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Matching forerunner cities: Climate policy in Turku, Groningen, Rostock, and Potsdam

Kristine Kern[1,2] | **Sam Grönholm**[2] | **Wolfgang Haupt**[1] | **Luca Hopman**[3]

[1]Research Group Urban Sustainability Transformations, Leibniz Institute for Research on Society and Space, Erkner, Germany

[2]Faculty of Social Sciences, Business and Economics, Åbo Akademi University, Turku, Finland

[3]Utrecht University School of Governance, Utrecht University, Utrecht, The Netherlands

Correspondence
Kristine Kern, Leibniz-Institute for Research on Society and Space, Flakenstraße 29-31, Erkner 15537, Germany.
Email: kristine.kern@leibniz-irs.de

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Abstract

This article analyzes and compares the climate policy and transformation pathways of the forerunner cities Turku (Finland), Groningen (The Netherlands), Rostock, and Potsdam (both located in Germany). Our study combines an international comparison of cities located in three different countries with a national comparison of two German cities. This research design is based on the assumption that national context matters. We argue that the chances for scaling local experiments between cities are particularly high among matching cities, which resemble each other. Such cities have the capability to learn by matchmaking, nationally as well as internationally. All four cities are mid-sized cities of roughly the same size located in advanced democracies in northern and continental Europe. Moreover, within their countries, all four cities have acquired the reputation of being forerunners in the area of climate policy. First, we focus on a comparison of the four cities and identify the strengths and weaknesses of their climate policies. Second, we assess the scaling potential of local experiments, in particular institutional and organizational innovations, integrative and participatory approaches, and leadership. Third, we analyze actual

scaling between the two German cities, which share the same national context. More generally, we explore how matching cities can develop from local pioneers to internationally acknowledged leaders, which have the ability to upscale successful local initiatives, nationally as well as internationally.

KEYWORDS
cities, climate policy, experiment, forerunner, scaling, urban transformation

INTRODUCTION

Research on urban climate governance has focused in particular on big cities, while smaller cities and towns have been neglected (Häußler & Haupt, 2021; Hoppe et al., 2016; Kern, 2019; Van der Heijden, 2019). Therefore, this article analyzes and compares the transformation pathways of four mid-sized cities in Europe that have all acquired the reputation of climate policy forerunners: Turku (Finland), Groningen (The Netherlands), Rostock, and Potsdam (both located in Germany). These cities were chosen as case-studies because they share many characteristics and match with respect to cultural heritage, socio-demographic factors, economic structure and development, etc.

Previous findings suggest that transfer and learning between cities have higher chances of success if the partners share certain contextual preconditions (Fisher, 2014; Haupt, 2021; Matisoff, 2008; Shefer, 2019). Although existing research has pointed to the importance of contextual factors, studies have neglected not only the characteristics of cities but also their embeddedness in multi-level systems (Kern, 2019), which may lead to transfer failure. These contextual factors include characteristics of the energy system and the national energy mix, financial autonomy of municipalities, national funding programs, and local decision-making. Assuming that the scaling potential between cities is higher if they share the same national context, we combine an international comparative analysis of four forerunner cities in three European countries (Finland, the Netherlands, and Germany) with a national comparison of two German cities.

Our analysis focuses on "matching cities" and develops an approach that combines the characteristics of cities that structurally resemble each other with potential and actual scaling of local experiments between them. We analyze three dimensions of matching cities: First, we start from a comparative approach and study the climate policies of matching cities, including for example their ambitions, strategies, institutional capacities, and international activities. Taking the similarities and differences of matching cities in climate policy into account, we can assess their strengths and weaknesses. Second, we study the scaling potential between matching cities, in particular with regard to institutional and organizational innovations, integrative and participatory approaches, and leadership. Here, we focus on local experiments (Bulkeley & Castán Broto, 2013; Kern, 2019) in matching cities and assume that they provide an excellent basis for exchanging knowledge and learning from each other. Third, we analyze actual scaling between the two German cities. We expect that forerunner cities that share the same national context are in a favorable position to jointly create solutions for new and emerging problems.

We assume that utilizing the full scaling potential may help matching cities to drive their transformation towards climate neutrality and resilience. We argue that the options for scaling

are particularly high among matching cities, which share many characteristics. Such cities have the capability to learn by matchmaking, i.e., by intentionally choosing other forerunners, nationally as well as internationally, with very similar characteristics and drawing lessons from their experiences.

Therefore, we study the preconditions for scaling local experiments. More generally, we ask whether and how the matching of mid-sized forerunner cities supports the scaling of local initiatives. We assume that collaboration between matching cities is a tool to develop new solutions, which can be applied to other cities, and that a city's capacity to engage in joint learning facilitates urban transformations. Overall, this paper fills a knowledge gap by systematically analyzing the chances and limitations of scaling between cities, while at the same time showing how matching cities can successfully cope with such challenges, in particular if they are located in the same country.

We continue with an explanation of the case-study selection and the methods, followed by the presentation of our conceptual framework and the context of our case-studies. Subsequently, we discuss the characteristics of matching forerunner cities from a comparative perspective and the scaling potential of local experiments. In addition, we explore actual scaling between the case-study cities which share the same national context. Finally, we draw some conclusions with respect to the chances and challenges of scaling between matching cities.

CASE SELECTION AND METHODS

For this comparative study we chose a most similar cases design. Therefore, we selected four forerunner cities from three EU member states. Our study includes not only an international but also a national comparison (Rostock and Potsdam, both located in Germany), which was added to show that national context matters. All four cities are growing mid-sized cities of roughly the same size (around 200,000 inhabitants), located in advanced democracies in northern and continental Europe (Table 1).

Turku has a rich cultural heritage and is the oldest city in Finland, founded in 1229. The city is situated in the vicinity of the Baltic Sea coast and sheltered by the islands of the Archipelago Sea. Turku's geographical location facilitated that the city became a significant Hanseatic city and important seaport. Today, with a population of around 194,000 inhabitants, Turku is the capital of the region of Southwest Finland, the third most populated Finnish region (with around 479,000 inhabitants). The city is a business and innovation hub, known for hosting a high tech science park and educational facilities in the fields of biotechnology and IT industries.

Groningen is an inland city in the northern part of the Netherlands, located close to the North Sea. It was first documented in 1040 and has played a dominant economic and political role in the northern part of the country throughout history. The city was a member of the Hanseatic League and had therefore many trade connections with northern Germany. Groningen hosts one of the oldest Dutch universities (founded in 1614) and is an important knowledge and education hub. Today, Groningen is with around 203,000 inhabitants the seventh biggest city in the Netherlands and the dominating city in the Province of Groningen (with around 587,000 inhabitants). It has a leading role in the bio-based economy and aims to become an important player in the "tech scene".

Rostock is a coastal city in the northeast of Germany in the former German Democratic Republic (GDR). The city extends about 16 kilometers along the river Warnow up to its mouth in the Baltic Sea. The first documents that mention the city date back to the year 1218. Rostock's

TABLE 1 City profiles

	Turku	Groningen	Rostock	Potsdam
Population (2020)	194,391 inhabitants; fast growing city; relatively young and above-average educated population	203,105 inhabitants; fast growing city; relatively young and above-average educated population	209,061 inhabitants; growing city since 2007; relatively young and above-average educated population	182,112 inhabitants; fast growing city; relatively young and above-average educated population
Economy	Industrial city, service economy growing; trade, shipyards, high-tech industry	Service economy; public services, health, commercial services, education	Industrial city, service economy growing; maritime economy, trade, shipping, life sciences, aerospace, wind power	Service economy; media and IT, life sciences and health, tourism and congresses, science and research
Local government (politics and administration)	Climate action supported by city administration; very engaged mayor; high representation of the green party in the local council	Climate action supported by city administration; engaged alderman; growing influence of the green party in the local council	Climate action supported by city administration and vice mayor; local council dominated by left-green parties	Climate action supported by city administration; local council dominated by left-green parties
Public utilities and services	Regionally operated public utilities and services, intercity cooperation	Privatized utilities	Regionally operated public utilities and services	Regionally operated public utilities and services
Research environment	University city with around 40,000 enrolled students; two universities, educational institutions	University city with almost 60,000 enrolled students; university, educational and research institutions	University city with around 15,000 enrolled students; university, educational and research institutions	University city with around 25,000 enrolled students; university, educational and research institutions
Civil society	Citizen engagement in local climate action relatively low; local engagement underdeveloped	Citizen engagement in local climate action relatively high; participatory mechanisms established	Citizen engagement in local climate action relatively high; participatory mechanisms established	Citizen engagement in local climate action relatively high; participatory mechanisms established

historical city center hosts one of Germany's oldest universities and the city port is a remnant of Rostock's cultural and economic significance within the Hanseatic League and the Baltic Sea region. With around 209,000 inhabitants, Rostock is by far the largest and economically most important city in the German federal state (*Land*) of Mecklenburg-Western Pomerania (with around 1,610,000 inhabitants) and an important regional economic hub, dominated by the harbor and its maritime economy.

Potsdam was first mentioned in the year 993, has a rich cultural heritage, and became known as a Prussian garrison and residence town. The city is located southwest of Berlin in the former GDR and shares a direct border with Germany's capital. The city stretches along the river Havel and five large lakes that surround the city center. Potsdam's Prussian gardens and palaces that cover about one third of the city territory were awarded the UNESCO world heritage status in 1990. With around 182,000 inhabitants, Potsdam is the capital and largest city of the German federal state (*Land*) of Brandenburg (with around 2,530,000 inhabitants). After the reunification of Germany, Potsdam became a dynamic regional economic hub characterized by research institutions and the service sector.

Our study relies on a qualitative approach to provide a contextually driven understanding of urban climate policy pathways in three different countries. It is based on reports on all four cities, starting with an extensive document analysis, spanning all key policy areas related to climate policies in each city (e.g., development of environmental and sustainability policies such as Local Agenda 21, mitigation and adaptation strategies, climate and energy reports, minutes of city council meetings).

The city reports constitute a point of departure for the study and has informed the interviews conducted with key actors. A total of 42 semi-structured interviews with 47 interviewees were conducted. 32 interviews took place between April 2020 and April 2021, while ten additional interviews were already conducted in 2017 and 2018. Most interviewees work in city administration (including leadership) (28), and public utilities (6). In addition, we interviewed local politicians (3), representatives of stakeholder groups and civil society (8), and persons working at higher levels of government (2).

Particular important are "veteran interviews", i.e., interviews with almost or already retired employees who have expertise on the development of environmental policy, sustainable development, and climate policy in the city over a long period of time (around 30 years). To complete the picture, we attended several events and workshops in the case-study cities that were organized by key decision-makers and specialists in the area of climate governance. Moreover, in 2020 we have carried out two focus group meetings that were attended by city staff and politicians from Turku, Rostock, and Groningen.

SCALING OF LOCAL EXPERIMENTS BETWEEN MATCHING FORERUNNER CITIES

Scaling of local experiments

In recent debates the scaling of local experiments has gained importance (see for example Kern, 2019; Van der Heijden, 2022). These debates are relevant from a theoretical as well as a practical perspective because they affect national and EU (funding) programs that often start from the assumption that good practices spread on a voluntary basis and facilitate urban transformations. This neglects the fact that different types of cities exist, among them many cities with a lack of transformative capacities.

The discussions on the scaling of local experiments focus on the question how local experiments spread within and between cities. Scaling within cities refers to place-based experiments such as pilot and demonstration projects that can spread from one neighborhood to other neighborhoods within the same city. The potential for scaling within cities has been subject to scholarly debates, for example with respect to the forerunner city of Copenhagen (Van Doren et al., 2020). This discussion focuses on instrumental and transformative knowledge that can be derived from low-carbon initiatives and emphasizes different categories of learning practices.

Moreover, there are different types of scaling local experiments (Kern, 2019): First, horizontal scaling which focuses on the voluntary spread of policy innovations between (forerunner) cities. This debate is based on older discussions on policy diffusion and policy transfer. However, it transcends these ideas because it takes the interdependent relations between cities, the options for joint learning, and the transformative potential of policy innovations into account. Second, vertical scaling focuses on the multi-level context of local authorities and concentrates on the scaling potential of local experiments in multi-level systems, including for example the impact of national and EU funding programs on "ordinary cities" (Haupt, Eckersley, et al., 2022) that lack the capacities of forerunner cities. Third, hierarchical scaling comes into play when voluntary forms of scaling do not work, in particular with respect to latecomer and laggard municipalities that do not even have enough capacities to apply for external funding. As our study focuses on forerunner cities only, we concentrate primarily on horizontal scaling between matching cities.

Matching cities

Urban transformations require policy change and social learning (Hall, 1993). Policy changes need to shift from existing to new policy instruments, and ultimately lead to changes of the underlying policy paradigm. We suggest a matching cities approach, which focuses on structurally similar cities, such as Turku, Groningen, Rostock, and Potsdam because we assume that scaling works best among matching cities—in particular if the national context is identical. We explore how matching cities can develop from local pioneers to international leaders. Based on previous research (Jensen et al., 2016; Kern, in press; Kern, Grönholm, et al., 2021; Kern, Irmisch, et al., 2021), our analysis concentrates on three dimensions of matching cities.

Comparison of matching cities

First, we compare matching cities and identify the strengths and weaknesses of their climate policies. Matching cities share many characteristics and show structural similarities related to population, economy, politics, public utilities, research environment, and stakeholder and citizen participation. Although we concentrate on mid-sized cities here, the matching cities approach can also be applied to smaller or bigger municipalities. Moreover, this approach is not limited to analyze forerunner cities but can as well be used to study latecomer or laggard cities. Based on the structural characteristics of matching cities and a comparative case-study approach, we therefore examine the climate policies of all four cities in a first step.

Scaling potential of local experiments

Second, we assess the scaling potential of local experiments. In this step we take only already existing policies and institutional innovations in the examined cities into account. Since matching

cities are not identical twins, they may differ with respect to their performance in specific policy areas (such as energy, transport, and green space). This enables them to learn from each other on a bilateral basis. This step requires a comprehensive assessment of climate policy approaches and their implementation in matching cities. On this basis, it is possible to identify and select institutional and policy innovations which seem to be the most appropriate candidates for scaling between matching cities. In this step, we focus on local climate experiments, in particular on institutional and organizational innovations, integrative and participatory approaches, and leadership.

Scaling between matching cities

Third, we analyze actual scaling between matching cities. In this step, we combine an international comparison with a national comparison of two matching cities in Germany, assuming that the prospects for successful scaling between matching cities are better if the national context is identical. We assess how these cities exchange their knowledge and experiences, and adjust innovations to local conditions. In this step, we focus not only on existing innovations. We identify new and emerging challenges that matching cities face in a similar way, and that may require not only new policy instruments but changes of the underlying policy paradigm. Starting from the assumption that matching cities have the potential to jointly develop new solutions for common problems, the matching cities approach also includes an assessment of the chances for the joint creation of new approaches.

The comparative analysis (step 1) provides a basis for assessing the scaling potential of already existing and tested policy innovations (step 2). Moreover, the comparison also helps to identify emerging problems and possible solutions in matching cities (step 3).

Climate policy forerunners

In this article, we focus on matching forerunner cities, though our approach also works for other types of cities. Matching forerunner cities show a similar combination of structural characteristics (such as a growing population, a vibrant research environment, and an active civil society), which makes them most likely climate policy forerunners. These characteristics are namely (Bedsworth & Hanak, 2013; Eckersley, 2018; Fitzgerald & Lenhart, 2016; Homsy, 2018; Hoppe et al., 2016; Keeler et al., 2019; Kern, 2019; Kern, Grönholm, et al., 2021; Kern, Irmisch, et al., 2021; Krause, 2011; Sharp et al., 2011; Zahran et al., 2008):

- a growing, young and above-average educated and skilled population;
- a sound economic situation and a high number of jobs in the service and green tech industry;
- political and administrative support for climate action and political influence of green parties;
- ownership of public utilities and service companies (in particular energy, transport, and housing);
- a supporting research environment, in particular research which focuses on climate issues;
- a strong and active civil society, especially environmental and climate action groups.

Based on an extensive document analysis and interviews in all four cities (see Section "Case selection and methods"), Table 1 shows the city profiles of our case-study cities and demonstrates

that they share almost all characteristics, which are considered as good predictors for becoming a climate policy forerunner.

All four cities acquired the reputation of a (relative) climate policy forerunner, at least from a national perspective, and are recognized as forerunners by their peers. Turku is among the most advanced cities in Finland (Grönholm, 2022; Huovila et al., 2022), characterized by a strong EU and international orientation. Groningen is leading among mid-sized Dutch cities and known for its early institutionalization of environmental policy and its bike-friendly policies. Turku as well as Groningen applied and were selected by the EU for the EU "Mission on 100 Smart and Climate-Neutral Cities". Both German cities show a more national orientation, but they have been successful in competitive national bids and received awards for their climate policy efforts (see Haupt, Kern, et al. 2022; Otto et al., 2021). However, Table 1 also reveals a few weaknesses of our selected cities, namely Groningen's privatized utilities and Turku's underdeveloped civil engagement.

CONTEXT MATTERS

As all four cities are located in EU member states, EU legislation influences their climate policies, in particular by regulations (such as the regulation of CO_2 emission standards for vehicles) and directives (such as the regulations on energy efficiency standards for new buildings). EU legislation restricts local climate policies in certain areas such as the EU ETS that regulates all big companies within city boundaries. However, this EU influence has the same or at least very similar effects on all four cities.

In all three countries climate policy is a voluntary task of municipalities. While it is part of local self-government in Rostock and Potsdam, based on rather traditional forms of governance, Turku's voluntary efforts link such forms with new multi-level governance features. Groningen's climate activities are also voluntary, but Dutch municipalities take up climate initiatives agreed upon in the national Climate Accord (2019) between the national government and key stakeholders such as the Association of Dutch Municipalities (VNG). While local governments in all three countries started climate action on a voluntary basis, their initiatives take place in different national contexts, in particular with respect to the national energy mix, financial autonomy, national funding programs, and local decision-making.

As the energy mix and the dependency on fossil fuel differ considerably between Finland, the Netherlands, and Germany (Table 2), cities in the three countries face different challenges

TABLE 2 Share of energy products in total energy available, in %, 2019

	EU	FIN	NL	GER
Solid fossil fuels	12.6	10.9	8.2	19.6
Total petroleum products	36.4	25.7	47.6	36.0
Natural gas	22.4	6.2	36.5	24.4
Nuclear energy	13.1	16.4	1.0	6.2
Renewable energy	15.3	35.4	6.2	14,6
Others	0.2	5.4	0.5	0.0
Fossil fuel	71.4	42.8	92.3	80.0

Source: Eurostat (2021).

to become climate-neutral. Turku's ambitious climate policy is supported by the most favorable contextual setting because Finland aspires to become fossil-free by 2035 (Finnish Ministry of the Environment, 2021a; IAEA, 2019), compared to Germany in 2045 and the Netherlands in 2050. With respect to interim goals, Germany (with reductions by 65% by 2030 and 88% by 2040) is more ambitious than the Netherlands (with 55% to 60% by 2030, 70% by 2035, and 80% by 2040) (VVD, D66, CDA, & ChristenUnie, 2021). Finland also shows the highest shares of renewable and nuclear energy in the energy mix, and the use of coal for electricity generation will be phased out by 2029.

Despite insufficient funding and a privatized energy market, Dutch cities are responsible for the energy transition within their boundaries, i.e., for the heating and electricity systems of their housing stock (Government of the Netherlands, 2019) (interviews 33, 38). The main challenge in the Netherlands is to phase out natural gas. In 1959, one of the biggest natural gas fields in Europe was discovered in the Province of Groningen, and in 2019 around 90% of the total national housing stock was connected to the national gas grid (Statistics Netherlands, 2021). In 2018, it has been decided to stop gas extraction in the region of Groningen by 2030. Until then, the gas field in Groningen should be mainly used as a source in reserve. Dutch gas was increasingly replaced by imported gas (Ministry of Economic Affairs and Climate Policy, 2020). However, due to the war in Ukraine and the stop of gas imports from Russia, the extraction of own gas as well as nuclear energy are back on the political agenda.

Although the generation of renewable energy in Germany has increased considerably over the years (Strom-Report, 2021), Germany's energy transition (*Energiewende*) (Beveridge & Kern, 2013) is characterized by the double challenge of phasing out both nuclear energy and coal. After ongoing debates since the year 2000, the Fukushima disaster in 2011 led to the final decision to phase out nuclear energy by 2022. In addition, the German parliament decided in 2020 to phase out coal by 2038. Yet, the war in Ukraine has considerable impacts on Germany's energy policy due to the historically high dependence on natural gas from Russia. The need to replace Russian gas led to debates to extend the life span of the three remaining nuclear power plants and the need to reduce the consumption of natural gas.

In all three countries, municipal funding consists mainly of own revenues (such as property taxes) and financial transfers, in particular from the national government, based on certain indicators (e.g., number of inhabitants, characteristics of the population, size of the municipal area). Yet, financial autonomy differs considerably between the three countries. Finnish municipalities are the main producers of welfare services and therefore far more autonomous than Dutch and German municipalities. They have the right to directly levy municipal income taxes, and thus around 76% of the revenues consist of direct municipal taxes and fees, while only about 24% are made up of financial transfers from the state (Finnish Ministry of Finance 2021). In contrast, Dutch municipalities receive around 60% of their income from the national government (COELO, 2021), including 52% from the *Gemeentefonds* (VNG, 2021a). In Germany, financial transfers, including a share of federal income taxes, account for more than 50% of the local revenues, especially in poor municipalities (Thöne & Bullerjahn, 2020).

Although some sort of funding program for local climate action exists in all three countries, German cities enjoy the best options to apply for national funding. In 2008, the German federal government set up a national funding program for local climate policy as part of the national climate protection initiative. The program (called "*Kommunalrichtlinie*") has supported the funding of technical infrastructure (such as street lightning), created new jobs for climate managers, and facilitated the development of local climate strategies. By the end of 2020, almost 19,000 projects in around 4000 German municipalities were funded (with around 820 million

Euros) (German Association of Local Public Utilities, 2021). In Finland, the "Municipal Climate Change Solutions Program", set up by the national government in 2018, aims for translating national reduction targets into local action. The program aspires to reduce local GHG emissions as much as possible in a fast, cost-effective, and widely accepted way. Most of the funding is directly targeted to support innovative municipal climate projects (Finnish Ministry of the Environment, 2021a, 2021b). In the Netherlands, the implementation of the national Climate Accord is supported by funding programs (e.g., "Program Natural Gas-free Neighborhoods"), especially for pilot projects (interview 38). The VNG and the Council for Public Administration asked for a long-term financial plan that gives municipalities more autonomy to act (Council for Public Administration, 2021; VNG, 2021b).

In all three countries, local decision-making depends on stakeholder and citizens' participation. There are statutory rights to initiate referendums, e.g. city council members may initiate a referendum, or a minimum quorum of eligible voters may submit a referendum motion to the city council. However, referendums are not always legally binding, meaning that city governments have various options to deal with the result of a referendum (for Finland see Jäske, 2017). Moreover, the practice of such forms of direct democracy differs considerably between the three countries. In Groningen, local referendums have taken place and influenced urban planning (interview 38). Groningen pursues an active approach to citizen participation, including the integration of citizens' perspectives in neighborhood-based energy transition projects (interviews 33, 37). Similar to the Netherlands, local referendums can be of great importance in German municipalities, such as a referendum on bike infrastructure in Rostock (interviews 2, 4, 6, 9). Although similar legal provisions exist in Finland, these options are hardly used. For instance, the development of Turku's climate policy has not relied on forms of direct democracy and institutionalized forms of stakeholder and citizen participation.

This overview on the national energy mix, financial autonomy, national funding programs, and local decision-making shows that the national context differs considerably between the three countries. Finnish municipalities are in a far better situation with respect to the national energy mix and financial autonomy, German municipalities are in a favorable position with respect to national funding programs for local climate action, and Dutch municipalities have a long experience with citizen participation. It can be assumed that these strengths and weaknesses can be balanced to a certain degree. For instance, limited financial autonomy may be compensated by a national funding program. In other words, contextual conditions in different areas may work as functional equivalents. However, the pronounced differences of the national energy mix in the three countries puts Finnish municipalities in the best position to become climate-neutral.

ANALYSIS OF MATCHING CITIES

International comparative analysis

Our findings suggest similarities as well as differences between the four cities (Table 3). Although Turku has set the most ambitious climate policy target by aspiring to reach climate neutrality by 2029, all four cities are national forerunners. They succeeded in competitive bids (such as the German program for Masterplan communities) and participate in programs that require permanent monitoring and evaluation reports (such as the EU Covenant of Mayors). By aiming for CO_2 neutrality by 2035, Groningen and Rostock are forerunners compared to other Dutch and German cities (Municipality of Groningen, 2018).

TABLE 3 Climate policy in Turku, Groningen, Rostock, and Potsdam

	Turku	Groningen	Rostock	Potsdam
Ambitions	Climate-neutral by 2029	Climate-neutral by 2035; climate-resilient by 2050	Climate-neutral by 2035	Climate-neutral by 2050
Strategies	Integrated strategy: mitigation strong, adaptation limited	Separate strategies: mitigation strong, adaptation improving	Separate strategies: mitigation and adaptation balanced	Separate strategies: mitigation and adaptation balanced
Capacities	High institutional and financial autonomy for voluntary climate action	High institutional and limited financial autonomy for voluntary climate action	High institutional and limited financial autonomy for voluntary climate action	High institutional and limited financial autonomy for voluntary climate action
Implementation	Implementation by city subsidiaries, regional cooperation; investment program, pilot and demonstration projects	Implementation in selected city districts; pilot and demonstration projects	Implementation by local utility company; pilot and demonstration projects	Implementation by local utility company; pilot and demonstration projects
Monitoring	Mitigation monitoring system based on CoM and UN models; adaptation not systematically monitored	Mitigation monitoring system based on CoM model; energy monitoring platform involving local stakeholders; no adaptation monitoring	Mitigation monitoring system based on CoM model; adaptation monitoring based on Mayors Adapt	Mitigation monitoring system based on German model; adaptation monitoring based on environmental monitoring system
Stakeholder and citizen involvement	Citizen engagement relatively low	Citizen engagement relatively high; neighborhood approach	Citizen engagement relatively high; institutionalized participation (LA21 Office)	Citizen engagement relatively high; institutionalized participation (Climate Council)
International activities	Membership in city networks; increasing international activities at the core of climate policy; external funding, including EU funding	Engagement in city networks; external funding, including EU funding	Membership in city networks; external funding from national government, little activity to attract EU funding	Membership in city networks; external funding from national government, no activity to attract EU funding

Turku's governing system provides high capacities to steer the transformation of the energy system and facilitates regional climate solutions, coordinated by city subsidiaries and regional cooperation partners. Like Turku, both German cities have the capacity to steer the local energy and housing companies, while Groningen has less influence due to its privatized energy company (Table 3).

The organizational features of all four cities also show similarities. In Rostock and Potsdam, specialized organizational units for implementing climate policy were set up. Turku's climate strategy is based on an organizational structure that links the central administration, the environmental office, and the Sustainable City Commission of the Union of the Baltic Cities (UBC).[1] Groningen's roadmap for becoming climate-neutral by 2035 (Municipality of Groningen, 2018) is mainly implemented by the energy department and supported by other departments.

There are also distinct and unique features in all four cities (Table 3). Turku shows high ambitions to become an internationally recognized climate policy forerunner, which is facilitated by unanimous political support across political parties (interviews 26, 27, 29). In Groningen, climate policy is framed as energy policy due to the city's experience with earthquakes and the need to phase-out natural gas (interviews 33, 35, 38). The institutional setting of Rostock is characterized by the Local Agenda 21 Council, which was established in the early 1990s, is composed of active citizens, and has become a visible player in Rostock's urban development. Finally, Potsdam's climate policy ambitions are facilitated by an exceptionally supportive research environment, including the Potsdam Institute for Climate Impact Research (PIK) that was actively involved in the development of the city's climate mitigation and adaptation strategies.

Scaling potential of local experiments

All four cities started a variety of initiatives, practices, and experiments. We examine the scaling potential of (1) institutional and organizational innovations, (2) the integration of climate mitigation and adaption, (3) participatory approaches, and (4) local, national and international leadership.

Institutional and organizational innovations

All four cities developed institutional innovations within the administration such as climate coordination offices, internal interdepartmental committees, and new operating procedures. In addition, they institutionalized cooperation with external actors by setting up climate advisory councils and city-university partnerships.

In 2008, Rostock and Potsdam independently from each other established a *climate coordination office*, subordinated only to the deputy mayor. Local climate action, which is organized parallel to existing administrative structures, improves cross-sectoral integration of climate policy within these structures (interviews 2, 3, 9, 12, 22). In a similar way, Turku has established a climate team within the central administration, subordinated to the mayor. It does not have formal coordination power but provides climate policy knowledge. In addition, Turku relies on the international expertise of the Sustainable Cities Commission of the UBC, which formally belongs to the city administration. Its institutional position has been strengthened as it reports to the central administration now, while previously it reported to the environmental department (interview 29).

In Groningen, no climate coordination office exists, but the city established an *internal inter-departmental committee* that serves as internal advisory board for the city council. It is made up of policy experts and covers climate policy, among other issues. In addition, there is a steering group of aldermen on adaptation. This group, together with the employees working on climate adaptation, discusses related topics on a regular basis (interviews 33, 34).

In 2019, Turku's city subsidiaries adopted *new operating procedures* and are now obliged to assess the impacts of their investments and acquisitions from a climate perspective (Turku City Council, 2019). Although the city has not yet introduced a GHG assessment of all council decisions, it is in the process of developing a model for assessing the climate impacts of city investment projects. In a similar way, Groningen measures the impact of projects that affect climate and energy issues.

Potsdam has set up an external *climate advisory council* (*Klimarat*) in 2008 that has developed into a key player of local climate action (interviews 12, 22, 23). The council consists of eight members from politics, economy, science, and civil society. It meets once a month to discuss relevant topics and advises the local government. Though Rostock has not established a formal climate advisory council, a Local Agenda 21 Council exits since the early 1990s, focusing on sustainable urban development. As meetings take place on a regular basis, the council has become a visible player in local politics (interviews 1, 2, 4, 10).

Turku formally established a *city-university partnership* in 2010 as cooperation platform with local universities. The intention to set up the "Turku Urban Research Programme" was to enhance local policy-making capacities by facilitating knowledge transfer between local academic institutions on the one hand and city employees and local politicians on the other (interview 27). In 2012, Potsdam established a specialized platform to facilitate collaboration between the city administration and local research institutes, focusing on climate change and closely related areas. Since 2018, it has been known as the "City-science Climate Partnership" (*Klimapartnerschaft Stadt und Wissenschaft*) (interviews 12, 22). In Groningen, the cooperation between the city and the university is less formalized, but they frequently collaborate within the framework of externally-funded pilot projects (interview 40).

Although institutional and organizational innovations have been developed in all four cities, these novel forms of governance most often operate in parallel, but not yet in conjunction with traditional forms of governance. Hierarchically organized processes, based on sectoral divisions, still dominate within the administration. However, they are now combined with multi-level governance arrangements, including new processes of local climate governance that support institutional change (Grönholm, 2022).

Integration of climate mitigation and adaptation

Increasingly, both climate mitigation and adaption are considered as equally important pillars of local climate action (Grafakos et al., 2019; Haupt et al., 2020; Kern, Irmisch, et al., 2021; Otto et al., 2021). However, only a few cities have succeeded in addressing both issues simultaneously. Based on our own research, we distinguish three different models of integrating climate policy: (1) In the *full integration model*, mitigation and adaptation tasks are concentrated in the same organizational unit or strategy; (2) in the *pillarized model* they are allocated to several organizational units or strategies; and (3) in the *project-based integration model* they are integrated at the operational level only.

Potsdam and Rostock began relatively early with tackling climate change adaptation and are two of the very few mid-sized cities in Germany, and the only cities in East Germany that

succeeded in maintaining a balanced approach focusing on both, mitigation and adaptation. Consequently, Otto et al. (2021) classified both cities as climate policy forerunners. Nevertheless, they followed two different approaches: While Potsdam opted for a *full integration model*, Rostock separated mitigation and adaptation, following a *pillarized model*.

Potsdam's climate coordination office is responsible for both mitigation and adaptation (*full integration model*). Staff that had worked on mitigation issues became responsible for adaptation. This has practical advantages since there are many thematic overlaps between mitigation and adaptation. The integration in one organizational unit enabled direct and informal communication among actors working on adaptation and mitigation (interviews 12, 22). This seems to be a key challenge because adaptation itself is already a cross-sectoral task that requires good communication channels with various different city departments.

Rostock established a climate coordination office aiming primarily at the cross-sectoral integration of climate mitigation, i.e., climate policy in Rostock was institutionally separated and coordinated by two different departments (*pillarized model*). However, in 2020 an administrative reorganization took place and led to the integration of climate mitigation and adaptation in the environmental department (interviews 2, 9, 10). While Rostock managed to place high emphasis on both mitigation and adaptation, coordinating both topics did not always succeed. An example is the development of the low-carbon residential neighborhood *Petriviertel* that was built from scratch on a former brownfield. During the complex planning process only mitigation concerns were taken into account (e.g., energy efficiency standards). As adaptation was not sufficiently addressed, the result is an eco-district that is not sufficiently prepared for extreme weather events (interviews 2, 4).

In contrast to Potsdam and Rostock, Turku and Groningen did not yet succeed in accomplishing a balanced approach (Kern, Grönholm, et al., 2021; Kern, Irmisch, et al., 2021). Both cities can be regarded as mitigation forerunners within their countries but lag behind in adaptation. Groningen shows elements of two different types of integrating climate policy. Adaptation and mitigation are organizationally separated and are based on different policy goals (*pillarized model*). Moreover, both Groningen and Turku have occasionally integrated climate mitigation and adaptation at project level (*project-based integration model*). In Groningen, for example, adaptation measures were integrated into a project on the construction of a heat grid in one neighborhood. Project-based integration offers the opportunity to get familiar with the challenges and chances of integrating mitigation and adaptation. Yet, it represents a rather weak form of integration that hardly leads to the same level of performance as the *full integration model* (interviews 33, 34).

Participatory approaches

Citizens and local communities are increasingly recognized as important players within urban climate change, for example by the introduction of the concept of "energy communities" in EU legislation (European Commission, 2020). Yet, how cities steer, organize, and respond to the engagement of citizens varies. Based on our research, we distinguish several "cultures" of participation. There are differences with regard to municipal communication towards citizens, participatory initiatives, the institutionalization of participation, and the use of direct democracy instruments.

Attempts to facilitate *communication towards citizens* exist in all four cities. They provide public outreach activities, as for example Turku and Rostock organize both an annual event.

Furthermore, Groningen and Potsdam provide permanent options for citizens to contact the municipality.

Participatory initiatives include educational activities, contribute to awareness-raising and fulfill important social functions. Several awareness-raising projects and subsidy schemes that create incentives for behavioral changes are actively promoted by the city of Groningen, often facilitated by (environmental) NGOs.

Rostock and Potsdam are good examples of cities that have established *institutionalized forms of participation*. This can mainly be explained by a culture of citizen-led grassroots movements that were formalized and institutionalized through the Local Agenda 21 Council since the early 1990s (interviews 1, 2). Potsdam's climate advisory committee (*Klimarat*) has become a key driving force of the city's climate policy. Two local Fridays for Future activists were invited to participate in the regular meetings, without having voting rights though (interviews 22, 23, 24). Although such institutionalized forms of participation do not exist in Groningen, the city works with a so-called "district-approach" that embeds formalized local engagement within climate mitigation policies that are scaled down to the neighborhood level (Municipality of Groningen, 2019).

Last, Groningen and Rostock have used *direct democracy instruments* to steer political action. In Groningen and Rostock, referendums became the starting point of path-dependent processes. In Groningen, referendums led to the development of a bike-friendly city (interview 35). While still having a long way to go before becoming as bike-friendly as Groningen, in Rostock a citizen-driven referendum in 2019 triggered major administrative reorganizations; more precisely, the establishment of an independent "Department of Mobility", which is responsible for Rostock's transformation into a bike-friendly city (interviews 2, 6, 9).

Germany stands out for more citizen-led movements that became institutionalized, while in the Netherlands a strong political culture of citizen engagement exists. The embedded societal norms in Finland have hitherto impeded both systematic citizen engagement and have not provided impetus for cities to institutionalize pathways facilitating citizen participation. This seems to be a result of a general lack of "grassroots" level activities in Finland.

Local, national, and international leadership

All four cities are forerunners, at least from a national perspective. Leadership requires that a city increases its capacities and becomes recognized as a model for others. This implies to identify areas where a city's performance is already outstanding and promote these innovative ideas to the outside world. Local leadership can be considered as an essential precondition for national and international leadership.

Local leadership requires personal engagement, either by a leading politician or a leading administrator (Bedsworth & Hanak, 2013; Homsy, 2018; Hoppe et al., 2016). Leading cities need a face, representing local climate policy within and outside the city. Turku's city mayor is such a vocal supporter of climate action—within the city but also at national and international stage (interviews 27, 29, 30). Turku's culture supports the emergence of policy entrepreneurs in the city, i.e., local climate leadership is emphasized by the city's political and administrative leadership (interviews 29, 31). In Groningen, the responsible alderman, the current government coalition, and some active project managers can be seen as leaders, even within the region. Rostock's green environmental mayor was a driving force behind the establishment of its climate coordination office (interviews 3, 10), and the new mayor (elected in 2019) aims at transforming Rostock into a leading city in the area of mobility (interviews 2, 4, 9). In Potsdam, the political and admin-

istrative leadership has been less active, but representatives of the independent green-left group *DIE aNDERE*, which have been members of Potsdam's city council since 1993, have strongly and consistently pushed for environmental and climate action (interviews 12, 23).

Moreover, all four cities can be regarded as national leaders. Turku set the most ambitious target with respect to climate-neutrality among the six biggest cities in Finland (Huovila et al., 2022, interviews, 27, 29, 30), and has demonstrated national leadership by turning ambition into action. Among mid-sized Dutch cities, Groningen is a forerunner and partakes in several national pilot programs to steer climate mitigation and adaptation. The city wants to be a forerunner (Municipality of Groningen, 2018) and has become an important player in the on-going knowledge sharing between Dutch cities. Rostock and Potsdam are two climate policy forerunners from East Germany (Haupt, Kern, et al. 2022). Both succeeded in a competitive tender process to participate in the "Master plan" funding program (*Masterplan 100% Klimaschutz*) that supports the development of ambitious mitigation strategies. In a ranking of German cities, Rostock ranks second and Potsdam fifth among 90 mid-sized cities with less than 500,000 inhabitants (Otto et al., 2021).

The ambition to become not only a national but also an *international leader* differs considerably between the four cities (Table 3). In Turku, international activities are at the core of transforming Turku into a climate-neutral city (Kern, Grönholm, et al., 2021). Turku aspires to become recognized as international climate leader, based on its broad international engagement and memberships in transnational city networks. Under the political leadership of its mayor, Turku has taken an active role towards the United Nations (e.g., UN Sustainable Development Goals, UN Climate Change Conferences) (interview 29). Moreover, Turku joined the EU Covenant of Mayors and uses the Regional Council of Southwest Finland and its Brussels office to demonstrate its achievements and attract EU funding (Kern, Grönholm, et al., 2021). Thus, the city was chosen by the EU Commission for the EU "Mission on 100 Smart and Climate-neutral Cities".

Groningen is less active on the international stage. The city is a member of the Covenant of Mayors, and recently the Global Centre of Climate Adaptation settled in Groningen. Due to a lack of initiatives by the national government, Groningen has focused its attention towards the EU. The city has two employees working in Brussels and developed a strategy to apply for EU funding, in particular in the area of energy transition, including hydrogen technology (interview 33). Thus, Groningen is partaking in several collaborative EU-funded projects (such as the MAKING-CITY project on energy-positive buildings). Moreover, the city has created a consortium to apply for funding from the European Just Transition Fund to speed up local energy transitions. In addition, the city of Groningen was like Turku selected by the EU for its City Mission.

Both German cities are far less active than Turku at the European and international levels. Potsdam is exclusively nationally oriented, while Rostock has started at least some international activities. The city is, like Turku, a founding member of the Union of the Baltic Cities and joined the Covenant of Mayors. Nevertheless, the main focus of both German cities is primarily at the national level. They collaborate with like-minded German cities (interviews 2, 10), derive strategic funding primarily from national sources, and do not have the ambition to become internationally known climate policy forerunners.

The comparative analysis of the four cities clearly shows the scaling potential of institutional innovations (such as Potsdam's climate advisory committee), new forms of integration of climate mitigation and adaptation and a more balanced approach (like in Rostock and Potsdam), participatory approaches (such as Groningen's district approach), and ways to improve leadership (such as Turku's and Groningen's successful attempts to attract EU funding). The next section shows that the scaling potential of these institutional innovations and policy experiments can lead to actual scaling.

Scaling between matching cities

It can be assumed that the scaling of policies is facilitated if matching forerunner cities share the same national context like Rostock and Potsdam. Both cities are by far the largest and most important cities within their regions (*Länder*), Mecklenburg-Western Pomerania (Rostock) and Brandenburg (Potsdam). Since these regions offer little to no support and guidance to municipalities willing to act on climate change, it is hard for both to find partners for collaboration within these regions. Thus, both cities have financed significant parts of their climate activities (e.g., the development of their mitigation and adaptation strategies) through national funding schemes and are active in nationally oriented networks that offer opportunities to exchange experiences with other forerunner cities (Haupt, Kern, et al., 2022).

As matching cities are similar but not identical, there are many opportunities for them to learn from each other. Since both cities have joined the Climate Alliance at an early stage, Rostock and Potsdam have collaborated with each other for a long time. Subsequently, both cities have inspired each other and collaborated on various occasions. In 2012, Rostock successfully applied for participation in the "master plan" funding program (*Masterplan 100% Klimaschutz*), which financially supports the development of mitigation strategies, aiming at climate neutrality. Four years later, Potsdam was admitted to the same program. The decision to apply was decisively influenced by the experiences of Rostock. In fact, city staff from Rostock encouraged city staff from Potsdam to apply. Interviewees from Potsdam specified that they would not have applied if Rostock had not encouraged them to do so (interview 23).

Vice versa, Potsdam's activities were met with great interest by Rostock's city staff. This applies in particular to the fact that Potsdam has set up a climate advisory committee in 2008. City staff from Rostock was impressed by Potsdam's successful attempt to institutionalize such an advisory board and plans to establish a similar board in Rostock (interview 10).

Apart from such bilateral transfers, matching forerunner cities also have the potential to jointly create new approaches, even if they require paradigmatic changes. For our four case-study cities, we see such a potential to jointly develop new approaches particularly in the field of city-university partnerships. To pioneer innovative approaches that can contribute to urban climate action and sustainability transformations, cities urgently need a solid knowledge base. Preferably, such knowledge should be co-created with researchers (Eckersley, 2018; Keeler et al., 2019; Kern, Grönholm, et al., 2021).

In 2010, Turku set up the Turku Urban Research Programme, a highly institutionalized city-university partnership with local universities that aims at transferring academic knowledge into urban policy-making (interview 27). Therefore, it provides funding for research projects on topics relevant for sustainable urban development. Potsdam has also established a collaboration platform in 2012, which was transformed into a formal climate partnership (*Klimapartnerschaft Stadt und Wissenschaft*) in 2018 (interviews 12, 22). Although the partnership in Potsdam is less formalized than in Turku, it provides an excellent basis for more formalized partnerships since the city hosts three distinct climate-related research institutions: the Potsdam Institute for Climate Impact Research (PIK), the Institute for Advanced Sustainability Studies (IASS), and the German Research Centre for Geosciences (GFZ).

By contrast, in Groningen and Rostock there are no formalized forms of city-university partnerships. In Groningen, the "Platform Groningen CO2-Neutraal 2035" includes educational institutions, public institutions, and local businesses. In addition, the "Accord of Groningen" is a strategic cooperative network between educational institutions, the municipality and the province, concentrating on themes such as energy, healthy aging, and digitalization (interview

40). Rostock's attempts to establish city-university partnerships have been less successful. The city established a very broad coalition of actors (*Klimaallianz*), including municipal companies, research institutions, private companies, and environmental groups. However, due to the high number and variety of actors, finding consensus proved to be very difficult (interview 4).

Taking the relatively high scaling potential of city-university partnerships between our case-study cities into account, all four cities could start working on a joint format to set up such institutionalized partnerships, focusing specifically on local climate action. The starting point could be the already successful Turku Urban Research Programme. Scientific input for co-creation could be provided by the universities and research institutes located in all four cities. Experts from the scientific partner institutions could co-create knowledge together with local decision-makers in all four cities. This means that the relationship between matching cities could lead to the joint development of institutional innovations and improve the knowledge transfer between local research institutions and other stakeholders.

The presence of universities and centers of higher education would also allow the establishment of an applied Master program focusing on city planning in times of climate change. Through such a study program, future city practitioners such as urban planners and climate managers could obtain skills needed for the challenges ahead. Students could complete internships in the cities and spend time attending different classes in each of the four cities. The teaching could be undertaken not only by academics but also by city practitioners and specialists in the field of climate governance.

CONCLUSIONS

Our study shows that mid-sized forerunner cities such as Turku, Groningen, Rostock, and Potsdam have developed and tested new policy approaches. Although the national context of these cities differs considerably (e.g., dependency on fossil fuel), novel approaches with a high scaling potential can spread between them, such as setting up a climate coordination office (Rostock and Potsdam), establishing an external climate advisory council (Potsdam), introducing new participatory initiatives (Groningen), and launching an urban research program (Turku). By identifying the climate policy strengths and weaknesses of these four matching cities, the article generates new insights and knowledge for climate policies in mid-sized forerunner cities, especially on the scaling of local experiments between matching cities. The article also contributes to the ongoing debates on the scaling of experiments.

Institutional, legal, and cultural differences may complicate the scaling of innovations between cities from different countries. Thus, the greatest possible similarities between cities need to be ensured in order to increase the scaling potential. The matching cities approach is therefore relevant for scaling policies between cities in different countries or even on different continents. This is relevant for EU research and innovation projects (such as the Smart Cities and Communities Programme) because projects may fail if cities do not match. In other words, the scaling potential of policy innovations cannot be utilized if the context and characteristics of cities differ considerably. Careful selection of matching cities is necessary to guarantee that joint projects will actually lead to changes on the ground, in particular if the transformation requires paradigmatic policy changes.

Although we have applied the matching cities approach to forerunner cities, it is not restricted to them. Instead it can also be applied to other groups of cities, such as ambitious smaller cities which are still in a starting phase or latecomer towns in rural areas. Such types

of cities and towns do not learn best from forerunners, like our four case-study cities, but need appropriate models.

We argue that the matching cities approach reduces the possibilities for failure as it accepts and reflects on possible barriers for reaching climate goals (e.g., energy mix in different countries, differences in operational settings). Although the matching cities concept is a promising approach, it needs further development because our study is limited to four cities. This approach needs to be supplemented by a typology of cities that facilitates the selection of matching cities, including types of forerunner cities (such as university cities) as well as types of latecomer and laggard cities (such as declining industrial cities).

The study demonstrates that context matters because scaling is facilitated when matching cities share the same national context such as Potsdam and Rostock. Apart from matching cities located in the same country, cities in different countries may face similar context conditions. This applies in particular to cities in the Nordic countries, where many forerunner cities are located. In these countries, cities are in a more favorable position than cities in other parts of Europe to develop and test novel approaches such as introducing a climate budget (e.g., in Oslo). The study also shows that climate activities require new forms of climate governance. Administrative capacities need to be strengthened and become more strategic, integrative, adaptive, and innovative.

It can be concluded that the chances for successful scaling is particularly high among matching cities that share many characteristics. Such cities have the capability to learn by matchmaking, i.e., by intentionally choosing other forerunner cities, nationally as well as internationally, with very similar characteristics, and drawing lessons from their experiences, either bilaterally or within a group of matching cities. On a more general scale, matching cities can support mid-sized forerunner cities to develop from local pioneers to international acknowledged leaders, which have the ability to upscale successful local projects, nationally as well as internationally.

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ORCID

Kristine Kern https://orcid.org/0000-0001-9923-4621

ENDNOTE

[1] Turku is a founding member of the Union of the Baltic Cities and has hosted its Sustainable City Commission (Environmental Commission) from the outset. It funds the premises and personnel. The Commission is internationally active and visible, and has wide experience with attracting external funding and run international projects.

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AUTHOR BIOGRAPHIES

Kristine Kern is professor and head of the research group "Urban Sustainability Transformations" at the Leibniz Institute for Research on Society and Space in Erkner (Germany). She is also affiliated to Åbo Akademi University in Turku (Finland). Her research concentrates on environmental and climate governance, sustainability transformations in multi-level systems, including transnational governance of cities and regions.

Sam Grönholm is University Lecturer at Åbo Akademi University (Faculty of Social Sciences, Business and Economics; Public Administration). His research interest is the networked governance of the Baltic Sea region and in particular the fields of environmental and climate governance of this region.

Wolfgang Haupt is research associate in the research group "Urban Sustainability Transformations" at the Leibniz Institute for Research on Society and Space in Erkner (Germany). His research focuses primarily on urban climate governance, urban resilience, material and immaterial cultural and world heritage and its significance for urban development, and questions of innovation transfer between cities.

Luca Hopman is a PhD candidate and Lecturer at Utrecht University (Faculty of Law, Economics and Governance; Utrecht University School of Governance). Her research themes are centered around urban development and climate change governance, the organization of public goods and services, social policy and changing notions of citizenship.

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