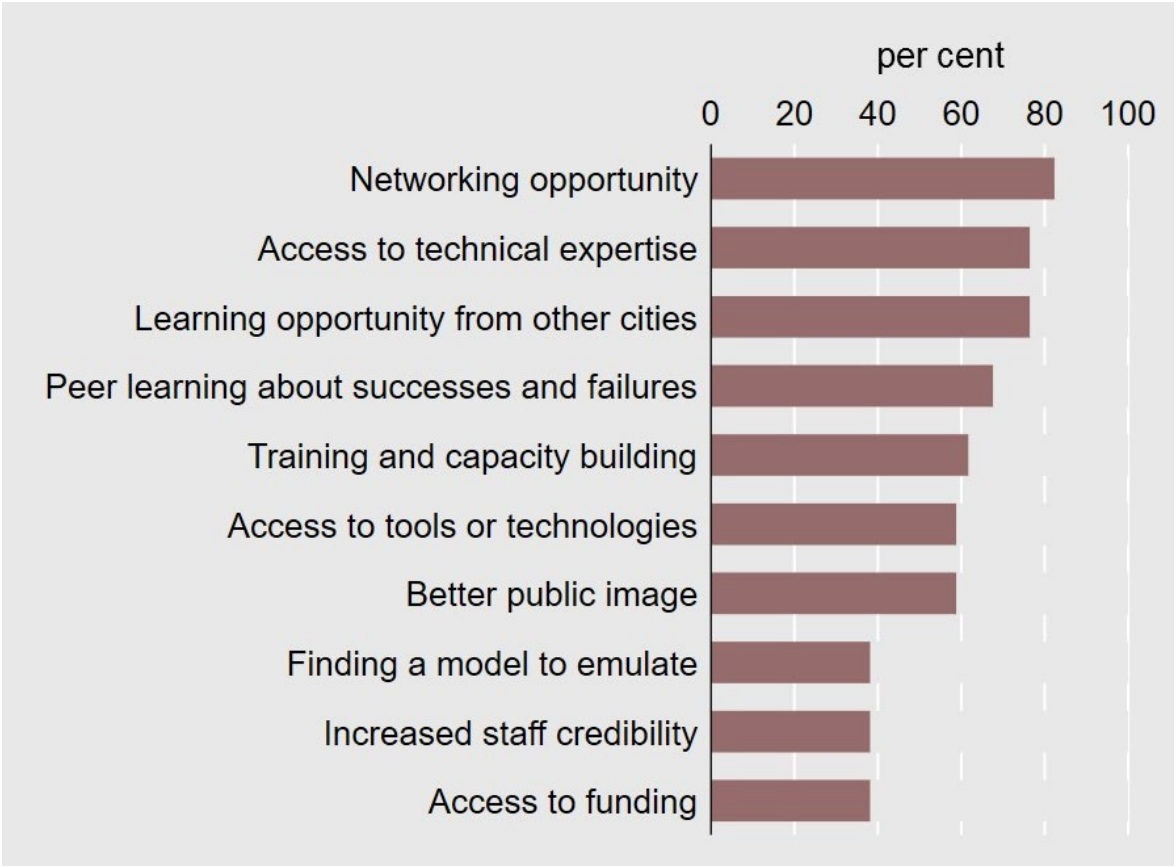
36 It is likely that most cities are even part of more city networks as we only asked about the most common ones. That assumption was also aligned to what we observed in our data set.

biggest city network with 10,000 members while ICLEI also has 1,500 city members (see subsection 2.2.2).[37]

The survey further asked cities to indicate what advantages they saw in being a member in these networks. Although most cities expressed various reasons as to why they joined a network, networking opportunities and increased knowledge through peer learning from other cities seemed to be at the heart of the benefits seen in a city network. Over 80 per cent of the 34 cities that replied to this question reported that the opportunity to network with other cities was a benefit (see Figure 18). This was followed by access to technical expertise (77 per cent), and learning opportunities from other cities (76 per cent). Access to funding played a minor role and scored lowest with 38 per cent of cities seeing this as a benefit of network membership.

Finally, the survey asked cities to indicate which further services they wished networks would provide. Some of the most frequently mentioned suggestions included technological transfer, training in collecting climate change data, support for the development of local GHG emissions inventories, and support in analysing risks.

Figure 18: Network benefits



Source: Authors

37 It is important to note that there might be a bias as ICLEI helped with the distribution of the survey as described in subsection 3.3.1

4.1.8 Summary

The responses we received showed a positive tendency in the way local governments approached GHG emission reduction activities. The survey revealed that at least some cities embed their activities in strategic, long-term climate action frameworks, and mainstream climate change in local decision-making from planning to procurement. Most local governments have introduced emission reduction targets without being obliged to do so by national governments. However, even though most cities conducted GHG inventories, some still do not. As the existence of GHG inventories is a prerequisite for cities to introduce reduction targets, reliable GHG inventories and the improvement of measurements should be a priority of cities. Further, CO2 reduction and adaptation efforts in cities in general need to become a major policy priority. It is concerning that even in our sample of proactive cities which could be assumed to be more progressive than the average of cities, a third considered neither mitigation nor adaption efforts as a major policy priority.

The survey brought to light significant achievements as well as some priority areas for the future evolution of urban climate change action. High city GHG emission levels are a warning sign that underpins the need for genuine and rapid change. Despite the successful mainstreaming of climate accounting through regular GHG inventories in most cities, it should not be overseen that many other cities still need to introduce rigorous climate accounting to lay the foundation for the future monitoring of mitigation activities. It is an encouraging result that concrete climate action plans and emission reduction targets have been established or are being developed in most cities that responded. Climate action seems to be gradually becoming institutionalised, which decreases the risk of reform reversals. Finally, because of the trend of decreasing per capita urban GHG emissions between 2013 and 2018, the cities in our sample seemed to be on the right track towards reduced GHG emissions.

The finding that international actors play an important role in cities of the Global South supports the activities of donor organisations in cities. However, combined with the overall higher degree of guidance sought by cities in the Global South compared to the Global North, this underlines that these activities should focus on establishing *local* structures. Additionally, the intensity of stakeholder involvement shows room for improvement, which is especially relevant as broader coalitions seem to be more successful in accelerating the planning and implementation processes of GHG emission reduction activities. It is therefore key to highlight the need for action in the field of stakeholder involvement – not least to reverse the negative impact of the COVID-19 pandemic on participative approaches to climate-mitigation activities.

Our findings also illustrate that the underlying structure of fiscal systems creates a considerable variety in the conditions for cities to raise finance for transformative projects. It emphasises the need to design tailored, financial solutions for individual cities. If additional funding could be mobilised more easily, this would be a promising step, particularly being mindful of the identified positive relationship between higher funding and lower GHG emissions.

Moreover, having found that data on GHG emissions, for example, is collected in most of the cities but that lessons learned from previous projects are not always incorporated into ongoing or future projects, this highlights the fact that data should be made available more broadly for different stakeholders to use. More scientific and increasingly rigorous ways to assess impact are also necessary because they seem to facilitate the expansion or replication of mitigation activities.

Lastly, although city networks play an important role in connecting cities, creating knowledge exchange, and learning opportunities, the potential of these networks in terms of extending and replicating projects on a national – and particularly international – level has not yet been fully exploited and should be emphasised more in the future.

4.2 Case study Bonn

4.2.1 Introduction and context

Bonn is a densely populated city of c. 330,000 inhabitants located on the river Rhine in the German federal state of North Rhine-Westphalia (NRW). Between 1949 and 1991, it was the capital of the Federal Republic of Germany. Today, six federal ministries and numerous agencies are still based in Bonn. In addition, it is Germany's United Nations City as well as home to many national and international organisations, six universities and numerous other research institutions, many of which work on issues of sustainable development and climate change.

As such, the city has long been characterised by a high relevance of the service sector, which accounted for 91.9 per cent of overall employment in 2017 (OECD, 2020, p. 16). Economically, the city is doing well as it had the second largest gross domestic product (GDP) per employee of all cities and regions in the state of North Rhine-Westphalia (EUR 94,325 per employee in 2018) and a comparatively low unemployment rate of 6.4 per cent in 2018 (lower than the NRW average but higher than the German average) (OECD, 2020, p. 16). Nevertheless, the growing city also faces developmental challenges such as increasing poverty of the elderly and a growing need for affordable housing, energy, and mobility (OECD, 2020, p. 29ff).

Although the city of Bonn has clear-cut administrative boundaries, the metropolitan area of Bonn – also called functional urban area (FUA) as defined by OECD and the European Commission – is much larger and includes 19 surrounding municipalities. Their labour market is highly integrated into the city, and they therefore form a so-called commuting zone. In total, around 925,000 people live in the FUA of Bonn (OECD, 2020, p. 32). A mayor and a city council with currently 66 members govern the (smaller) administrative area of Bonn, which our research focused on. Elected directors head the city administration. Typically for Germany, however, most administrative staff do not change along with political cycles as the administration is mainly responsible for policy implementation and is seen as being independent of political goal-setting.

When the federal government moved to the new capital of Berlin in 1999, Bonn underwent massive structural changes. For that purpose, a redevelopment plan was set up that has had a great impact on the city's development over the past decades. It is against this background that Bonn became a frontrunner city for transformative change in Germany.

Bonn already started its climate-mitigation efforts in the mid-1990s and has since passed and implemented numerous strategies and measures. Already by 2016, it had reduced its per capita emissions by one-quarter as compared to 1990. Nevertheless, being in a high-income country, per capita emissions levels remain high above the global average (6.9t per capita in Bonn in 2016 versus 4.8t global average in 2017) (Ritchie, Roser, & Rosado, 2020) and are likely still being underrated given the high consumption levels of goods that are consumed there but produced abroad. While private households and the private sector account for close to 30 per cent of CO2 emissions each (29 per cent and 28 per cent respectively), 40 per cent of Bonn's emissions originate from the mobility sector and have been increasing in recent years (Bonn, 2018a, p. 72). Notably, the city's modal split has remained almost unchanged in the past years (see Table 2). Bonn therefore seems to incorporate both the benefits and challenges of many mature cities (see WBGU, 2011), namely a strong institutional set-up on the one hand and established structures and path dependencies on the other.

4.2.2 Climate action in Bonn

The 1994 local elections laid the foundations for Bonn's engagement in mitigation and sustainable development. After almost 50 years of political leadership by the conservative CDU

party (Christian Democratic Union of Germany), a coalition of the social democratic SPD and the Green Party won elections and Bärbel Diekmann (SPD) became mayor. The new administration soon began to pass climate-friendly policies and measures. In 1995, the city council passed a so-called Klimaoffensive (special initiative for the climate), which included a list of measures and led to the creation of a dedicated department for environmental policy (Umweltdezernat).

The focus of Bonn's early climate-mitigation activities was on the energy sector. For instance, the city was a pioneer in introducing cost-equitable feed-in remuneration for solar energy. This focus was reflected in the first climate action plan, the Energy and Climate Mitigation Concept of 1997. In 2003, Bonn started to participate in the European Energy Award and has been using the EEA climate management system for internal monitoring and auditing of climate action ever since. The EEA also provides the city with external auditing and the results served as a basis for the establishment of another climate action plan in 2007 (Bonn, 2011).

In 2011, the city adopted a masterplan on energy and climate (Masterplan Energiewende und Klimaschutz), which was another important milestone. Apart from a long list of measures to reduce CO2 emissions whilst also exiting nuclear power, the plan proposed the setting-up of a climate action advisory board (Klimaschutzbeirat), as well as an office for climate change issues, the so-called Leitstelle Klimaschutz (LSK) (Bonn, 2011). Today, this office coordinates all municipal activities related to climate change, covering both mitigation and adaptation (LSK [Leitstelle Klimaschutz], 2020).

After the adoption of the Agenda 2030 with its 17 Sustainable Development Goals (SDGs) in 2015, Bonn was among the first German cities which committed itself to making an active contribution to the implementation of the goals by signing the model declaration of the Association of German Cities and the Council of European Municipalities and Regions on the Agenda 2030 in 2016. In the same year, Bonn participated in the model project Global Sustainable Municipality in NRW[38] (Global Nachhaltige Kommune NRW) during which a SDG-based sustainability strategy was formulated in a multi-stakeholder process. Since then, the SDGs have become an important framework in the city's efforts to work on sustainable development (Bonn, 2020a, p. 9; OECD, 2020, pp. 22, 25). The strategy has an overall focus on environmental sustainability, with two out of six focal areas being especially relevant for mitigation: mobility, and climate & energy.

In June 2019 – only a few months after the launch of the new sustainability strategy – the city council passed a Declaration of Climate Emergency, following two citizen proposals. In its declaration, the council stressed that climate protection should have the highest priority in all municipal actions and set a carbon neutrality goal by 2035 (Bonn, 2019). Prior to this, Bonn had already committed to other emission reduction goals, including a 40 per cent reduction by 2030 (base year 1990), as part of its membership in the Covenant of Mayors, and a 50 per cent emission reduction by the same year (base year 1987), as part of the so called Klima-Bündnis Bonn (LSK, 2020). However, being passed by the city council, the new goal ranked higher in priority and is thus the goal that all municipal activities are currently directed towards.

Today, CO2 emission reduction activities in Bonn still have a strong focus on energy – but also on mobility, urban green areas, and climate education. In the field of energy, Bonn has focused on the promotion of renewable energies, especially photovoltaic and solar thermal energy, as well as energy efficiency in construction and housing. Efforts in the field include energy standards and a fund for supporting photovoltaic systems for private households. Furthermore, the city closely cooperates with the 100 per cent publicly owned public utility company

38 Bonn was one of 15 pilots in the state of North Rhine-Westphalia. The concept was quite new at the time but has been replicated in many other cities since then. For more information, see LAG, 2021.

Stadtwerke Bonn (SWB)[39] to decarbonise energy generation for electricity and heating. A frequently mentioned achievement is the energy agency Bonner Energieagentur e.V., an umbrella organisation of 21 both public and private organisations in the fields of construction, housing and financing, which has offered energy consulting for private homeowners since 2012. In the field of mobility, the city wants to reduce overall traffic, expand bicycle lanes, create a CO2-free inner city, and provide more and increasingly CO2-neutral public transport. There are also numerous efforts in the preservation and extension of urban green areas, forestation and land de-sealing. Here, positive effects are foreseen for both climate mitigation and climate adaptation with regard to heat islands and heavy rainfall (Bonn, 2020b; LSK, 2020), for example. Finally, Bonn engages in many educational and awareness-raising events and programmes (Bonn, 2018b, pp. 11-13).

The municipal government also aims at reducing its own CO2 emissions. Although the municipality's emissions are only 3 per cent of citywide emissions and thus comparatively low (Bonn, 2018a, p. 72), the administration wants to lead by example. Therefore, it committed to higher energy standards for public buildings, is gradually switching its vehicle fleet to electric cars, and is undertaking efforts to make public procurement more sustainable (LSK, 2020).

As internationalisation is an important strategic asset for Bonn, the city is involved in several international city networks. Among them is one of the largest and oldest networks, ICLEI, whose headquarters are also located in the city. The then mayor of Bonn, Ashok Sridharan, presided over ICLEI from 2016 to 2020. Bonn is also a founding member of the Covenant of Mayors for Climate and Energy, the network of large European cities EUROCITIES, as well as several smaller networks and initiatives[40] (Bonn, 2020a, p, 9).

39 Stadtwerke are public enterprises run by the city which are in charge of providing utilities and public services. In Bonn, the SWB has several subsidiary companies, among them one in charge of public transport, one in charge of energy and water provision, and one for waste management, besides others.

40 These are: the OECD Champion Mayors for Social Inclusion; the Marrakesh Partnership Leadership Network (climate); the Green Circular Cities Coalition (recycling); the Prevent Waste Alliance (cooperation in waste management); Cities for Nature, and the United Nations Economic Commission for Europe (UNECE) Trees in Cities Challenge (Bonn, 2020a, p. 9).

Table 2: General, emissions-, and climate action-related data on Bonn

		Various years (1990-2015)	Various years (2016-2020)	Notes and sources
GENERAL				
Population size			333,794 (2020)	(Bonn, 2021)
City real GDP per employee		EUR 99,429 (2014)	EUR 94,325 (2018)	(2014: IT.NRW [Information und Technik Nordrhein-Westfalen], 2017, p. 14) (2018: OECD, 2020, p. 16)
Unemployment rate		7.3% (2015)	6.4% (2018)	(OECD, 2020, p. 16)
Population density (people per km²)			3,137 (2020)	(Bonn, 2021)
Modal split	Motorised individual traffic (MIT)	31%	29%	(2008 versus 2017: Bonn, 2018a, p. 57)
	MIT – with passengers	12%	12%	
	Public transport	16%	17%	
	Cyclists	13%	15%	
	Pedestrians	30%	28%	
EMISSIONS				
Total emissions (in million tCO2e)		2.82 (1990)	2.24 (2016)	(LSK, 2019, p. 7)
Emissions (tCO2e) per capita		9.3 (1990)	6.9 (2016)	(LSK, 2019, p. 9)
CITY CLIMATE ACTION				
Approval year of city's first Climate Action Strategy/Plan or equivalent		1997		Interview with city official (16 April 2021)
City's net-zero-carbon target year		2035		(Bonn, 2019)
Municipal lead department or unit		Leitstelle Klimaschutz (Umweltamt)		

Source: Authors

4.2.3 Status of transformation

Bonn has been calculating its CO2 emissions since 2009, but thanks to a thorough analysis conducted by the Fraunhofer-Institute, has reliable information dating back to 1990. Today, the city reports CO2 emissions using the BISKO standard.[41] The latest year for which data are

41 BISKO (Bilanzierungs-Systematik Kommunal) is a standardised method for CO2 accounting that was introduced by the then Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) to make local CO2 accounting comparable (see Hertle, Dünnebeil, Gugel, Rechsteiner, & Reinhard, 2019).

available is 2016. CO2 emissions have gradually decreased from 9.3t per capita in 1990 to 6.9t per capita in 2016, equalling a per capita reduction of 25 per cent and a citywide reduction of 21 per cent (LSK, 2019, p, 9). By way of comparision, national CO2 emission reductions were estimated at 27.3 per cent for the same period (BMU [Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit], 2018, p. 26).

Setting the goal of carbon neutrality by 2035 was noteworthy, especially given the fact that the city failed to achieve its self-imposed carbon reduction goals before. Already in 2013, an external feasibility study showed that it would not be possible to achieve the carbon reduction goal of 40 per cent by 2020, which had been envisioned in the above-mentioned “Masterplan” on energy and climate. The report concluded that a maximum reduction of 28 per cent could be achieved, but only if the city invested an additional 53 million euros (Gertec, 2013). However, the concepts and measurements suggested in the study were never adopted and the climate goal for 2020 has been missed by far.

Today, the city has set an even more ambitious goal and it remains unclear how this new target can be met. The most recent CO2 emissions report states that an ongoing, linear reduction trend will lead to a reduction of only 34 per cent (+/- 4 per cent) by 2030 (LSK, 2019, p. 9). Achieving the carbon reduction goals therefore requires truly transformative – in the sense of accelerated and non-linear – changes in CO2 emission reductions and therefore a significant increase in efforts. Despite the announcement of 150 measures to reduce CO2 emissions, the declaration did not deliver answers to the question of how to achieve the ultimate goal of carbon neutrality (Bonn, 2020b). Finding answers to this question will be the key task of the participatory process “Bonn4Future”. The process had been initiated by two local NGOs, which, together with around 50 other supporting organisations from both civil society and the private sector, filed a citizen proposal that was later adopted by the council with great majority. The Bonn4Future process was launched in 2020 and is financially supported and partly coordinated by the municipality.

With regard to the second success dimension “dynamics of transformation”, it can be noted that climate-mitigation efforts have taken up momentum in Bonn since the declaration of a climate emergency in 2019. According to a city official, climate protection today is being taken into consideration much more than before and movements like “Fridays for Future” have played an important role in this regard. However, data is lacking to assess whether this has been accompanied by an acceleration in planning and implementation.

Bonn has generally achieved a high degree of systemic integration of climate-mitigation measures in the past 25 years. However, questions remain regarding the potential duplication of tasks between departments, especially since climate action and sustainability promotion are the responsibilities of different departments in Bonn despite their thematic interlinkages.

The LSK office is coordinating all climate activities within the municipality and with third parties. Currently, it employs 4.59 full time equivalents with plans to increasing its resources to achieve the 2035 zero emission goal (Bonn, 2020b). Together with the public utility firm for Energy and Water and the consumer association of NRW, the LSK office forms a so-called “energy team” which is conducting annual internal audits by listing and evaluating climate-mitigation activities and their implementation (LSK, 2020). The LSK also heads the climate advisory board (Klimaschutzbeirat) which includes politicians from each of the parties represented in the city council and other relevant stakeholders and which is advising the government on climate action.

Sustainability promotion, including the coordination of Local Agenda 21 activities and sustainability reporting is the responsibility of another entity, the so-called Lokale Agenda Büros (Local Agenda Office). Yet another entity, deals with international sustainability issues. The Department for International Affairs and Global Sustainability (Amt für Internationales and globale Nachhaltigkeit) is located directly in the mayor’s office and, among other tasks, led the

development of Bonn's sustainability strategy. Its main responsibility is the promotion of Bonn as an international hub, UN-city and a frontrunner city for sustainable development. It coordinates all international network activities, such as membership with ICLEI and so on. Finally, there is also a steering group for the implementation of the sustainability strategy and another stakeholder-expert committee on sustainability (OECD, 2020, p. 23).

It remains to be seen to what extent the above-mentioned committees and advisory boards complement each other or coexist as parallel structures, and how successful this institutional set-up is going to be in coordinating and mainstreaming issues of climate mitigation and sustainability across all relevant departments. According to the OECD report (2020), the development of the sustainability strategy revealed the difficulty of bringing on board different municipal departments and showed that parts of the municipality still lack awareness of SDG-related topics. This could become a challenge for the implementation of the strategy. Nevertheless, the OECD considers the development of a common sustainability strategy a successful step towards a systematic implementation of the SDGs, as it aligns with both state and federal-level sustainability strategies and has brought together a wide array of city-level plans and measures under one common strategy[42] (OECD, 2020, p. 22f). Looking at current projects and processes, there are further promising efforts to mainstreaming sustainability and climate action across municipal departments, such as a pilot project on introducing a "sustainability budget" (see also subsection 4.3) and plans to implement a climate impact analysis (Klimafolgenabschätzung) for political decision-making.

Upscaling and replicating projects within the city ("spatial upscaling") do not seem to play a major role in Bonn. Apart from the plan for a carbon-neutral inner city, activities and strategies do not focus on specific parts of the city but rather on energy and mobility infrastructures. Nevertheless, along with the Bonn4Future Process, there have been some efforts to foster exchange and learning between different parts of the city. For example, the city wants to set up an online platform to make initiatives and organisations working on sustainability and climate action more visible in the city.

Bonn's activities in several international city networks and longstanding partnerships with cities around the world stand out. The city's strategy for international cooperation, adopted in 1999, initiated project partnerships with Cape Coast in Ghana, La Paz in Bolivia, Bukhara in Uzbekistan and Chengdu in China, for example, to foster knowledge exchange on – among other topics – sustainable urban development (OECD, 2020, p. 25). Nevertheless, much more potential exists for increasing peer learning with other German and international cities. In fact, this is one of the OCED report's recommendations to the city (OECD, 2020, p. 65).

Acceptance for GHG mitigation efforts seems to be high in Bonn. A rather large group of citizens and civil society organisations are actively demanding more municipal action on this. The declaration of a climate emergency, as well as the comprehensive participation process Bonn4Future are examples of municipal action in response to such demands. Furthermore, in September 2020, a candidate from the Green Party was elected mayor of Bonn for the first time. There is no data to determine the exact share of citizens who are in favour of or against municipal mitigation activities. However, a city official said that, along with climate protection, other aspects such as functionality and convenience continue to be highly relevant to citizens. For instance, citizens complained about newly installed energy-efficient streetlights when they found them to be too dim. In another case, the installation of air conditioning in new elective public buses was debated due to higher energy consumption. However, they turned out to be an important feature for citizens to accept and use them instead of their private vehicles. While groups opposing climate-mitigation activities do exist in Bonn, they are not organised at the city-

42 These include: the Master Plan for Climate and Energy; the project Future Bicycle Mobility; participation in the Covenant of Mayors for Energy and Climate; the fair procurement principles; and the certification as Fair Trade Town, among others.

level, as a municipal employee explained. In the field of mobility, however, stakeholders such as inner city management, city marketing agencies, and shop owners organised to oppose plans to ban cars from the inner city.

Acceptance of climate mitigation will most likely also be determined by the city government's ability to balance several developmental trade-offs in their transformation. While it is crucial, for instance, to maintain green spaces both for mitigation and adaption purposes, the growing city also needs to provide sufficient and affordable housing. Especially poverty of the elderly is an increasing challenge in Bonn. Therefore, the OECD report emphasises that climate policies should not disproportionately affect low-income households and therefore may require compensatory measures (OECD, 2020, pp. 35, 47f).

4.2.4 Explaining change

In the case studies, our analysis is divided into two parts. The first part is what we call the "main story", which presents our overall analysis in broad strokes and highlights those enabling factors and challenges that we had not included in our initial theoretical framework. The second part goes into more detail on what we expected to be the main explanatory variables, namely stakeholder involvement, financial resources and impact assessment.

4.2.4.1 Main story

Given that Bonn was the earliest of our three case study cities to adopt climate-mitigation policies, a closer look at the conditions under which this was possible is warranted. As already indicated, the 1994 local elections led to a pro-climate mitigation action change in political leadership. According to a then-member of the council, the election result had been quite unexpected and was interpreted as resulting from opposition to the previous mayor rather than support for the opposition party's candidate based on her more environmentally friendly stance. And, according to this interviewee, it was not the large community of environmental activists and civil society organisations in Bonn but rather the close connections to federal politics that triggered transformative climate action in the city. In the Bundestag (the lower house of the German parliament), the Green party had been working on climate change since the late 1980s. Facilitated by a change of personnel and a new administration, the topic thus "trickled down" to the municipal level. High levels of acceptance for climate action by civil society groups were nevertheless helpful.

The structural changes and the measures also contributed to the early success. According to a former council member, the Klimaoffensive resolution and the installation of a dedicated department enabled the city administration to develop new concepts and ideas. The key to success, however, was the fact that there were motivated and progressive people working within the city administration who delivered on the council's initiative. At the beginning, the city focused on inexpensive projects that could be quickly passed and implemented. In the field of mobility, for example, they introduced coloured bicycle and bus lanes (interview with a former member of council, 30 July 2021).

Since these first climate activities in Bonn, emissions have been cut by more than a fifth (21 per cent in 2016 as compared to 1990). The city's most recent sustainability report sees the main reason for the reduction in increased energy efficiency in sectors like local electricity production and in the increasing use of renewable energy in the municipal company for energy and water's energy mix (SWB EnW) (Bonn, 2018a, p. 72f). Bonn's efforts to decarbonise its energy sector have started to show results while at the same time, the city is still far from achieving its self-imposed goal of zero-carbon emissions by 2035.

4.2.4.2 Stakeholder involvement

Public participation in Bonn is highly institutionalised and many instruments exist for citizen involvement in municipal activities. Historically, however, this has not always been the case. In the mid-1990s, when climate action began, stakeholder involvement did not play a major role. Back then, the city government focused on quick implementation without prior consultation of stakeholders. While this way of proceeding was sometimes criticised, it was regarded as more effective, as a former politician pointed out. Nevertheless, according to a longstanding municipal employee, public participation has increased ever since. Data provided by the 2020 Voluntary Local Review show that the number of participation procedures has grown since data collection started in 2015. In 2018, there were 33 participation procedures in total (not exclusively linked to climate), equalling a ratio of 0.1 participation procedures per 1,000 inhabitants (Bonn, 2020a, 42).

Today, the coordination office for public participation (Koordinierungstelle Bürgerbeteiligung) is responsible for deciding on the kinds of participation measures as well as their timing and targeting. The office was established in 2010 and is directly located at the mayor's office for strategic projects. It operates as a focal point for government, administration and citizens in everything concerning participation. For example, it can be consulted for the development, implementation and assessment of a suitable participation format for a given project. Since 2014, public participation is regulated by the city's guidelines for public participation (Leitlinien Bürgerbeteiligung). An advisory board, consisting of randomly chosen citizens, politicians and municipal employees, discusses the question of when and how to involve citizens and provides recommendations to a citizen committee.

Depending on the kind of project and sector, the range of actors involved (**H1.1**), and the modes of involvement (**H1.2**) differ in Bonn. Projects like the redesign of a public park or the conversion of a street into a car-free zone can cause conflict but only affect a small number of people. Such projects are therefore accompanied by small-scale and standardised participation procedures. Other issues and projects that affect a wide range of citizens are dealt with in broader and more complex participation procedures. Naturally, such procedures also require much more time and resources. An example was the development of the city's sustainability strategy between 2016 and 2019 and, of course, the recently launched Bonn4Future process. A key difference between the early non-participatory municipal approaches and today's comprehensive approaches to stakeholder involvement lies in their ambition. While at the beginning, the goal was to implement individual measures, today the focus has shifted towards a more holistic transformation towards a sustainable way of living. As this involves tackling structural issues, breaking path dependencies, and fostering habitual (un-)learning, it is considered important to get as many societal groups on board this process and to build a broad coalition that supports transformation.

For most tools and formats, both digital and analogue participation options are offered. With the pandemic, digital modes of participation have increased. While participation measures should reach a diverse segment of citizens, the city has learned that participating citizens mostly belong to the better-educated and mostly well-off middle class. Getting marginalised groups to participate has been much more difficult, and, despite higher investments of time and resources, not always successful. The city therefore uses schools and district authorities as multipliers. Involving the private sector also has not been easy. While some companies reached out to the city, no formalised way of regularly involving them has been established. Multipliers, such as the Chamber of Commerce or City Marketing therefore play an important role for business participation. When it comes to academia, many universities and institutes are engaged in sustainability research but there seems to be little collaboration with local government. In contrast to the two other case studies, for example, we could not find any scientific case studies on climate action in Bonn with the exception of the OECD study (OECD, 2020).

Despite these challenges, the city involves a broad range of stakeholders in its climate activities. Representatives from the private sector are, for instance, involved in numerous advisory boards

and committees, jointly with representatives from academia, civil society and the city's public utility companies. According to a city official, the Bonn4Future process is especially important in this regard, as it involves the majority of the city's climate community (interview with a city official, 26 March 2021). Also, the process involves citizens via "climate fora", which consist of 100 randomly chosen citizens, as well as experts from different parts of society via a process advisory board (LSK, 2020). The fact that the city puts a lot of hope into the Bonn4Future as a process for generating ideas to accelerate CO2 emission reduction also shows how meaningful and important participation has become in Bonn. The official also stressed the importance of the civil society umbrella organisation "Bonn im Wandel e.V." which facilitates access to all relevant actors and enables organisations to better coordinate and voice their demands.

Apart from the participation mechanisms mentioned above, there are also established formal ways of taking up ideas and suggestions from citizens and civil society. The main tool is the citizen proposal (Bürgerantrag).[43] A city official estimated that approximately half of the proposals deal with climate issues. The declaration of a climate emergency followed such a citizen proposal, for example. The Bonn energy agency (Bonner Energieagentur) is another example of a project that started as a private initiative and was then taken up by the city. Finally, there are also citizen initiatives that collect and submit signatures to push political action as in the case of the Bonn Bicycle Ruling (Bonner Radentscheid) about an improved cycling infrastructure in Bonn which was adopted by the council in February 2021.

The main objective of participation for the city of Bonn is the prevention of conflict and the generation of acceptance. According to a city official, the goal is to find solutions that are supported by a majority and that can be accepted by the opposing groups. From his perspective, participation is an effective tool to convince citizens of the advantages of a project. Beyond generating acceptance or asking citizens to choose between different options, however, processes like Bonn4Future also aim at generating ideas for how to reach zero carbon by 2035. A city official also pointed out that participation helps to accelerate climate action in Bonn. Drawing from his experience, an increased number of procedures for participation did not delay processes if the timing of such interventions was right. On the contrary, if certain topics or issues gained support in the population – such as climate action did in the past years through movements like Fridays for Future – this could accelerate processes.

Apart from the positive effects, some disadvantages of participation were also pointed out. Participation absorbs financial and human resources, it may create expectations that need to be managed, and it can be difficult for citizens to accept that the final results do not necessarily reflect their individual interests just because they were involved. While it was said that this could lead to frustration and alienation from local politics, the overall benefits of participation were acknowledged.

In general, it seems that citizens and civil society are highly active in the field of climate action in Bonn – a positive factor for the city's transformation towards zero carbon. One city official assumed that a reason for this was that Bonn hosts many (inter-)national NGOs and organisations dealing with issues of sustainable development and climate action and that their large number of employees are not only passionate about the topic in a professional setting, but also in their private life. Beyond their representation in advisory boards, the involvement of private-sector actors seems to be challenging today.

43 The submission of a citizen proposal is a right granted by state legislation. Every four to six weeks a citizen committee reads the approximately twenty proposals and forwards them to the corresponding technical committees.

4.2.4.3 Urban finance

According to a former politician, in the early stages of climate action in Bonn, the availability of financial resources was not considered decisive. This was because the city initially focused on low-cost projects. Although the city was not poor in comparison with other local governments, the construction of the metro had recently been completed at that time and it would not have been possible to finance another large and expensive project.

With regard to the current situation, the OECD report finds that lacking linkages to budgetary decisions present a challenge in the implementation of the sustainability strategy. Especially in the field of mobility, many measures required case-by-case funding decisions by the city council (OECD, 2020, p, 23). Above all, the city's financial flexibility has been severely limited since 2015 due to an ongoing fiscal consolidation process in which every two-year budget has to be approved by the superior district authority in Cologne (OECD, 2020, p, 23). The city aims at a balanced budget by 2021, however the pandemic has likely limited the city's financial scope further. Nevertheless, Bonn has reserved an additional budget of five million euros for measures to comply with the climate emergency declaration in May 2020 (Bonn, 2020c, p. 550).

An important step has been Bonn's engagement in efforts to implement a so-called impact-oriented budget (Wirkungsorientierter Haushalt) since 2011. As part of this process, the city participated in the project Municipal Sustainability Budget in 2020, funded by the state of NRW. Instead of focusing on the acquisition of additional funding for specific projects, this approach is targeting all municipal operations by making sustainability the basis for all budgetary decisions. The idea is to link sustainability goals to budgetary requirements and present them via a web-based application. As a result, financing needs, as well as actual expenses and their impacts, become more transparent and easier to understand for politicians and for the public (LAG 21 NRW [Landesarbeitsgemeinschaft Agenda 21 Nordrhein-Westfalen], 2021a, 2021b). The sustainability budget can serve as an effective management tool (interview with a city official, 16 April 2021). This approach is currently being rolled out in four pilot departments in Bonn: the City Treasury; the Department for International Affairs and Global Sustainability; the Department for Environment and Urban Green (including the climate action office LSK); and the City Planning Office (LAG 21 NRW, 2021a, p. 14f).[44]

The case of Bonn shows that, in addition to the generation of additional funding, the revision of existing budgetary expenses has to be considered as a potential tool for fostering urban transformation. A sustainability budget could even be considered a more systemic approach for financing transformation than the mere generation of additional revenues. However, because the project is still being implemented, a thorough assessment is not yet possible.

4.2.4.4 Impact assessment

Since 2010, Bonn has a detailed and reliable system for CO2 accounting in place. While it is not possible to assign CO2 reductions to each individual measure, there have been attempts to assess the effect of selected measures on CO2 reductions. Usually, these calculations are undertaken at the beginning (baseline) and at the end of the project. The city also conducts user surveys on some projects to assess impacts such as in the case of introducing electric public buses. An integrated impact assessment that also considers social and economic impacts, however, does not yet exist.

Reporting also plays an important role in Bonn. Several reports have been published over the past years on issues of sustainability. Since 2005, the Local Agenda Office has published

44 For more information on the sustainability budget project, see https://www.lag21.de/aktuelles/details/kommunaler-nachhaltigkeitshaushalt-projektbericht/

sustainability reports every three years. The latest report, published in 2018, considers 55 indicators in four categories: wellbeing, social justice, environmental quality and resource efficiency, and economic efficiency (Bonn, 2018a). The new Sustainability Strategy of 2019 provides a good framework for future reports. It defines six focal areas, each of with comes with a thematic guideline, long-term strategic goals, as well as medium-term (3-5 years) and specific operative goals and measures (Bonn, 2018b) that allow for more precise monitoring. Based on the last sustainability report, Bonn published a Voluntary Local Review in 2020. Here, sustainability efforts are linked more directly to different SDGs (Bonn, 2020a). In terms of external reports or studies, the OECD published a report on SDG implementation in Bonn in 2020. From 2018 to 2020, the city participated in the OECD project "A Territorial Approach to the Sustainable Development Goals" as one of nine pilot cities (OECD, 2020). In addition to these broader sustainability reports, the LSK has also published annual reports on climate mitigation and adaptation in Bonn since 2018.

In general, city officials considered impact assessment as important and potentially helpful to develop even more meaningful and effective activities. At the same time, they stated that more in-depth impact assessments play a minor role. This is true for climate-mitigation activities as well as for citizen participation. According to one of the interviewees, better impact assessment would be an important tool for public communication and accountability. Information on the reasons for, and the potential impact of, specific measures was seen as a prerequisite for public debate and citizen involvement. Impact-oriented budgeting was also mentioned as an important way to further increase transparency and accountability.

4.2.5 Summary

Bonn's transformative efforts towards zero carbon can be described as "established, participatory and learning". The city was a frontrunner in climate action and has since firmly institutionalised it. Several action plans and resolutions exist to foster CO2 mitigation. At the same time, however, CO2 emission reductions remain comparatively small. Involving stakeholders and citizens plays a major role in Bonn. Participatory processes have been established, and civil society groups engaged in urban climate action are using them. In recent years, the council has adopted several citizen proposals such as on bicycle infrastructure and on the declaration of a climate emergency. The Bonn4Future participation process has been set up as a main tool for finding ways for achieving the city's zero emission goal. Together with the declaration of climate emergency and the election of a mayor from the Green Party, this shows that climate action is well-established in Bonn.

4.3 Case study Quito

4.3.1 Introduction and context

Quito (formally: San Francisco de Quito) is the capital of Ecuador and is located in the north-central highlands of the country at an average height of 2,800 meters above the sea level. The city sits amid volcanos and deep valleys and became a World Heritage Site in 1978 due to its architecture and biological diversity (Alcaldía de Quito, 2017). Economically, the city is comparatively well positioned as its GDP exceeds the national one by 59 per cent. The most important economic sectors are construction and buildings, the public sector (local, subnational or national) and wholesale and retail trade.

The Metropolitan District of Quito is home to more than 2.6 million people (INEC [Instituto Nacional de Estadistica y Censos], 2021). It is characterised by a strong socio-economic segregation (Nadal et al., 2019) that is also reflected in the spatial composition of the city. While the central-northern

parts are populated by citizens with higher socio-economic status, the south – as well as peripheral areas – are home to people with lower socio-economic status. 43.5 per cent of Quito's inhabitants live below the national poverty line, mostly in informal settlements. These are often located in high-risk areas where floods, earthquakes and landslides have the potential to cause extensive damage (Obermaier, 2013).

The Metropolitan District of Quito is located in the province of Pichincha and covers an area of approximately 4,218 km². It is composed of nine administrative units, which are further divided into 32 so-called urban and 33 so-called rural parishes. A mayor, at the time of writing Jorge Yunda, and a 21-membered city council govern Quito (MDMQ [Municipio del Distrito Metropolitano de Quito], 2021a). According to the Ecuadorian Constitution, the Municipality of the Metropolitan District of Quito is a decentralised autonomous government. It has decentralised powers to plan and exercise control over various aspects of urban development (TARSC [Training and Research Support Centre], 2017).

In 2015, Quito emitted 7.61 million tonnes CO2e. 40 per cent of these GHG emissions were linked to the transport and mobility sector, 26 per cent were related to land use, 24 per cent to the energy sector and 10 per cent to solid waste (Secretaría de Ambiente, 2020). The ongoing urban expansion and dispersion pose a further challenge to the sustainable restructuring and provision of public services in these sectors (Instituto de la Ciudad, 2015; Quito Como Vamos, 2020).

In the past years, Quito's efforts to combat climate change have increasingly been acknowledged and the city has even been recognised as one of the most sustainable cities in Latin America (Zenck, Ríos Rivera, & Urrutia Camchong, 2018). Also, the Global Covenant of Mayors has recognised Quito for its efforts in mitigation and adaptation. They hereby especially highlighted the city's constant evaluation of climate-related risks, the planning processes to build a more resilient city, and the efforts to decrease the vulnerability of priority groups (Quito Informa, 2020).

4.3.2 Climate action in Quito

Public debate on climate change in Ecuador started in the 1990s with a strong emphasis on adaptation, since climate change was associated with an increasing frequency of "El Niño" weather occurrences[45] (Lechón Sanchez, 2015). Climate change-related activities in Ecuador therefore mostly addressed the coastal areas. Activities took place mostly at the national level, with the Ministry of Environment as the main actor. At that time, cities were not involved in any climate change efforts.

The focus of environmental action in Quito at that time has also mainly been on the conservation of biospheres and freshwater wells in rural areas. There were some early initiatives in the city such as the introduction of an electric trolleybus lane (Trolebús) in 1994, urban gardening projects launched in 2000, and the Ciclopaseo in 2003, which meant that the city centre was closed for traffic every Sunday to allow cyclists and pedestrians to move along. While these smaller projects might have contributed to mitigating emissions in Quito, they were not designated as mitigation projects.

The reduction of GHG emissions became increasingly important when the Ministry of Energy proposed a comprehensive national strategy to combat climate change in Ecuador in 2007 (World Bank, 2011). This led to the gathering of climate-related data in Quito and Guayaquil.

45 "El Niño" is an irregular warm ocean current that runs southwards along the coast of Peru and Ecuador, bringing disastrous flooding in some areas and droughts in others. It owes its name to the fact that it often peaks around Christmas.

These data showed for the first time that not only the coastal areas but also Quito itself was at a particularly high risk of suffering from the negative consequences of climate change. The most prevalent risks in Quito were found to be landslides, heavy rainfall, volcanic eruptions, earthquakes, and forest fires (Alcaldía de Quito, 2017). Another finding was a temperature increase of 1.2 to 1.4°C in Quito between 1891 and 1999 (MDMQ, 2009). This increase had already caused significant change in weather patterns that have had negative effects on water availability, human health, food security, fragile ecosystems and hydroelectric generation, among others (Zambrano-Barragán, Zevallos, Villacis, & Enríquez, 2011).

Another important milestone in Ecuador's climate politics was the adoption of a new constitution in 2008, which had a strong influence on environmental protection, not least due to the influence of indigenous and environmentalist groups. It grants a right to a "good living" (*buen vivir, sumac kawsay*) that guarantees sustainability and supports the use of clean, non-contaminating technologies and sources of energy (see Asamblea Nacional, 2008: Articles 14f). Furthermore, it is one of the first constitutions worldwide to guarantee rights to nature itself (Suárez, 2013).

In light of these events, the administration of Augusto Barrera marked an important turn for climate action in Quito. Early in his administration, he undertook important institutional changes and converted the municipal environmental directorate (Dirección Metropolitana Ambiental), which had been established in 1994 with its predecessor active since 1989, into an Environment Secretariat (Secretaria de Ambiente), and thus provided it with more resources and capacities.

Today, the Environment Secretariat is the city's main governing authority for environmental management and for its climate-related strategic plans and initiatives (Secretaría de Ambiente, 2021).[46] It has the responsibility to regulate all environmental activities in the Metropolitan District of Quito, mainly the Directorate of Environmental Policies and Planning.

Already in 2009, the Environment Secretariat, jointly with the municipal government, published its first climate strategy (Estrategia Quiteña al Cambio Climático) with four strategic pillars: i) Providing information and research for adaptation and resilience; ii) mitigation of emissions in key sectors; iii) communication, education and public participation; and iv) strengthening institutional capacities (MDMQ, 2009). A ten-point action plan on climate change (10 Acciones de Quito frente al Cambio Climático) which was published two years later further defined measures as part of the Pacto de Quito, an initiative of local governments in Ecuador to combat climate change (MDMQ, 2011). In 2012, another Climate Action Plan was adopted (Plan de Acción Climático de Quito) that mostly summarised earlier plans, but provided more detailed information on objectives, envisioned results, and costs. The plan also included the city's first emission reduction target: 15 per cent of GHG emissions in the Metropolitan District relative to the projected increase (Secretaría de Ambiente, 2012).

Based on these strategies and action plans, the municipal government implemented several climate-mitigation measures and projects. In the field of mobility, these included – among others – the construction of a metro, the extension of bicycle lanes, public bicycle rental, and a restriction rule for private vehicles, known as *pico y placa* (MDMQ, 2011; Trámites Básicos, 2021). In the field of waste management, the public utility firm was strengthened, and waste separation and recycling were encouraged. In the energy sector, the use of renewable energies, specifically photovoltaic energy, was promoted.

46 Other local entities have powers with regard to environmental issues, above all the Transport Secretariat (Secretaría de Movilidad); the Territorial Secretariat (Secretaría del Territorio); and the Municipal Institute for Urban Planning (Instituto Metropolitano de Planification Urbana). The city also created the following autonomous entities: Fondo Ambiental (Environmental Fund); Empresa Pública Metropolitana de Gestion Integral de Residuos Sólidos (Metropolitan Company for Solid Waste Management); and Empresa Pública Metropolitana de Aseo de Quito (Metropolitan Cleaning Company of Quito).

Projects to increase resilience and adapt to climate change also played a significant role. Here, a focus was on integrated risk management, sustainable fresh water management and nature conservation. Interestingly, the 2009 climate strategy closely combined adaptation and mitigation and even formulated a set of programmes to target both objectives at the same time. Such projects included the installation of a network of green corridors in the city (Red Verde Urbana).

Under the subsequent administration of Mauricio Rodas (2014-2019), Quito joined several international city networks and became internationally known as a frontrunner in sustainability and climate action (Alcaldía de Quito, 2019, p. 163). For their engagement in international city networks such as UCLG, ICLEI, C40, GCoM, and others, both the city and Rodas were internationally acknowledged (World Economic Forum, 2021).

In 2016, Quito hosted the United Nations Conference on Housing and Sustainable Urban Development (Habitat III). According to an interview partner, who was involved in the conference, it set into motion a stronger connection between urban development and sustainability in the city's politics. For instance, the mayor announced that the city's historic centre would be converted into a carbon-free zone in order to comply with parts of the New Urban Agenda of Habitat III (Quito Informa, 2018). Since then, several streets have been pedestrianised (Alcaldía de Quito, 2019, p. 123ff).

Further accomplishments during this period included the extension of public transport, especially the continued construction of the metro, the renovation of public parks, and continued efforts in the areas of waste collection and reforestation. In the field of construction, an eco-efficiency ordinance was passed to encourage the construction of more environmentally friendly buildings by allowing the construction of more floors in exchange for the installation of water and energy saving technology (Secretaría de Territorio, 2017).

In 2020, the city published its most recent Climate Action Plan, which was compiled with the assistance of C40 Cities. Compared to the preceding plans, it has a much stronger focus on mitigation and even includes a carbon neutrality goal to be reached by 2050 (Secretaría de Ambiente, 2020). The following activities were highlighted to reach this goal: sustainable buildings and urban growth; sustainable water management; ecosystem services; sustainable agriculture; governance and climate research; waste management; sustainable mobility; and inclusive and equitable climate action.

Apart from publishing this ambitious plan, the Jorge Yunda administration has not yet engaged in the implementation of climate-mitigation measures but, most likely, the first metro line will open during his administration. The project is by far the most significant project in terms of emission reduction, but also the most costly infrastructure project in Quito. The costs of the project exceed USD 1.39 billion and it is estimated that the project will reduce emissions by 163,942 tonnes CO2e per year (Secretaría de Ambiente, 2012). Metro construction began in 2012 and had been expected to be operational in August 2020 but was delayed and pushed back to 2022 (Primisias, 2021).

4.3.3 Status of transformation

Regarding our first dimension of success, a sound and reliable database that would allow one to draw information on tendencies is still missing. This is due to the fact that only one inventory of the city's GHG emissions has been conducted so far: in 2015 (based on the Global Protocol for Community Greenhouse Gas Emissions standards). However, the Environment Secretariat has also published data on the GHG emissions of 2011 with the support of the initiative Huella de Ciudades. While comparing these figures is problematic because it is unclear whether the same accounting method was used, it is interesting that the significant difference between the

figures points to an increase in total CO2e emissions, although per capita emissions have slightly decreased due to population growth (see Table 3).

Table 3: General, emissions-, and climate action-related data on Quito

		2011	2017	Notes and sources
GENERAL				
Population size (million)		2.4	2.6	(INEC, 2021)
City real GDP per capita (billion USD)			22.5 (2016)	Resilience Strategy Distrito Metropolitano de Quito (DMQ) (Alcaldía de Quito, 2017)
Unemployment rate (in per cent)			7.8	Resilience Strategy DMQ (Alcaldía de Quito, 2017)
Population density (people per km²)		5,643	6,113	Resilience Strategy DMQ (Alcaldía de Quito, 2017)
Modal split	MIT		22.6%	Data from 2015, Resilience Strategy DMQ (Alcaldía de Quito, 2017)
	Public transport		61.7%	
	Pedestrians		15.4%	
EMISSIONS				
Total emissions (in million tonnes CO2e/year)		5,164,946 (2011)	7,598,856 (2015)	2011: (CAF [Corporación Andina de Fomento – Banco de Desarrollo de América Latina], 2017) 2015: Plan de Acción Cambio Climático de Quito 2020 (Secretaría de Ambiente, 2020)
Emissions (tonnes CO2e) per capita		2.32 (2011)	2.08 (2015)	2011: (CAF, 2017) 2015: Resilience Strategy DMQ (Alcaldía de Quito, 2017)
CITY CLIMATE ACTION				
Approval year of city's first Climate Action Strategy/Plan or equivalent		2009		Estrategia Quiteña al Cambio Climático (MDMQ, 2009)
City's zero-carbon target year		2050		Plan de Acción Cambio Climático de Quito 2020 (Secretaría de Ambiente, 2020)
Municipal lead department or unit		Secretaría de Ambiente		

Source: Authors

Quito wants to reduce its CO2e emissions by 30 per cent by 2030 and intends to reach carbon neutrality by 2050 (2015 is the base year for both goals). The main instrument to achieve this is the Climate Action Plan which also includes sectoral goals. The activity with the largest contribution to this goal is the metro.

Turning to acceleration of efforts, several of our interview partners observed that the topic of climate change, and climate mitigation more specifically, have gained momentum in the past years and are being increasingly discussed. Nevertheless, we could not find hard evidence for the acceleration of processes linked to concrete emission reduction activities.

Concerning the systemic scope of change, Quito is on its way to systemically integrating the topic of climate change into its institutional framework. The conversion of the environment directorate into a secretariat was an important step in this regard, as it provided it with more powers and resources and thus enabled the development of meaningful climate strategies (interview with a former politician, 13 August 2021).

Over the past years, Quito has gained international acknowledgement in drafting high quality plans and strategies on how to tackle climate change in the city. Implementation and alignment with other departments' activities, however, have been a challenge, as several interview partners pointed out:

> One thing that is not missing in Quito is to have policy written down somewhere [...] but what is missing is that these policies come down to practice and [are converted into] sustained projects. (Interview with a former city official, 13 April 2021)[47]

Several interviewees argued that past actions represented rather small-scale, isolated, or pilot projects. Also, a certain incoherence in public policy was observed. What was missing was a more systematic approach to the sustainability transformation, going beyond individual projects. Many interview partners argued that Quito would need a transversal governance in this field that would influence every single policy passed and activity enrolled.

To tackle this issue, the secretariat of the environment has tried to get the various different municipal departments to collaborate on issues of climate change and sustainability. One approach is the climate change committee (Comité del Cambio Climático del Distrito Metropolitano de Quito), which brings together key actors from the municipal government (secretariats of mobility, territory, planification, and social inclusion, as well as public enterprises of transport and construction and of drinking water and sanitation). The committee first met in January 2020 and is set to be the principal strategic and political actor for the monitoring and evaluation of the implementation of the new Climate Action Plan (Secretaría de Ambiente, 2020).

While changes in the administration had a negative impact on the continuation of projects and the efforts put into work on climate change, it is considered unlikely that a newly elected government would end emission reduction activities. Also, the number of staff mainly working on CO2 emission reduction has increased since 2013 by up to 20 per cent and the speed of planning, approval and implementation of climate activities has increased somewhat, according to information provided in the survey. Procedural continuity still depends on individuals, but there have been positive examples where the transfer of power did not interrupt work. For instance, the public water enterprise (Empresa Pública de Agua Potable) was mentioned several times as a positive case in the interviews.

Regarding the spatial scope, survey results indicate that the municipality replicated or expanded CO2 emission reduction activities to other parts of the city several times. However, we could not find further information on this. Beyond the city, Quito is portrayed as a point of orientation and reference for other cities, both in the country and internationally. As it is the capital of Ecuador and is active in many city networks, GHG emission reduction activities have been taken over by cities in other countries several times in the past. *Within* Ecuador, however, this does not seem to happen. With the exception of a nationwide upscaling of the "Quito Climate Pact" initiative in June 2011 (Proaño-Castro, 2017), there seems to be no mechanisms for peer-learning between cities in Ecuador. A former city official explained that the extension of successful projects to other cities is not the responsibility of the secretariat of the environment since it is only active within the district of Quito.

Turning to acceptance, the general population in Quito seems to be less aware of climate change and related activities. Several interview partners stated that most citizens did not know

47 All citations in subsection 4.2 are originally in Spanish and have been translated by the authors.

or think about climate change and emission reduction. Even events like the Habitat III conference in Quito in 2016 apparently did not change this. It is important to distinguish this unawareness from resistance or indifference. For example, one interview partner pointed out that, for many people, living with air pollution has become a normality and that they are not aware of their rights to a clean city. Another interviewee stressed that for most people short-term needs, such as the provision of basic services, were much more pressing than the abstract and long-term preoccupations on CO2 emissions. Climate change and sustainability are therefore seen as topics of a rather elitist and technical discourse that people with higher educational levels or technical experts engage in.

Unawareness can be a challenge to the implementation of projects when it leads to a lack of understanding of why certain activities are undertaken or certain measures are in place. While awareness of mitigation activities was seen by interview partners to contribute to achieving broader acceptance, the kinds of projects themselves might be of even greater importance. For example, many stakeholders might not think about the metro of Quito in terms of its contribution to emission reduction, but rather perceive and evaluate it as a mere mobility project and according to its direct impact on their lives.

Based on survey results, acceptance levels for GHG emission reduction activities were estimated to be around 50-75 per cent but no other systematic data about public levels of acceptance exist. Two groups were mentioned which are opposing GHG reduction emissions in the city. These are some public enterprises and private transport operators. Transport operators oppose efforts to change the transport system for economic reasons. As many of them are still operating old fleets, any law raising environmental standards would negatively affect their businesses. Acceptance among other groups, such as NGOs, on the contrary, seems to be limited by a perceived lack of systemic action on climate change.

4.3.4 Explaining change

After an overview of GHG reduction activities in Quito, the question is what determines the relative success in Quito? Which factors are positively or negatively associated with the transformation of the city? The following subsection takes a closer look at what the “main story” seems to have been and, subsequently, what roles our three explanatory variables stakeholder involvement, urban finance, and impact assessment have played in this case.

4.3.4.1 Main story

While stakeholder involvement, finance and impact assessment are relevant factors for urban transformation processes, they are embedded in a broader context of important factors. In the case of Quito, the political context in which climate action has taken place over the past years has been decisively shaped by political cycles, national politics, and economic crises.

Political continuity in the field of climate action has been negatively impacted by political and economic crisis. In the past years, Quito has gone through a long phase of political polarisation and volatility, paired and fuelled by an ongoing, economic crisis. Thereby, national dynamics have had a strong influence on the capital city.

During the early phases of president Rafael Correa’s self-labelled “citizen revolution”, there was a strong movement for a proactive and strong state. Large investments were made in infrastructure, social systems, and access to basic services. Poverty levels subsequently decreased and the right to a healthy and sustainable environment was included in the new constitution. However, conditions changed when public support for Correa’s movement vanished in response to unpopular decisions (for example, salary cuts for public officials, a capital gains tax, a property tax), allegations of an autocratic leadership style, and the

obstruction of the freedom of press. A severe economic crisis caused by, among other things, falling oil prices in 2014 and by the appreciation of the dollar as well as the 2016 earthquake exacerbated the political crisis. These crises had a strong influence on policymaking and implementation in the capital, both in terms of political uncertainty and resources.

With 84.9 per cent of their total income in 2016 (OECD/UCLG, 2019), central government transfers are the main source of income for subnational governments in Ecuador. The country's ongoing economic crisis therefore limits the availability of funds for local governments and also for local climate change action (for more on this, see subsection 4.3.4.3).

A political shift could also be observed. While there was a strong focus on strengthening the public sector for solving the city's social and ecological challenges during the 2009-2014 administration, the succeeding government followed a very different political approach. Internally, it relied much more on the private sector, while it engaged in international platforms and discourses on climate action externally, not least by hosting Habitat III in 2016. The current administration's climate actions also have suffered from political crisis as well as from the effects of the pandemic. However, a former politician pointed out that another hurdle to more climate action in Quito is constituted by a lack of political incentives, resulting from a combination of scarce resources and a rather low awareness of the issue among the broader public.

According to several interview partners, political discontinuity is a key limiting factor for transformative action in Quito. When governments change, so do public policies and projects. Oftentimes, projects of predecessors would not be continued or cut down. Many interview partners identified this to be a key challenge to the longevity of projects:

> Every time the mayor changes in Quito, many projects are cut down or eliminated. It is really a challenge to achieve continuity in Quito. (Interview with a City Official, 20 April 2021)

Several interview partners, both public and non-public, also saw the siloed municipality structure and the lack of coordination between departments and agencies as a main inhibiting factor for a more comprehensive approach to tackling climate change. Even within the municipality, they argued, many officials would be unaware of the city's mitigation measures.

To add to this, bureaucratic red tape and understaffing were seen as inhibiting factors for the acceleration of efforts. Representatives from different NGOs that were cooperating with the municipality observed that lengthy administrative processes and a lack of funding were responsible for delays in the implementation of joint projects. According to them, the metro project played an important role here. Not only has it absorbed almost all available funding, it also represents a milestone whose accomplishment is awaited before other initiatives are taken any further.

Finally, circumstances like the COVID-19 pandemic, and difficult political and economic conditions affect the transformation process. Apart from funding shortages, this can also lead to risk-aversion and the reluctance to share knowledge and to cooperate. While many of these factors are certainly not exclusive to Quito, this context shapes whether actors engage in political processes; if projects are financed; and how political achievements are monitored, measured and evaluated.

4.3.4.2 Stakeholder involvement

Several interview partners concluded that broad coalitions and cooperation between stakeholders have positive effects on the continuation of projects in Quito as they help to overcome challenges resulting from changes in administration (**H1.1**). However, it seems that this has not yet become common practice. In terms of stakeholder involvement, Quito seems to mainly engage in short-term modes of involvement with a focus on information and consultation (**H1.2**).

According to a former public official, secretariats and government agencies working on climate change always involve national or subnational NGOs, as well as universities and research institutes into their CO2 emission reduction activities in some degree or form. Community groups, local NGOs and the local private sector were said to be often involved. Representatives from civil society, in particular professional associations, and non-profit organisations, however, seem to be very vocal in demanding more participation and information in the field of urban transformation.

International actors such as international donors and development banks play an important role in the transformation process of Quito. In fact, many projects in the field of climate action in Quito – both public and private – involve external actors, who present an important source of information and financing of climate projects (see also subsection 4.3.4.3 on urban finance). They seem to have a great impact on shaping urban transformation in Quito. As international cooperation projects often work with both municipality and other stakeholder groups, they work as pivots for cooperation. However, it was also observed that international donors sometimes focus too much on planning and less on implementation on the ground.

Global and regional city networks also represent important partners for the urban transformation of Quito. They can, for example, provide useful frameworks and methodologies, but are also actively involved in projects. Furthermore, according to a former city official, their support has led to increased institutional resources and capacities.

In Quito, many local initiatives and NGOs work on climate-related issues such as sustainable mobility, public spaces, waste collection, and urban greening. Civil society organisations have a record of successful cooperation with each other. However, several interview partners also signalled that it can be difficult to build coalitions, as some actors focus on specific demands instead of working on a broader vision of transformation. Trying to overcome these challenges, the civic assembly (Cabildo Cívico[48]) is a key player. It is a network of more than 100 civil society organisations, most of them active on climate change issues, which are jointly working on urban development and are actively pushing for deeper participation.

Cooperation between the Cabildo and its organisations and the municipality seems to be rather informal and temporary. While there have been exchanges in the past, our interview partner stressed that this had only been possible due to the commitment of individual people working in the municipality and their former professional and activist relationships. Formalised sharing of information and institutionalised public participation does not take place.

Other types of cooperation – for instance with professional associations, social enterprises and consultancies – occur, but seem to be consultative and project-bound. It appears that cooperation is often initiated by civil society actors or required by external actors. In general, these organisations seem to be vocal in demanding more participation in urban transformation.

All civil society interview partners expressed some form of discontent with the way cooperation was or was not taking place. For instance, access to the agency or official in charge was sometimes difficult. Also, cooperative relationships were often not maintained beyond a project's lifespan, making it difficult to incorporate results into policies. Administrative delays and government changes were mentioned as additional challenges. In another case, an interview partner said that there was a reluctance to conduct or permit projects, such as the closing of streets, that might not immediately find broad acceptance. Interestingly, she explained that the municipality often relied on professional associations or NGOs to approach citizens, as they would sometimes be trusted more by citizens (interview with an NGO representative/former vice-mayor of Quito, 20 April 2021).

48 The Cabildo was founded in 2019 and is organised into seven thematic round tables (among them: sustainable mobility, public space, democratic participation) with the aim to achieve collective and integrated action in these fields and to lobby for their topics towards the municipal government.

With regard to the involvement of the general public, participation is applied rather sporadically whenever it is perceived to be of importance for a project. While the new Climate Action Plan calls for “a strong element of inclusion”, it seems that, in general, participation has an informational and educational focus, mostly aiming at raising awareness for the issue.

In the interviews, three main challenges for public participation were mentioned. First, the level of awareness of and the relevance of climate change issues for many citizens is rather low compared to more immediate challenges. A former politician argued that, especially in working-class districts, it was crucial to tackle environmental issues through solving people’s urgent problems to gain support. Second, a former city official said that institutional capacities presented a limiting factor. Third, several NGO representatives also said that low levels of trust in government and political frustration among the citizens of Quito were leading to low levels of participation. Often, participation would lead to conflict, with the result that officials have begun to perceive public participation more as a hurdle than a helpful approach.

Cooperation on GHG mitigation between the local government and the private sector appears to be rather limited. According to several interview partners, this was due to a cleavage between the private and the public sector that had worsened in the recent past because of the political crisis. Nevertheless, several interview partners pointed out that private-sector support would be highly relevant for Quito’s transformation process, especially in terms of financing activities (see next subsection). According to a former city official, some companies supported initiatives like the planting of several thousand trees. Furthermore, representatives of the private sector were involved in the preparation of the new Climate Action Plan, with a specific view on the implementation and financing of activities. Among the factors inhibiting more elaborate forms of cooperation, like public-private partnerships, the absence of a legal foundation was often mentioned.

Cooperation between academia and the municipal government in the field of mitigation activities is scarce. Some institutes are sometimes consulted prior to decision-making. There are also project-bound consultations that seem to be regularly involved in technical cooperation projects. However, it appears that both the municipality and academia would be interested in increasing cooperation. A comparative advantage of academia vis-à-vis the private sphere was seen in their more neutral position. Also, a more long-term cooperation could help to gain a holistic (transversal) and multidisciplinary view on strategies and activities. A challenge for increasing cooperation seems to be the lack of capacities on the one hand with the Secretaria del Ambiente being overburdened with tasks, along with the lack of public funding for applied research.

4.3.4.3 Urban finance

Diversification of financing sources is low and there is a strong dependence on central government transfers and international funding from development banks and donors. According to a former politician, it was difficult to access funding from (international) ecological funds during his time of service (2009-2014) and this still seems to be the case.

The city’s main source of income is central government transfers. According to one former city official, they account for 35-40 per cent of the city’s financial resources and 84.9 per cent of total revenue for local governments in the country in general according to SNG-WOFI (OECD/UCLG, 2019). Revenues from fees and taxes account for approximately 30 per cent of the city’s budget and constitute the second most important source of finance, according to a former city official. The country’s economic dependency on oil extractions and mining continues to be a key conflict. While they represent crucial sources of revenue, especially in times of economic crisis and the pandemic, they are counter-productive to mitigation efforts and fuel socio-ecologic conflicts, especially with regard to indigenous rights and interests (BMZ [Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung], 2021).

The third main source of income are national and multilateral development banks. These are especially relevant for the financing of GHG emission reduction activities – above all the construction of the metro. A former politician argued that emission reductions were a particularly important argument for receiving national government funding.

International development cooperation was frequently mentioned as an important funding source for climate projects. However, while advancing the transformation process, it might also hinder the emergence of internal financing structures.

The Fondo Ambiental Quito has been created as a special institution that can manage its funds and take decisions independently from the local government. However, since its founding 16 year ago, the fund has never raised significant amounts of money. In the past year, the highest amounts so far could be raised (USD 600,000 for June 2020 to March 2021), consisting of grants from international cooperation (GIZ, Wuppertal Institute (Solutions+ project), EU (CleverCities project), UN Habitat).

Lastly, private-sector financing plays a minor role in the financing of sustainability projects in Quito. Some private enterprises, which themselves are committed to social and environmental responsibility, have supported sustainability projects of the city, such as the financing of several thousand trees.

As illustrated above, local resource mobilisation plays a role but is constrained by limited administrative capacity. An example of successful local resource mobilisation is the water fund FONAG. Moreover, although it is legally allowed to do so, Quito has so far not tapped the potential of financial markets to raise funds for sustainability projects.

In general, the availability of funding for sustainability projects is a challenge that is holding back CO2 emission reduction efforts in Quito (**H2**). While the metro will reduce emissions once it is finished, it is also blocking other projects and initiatives from growing as it absorbs all available funding. Huge individual infrastructure projects can therefore have negative side-effects when considering that transformative change requires simultaneous change at multiple levels at the same time.

4.3.4.4 Impact assessment

Impact assessment plays a minor role in the activities of the local government of Quito, which is why we could not find evidence to support **H3** on comprehensive impact assessment. One interview partner said that, while she worked in the city administration, in-depth impact assessments were hardly ever conducted, and if so, then only for projects from multilateral institutions or international donors which required such reporting. There are some small-scale examples. One such example is the measurement of air quality in the city that was achieved through the installation of sensors that provided real time data on air quality. Nevertheless, impact assessment is perceived to be important and plays a more prominent role in the new Climate Action Plan.

The most common instrument used by the local government seems to be monitoring and (mostly quantitative) evaluation of indicators and goals, which are established for projects and strategies. For example, the new Climate Action Plan defines such indicators and annual goals up to the year 2050. Here, the secretariat used the methodology of the CDP by C40.

Reporting on indicators and goals developed by national agencies is required, such as the guidelines developed by the national planning secretariat (Secretaria Nacional de Planificación). However, indicators are mostly on the output rather than the outcome level. Such differentiation exists, for example in the city's resilience strategy. But outcome indicators are difficult to measure at the local level, especially as such data is often only generated at the national level.

Even with well-designed indicators in place, capacities and competencies for measuring impact are limited. Agencies which are frequently in charge of too many responsibilities already often see impact assessment as an additional burden.

The quality and fit of available data is also seen as a problem. Often delimitation is difficult, and data is not available on city level. Also, the earlier climate action plan lacked a baseline assessment for many planning instruments that would have permitted one to carry out impact assessments. However, the new plan has improved in this regard. Apart from the emissions inventory mentioned earlier, risk and vulnerability analyses have been carried out.

The results of evaluations conducted by the Environmental Secretariat are communicated to external actors on request, but also to the public, using social media, informing citizens about the activities that have been undertaken.

There seems to be little cooperation with academia in terms of GHG emission reduction impact assessment. The cooperation that exists is mostly in the field of monitoring and can also be conducted for public enterprises. An important municipal player involving academia is the Instituto Metropolitano de Planificación Urbana. Its urban development plan Visión Quito 2040 was developed together with several local universities (IMPU [Instituto Metropolitano de Planificación Urbana], 2021; Municipio del Distrito Metropolitano de Quito, 2021b). Some interview partners argued that more involvement of academia would be beneficial. Lack of available funding seems to be a key barrier for collaborating with academia, as other expenses on impact assessment are prioritised.

One of Quito's interesting features is that there are several civil society initiatives that generate data that could be used to advance mitigation efforts. One of them is the initiative Quito Cómo Vamos, which represents a common effort of civil society, academia, media, and the private sector to monitor and evaluate the quality of life in Quito by generating reliable data and information on twelve sub-dimensions of the quality of life. Their aim is to contribute to an effective and transparent municipal government and to enable the establishment of well-informed public participation (Quito Cómo Vamos, 2021). The initiative was launched in 2020 and has so far published a report on the status quo of Quito (including the environment and mobility), as well as a survey with around 1,600 participants on citizens' perceptions of quality of life in Quito.

4.3.5 Summary

The City of Quito's transformative efforts towards zero carbon can be summarised as "partial and challenged but ambitious". The lack of data on CO2 emission tendencies over the past years makes an assessment of Quito's success difficult. Mitigation activities are still comparatively recent as the city's main focus lies on building resilience and adaption to climate-induced changes and threats. With this in mind, Quito's recently launched Climate Action Plan is ambitious and includes some lessons learned from the past such as a baseline of CO2e emissions that enables progress monitoring.

Quito can build on progressive legal foundations regarding climate action, as well as plans and strategies that have been widely recognised and applauded. Nevertheless, much work remains to be done in terms of implementation. To date, many projects and efforts still depend on engaged individuals and are exposed to political cycles and economic uncertainty. Therefore, even well-designed and well-functioning projects struggle to persist and be extended. A more systemic institutionalisation of climate change action local government procedures would be useful. The city could exploit synergies in combining climate action with finding solutions to other pressing urban challenges such as mobility, food security, and waste management, for example.

Currently however, the pandemic has further aggravated the situation to an extent that almost brought the implementation of mitigation activities to a standstill. Because of this, development banks and international cooperation agencies have become even more important for keeping up climate change action in Quito. However, their role is ambiguous as their presence and funding might also hinder the emergence of sustainable internal financing and implementation structures.

4.4 Case study Cape Town

4.4.1 Introduction and context

Cape Town is located on the Western Cape province's coast. It is home to more than 430,000 inhabitants and one of the largest cities in South Africa. In 1652, it was the first city to be founded by European colonists. In its present-day form, however, the City of Cape Town Metropolitan Municipality was formed after the 2000 municipal elections based on South Africa's constitution and subsequent local government laws and regulations. The city is also the seat of the national Parliament.

Cape Town is the country's third main economic hub with 75 per cent of the city's GDP coming from the third sector in 2018 (mainly finance, insurance, real estate and business services, as well as wholesale, retail trade, catering, and accommodation). The sector also accounts for 79 per cent of formal employment. Informal employment was at 21.6 per cent in the same year (Western Cape Government, 2020). Although still far below national averages, unemployment, poverty and inequality indicators have increased over the past years (see Table 4).

The City of Cape Town is a so-called metropolitan municipality. It is governed by a mayor and a 231-member city council. In most electoral terms, Cape Town has been governed by the national opposition party Democratic Alliance.

The historical inequalities of Apartheid shape the context in which Cape Town and other South African cities respond to climate change. In addition to what has become known as the "triple challenge" in South Africa – poverty, inequality, and unemployment – the importance of climate change has grown in recent years. The country has hosted international high-level climate conferences, which have reinforced the national government's attention to the matter. As a prominent global tourist destination and a city with rich biodiversity, Cape Town in particular has built an international reputation as one of the country's and continent's climate policy frontrunner cities.

However, while South African cities remain highly unequal and urban development lags behind compared to other emerging countries, their emission levels are on a par with cities with higher development levels in Europe (see Table 4). This is partly due to the fact that South Africa's electricity production is mainly coal-based. It is centrally provided by Eskom, the country's public electricity utility. Eskom produces and sells electricity to municipalities which then sell it on to consumers. This means that reducing the consumption of electricity also reduces the city's revenue. At approximately one-third of total income, re-selling electricity currently represents one of South Africa's cities' most important sources of revenue.

Next to electricity, the second largest source of emissions is transport, which relies heavily on diesel and petrol. The geography of South African cities is shaped by their Apartheid past and thus highly segregated, which means that large neighbourhoods are located far outside the city centre. Since many regard public transport as insecure and unreliable, car ownership, traffic, and transport-related emissions have increased in recent years (see Table 4).

Overall, because of the massive socio-economic challenges in South African cities, climate action is still seen as opposed to and conflicting with economic growth and service delivery by many local governments. Also, because climate change is still a rather new policy area in the

country, many details of the division of labour between the national, provincial, and local tiers of government in this field remain unresolved as the case of the City of Cape Town shows.

4.4.2 Climate action in Cape Town

Climate change became part of the policy debate in Cape Town in the year 2000 with a study on the risks of sea-level rise. Three institutions were crucial in that early phase of urban climate change discourse and capacity building. They also provided an expert pool from which several experts would later join the City to work on various aspects of climate change. These institutions were the University of Cape Town (UCT), particularly its environmental department, ICLEI, and a non-profit research and advisory spin-off from the UCT called Sustainable Energy Africa (SEA). For many years and with international funding, this organisation ran the Sustainable Energy for Environment and Development programme, which deployed energy advisors with a focus on renewable energy to several South African cities in 2000, Cape Town being one of them. In 2006, Cape Town became the first city in the country to approve a municipal Energy and Climate Change Strategy and to employ an energy officer with a focus on climate change. In the following years, the initial Energy and Climate Change Unit grew into what is today the Energy and Climate Change Directorate with the Sustainable Energy Markets Department as the responsible unit for energy-related mitigation issues.

In 2008, the initial energy and climate goals were integrated into Cape Town's Integrated Development Plan (IDP). In South Africa, the IDP is the local government's medium-term planning tool from which the annual plans and budgets are derived. Today, Cape Town's climate action is based on the city's Climate Change Policy (City of Cape Town, 2017), the Climate Change Strategy (City of Cape Town, 2020a), and the recently developed Climate Action Plan (City of Cape Town, 2021). The City aims to reach zero-carbon status by 2050. Based on the city budget, national transfers and donor funding, climate action in Cape Town has expanded massively since 2006. One area supported by national programmes was the increase of energy efficiency in municipal operations, for instance, by retrofitting municipal buildings and installing solar water heaters (Mahomed, Tait, & Kruger, 2019). Small-scale embedded solar energy generation was also supported and increased, both on municipal buildings and on private homes. A zero-carbon building by-law for new buildings is in progress. The City also organises the Cape Town Future Energy Festival to raise public attention for sustainable energy and climate change innovation and promotes more energy-efficient consumer behaviour through communication campaigns. Moreover, in collaboration with the Western Cape Government, the City helped to set up the continent's first green-tech focused special economic zone Atlantis (Grant, Carmody, & Murphy, 2020). Also in partnership with the provincial government, the City established GreenCape, a so-called sector development agency, which provides information and brings together city government, private companies, investors and other interested stakeholders on climate change-relevant green economy issues (LEDS GP [Low Emission Development Strategies Global Partnership], 2016).

While small-scale embedded solar energy generation has grown in Cape Town and other municipalities in recent years, there is huge potential in procuring large-scale renewable energy from independent power providers (IPPs) to replace centrally provided coal-based electricity. The main obstacle here is legal uncertainty. There is disagreement about whether the National Energy Regulator of South Africa and the Minister of Mineral Resources and Energy have to grant municipalities the permission to procure renewable energy in large quantities from IPPs. After having failed to receive a reply from the Minister, the City of Cape Town took the government and the regulator to court in 2017. In October 2020, the High Court directed the City to seek a cooperative agreement with the minister and the regulator. It did, however, add that the court is willing to hear the case again if these efforts are not successful.

Table 4: General, emissions-, and climate action-related data on Cape Town

	2011	2017	Notes and sources
GENERAL			
Population size (million)	3.74	4.17	(SEA [Sustainable Energy Africa], 2020b)
City real GDP per capita (South African Rand)	69,000 (approximately EUR 6,950)	65,302 (2018; approximately EUR 4,186)	2011 data: (Western Cape Government, 2017) 2018 data: (Westen Cape Government, 2020)
Inequality (Gini coefficient)	0.60	0.62 (2018)	2011 data: (Western Cape Government, 2017) 2018 data: (Western Cape Government, 2020)
Poverty (in per cent)	43 (2009)	45.9 (2019)	Upper poverty line of S. A. Rand 1,227 (approximately EUR 77) (City of Cape Town, 2020b)
Unemployment rate (in per cent)	18.0	23.1 (2019)	(Western Cape Government, 2020)
Population density (people per km²)	1,523	1,700	(SEA, 2020b)
Private vehicles per 1,000 people	222	239	(SEA, 2020b)
EMISSIONS			
Total emissions (in million tonnes CO2e)	18.5	21	(SEA, 2020b)
Emissions (tonnes CO2e) per capita	5.4	4.9	(SEA, 2020b)
Emissions (tonnes CO2e) per gross value added (million S. A. rand)	56	51	(SEA, 2020b)
CITY CLIMATE ACTION			
Approval year of city's first Climate Action Strategy/Plan or equivalent	2006		Municipal Energy and Climate Change Strategy
City's zero-carbon target year	2050		
Municipal lead department or unit	Energy and Climate Change Directorate (Sustainable Energy Markets Department for GHG mitigation)		

Source: Authors

4.4.3 Status of transformation

Between 2011 and 2017 – the years for which the most comprehensive emissions data are available for Cape Town – total emissions have increased from 18.5 to 21 tonnes CO2e (see Table 4). However, during the same period, per capita emissions decreased from 5.4 to 4.9 tonnes CO2e per person, and emissions per economic unit from 56 to 51 tonnes CO2e per gross value added (GVA) in million rand (see Table 4). Despite the growth of its population and the economy, the city has been able to reduce its relative CO2e emissions during this period. As the State of Energy in South African Cities 2020 report puts it, "electricity demand is decoupling from economic growth" (SEA, 2020b, p. 43). These numbers suggest that Cape Town's transformative efforts have begun to work.

The secondary success dimension "dynamics of transformation" also indicates progress in transformation. While we lack the data to assess whether the speed with which transformative action is developed and implemented ("acceleration") in Cape Town has changed, some interviewees indicated that this might be the case.

In the past years, the City of Cape Town has developed several sophisticated climate change and emission mitigation documents and has set the goal for the City to reach carbon neutrality in 2050. Significant progress has been made with integrating these strategies and plans into the city's institutional framework and procedures across electoral cycles ("systemic integration"). However, a researcher who has worked with the City for a long time noted that the City is "still struggling to really embed the idea of a green economy or a climate resilient economy as central organising principle" (interview with a researcher and consultant, 21 April 2021; see also (Cartwright & Savage, 2019).

Another indicator of the increasing strategic importance of climate policy is the growth of the department responsible for mitigation action in recent years,[49] as well as the upgrading of climate change and energy to the level of a directorate. According to a think tank representative who works closely with Cape Town and other cities in South Africa, this kind of institutional growth with the creation of several new positions is "unheard of in other cities. To create a new position in a city organigram is really difficult" (interview with a think tank representative, 22 April 2021).

While upscaling and replication within the city ("spatial upscaling") do not seem to play a major role, emission reduction activities seem to have had a certain "impact beyond the city". Several forms and procedures that were developed in Cape Town have been adopted by other South African cities, for example, the City's documentation of small-scale embedded solar electricity generation (SEA, 2020a, p. 130). This is also reflective of the City's strong resource and capacity endowment compared to other South African cities.

It is difficult to assess the level of acceptance the City enjoys among citizens and stakeholders regarding its decarbonisation efforts. As in the rest of the country, public protests in Cape Town focus on the absence of or low-quality service delivery or the lack of security rather than on decarbonisation activities. More generally, as several interviewees mentioned, the overall awareness of the consequences of climate change and the need to reduce emissions is low in some groups of the society.

Overall, while a lot of work remains to be done to reach the City's zero-carbon emission goal by 2015, Cape Town has been rather successful so far in beginning to reduce relative CO2e emissions and integrating decarbonisation and climate action into its overall governance framework.

49 This has increased by more than 20 per cent between 2013 and 2018 according to our survey response.

4.4.4 Explaining change

Our analysis of the City of Cape Town's early decarbonisation transformation is again divided into two parts. The first part presents our overall analysis in broad strokes and highlights those enabling factors and challenges that we had not included in our initial theoretical framework.[50] The second part goes into more detail on what we expected to be the main explanatory variables, namely stakeholder involvement, financial resources and impact assessment.

4.4.4.1 Main story

To sum up our analysis of the case of Cape Town in one headline, we arrived at the phrase "proactive but stretched and constrained". "Proactive" refers first to the early change agents who worked with, or joined, the city in the early 2000s to convince colleagues and local politicians of the relevance of the topic. It also refers to the city's subsequent proactive role on climate action and CO2 mitigation at the national level. Work on GHG mitigation and adaptation began with experts who were seconded to the city for limited periods of time and with researchers who worked together with city officials to share knowledge and build expertise. Both efforts were funded externally. Several of these external experts later joined the city administration and lead its climate work until today. They turned into internal change agents but had a hard time convincing their colleagues in the city administration of the relevance of the topic: other municipal departments had different priorities and institutional cultures (Froestad, Shearing, Herbstein, & Grimwood, 2012).

A recent study by the South African Cities Network (2020) investigated the formal and informal rules governing bureaucratic behaviour in municipal spatial planning departments and showed that current performance management systems create a "compliance culture" which tends to "reward institutional compliance rather than transformative development" (South African Cities Network, 2020, p. 3).

In addition to different institutional cultures and compliance-driven bureaucratic inertia (Taylor, 2016), climate action and service delivery as well as economic growth were often genuinely seen as priorities that were mutually exclusive, both because of budget constraints and because of policy targets.

Another challenge for these highly qualified and mission-driven internal change agents was to obtain authorisation from local politicians up to the mayor to work on municipal climate change policies, strategies and action plans. Two strategies were key for achieving that: First, they generated political legitimacy for themselves and climate action by strategically using the intensifying global climate dialogue and the emerging organisations and networks. The fact that South Africa hosted several high-level climate conferences in the early 2000s and that Cape Town was a popular international tourist destination with rich biodiversity made this a very powerful approach in the City. Organisations such as C40, ICLEI as well as multilateral and bilateral donor agencies provided resources, advisory services and global exchange opportunities. Crisis events such as the drought in Cape Town in 2017/18 (Ziervogel, 2019) also helped to draw national and municipal attention to the potential impact of climate change and to the need to mitigate emissions and adapt. The second strategy that change agents used to make climate action more appealing for local politicians was to reframe it in line with the economic and political priorities of the party that ruled the City, which were economic growth and job creation. The concept of a "green economy" has therefore become popular both in Cape Town and in the country.

50 For a comparative study of other South African cities with a similar purpose, see SEA, 2020a.

As a result of their successful internal administrative and political lobbying, Cape Town became the first South African city to approve a municipal Energy and Climate Change Strategy in 2006 and employ its first energy officer. The inclusion of climate goals into the City's IDP meant that climate action was mainstreamed and integrated into Cape Town's routine work. In subsequent years, the City developed more sophisticated climate action policies and strategies and boosted energy efficiency in municipal operations, increased small-scale embedded solar energy generation, promoted more energy-efficient consumer behaviour, and set the goal of reaching zero carbon by 2050.

Another important proactive step that the climate change department in the City took together with the Western Cape Government was the creation of a sector development agency (GreenCape) (LEDS GP, 2016) and other intermediaries (Economic Development Partnership) (Western Cape Economic Development Partnership, 2014). These organisations primarily attract and link potential investors and the private sector more generally to the City and the Province. The goal is to facilitate the growth of their green tech sector and to identify synergies between government and private companies.

In many regards, the City of Cape Town is today regarded as one of the urban climate action models in South Africa. It has been particularly proactive in using existing policy space (for instance, small-scale embedded renewable energy generation; requesting high energy efficiency standards in buildings) and even challenging the national government in court with regard to large-scale renewable energy procurement from IPPs.

While the climate action change agents' internal proactivity within the City has been quite successful, the City's broader external success now depends on resolving institutional and regulatory inconsistencies and unclear responsibilities and authorities across local, provincial and national levels of government (see also Petrie et al., 2019). Particularly with regard to reducing the dominance of centrally distributed coal-based electricity, substantial changes at the national level and in the way national and municipal governments interact are necessary. It is because of this that we call the Cape Town's zero-carbon transition efforts "constrained".

Finally, the City of Cape Town's transformation attempts are "stretched" because poverty, un- and underemployment as well as inequality remain high and urban services still do not reach everybody and are often low-quality. The expansion of services, economic growth and job creation therefore remain high on the municipal political agenda. These are also the concerns that have fuelled major public protests across the country in recent years, especially at the local level, including in Cape Town. Despite all the efforts of integrating these priorities with climate and emission reduction goals, when capacity and resources are scarce – as they often are – the latter tend to lose out. Therefore, even in the City of Cape Town, which has a higher level of capacity and resources than most other South African cities, it remains challenging to integrate socio-economic and climate priorities into everyday practice.

To conclude, the City of Cape Town's internal and external proactivity has been driven by a group of highly competent and mission-driven experts-turned-city-officials with strong networks to external experts and researchers. In addition to their expertise, they were sensitive to the local administrative and political context so that they could lobby for their cause, often supported by international events, networks and resources as well as by some national initiatives. Local agency and capacity were key during this initial phase of the transformation. For the next phase, however, urban socio-economic and climate challenges have to be integrated even further. In addition, institutional and regulatory inconsistencies and uncertainties between national and local government levels should be sorted out. It will be only then that an urban transformation can lead to more equal development that is also carbon-neutral by 2050.

4.4.4.2 Stakeholder involvement

Broad participation of stakeholders is often considered essential for the transformation towards carbon neutrality (**H1.1**). In practice, however, coalitions of stakeholders in Cape Town are not very broad. While a strong focus lies on the participation of researchers, broader civil society and lower-income groups are often not included. Accordingly, the kind of coalition so far seems to have mattered more for the transformation towards carbon neutrality than the size or the breadth of these coalitions. To get a better understanding of the stakeholders involved in climate-mitigation activities in Cape Town, the following paragraphs will give a brief overview of relevant stakeholder groups.

To build partnerships between different groups of stakeholders, organisations such as GreenCape or the Western Cape Economic Development Partnership have the mandate to facilitate collaboration between the local government, the private sector, academia, and NGOs.

Academia plays a particularly important role in Cape Town. From the very beginning of climate action in the City of Cape Town, the city administration cooperated closely with several departments and institutes of UCT such as the environmental department and the African Centre for Cities (ACC). There are also a variety of think tanks and consultancies in Cape Town that work on climate-related matters. Several of these organisations are non-profit organisations and therefore blur the boundaries between consultancies, think tanks, advocacy organisations, and NGOs. Examples of this type of organisation are Sustainable Energy Africa or South South North.

Although a broad range of NGOs are active in Cape Town and South Africa, many of them primarily work at the national level. In the collaboration of the city administration with other stakeholders, NGOs tend to play a marginal role. The following statement illustrates the relationship between NGOs and the local government: “The city has got a bit of a reputation of not listening to grassroots stakeholders. It is not very easy for communities that are not professionals to access the city” (interview with a think tank representative, 22 April 2021).

The most underrepresented group of people in the transformation process are those with the lowest income. Many of them do not have basic education and cannot afford transport to participate in stakeholder meetings and workshops. In addition, carbon neutrality is an intangible issue for many people in Cape Town who are facing more urgent problems than the reduction of CO2 emissions. In many marginalised communities, trust in the local government is low.

The private sector in Cape Town is generally willing to collaborate with the city administration. Businesses are often able to join discussions and give their input before other groups. Yet, one interviewee emphasised that many private companies do not want to be seen as too close to government and therefore insist on clear boundaries between their role and the role of the local government (interview a with sector development agency representative, 23 April 2021).

Other major stakeholders in Cape Town are international city networks such as ICLEI and C40. ICLEI was particularly influential at the start of the sustainability debate in Cape Town in the early 2000s. In recent years, C40 has become more significant. Since 2018, a C40 city advisor has been working as an additional resource person in the city administration to facilitate and support the development of the Climate Change Strategy and the Climate Action Plan.

The mode of involvement depends on the respective stakeholders and the purpose of their involvement (**H1.2**). As the following statement illustrates, it is important to start involving stakeholders early in the process: “People appreciate that they are asked in the generation of the ideas, not to critique what has already been done” (interview with an NGO representative, 20 April 2021).

A continuous and collaborative relationship exists in particular between researchers and mission-driven professionals in the Energy and Climate Change Directorate. Some of these

officials tend to use their professional networks to recruit more people for the Energy and Climate Change Directorate, thus establishing a direct relationship and a close collaboration between the city administration and these organisations. In that way, a different culture has been able to enter the department from outside: innovative, knowledgeable, and mission-driven professionals with a strong capacity and ambitious goals seem to be able to drive innovation in a different way than officials who have been working within the structures of the city administration for many years. Moreover, through an embedded researcher programme, PhD students were inserted into the city administration for a limited period to conduct policy research related to climate change, which was of interest to both the city administration and the academics (Scott, Anderson, et al., 2019). As such, this continuous collaboration has been useful for capacity building, strategy development and mutual understanding between academia and the local government.

One example of knowledge co-production in Cape Town is the Climate Change Think Tank. Initially, the think tank started as the CityLab programme of the African Centre for Cities (ACC). The ACC was among the first academic institutions to recognise that a considerable amount of knowledge sits outside of the university. Eager to foster transdisciplinary knowledge co-production with the local government and civil society, the ACC signed a memorandum of understanding with the City. With external financial support, the result was the formation of a think tank led by the City of Cape Town and the ACC (Cartwright, Oelofse, Parnell, & Ward, 2012). Researchers from different academic disciplines, members of the local government and representatives of NGOs were involved. However, there were also gaps in participation: although certain NGOs such as the World Wildlife Foundation participated, other important civil society actors such as Slum Dwellers International or the Social Justice Coalition were not included.

The Climate Change Think Tank presented an innovative approach to climate change, both in terms of what knowledge was created, and how (Cartwright, Oelofse et al., 2012). To begin with, it commissioned research conducted by interdisciplinary teams consisting of academics, city officials, consultants and representatives of NGOs. Thus, the think tank created a space for experimentation and knowledge co-production. The local government benefited from the collaboration as it received support to its policy strategy, planning and implementation work. In turn, the researchers gained a better understanding of practitioners' knowledge and the difficulties associated with political processes and administrative structures in a city. Accordingly, the think tank fostered mutual trust and understanding between researchers and city officials, thus bridging the gap between local government and academia and advancing collaboration on climate change research and policy. The extent to which knowledge co-productive approaches were used in Cape Town is evidenced by the fact that researchers and city officials together published two books about their experiences and lessons learned (Cartwright, Parnell, Oelofse, & Ward, 2012; Scott, Davies, & New, 2019).

Apart from the collaborative involvement of researchers, a variety of other stakeholders are involved in the development of the Climate Change Strategy. In Cape Town, it is legally required for any strategy to go through a public consultation process. For the Climate Change Strategy, the local government received inputs from different stakeholders, for example through informal conversations and workshops. However, the strategy was not developed in a collaborative way since the actual drafting took place in an internal process.

In terms of impulses from the outside, the city administration does not seem to actively seek initiatives from non-public actors. Instead, the city administration has been leading and driving a lot of the engagement with stakeholders. Rather than seeking the initiative from outside, officials in the Energy and Climate Change Directorate seem to look for resources and allies in their fight against climate change within other departments of the city administration. However, one example for a project initiated by an NGO is the Kuyasa low-cost urban housing energy upgrade project. The aim of the project was to equip low-income housing with insulated ceilings,

solar water heater installation, and energy-efficient lighting. Although support and modest financing from the government were important, the project was largely financed with external and private funds and therefore needed an external push to happen, as it was difficult to implement within the traditional government bureaucracy.

4.4.4.3 Urban finance

Cape Town's budget for climate change mitigation is still marginal: in 2018, less than 3 per cent of Cape Town's annual budget was dedicated to GHG emission reduction activities. The most important sources to finance GHG emission reduction activities are intergovernmental transfers, local taxes, and grants from international organisation and donors.

Additional funding for green infrastructure seems to be beneficial for the transformation towards carbon neutrality (**H2**). This relationship appears particularly relevant in terms of donor funding since many expensive projects such as long-term research collaborations between the city administration and academia or the equipment of low-income housing with solar panels are funded by donors. However, the scope of funding per se does not seem to be the major bottleneck for transformative change in Cape Town. Instead, the prioritisation and mainstreaming of climate action in the municipal budget seems to be a bigger challenge. Moreover, several interviewees stressed the need to align mitigation activities with service-delivery improvements to be able to receive funding.

In Cape Town as in other South African cities, local resource mobilisation can act as an obstacle to the transformation towards carbon neutrality. The city is allowed to collect and keep own taxes, which it uses to finance GHG emission reduction activities. However, a major part of Cape Town's revenue originates from selling electricity. A challenge is thus the trade-off between mitigation efforts and revenue generation: as energy efficiency or reduced energy demand reduce the municipality's revenues, the local government has a monetary incentive to impede or slow down efforts to increase energy efficiency (Petrie et al., 2019).

So far, market-based financing options do not play a major role in the transformation towards carbon neutrality in Cape Town. The city qualifies for local and international financial instruments as well as for concessional lending through development banks and international organisations due to its solid financial governance and the resulting creditworthiness. Yet, the potential of market-based finance is ambiguous. On the one hand, Cape Town has issued a highly celebrated green bond, which has raised R1 billion for electric buses and sustainable water infrastructure (Petrie et al., 2019). On the other hand, one interviewee described green bonds merely as "expensive debt" for the municipality (interview with a researcher and consultant, 21 April 2021). Private capital and public-private partnerships seem to play a certain role in specific sectors as well as in service delivery and the provision of green infrastructure.

A variety of funding sources might be beneficial for transformative change in Cape Town, for instance preventing strong dependence on individual donors. However, bilateral donors and international climate funds often grant financial means for a specific project and a limited period of time. This can impede the reliability and continuity of climate action as well as the development of more sustainable ways of revenue collection in Cape Town (Petrie et al., 2019). Apart from that, transformative action in Cape Town seems to depend less on the variety of funding sources than on the prioritisation of climate action in the municipal budget.

Obviously, sufficient funding is necessary to advance mitigation efforts and reduce GHG emissions. The case of the Kuyasa low-cost urban housing energy upgrade project illustrates the importance of funding for a mitigation project to reach a certain scale: After the pilot phase, there was a promising opportunity to scale up the project and create further benefits in Cape Town's low-income housing sector. However, due to limited flexibility in financing, the upscaling did not take place.

Nevertheless, an increase in available funding alone is not sufficient to achieve a transformation towards carbon neutrality, as funding is not the major bottleneck in Cape Town. Different priorities in the local government, enormous developmental challenges, as well as a bureaucratic inertia and a lack of coordination within the city administration seem to be other obstacles to a successful transformation. A particular challenge in Cape Town is the immediate need for infrastructure and service-delivery improvements in contrast to the perceived high cost of green infrastructure investments. Accordingly, the local government may prefer tangible service delivery improvements to high-cost investments in green infrastructure.

4.4.4.4 Impact assessment

Cape Town is currently building up its capacity to systematically collect data on GHG emissions. To a certain extent, this progress was triggered by the city's commitments to international reporting (such as to the CDP). In addition, the city is receiving external support, for example by C40. Since 2018, a C40 city advisor has been supporting the city administration with technical issues, GHG modelling, inventory work, target setting and the development of scenarios. Overall, the importance of measuring GHG emissions is increasingly recognised.

However, there is no comprehensive impact assessment in Cape Town (**H3**). While a lot of progress has been made in terms of data collection in recent years, an integrated system for evaluation and learning is not yet in place. According to one interviewee, systematic evaluation procedures as well as collaborative evaluations with multiple stakeholders do not usually take place (interview with a researcher, 19 April 2021). Yet, Cape Town has a strong media and communication department, which actively communicates the city's activities and its success in the field of climate action to its citizens and to the international community.

Generally, it seems to be difficult to attach a causal impact to specific mitigation activities in Cape Town. Yet, one interviewee emphasised that the main objective of monitoring and evaluation in the city is not to attribute impacts to specific activities but to guide strategic attempts and strengthen the city's overall approach to climate change (interview with an international adviser, 19 April 2021).

Monitoring and evaluation is mainly done in-house by the city administration and with support from the C40 city advisor. In addition, the city administration is collaborating with external providers to get access to different sources of data. One interviewee mentioned the possibility to outsource monitoring and evaluation to a university or a research institute with the aim to strengthen the accountability of the local government (interview with an international adviser, 19 April 2021).

4.4.5 Summary

The City of Cape Town's transformative efforts towards zero carbon can be summarised as "proactive but stretched and constrained". While a lot of progress has been made in recent years in terms of administrative and political awareness as well as institution-building and initial mainstreaming based on an internally proactive team and an externally proactive city, major challenges remain. The City remains stretched in terms of fully integrating climate change considerations into its economic growth and service-delivery priorities. And it remains constrained by the absence of clear mandates and authorities because a fully integrated multi-level government system for climate action and emission mitigation in South Africa is still "work in progress". A key feature of Cape Town's transformation path is the close link between research and local government, based on continuous exchange and working relationships.

5 Conclusions

This study has developed a new framework for the analysis of successful transformative change towards carbon neutrality in cities. It has applied this framework and provides new insights on major governance dimensions of urban zero-carbon transformation. Our findings indicate that stakeholder involvement, financial resources, and impact assessment are important governance factors for successful transformation. Efforts in these three areas can contribute to broadening, accelerating and legitimising transformative change.

The empirical part of our study was based on a worldwide survey and three case studies. The survey has brought to light significant achievements as well as priority areas for the future of urban climate change action. Three case studies contextualised the survey findings and complemented them by providing in-depth insights into the dynamics of the governance of urban transformation. The first part of the conclusions (subsection 5.1) summarises the results from the survey and the case studies and highlights where they complement or differ from each other. The second part (subsection 5.2) draws overarching conclusions.

5.1 Findings

With regard to our success dimensions for transformative change towards zero carbon, we found that many cities which participated in the survey showed decreasing per capita GHG emission levels between 2013 and 2018. Still, generally high city GHG emission levels indicated the need for further rapid change. This was also true for our three case study cities. While per capita emissions declined in all cases, total emissions increased in both Quito and Cape Town over the past years.

Climate accounting through GHG inventories was key for setting reduction targets and monitoring mitigation activities. In the Bonn case study, we learned that reliable data was also important for building acceptance and for accountability purposes. Therefore, it is reassuring that climate accounting through regular GHG inventories has been mainstreamed in most cities that responded to the survey. Nevertheless, the fact that this is not true for all responding cities, even in this sample of proactive cities, shows the need to establish reliable GHG inventories and access to relevant data more broadly.

Further, it is a promising result that concrete climate action plans and emission reduction targets have either been established or are currently being developed in most cities which took the survey. In Quito, the initiation of emission reduction activities through the local government is still comparatively recent. While it is true that Quito's ambitious climate-mitigation plans and strategies have been widely recognised, much work remains to be done with respect to their implementation. Bonn has been working with targets for a longer period of time. However, the city's ambitions have risen significantly with the introduction of a new target of reaching climate neutrality by 2035.

Drawing from the survey results, climate action seems to be being gradually institutionalised in the participating cities. All of our case study cities also indicated that the institutionalisation of climate action significantly boosted the actual climate activities taking place. An example of this is the establishment or expansion of agencies for climate action. Nevertheless, many climate-mitigation efforts and projects still depended to a large degree on individuals and were influenced by political cycles. To look ahead, a more systemic integration of climate change issues into the activities of local government could be beneficial. In Cape Town, important progress has been achieved in recent years in terms of administrative and political awareness. Information from the survey and interviews indicate that the integration of decarbonisation and

climate action into Cape Town's overall governance framework is likely to have contributed to a decrease in per capita CO2e emissions.

Most of the cities of the present study have been actively promoting the adoption of their approaches and solutions in other cities or regions in the same country. The promotion of activities in other countries is less pronounced, indicating potential for future international cooperation. A slight difference can be observed with regard to the case studies. While Quito and Cape Town both have an important role model function within their countries, more city-wide exchange and learning seems to have taken place in the case of South Africa. Quito and Bonn, on the other hand, have engaged more in presenting their cities as international frontrunners on sustainability and climate action.

Turning to acceptance, local governments further indicated that mitigation activities generally enjoyed support from local stakeholders and faced only limited opposition. Protests related to mitigation action were sometimes driven by demands for more ambitious goals and faster action. This also seemed to be true for the case of Bonn. Nevertheless, an important lesson learnt in Bonn was that, to find broad acceptance, climate-mitigation activities also have to have other benefits, such as improving service delivery.

It is generally difficult to assess the level of acceptance for climate-mitigation measures among citizens and stakeholders in a city. Other than in Bonn, however, where many mitigation initiatives were introduced by civil society, awareness for climate-related issues seemed to be lower among the general population of Cape Town and Quito. Here, the topic was primarily discussed among experts and activists. These cities face several other challenges, such as poverty, inequality and unemployment. For the next phase of transformation in these cities to be successful, it might be necessary to approach urban socio-economic and climate challenges in a more integrated manner, for example by combining CO2 emission reductions with improvements in public service delivery.

Regarding governance for transformative change, the survey provides descriptive evidence of a positive relationship between the inclusion of broad coalitions of stakeholders and an acceleration of CO2 emission reduction planning and implementation procedures. It also showed that frequent inclusion was associated with higher support for these activities in our sample. However, the stronger the inclusion of stakeholders in mitigation action, the lower the number of cities that applied these approaches.

With regard to the case studies, stakeholder involvement was an important factor but looked very differently in all three cities. In Bonn, broad coalitions in the field of climate action have emerged over the past 25 years, though it is important to note that stakeholder involvement was much more limited at the beginning of the process in the mid-1990s, when important reforms were initiated. Today, stakeholder involvement happens frequently and is highly institutionalised. The city uses broad participation also to jointly develop solutions on how to achieve carbon neutrality within the next 14 years. Stakeholder involvement also takes place in Quito, however it is often perceived as insufficient by civil society actors. Relations between the local government and stakeholder groups are often rather short-term and project-bound. Lack of trust and lack of continuity seem to be important factors that operate against longer-term forms of collaboration. In Cape Town, the process has been driven by a close collaboration between city government and academic institutions in externally funded projects and based on individual experts, some of which then switched from one sphere to the other. The strong involvement of academia is an interesting approach that sets Cape Town apart from the other case studies. However, the inclusion of broader civil society and especially lower-income groups is a challenge that all three cities share. To respond to low awareness levels, public participation in Quito often seems to have an educational and informational focus. In Bonn, local government made the experience that even with higher resources invested into more inclusive forms of participation, it is mostly people from a middle-class high-education background who participate.

Looking at urban financing, findings from the survey further show that additional funding for emission mitigation is associated with reduced GHG emissions over time. However, it remains open whether this means that additional funding leads to more emission reduction or that emission reduction enables the generation of additional funding, or both. Fiscal systems shape the capacities of cities to raise funds for transformative projects. Many cities rely mainly on traditional financing sources: intergovernmental transfers, local taxes and fees, and international grants in cities of the Global South. Additional funding through local revenue generation or market-based finance mechanisms is less widespread. Our case study cities Quito and Cape Town depend on external funding by international organisations and donors, which is less relevant in Bonn. Internal revenue and central government transfers, however, are important financing sources for all three cities.

The availability of funding presents a key challenge to Quito's climate action, as central government transfers tend to oscillate with the world price of oil – a main source of public income in Ecuador – and local revenues are insufficient. There is, however, an interesting difference between Quito's pathway of constructing a costly metro and Bonn's initial strategy of focusing on rather inexpensive measures. The case of Quito shows how a major infrastructure project may absorb fiscal space and administrative capacities and limit the space for other activities even though it may be highly relevant for future GHG emission reductions in the long run.

In Cape Town, a key lesson is the perverse incentives associated with the composition of local revenues: As South African cities generate approximately one-third of their income by re-selling coal-based electricity from the national provider to individual consumers, they may be less inclined to engage in expanding renewable energy production. However, Cape Town's efforts show that this negative incentive structure can be overcome. In general, funding is not a major bottleneck in Cape Town. However, socio-economic challenges and inequality often lead the local government to spend its budget on tangible service-delivery improvements rather than high-cost investments in green infrastructure. Similar circumstances were also said to reduce political incentives to invest in mitigation in Quito.

In terms of impact assessment, the survey provides descriptive evidence that cities that apply more rigorous methods of impact assessment have more frequently expanded or replicated mitigation activities within the city or are in the process of doing so. Most cities collect data, for example, on GHG emissions, but lessons learned from monitoring and evaluation are not always incorporated into ongoing or future projects. However, the use of impact assessment frameworks that link climate actions to specific outcomes such as emission reduction in cities is still a rather recent development. Like most other cities, neither Quito nor Cape Town have developed such frameworks but are focusing on improving data collection, the quality of data and the development of more general monitoring and evaluation systems. While data from Cape Town allows for the identification of basic emission tendencies over time, Quito has yet to conduct the respective measurements. Overall, it appears that much of the international acknowledgement both cities have received for their climate action in recent years is more based on ambitious goals, comprehensive plans, and ongoing projects than on current achievements.

In general, it seems that in the early stages of transformative change, the need for impact assessment is rather low as it is mostly committed people working on the topic who do not question the positive outcomes of emission reduction activities. Thus, scarce resources tend to be allocated elsewhere. In later stages however, awareness for emission reduction activities in the general population might be higher, as well as the amount of capital invested, and there might be a greater need to achieve acceptance of stakeholders as more transformational changes are to be introduced. Thus, accountability and learning seem to become more relevant at that stage.

5.2 Key lessons and limitations

Although our survey results sketch a positive tendency towards the advancement and institutionalisation of climate action in cities, the case studies reveal the many challenges that have to be overcome. These challenges include a variety of policy priorities, a lack of awareness of climate change, and financial constraints. Neither Cape Town nor Quito currently has a framework for inclusive governance and broad stakeholder involvement as the 2016 WBGU report envisioned (WBGU, 2016). Case study and survey results from Quito and Cape Town show that these cities often rely on external and donor funding for larger climate investments. This raises the question of how climate financing can be integrated more fully and more sustainably into local government funding and budgeting. In Bonn, such efforts are currently undertaken by introducing a sustainability budgeting system. Impact assessment is generally still at an early stage and seems mostly limited to quantitative data collection and analysis. Overall, these findings point to substantial room for improvements in urban climate action and real potential for more comprehensive and accelerated action in the future.

It is important to note, however, that the findings presented here are based on our specific conceptualisation of the topic and on limited access to data. Regarding conceptualisation, our study focused on climate-mitigation action. However, mitigation is only one side of the coin – especially since climate change is already having far-reaching impacts on urban habitats. Cities need to act on climate adaptation as well and they sometimes prioritise adaption over mitigation. In terms of planning and implementation, adaptation and mitigation are often closely interrelated and cannot be clearly distinguished. An analysis that includes both aspects could dig more deeply into these interrelations.

Our framework for success and governance dimensions entailed several simplifications for the sake of feasibility and operationalisation. For instance, we deliberately chose to analyse the three success dimensions independently from each other while being aware that they are interconnected in many ways. Also, the three governance factors that constitute our explanatory variables – stakeholder involvement, finance, and impact assessment – are not the only governance factors which could be considered. In the interviews, other factors – such as internal change agents, political leadership and collaboration between different levels of government – were repeatedly mentioned.

Field research was also affected by the COVID-19 pandemic, which prevented us from traveling and conducting in-person interviews and more comprehensive field work. Our analysis was further limited by the low response rate to our survey and the underrepresentation of cities from the Global South. Furthermore, the pandemic may have further diminished the capacity and willingness of local governments to respond to the survey. Getting access to local governments also took longer than expected, due to the massive workload of local officials at this moment.

Moreover, a general lack of data at the city level prevented us from integrating our survey data with other data sources. Future research should continue to explore correlations and causalities underlying transformative urban governance and climate action in cities. Such an approach would benefit from more, and expanded, initiatives to collect and publish larger data sets with more comprehensive city data samples on urban governance and climate action.

Being mindful of these limitations, this study contributes to the theoretical and empirical discussions in the field of transformative urban governance in several ways. First, our conceptual framework of success dimensions for transformative change is a contribution to ongoing theoretical and conceptional discussions in the field. Second, we address the broad data challenge in the field of urban governance and sustainability with our international survey which covered cities from various city networks and awards. While most studies on urban sustainability transformation focus on individual cities or a small number of cases from the same region, we adopted a micro-macro perspective by combining survey and case study data from

different continents. In addition, our analysis of financial resources and impact assessment addressed two largely overlooked but potentially important governance factors. Lastly, we investigated the widespread assumption that inclusive governance is needed for transformative change.

On the practical side, we are hopeful that our results will benefit city governments and the stakeholders that collaborate with them to reduce their urban GHG emissions. We hope that our research will contribute to the discussion and practice around GHG emission mitigation and transformative change towards zero carbon in cities.

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Annex

Table A1: List of all identified city networks and awards and contact strategy for the survey

City network		Sustainability award	
Name	**Contact strategy**	**Name**	**Contact strategy**
ASEAN Smart Cities Network	Individual contact strategy, depending on availability of public email addresses or website contact forms	C40 Cities Bloomberg Philanthropies Awards	Individual contact strategy, depending on availability of public email addresses or website contact forms
Association of Cities and Regions for Sustainable Resource Management		CIVITAS Award	
ASTon – Digital Transition for Sustainable and Inclusive Cities		European Energy Award	
BeePathNet (URBACT)		European Green Capital Award	
BioCanteens (URBACT)		European Green Cities Award	
C40 Cities Climate Leadership Group		European Green Leaf Award	
Carbon Neutral Cities Alliance		Global Green City Award	
C-Change (URBACT)		One Planet City Challenge	
Cities4Forests		Procura+ Awards	
Food Corridors (URBACT)		Smart 50 Awards (Mobility, Urban Infrastructure)	
Global Lead City Network on Sustainable Procurement		Sustainable Urban Mobility Planning (SUMP) Award	
Global Parliament of Mayors		The International Awards for Liveable Communities (Whole City Award)	
Global Platform for Sustainable Cities		Transformative Action Award	
Health & Greenspace (URBACT)		Transformative Cities Award	
IMPACTS		UN-Habitat Scroll of Honour Award	
Innovato-R (URBACT)		WeGo Awards (Sustainability, Mobility)	
Nordic Smart City Network		World Smart City Award	
POLIS Cities and Regions for Transport Innovations		WRI Ross Prize for Sustainable Cities	
Procura+ European Sustainable Procurement Network			
RegrowCity (URBACT)			
Resilient Cities Network			
Sharing Cities			
Smart En City Network			
Sustainable Cities Collaboratory			
City Loops			

City network		Sustainability award	
Name	**Contact strategy**	**Name**	**Contact strategy**
Edible Cities Network			
Ru:rban (URBACT)			
Stardust			
Tropa Verde (URBACT)			
Urb-En Pact (URBACT)			
Zero Carbon Cities (URBACT)			
CIVITAS Forum Network	Collaboration to contact member cities		
Global Covenant of Mayors for Climate & Energy			
ICLEI – Local Governments for Sustainability			
Cities for Mobility	Member cities not contacted		
Climate Alliance			
Energy Cities			
Eurocities			
IDB Cities Network			
Metropolis			
UN Global Compact Cities Programme			
WeGo (World Smart Sustainable Cities Organisation)			
World Resource Institute Ross Center for Sustainable Cities			

Table A2: International datasets covering aspects of transformative change in cities

Dataset	Variables covered	Size and coverage
CDP Full Cities Dataset	Emissions, renewable energy, mitigation action, climate hazards, opportunities, governance, water, adaption actions	812 cities, globally
Global City Emissions reproduced by the Global Carbon Atlas	Anthropogenic carbon dioxide emissions	343 cities, globally
Atlas of urban expansion	Air temperature, precipitation, CO2 concentration, population, population density, global human settlement population grid, GDP, particulate matter 2.5 concentration	200 cities, globally
OECD.stat Metropolitan areas	Various socio-economic and environmental indicators	668 OECD functional urban areas (city and its commuting zone) over 250,000 inhabitants in 33 OECD countries and Colombia
Environmental Insights Explorer	Size, population, building emissions, transportation emissions,rooftop solar potential; started: air quality and tree canopy	224 cities, not covering Africa
Carbonn	Population, area, GDP, targets, actions, performance (many missing values for last variables)	766 registered entities
Data Portal for Cities	Population, energy consumption	Several 10 thousand cities, however large differences based on countries, not covering Africa
Global Landscape of Climate Finance	Financing sources	Only for continents
UNdata	City population, availability of information and communications technology, type of water supply system, type of toilet, type of waste disposal, type of fuel used for cooking	Large sample of selected cities, exact selection criteria not clear

Dataset	Variables covered	Size and coverage
Urban Governance Survey	Jurisdiction, political representation and government structure, financial resources, assets and fiscal power, multi-level governance and decision-making processes, urban governance challenges, strategic planning instruments, transport governance	127 cities, globally
SNG-WOFI Database	Over 80 economic and financial indicators	National, state, and local government levels (Cities are not covered individually) in 120 countries in the world
eurostat metropolitan regions	Various socio-economic indicators	Cities in Europe and the United Kingdom
Geocoded datasets		
AidData geo data	Manifold	Regional data, not city-specific, globally
Major cities of the world	Country, subnational region and geoname ID	Cities above 15,000 inhabitants, globally
Geonames	Latitude, longitude, population	All cities with a population > 500, globally
World Cities Database	Latitude, longitude, density, population	Free version covers 26,000 cities globally, paid version up to 4 million cities/town, last updated 2020
Geocoded Datasets		
World (Major) Cities Database	Administrative division, population, and more	Different versions of dataset, up to 3 million cities worldwide
Urban Mobility Plan (UMP)	Urban mobility plan/transport strategy, population	829 cities and 695 larger urban zones in the EU, Iceland, Norway and Switzerland
GHSL – Global Human Settlement Layer	Population, population density, degree of urbanisation	Globally, per grid cell
City boundaries (polygon)	Administrative boundaries of cities	Globally (from Google Maps API)

Source: Authors

Table A3: City survey responses by source country

Source country	Number of city survey responses
Global North	**28**
Australia	1
Austria	2
Bulgaria	1
Finland	1
France	2
Germany	5
Greece	2
Iceland	1
Italy	2
Norway	1
Poland	1
Spain	1
Sweden	1
Switzerland	5
Turkey	1
United Kingdom	1
Global South	**15**
Argentina	1
Brazil	2
China	1
Colombia	1
Ecuador	1
India	2
Mexico	2
Peru	1
Philippines	1
Senegal	1
South Africa	1
Uganda	1
Unknown	**11**
Sum	**54**

Source: Authors

Table A4: List of interview partners for case studies

Interview partners

City of Bonn

- Senor city official, 26 March 2021
- Senior city official, 16 April 2021
- Sustainability advisory network representative, 22 April 2021
- City official (by email), 23 April 2021
- Former member of council, 30 Juli 2021

City of Cape Town

- Researcher, 19 April 2021
- International adviser, 19 April 2021
- NGO representative, 20 April 2021
- NGO representative, 20 April 2021
- Researcher and consultant, 21 April 2021
- Think tank representative, 22 April 2021
- Sector development agency representative, 23 April 2021

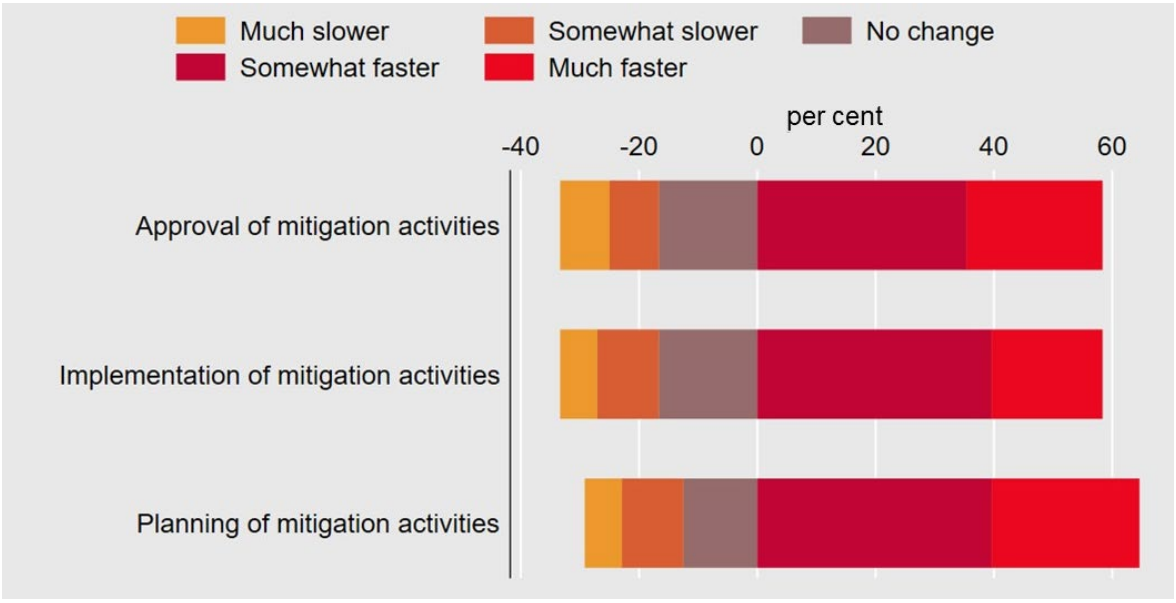
City of Quito

- Former city official, 13 April 2021
- NGO representative, 13 April 2021
- Researcher, 14 April 2021
- NGO representative, 15 April 2021
- Former city official, 16 April 2021
- City Official, 20 April 2021
- NGO representative and former politician, 20 April 2021
- NGO representative, 21 April 2021
- City Advisor (by email), 14 May 2021
- Former politician, 13 August 2021
- Ministerial advisor, 18 August 2021

Note: Due to the COVID-19 pandemic, all interviews were conducted virtually.

Source: Authors

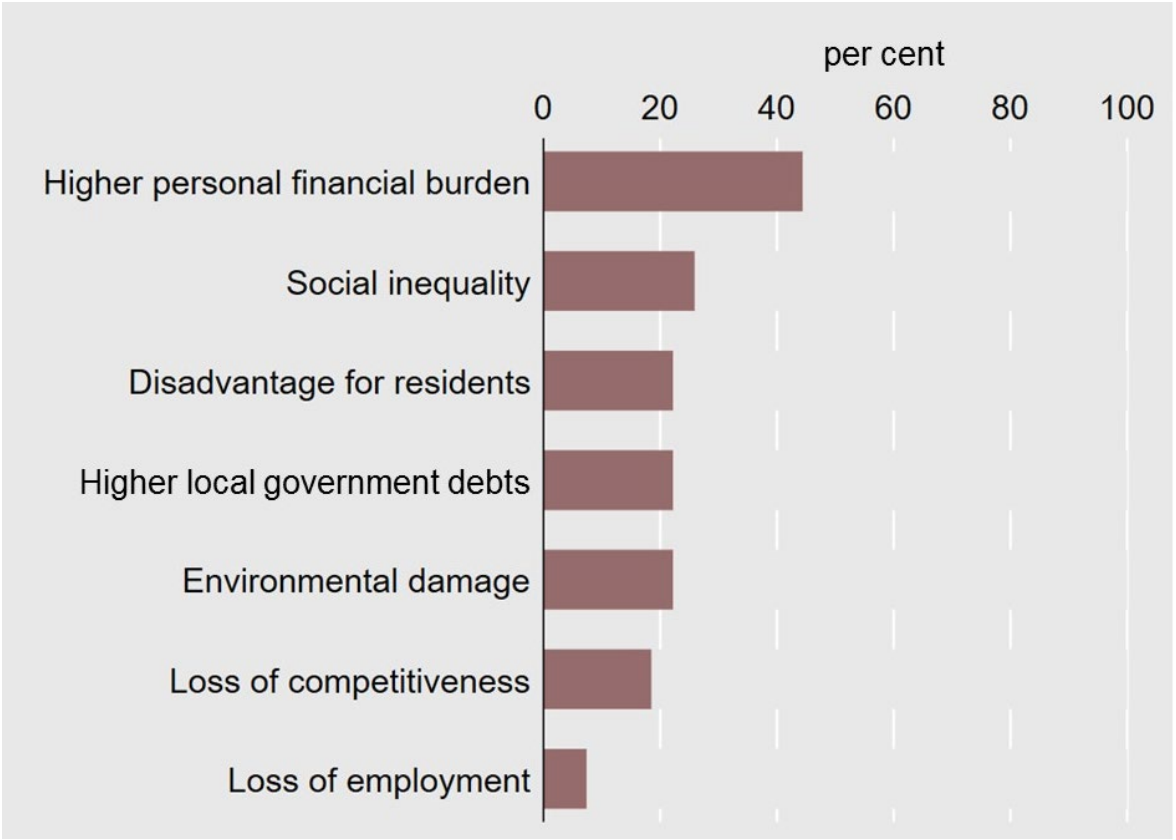
Figure A1: Change of speed (2013-2018) of approval, planning and implementation of mitigation activities



Notes: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Figure A2: Reasons for public expressions of discontent against mitigation activities



Notes: All percentages refer to the total of cities that responded to this survey question.

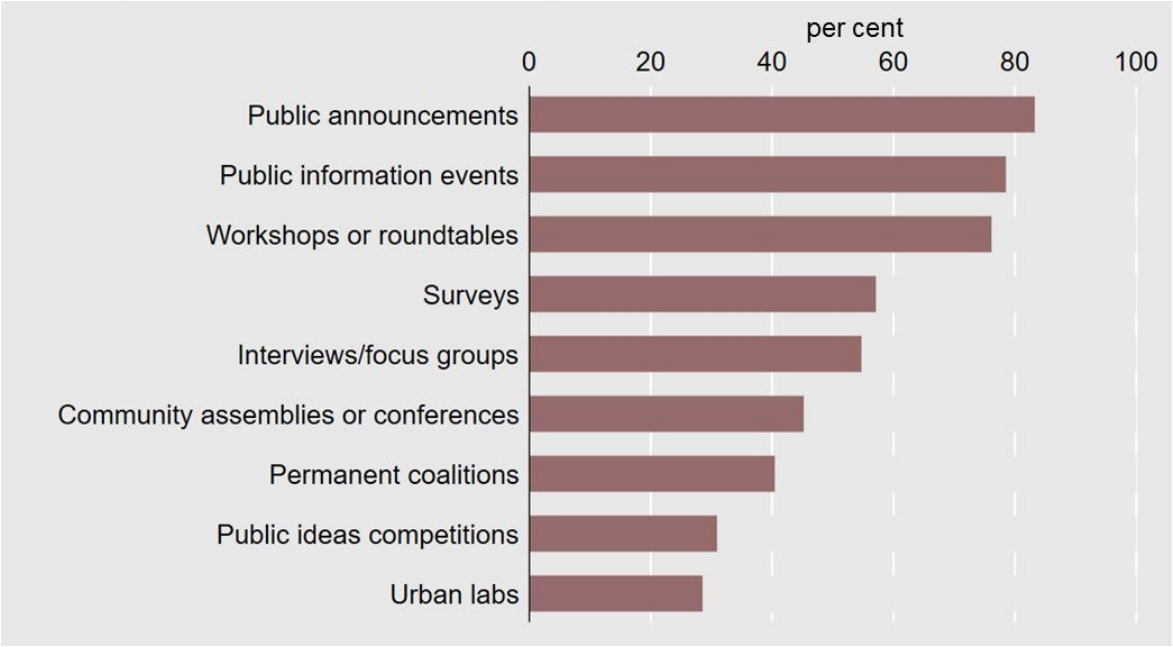
Source: Authors

Figure A3: Guidance cities rely upon in their mitigation activities

All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

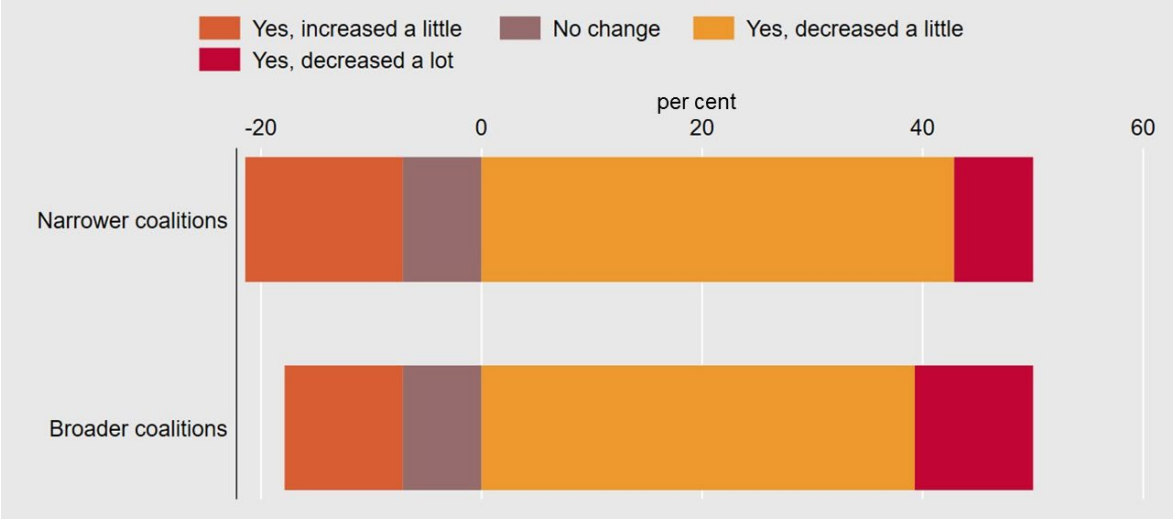
Figure A4: Tools used to involve stakeholders



Note: All percentages refer to the total of cities that responded to this survey question.

Source: Authors

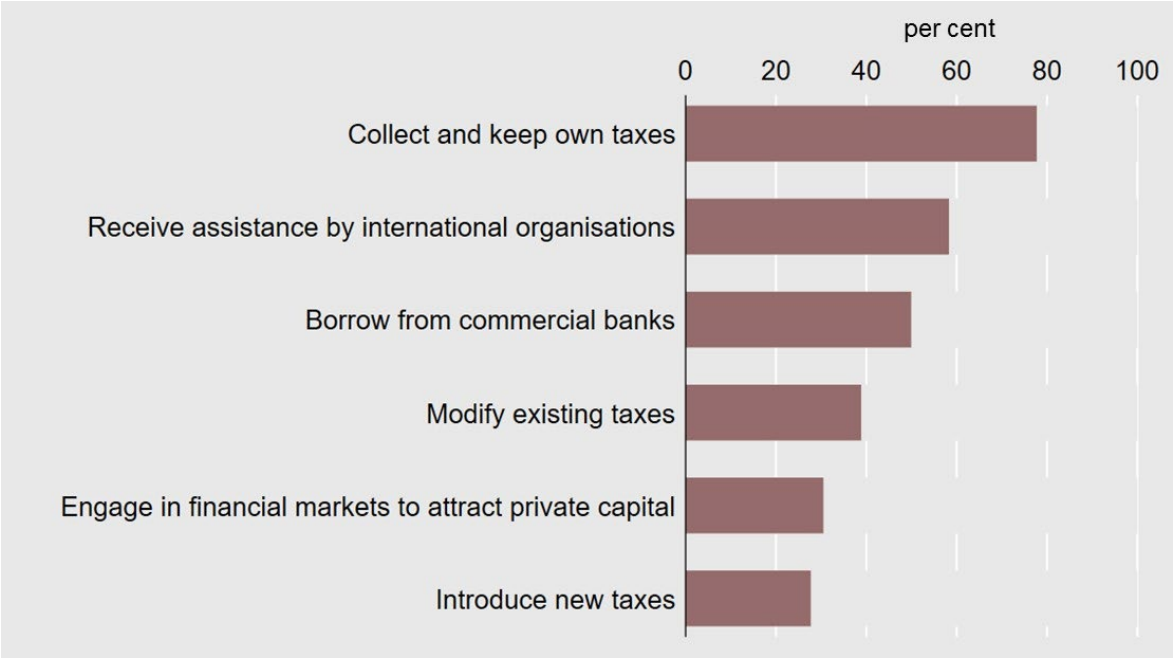
Figure A5: Cross-tabulation: Change in GHG emissions (2013-2018) and stakeholder involvement



Note: All percentages refer to the total of cities that responded to this survey question. Differences to 100 per cent represent those cities that chose “Cannot answer”.

Source: Authors

Figure A6: Local government financing options



Note: All percentages refer to the total of cities that responded to this survey question.

Source: Authors