

Climate change, energy and cities: understanding transitions in Hamburg and Hong Kong

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Abstract

The role of cities in enabling change to address climate change has gained increasing attention. A particular priority attempts to reduce carbon emissions generated from energy services for urban populations. Change within urban energy systems to mitigate the effects of climate change has therefore become a major issue in many cities. This raises the need to explore how and to what extent one can mobilise 'low-carbon' and 'more sustainable' pathways for the future on the local or urban level.

In this regard, this thesis aims to understand the role of cities in the context of socio-technical transformations of urban energy systems. Drawing on urban energy transitions (UETs) as an analytical frame, this thesis explores the drivers, processes and pathways for low-carbon energy transformations within cities. The research adopts a qualitative case study approach taking the cities of Hamburg and Hong Kong into account. Research methods consisting of desk research, a policy review, semi-structured interviews and a qualitative data analysis were employed. The empirical research investigates the distinct narratives for transformative change in the two cities through the dimensions of energy and climate politics, urban energy infrastructure, and wider multi-level relationships.

As a cumulative thesis, the research findings are presented in three original publications. Paper 1 and paper 2 present the empirical findings of each case individually and address the governance of UETs and climate change in relation to interests, actors, materialities and implications. Paper 3 provides a theoretical consideration of the role of cities in mobilising transformative change and adopts a concept of capacity to explain energy transitions pathways in cities.

Together, the thesis contributes to a deeper understanding of city-driven transitions, in the context of interdisciplinary debates around UETs. Although the focus in the thesis is primarily on energy and climate change, the findings demonstrate that decarbonisation is only one of many crucial aspects determining how urban energy systems could be transformed. The thesis contributes to the discussion on the complexity of change by drawing in a wide range of urban actors, and their capacity to create spaces for intervention and (re-)shape transition pathways.

An extended and partly novel perspective on how socio-technical change is governed, configured and conceptualised is offered here. The argument presented here builds up of better understandings of specific path dependencies by exploring interactions between actors in a learning context. An emphasis on how earlier material-related decisions partly contribute to shifting political interests and transition orientations is included (paper 1). Concerning the political nature of UETs, this thesis demonstrates how action on climate change and innovation for energy supply system are dependent on forms of collaboration defining urban energy provision and use (paper 2).

In the end, a new conceptual framing of capacity to explain how and why change happens in cities is presented (paper 3). The capacity framework outlines relevant elements for change in UETs and the dynamics in political, material, institutional or other energy-related societal contexts. The analysis suggests that the capacity that cities have to act independently is constrained. As illustrated in Hamburg and Hong Kong, cities are not going to be a magic solution for driving climate transformation, but they can still play a role in shifting some of the dynamics in mobilising change for UETs.

Overall, this thesis explores the ways in which multiple factors and dynamics are at play within the complex processes and trajectories for change within the context of UETs. Such examination of how pathways of city-driven transitions are defined and shaped allows insights into plausible futures of urban development.

Zusammenfassung

Die Rolle der Städte und deren Möglichkeiten, globalen Problemen des Klimawandels zu begegnen, findet zunehmende Beachtung. Vordringlich geht es dabei um die Ansätze, kohlenstoffhaltige Emissionen, die aus der Energieversorgung entstehen, zu reduzieren. Die Veränderung urbaner Energiesysteme zur Unterstützung des Klimaschutzes ist daher zu einer wesentlichen Aufgabe in vielen Städten geworden. Forschungsarbeiten, die untersuchen, wie und mit welcher Reichweite „karbonarme“ und „nachhaltige“ Entwicklungspfade auf lokaler oder urbaner Ebene mobilisiert werden können, sind damit immer relevanter geworden.

Vor diesem Hintergrund versteht sich die vorliegende Dissertation als ein Beitrag, der die Rolle von Städten im Kontext sozio-technischer Transformationen urbaner Energiesysteme in den Vordergrund stellt. Im Hinblick auf die Transformation städtischer Energiesysteme (urban energy transitions – UETs) als Analyserahmen werden die Triebkräfte, die Prozesse und Entwicklungspfade für eine Dekarbonisierung der Energiesysteme in Städten antreiben, untersucht. Dazu werden zwei qualitativ ausgerichtete Fallstudien der Städte Hamburg und Hong Kong durchgeführt. Als Untersuchungsmethoden kommen die Literatur-, Dokumenten- und Politikfeldanalyse, semistrukturierte Interviews und die Auswertung weiterer qualitativer Daten zur Anwendung. In der empirischen Forschung werden urbane Transformationsnarrative und die Dimensionen der Energie- und Klimapolitik, städtische Energieinfrastrukturen sowie die Handlungsmöglichkeiten und Funktionen der Städte im Mehrebenensystem Stadt-Region-Gesamtstaat analysiert.

Als kumulative Dissertation erfolgt die Präsentation der Untersuchungsergebnisse in drei wissenschaftlichen Publikationen. Artikel 1 und 2 behandeln die politisch-planerischen Verlaufsformen der UETs unter Betonung der Interessen, Akteure, Materialitäten und Implikationen für die beiden Fallstudien in getrennter Form. Artikel 3 stellt eine theorieorientierte Betrachtung vor, mit der die Rolle der Städte zur Mobilisierung von Transformationen hervorgehoben werden soll. Dazu wird ein Konzept der Kapazitäten entwickelt, um die Entwicklungsformen urbaner Transformationen zu erklären.

Die drei Artikel und der Rahmentext der Dissertation vertiefen das Verständnis von Transformationsprozessen, die durch Städte angetrieben werden, in einer interdisziplinären Perspektive. Obwohl der Fokus der Arbeit auf den Zusammenhang von Energie und Klimawandel gerichtet ist, zeigen die Ergebnisse, dass die Dekarbonisierung nur einen zentralen Faktor unter mehreren darstellt, durch den urbane Energiesysteme transformiert werden können. Die Dissertation trägt zur Diskussion über die Komplexität des Wandels bei, indem eine Vielfalt städtischer Akteure und ihre Kapazitäten betrachtet werden, die in der Lage sind, sich Raum für Interventionen und Gestaltungen des Transformationspfades zu schaffen. Dabei werden besonders die Pfadabhängigkeiten sichtbar, die durch die Untersuchung der Interaktionen zwischen den Akteuren und dabei erkennbarer Lernprozesse herausgearbeitet worden sind. Herausgestellt werden auch die Wirkung früherer Entscheidungen und ihre Nachwirkungen auf die Entwicklung politischer Interessen und Transformationsrichtungen (Artikel 1). Im Hinblick auf die politischen Qualitäten von UETs, zeigt die Dissertation auf, wie Klimaschutzmaßnahmen und Innovationen in der Energieversorgung abhängig sind von Formen der Kollaboration (Artikel 2).

Als Ergebnis der Fallstudien ergibt sich eine neue konzeptionelle Fassung der Kapazität, als Begriff und Kategorie, die erklärt, wie und warum sich Wandel in Städten vollzieht. Das Rahmenkonzept Kapazität verweist auf relevante Elemente für den Wandel in den UETs sowie die Dynamiken in politischen, materiellen, institutionellen und weiteren sozialen Kontexten. Wie an den Städten Hamburg und Hong Kong veranschaulicht wird, bieten Städte keine „magischen“ Lösungen für die Transformationspfade im Klimaschutz an. Sie können aber durchaus eine aktive Rolle zur Beeinflussung der Dynamiken der UETs einnehmen.

Fokussiert untersucht die Dissertation die Wege, auf denen sich multiple Faktoren und Dynamiken treffen und komplexe Prozesse und Formen des Wandels im Kontext der UETs auslösen. Die Analyse von Transformationsprozessen, die durch Städte ausgelöst und angetrieben werden, erlaubt daher plausible Einsichten in die Zukunftsperspektiven urbaner Entwicklungen.

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1. Introduction: climate change, energy and cities

Cities are an important means to tackle the global problem of climate change. From one perspective, cities have been considered for many years as the source of problem concerning the adverse contribution of greenhouse gases (GHGs) coming from urban areas. Currently more than half of the world's population lives in urban areas and cities account for between 71-76 % of global carbon dioxide emissions, the most common GHG (United Nations, 2019). As the urban population is projected to continue increasing, it raises the even more pressing challenge of how cities can be transformed to be 'low-carbon' and 'more sustainable' for the future.

Against this backdrop, the view of cities as the solution to the issue of climate change has emerged (UN-Habitat, 2017). In this context, the urban fabric and functioning of cities in enabling sustainable development and responding to climate change imperatives are increasingly highlighted. On the one hand, cities are seen as a space of possibility in engaging with challenges and allowing innovation for novel solutions (Bulkeley, 2013). On the other hand, urban planning, infrastructure and practices are critical in terms of supporting how cities operate. Both issues place a spotlight on cities and encourage an exploration of how, and to what extent cities can enable change to address global environmental challenges.

One way of understanding what cities can do to address climate change is to consider the urban energy system. Urban energy systems, encompassing both processes of energy supply and demand, play an important role in providing energy services to meet the demands of the urban population (Rutter & Keirstead, 2012). Energy services in forms of electric power for appliances, heating and cooling for spaces, lighting for

buildings and streets, transport for mobility and so forth serve to support the functions of our cities today. However, according to the IPCC (2014), excessive energy demands of urban areas account for about two-thirds of global energy use and represent over 70% of energy-related carbon emissions. One major source of carbon dioxide comes from the combustion of fossil fuels (e.g. coal, oil and natural gas) in providing those energy services for our economy and society. In this sense, change within the urban energy system, in particular to mitigate the effects of climate change has risen to the top of the agenda.

Considering the changing role and responsibility of cities in addressing the global environmental challenge, a focus on urban areas as 'key sites' or 'opportunities' for changes in the energy system has arisen (Basu et al., 2019). It emphasises the ways in which energy interventions and innovations take place in cities, in particular in relation to technological options and implementation, consumption habits, urban policy and planning, as well as management for energy supply and efficiency (Basu et al., 2019; Rutherford & Coutard, 2014). Taking this proactive role of cities into account, this thesis considers the ways in which cities are able to drive change in relation to climate change and urban energy systems.

To address concerns about what cities can do in enabling low-carbon development for urban energy systems, one emerging debate is that of urban energy transitions (UETs) (Rutherford & Coutard, 2014). This body of literature considers the inherent relationship between the transformation of energy systems on one hand and urban change towards sustainable development on the other (Rutherford & Coutard, 2014). A focus on UETs allows a theoretical exploration of change in the context of socio-

technical transformations of urban energy systems. Learning from past transitions, decisions for change have been driven by direct benefits to energy users such as lower costs, higher efficiencies and greater convenience. However, in the context of present/future transitions, the decision for change encompasses a broader level of expectations on energy systems in not only providing more efficient and accessible energy services to the population but also benefiting society and the environment as a whole (Rutter & Keirstead, 2012).

The process of change thus concerns not only technological transformations such as shifting primary fuels and advancing conversion technologies in urban energy systems, but also the associations with society concerning infrastructures, cultural practices and organisations (Bridge, 2018). In this sense, careful design and implementation of policy in the energy and climate change arena are crucial (Bridge, 2018). While the focus on the urban scale and the role of urban actors in the processes and policies for energy transitions are justified, one important research task is to take into account the complexity of transformation and develop ways to understanding how low-carbon development for urban energy system is driven and proceeds.

Drawing on the context above, this PhD thesis aims to understand **the role of cities in enabling change in urban energy systems in the context of climate change**. This is explored through the following research questions:

- Drivers: What are the interests and incentives driving UETs in cities? How are they reflected and embedded in urban configurations such as infrastructure and institutions?

- Processes: Who are the crucial actors and what role do they play in driving UETs? How do interactions between actors shape the processes and practices of UETs?
- Pathways: What are the implications of these drivers and processes for UET pathways in cities?

Overall, this PhD thesis seeks to contribute to a deeper understanding of how cities are responding to climate change, as well as the discourse and practice of transformation, which are emerging research fields in urban studies. The next section elaborates further on this topic by drawing out the relevant literature.

2. Understanding change within urban energy systems

To allow a theoretical exploration of how change happens within cities and urban energy systems, the literature of urban energy transitions (UETs) provides a useful entry point (Rutherford & Coutard, 2014). This body of literature considers the inherent relationship between the transformation of energy systems on one hand and urban change towards sustainable development on the other (Rutherford & Coutard, 2014). The processes related to UETs involve changes within multi-level, interconnected urban dimensions, touching on energy-related political, economic, social, environmental and material factors (Bulkeley & Betsill, 2005; Geels, 2005; Rutherford & Jaglin, 2015). In particular, the approach emphasises “a focus on energy materialities through a transversal view of energy systems as articulating contexts; a relational view of ‘the urban’ which is cognisant of the links between near and far places through which urban energy systems work infrastructures, flows and practices of production and consumption; and a concern for socio-technical change as always contested and thoroughly political” (Rutherford & Coutard, 2014, p. 1362). In this regard, managing change within urban energy systems is a complex process.

A focus on issues of governance is frequently highlighted to capture the drivers, processes and pathways for UETs (Dowling et al., 2018; Haarstad, 2016; Huang et al., 2018; Rutherford & Jaglin, 2015; Wolfram, 2019). Within such a governance perspective, the research field is interdisciplinary, where scholars from multiple disciplines such as geography, science and technology, environmental management, urban studies and energy policy consider the governance of UETs and relate it to their disciplinary approaches (Balmaceda et al., 2019; Rutherford & Coutard, 2014;

Rutherford & Jaglin, 2015; Van Veelen et al., 2019). While this discussion of UETs allows a theoretical exploration of change in the context of socio-technical transformation of urban energy systems, there is less work that identifies the range of aspects that have to be addressed in order to give a clear understanding of the process of UETs. For exploring this research area, Rutherford and Coutard (2014) have outlined overlapping areas of reflection such as “materialities of urban energy”, “relational energy urbanism” and “the urban politics of energy transitions” and demanded further conceptual and empirical research on emerging UETs. Inspired by the overview, this section outlines relevant aspects that are of crucial importance to position the research aim and questions of this thesis. To understand drivers, processes and implications for change, the section is structured according to dimensions, which allow an analytical distinction between different aspects of transforming urban energy systems. This includes visions, actors, local dependencies, interactions between actors, dynamics of politics and materiality and learning for change.

To understand how change is driven, it is important to look into the visions for change and the ways in which such visions are being articulated. In relation to low-carbon energy, change is implemented through multiple measures and interventions in the processes of energy supply, distribution and use (e.g. promoting renewable sources for power generation, improving energy efficiency in energy production and distribution, reducing energy consumption etc.). However, apart from the narrative of low-carbon energy, other visions such as energy for economic development and energy for thermal comfort and personal mobility also drive change within cities. These multiple visions for change in the urban energy system influence the discourse and approaches for implementing and achieving low-carbon energy in practice (Rutter & Keirstead,

2012). For example, countries/cities tend to rely on fossil-based energy sources like natural gas, nuclear and 'cleaner' coal as bridging fuels to meet their carbon emission targets in the short to medium term, and, as they argue, to compensate for the instability of renewables in order to maintain a 'stable' energy system for the population and economy (Bridge, 2018). From this approach to low-carbon development, we can see that the expectations and meanings of energy use and supply in cities encompass not only environmental interests, but also political, material, economic and other energy-related interests. The identification of visions for change is, therefore, useful to identify respective fields for action and spaces for change in urban energy systems.

Another important issue in understanding change is the role of actors and their views, interests and powers within urban energy systems. Broadly speaking, this takes into account both governmental and non-governmental actors and their arrangements to govern and intervene in change. Depending on the governance structure of cities, governmental actors include local and regional authorities and policymakers in the fields of energy and climate change (Rutherford & Jaglin, 2015). They are typical actors for governing change by developing and implementing regulations and policies, enabling the day-to-day functioning of cities, and promoting relationships with other actors (Ansell & Gash, 2007; Bulkeley, 2013; Bulkeley et al., 2014). In this regard, a number of studies have demonstrated the institutional role played by these actors and their capacity to lead change by analysing political willingness, financial and human resources and forms of intervention moving beyond policy initiatives from higher-level institutions (Anguelovski & Carmin, 2011; Tang et al., 2010).

While the notion of government is significant for leading change, it is also critical to consider a wider range of actors with different interests and stakes in energy provision and use in cities (Rutherford & Jaglin, 2015). This set of stakeholders includes energy utilities, local interest groups, activists and residents. For example, given the trend towards privatisation of state-owned energy assets, private energy utilities now have a stronger stake in deciding and controlling how energy is produced and distributed through strategic decisions and projects for the business, energy service provision, infrastructure management and public-private cooperation (Becker et al., 2017; Gregory et al., 2009). Moreover, actors from civil society, such as community-based groups and environmental NGOs who focus on energy in terms of fulfilling social interests and expectations, have also become more prominent, particularly with regard to emerging debates around energy democracy in Europe and North America (Van Veelen et al., 2019). The roles and responsibilities of these actors are steadily increasing through diverse interventions and advocacy, campaigning for/against and providing feedback about policy orientations and implementation (Acuto, 2013). Overall, while both governmental and non-governmental actors play a crucial role in driving change, there is a need for a careful examination of their views, actions and power in influencing change within urban energy systems.

A further issue is that of local dependencies, which relate to the local circumstances in which urban energy systems are embedded. Local dependencies have long been considered as contextual factors for translating and grounding the global/national problems of climate change and energy transitions at a local scale (Rutherford & Jaglin, 2015). However, while global environmental challenges require solutions in the local context, any urban responses should also “take into account the micro level of the very

local struggles about socio-technical futures in interdependence with the socio-technical system at large” (Rohracher & Späth, 2014, p. 1428). This consideration does not indicate that the wider context of governing UETs, such as urban-rural relations or influence of higher-level politics, should be disregarded (Bulkeley & Betsill, 2005; Haarstad, 2016; Kuzemko & Britton, 2020). Instead, it emphasises the role and capacity of cities as responsible entities for governing change in the local context.

Local dependencies also highlight the linkages between changes in urban energy systems and other local political issues, controversies and group interests, for example, the implications of competitive (dis-) advantages and public acceptance in cities. The process of change is subject to local political contexts, institutional frameworks, spatial-material configurations and fields for change (Basu et al., 2019). This emphasis becomes even more significant in those urban energy systems which are witnessing trends of decentralised policymaking and interventions, for example, a return to local utilities and the emergence of community energy initiatives (Becker et al., 2017; Rutter & Keirstead, 2012). Such place-based characteristics for change offer entry points to think about city-driven initiatives that are critical for transforming the urban energy system by identifying the fields in which cities can act autonomously and the kinds of impetus for change that cities can provide (Bulkeley et al., 2018).

A further issue considers relationships between actors. Interactions between actors draw attention to the political nature of change and are subject to compromises, collaborations and trade-offs between stakeholders with divergent interests in urban energy systems (Rutherford & Jaglin, 2015). In mobilising action for climate change, collaborative approaches such as co-ordination across levels of government, public-

private partnerships, and stakeholder engagement within cities, as well as sharing of best practice through international dialogues between cities have been increasingly observed. These collaborative approaches are largely framed as positive endeavours to create opportunities for change through sharing of resources and expertise, increased networking and developing rapport and consensus-building for policymaking (Barton et al., 2015; Leck & Simon, 2013).

While collaboration is seen as a way of enabling change, it brings into question how actors with diverging interests or even conflicting views on energy supply and demand can work together. Such disputes, tensions, struggles and conflicts are inevitable from the processes and consequences of change (Rutherford, 2014). For example, defensive efforts from incumbents may seek to maintain the status quo and resist any emerging change (Bridge, 2018). As Rutherford and Jaglin (2015, p. 175) aptly have described, “energy policymaking and decision-making is not a harmonious and neutral process either devoid of conflict and power relations or somehow more effective when these are bypassed or ‘resolved’”. It draws attention to the power dynamics between actors in navigating what and whose notion(s) of energy are considered and how they are mobilised in the process for change (McGuirk et al., 2014). The interactions and power dynamics between actors are thus important to in order to assess and explain the process of change in the urban energy system.

To explore the complexity of change in urban energy systems, recent attention has focused on the aspect of materiality and its relationship with urban energy politics. Materiality refers to both a condition and an outcome of the political process for change (Bulkeley et al., 2016; Haarstad, 2016; Kuzemko & Britton, 2020; Latham et al.,

2008; Rutherford, 2014; Tozer, 2019; Van Veelen et al., 2019). In the urban energy context, rather than considering energy's existing materials (e.g. infrastructure, resource availability, technological options, and regulations and forms of governing etc.) as physical objects and conditions for change, it instead considers them as active in framing and being framed by political actions and debates for change. For example, contemporary material arrangements are path dependent on earlier decisions, trajectories, practices and material configurations and are continuously configured and re-configured by contemporary and future urban energy politics (Moss, 2014). In the context of actors and their capacities in driving change, energy's materials are deployed to enact participation and enable capacity building to organise participatory flows and relations for change (Van Veelen et al., 2019). Moreover, the intangible aspect of materiality connecting desire, emotions and (future) visions is also considered. One relevant example concerns how emotions are actively played upon by Not-In-My-Back-Yard activists against the infrastructure of wind farms (Cass & Walker, 2009). In this sense, the aspect of materiality offers insights into the specific political processes, which lead to certain material-related dependencies, opportunities and limitations for change.

The notion of learning for change is useful for understanding how change happens through the interactions of multiple actors, as well as material-related political processes. Concerning time-space dynamics between actors, learning refers to the ways in which actors respond to or challenge the actions of others. It highlights their ability "to internalise past experience and failures, and use such experience to avoid repeating past mistakes and exercise caution in future decisions" (Da Silva et al., 2012, p. 135). In this sense, the experience of successes and failures from the past/present

consensual and confrontational interactions are significant to the (re-)orientation of change in leading to new forms of connections between like-minded actors or arousing potential conflicts of interest in the present/future (Roelich et al., 2018; Strasser et al., 2019). In the context of material-related political processes, a range of existing technological, political and societal measures, which could be applied to reinforce new/ advanced technology, policy agenda, and campaigns, needs to be taken into account as an ongoing process of experimenting, navigating, and re-positioning to achieve (shifting) ends (Wolfram, 2016). From this perspective, change is not limited to the promotion of innovation and the construction of new regimes, but also related to the modification of conventional regimes and the rejection of dominant practices. This understanding aligns with emerging energy-related social movements in opposing open-cast mining, coal-fired power plant development and privatisation of energy facilities (Becker et al., 2016). Taking into account the different approaches, understanding change is a contingent assessment of evaluating strategic purposes and decisive events at different stages.

Overall, this section demonstrates the significance of visions, actors, local dependencies, interactions between actors, dynamics of politics and materiality and learning for change as important mechanisms for understanding the drivers, processes and implications for energy systems change. More broadly, these aspects offer insights into the role of cities in enabling change for socio-technical transformation and highlight the significance of contextually dependent features. It is therefore likely that transformation proceeds differently across diverse urban contexts and empirical evidence is essential to provide a contextual explanation of how change happens in practice.

3. Methodology

3.1. Research approach and case study

This research aims to understand the role of cities in enabling change in urban energy system in the context of climate change. This is explored through the research questions concerning drivers, processes and pathways for UETs.

The research adopts a qualitative case study approach drawing on the cities of Hamburg and Hong Kong. A case study approach is a useful means of exploring the in-depth nuances and explanations of the drivers, processes and implications for change (Hay, 2016). Taking the place-specific character of UETs into account, this research utilises two case studies in order to provide a broader basis for supporting the theoretical arguments, by reflecting on the distinctive features and findings from each case.

In this sense, the cases of Hamburg and Hong Kong were selected because of their specific characteristics that make them interesting and relevant to the context of this research. These include first their political characteristics where they possess degrees of autonomy at policymaking level, secondly their specific features of urban energy demand and provision and thirdly some significant events and actors driving and challenging their UET pathways. Therefore, the analysis of climate and energy politics and the barriers and opportunities for change can provide insights into the initiatives, capacities and limitations for city-driven transitions for energy and climate change.

One important note here is that the intention is not to compare the two cases, but to provide deeper insights into how city-driven change proceeds within different urban energy systems in practice. However, it is also important to acknowledge the

limitations of case study research, which can only capture part of the transformation process within different urban contexts in practice.

3.2. Research methods

The research design comprises three phases, as below.

Phase 1: Desktop mapping and policy review

The first phase of research comprised desktop mapping and a policy review to gather contextual information regarding energy and climate issues in each city. The key aim was to outline the configurations of the social-technical energy system for low-carbon transitions in each city. This exercise also supported the process of identifying interviewees for phase 2 (semi-structured interviews) and coding and organising data for analysis in phase 3.

The desktop review included a review of statistics and policy and grey literature (for the last 10-15 years) published by governments and relevant institutions such as non-governmental organisations (NGOs), private companies and advocacy groups. The desktop mapping focused on three key areas: 1) energy and climate politics in city, 2) urban energy assets and options, and 3) role of city and city-region-nation connections (See **Table 1**). The listing in the table highlights the key areas, while also acknowledging inter-dependencies across the other themes. Considering the timeframe from carrying out the initial desk research and presenting the results in peer-reviewed publications, this desk research was regularly updated to ensure up-to-date information.

Table 1 Purposes of desk research for dimensions of research

Dimension	Focus of desk research
Energy and climate politics in city	City's key policies and regulations on energy and climate City actors in policymaking on energy and climate
Urban energy assets and options	Energy statistics Local energy infrastructure and major consumers, in geographical distribution and ownership Resources for local production Regulatory and institutional instruments apply to city
Role of city and city-region-nation connections	National and city climate goals (e.g. carbon reduction targets, future energy mix) Key authorisation, policies and regulations in city-region-national contexts Key collaboration projects in city-regional contexts

Phase 2: Semi-structured interviews

The second phase comprised semi-structured interviews with key informants in Hamburg and Hong Kong. Given that the review of policies and grey literature in phase 1 could only identify the collective outcomes of a prolonged decision making process, the fieldwork was designed to explore in greater depth how climate and energy policies were initiated and developed. Semi-structured interviews can fill the gap by collecting a diversity of meanings, opinions and experiences from various key actors.

The main fieldwork took place between April and July in 2018, in which 24 informant interviews were carried out (See **Table 2** for details). Based on the mapping exercise in phase 1, informants for the in-depth interviews were identified to reflect the political, economic, environmental and cultural interests related to the climate and energy governance in each city. Four key sectors were identified: government, energy production, energy consumption and civil society. Interview respondents were experts in the field or representatives from associated authorities or institutes, as follows:

Table 2 List of interviews in chronological order

Date	Representing organisation/ expertise in the field	Form	Language
24-Apr-18	World Green Organization	Face to face	English
25-Apr-18	World Wide Fund for Nature (WWF) Hong Kong	Face to face	English
27-Apr-18	Professor on environment and sustainability issues in Hong Kong	Face to face	English
30-Apr-18	World Wide Fund for Nature (WWF) Hong Kong	Face to face	English
2-May-18	Environmental Association Ltd	Face to face	Cantonese
2-May-18	Expert on energy and environment policy in Hong Kong	Face to face	English
3-May-18	Friend of the Earth Hong Kong	Face to face	English
7-May-18	Hong Kong Green Building Council	Face to face	Cantonese
7-May-18	Hong Kong General Chamber of Commerce	Face to face	Cantonese
8-May-18	Business Environment Council	Face to face	English
10-May-18	Civic Exchange	Phone	Cantonese
14-May-18	Environment Bureau Hong Kong	Face to face	Cantonese
17-May-18	CLP Power	Face to face	Cantonese
7-Jun-18	Chamber of Commerce Hamburg	Face to face	English
8-Jun-18	Green Party Hamburg	Face to face	English
11-Jun-18	EnergieNetz Hamburg	Face to face	English
13-Jun-18	Zukunftsrat	Face to face	English
14-Jun-18	Die Linke Hamburg	Face to face	English
18-Jun-18	Vattenfall	Face to face	English
19-Jun-18	Academic on energy transition and ownership in Hamburg	Phone	English
20-Jun-18	Campaign <i>Tschuess Kohle</i> representative	Face to face	English
20-Jun-18	Friends of Earth Germany (BUND) Hamburg	Face to face	English
20-Jun-18	Campaign Unser Hamburg Unser Netz	Face to face	English
25-Jun-18	Stromnetz Hamburg	Face to face	German (English interpretation)
3-Jul-18	Trade Union ver.di	Written response	English
3-Jul-18	Ministry for Environment and Energy Hamburg	Face to face	English
12-Jul-18	SPD Hamburg	Written response	English

- Government sector (e.g. local authorities, policy makers, etc.)
- Energy production sector (e.g. energy companies, labor unions, etc.)
- Energy consumption sector (e.g. industries, firms, households etc.)
- Civil society (e.g. environment-focused NGOs, advocacy groups etc.)

The research received ethics approval from the Human Research Ethics Committee at Macquarie University, Australia (reference number: 5201800079) (see Appendix).

Potential interviewees were contacted firstly by email. All communication highlighted that any participation was voluntary. Participants were given information about the purpose, methods, demands, risks and potential benefits of the research to enable an informed decision to be made. The interviews were audio-recorded and written informed consent was obtained from all participants.

Interviews started with broader opening questions. For example, the interviewees were asked to describe their history of engagement on climate and energy issues and their key interest in low-carbon development. Following this, questions were based on key issues identified for the research (**Table 3**). It should be noted that only primary questions are listed in the interview schedule. Secondary questions were raised spontaneously during the interviews when it was appropriate for clarification, follow-up or expansion of the issue, also with reference to the findings in phase 1. The following text explains the question design in more detail.

In relation to energy and climate politics in the city, the question design aimed to collect the diversity of meanings, opinions and experiences from city actors in order to understand the positioning of stakeholders and their dynamics in formulating policy orientations and undertaking processes for UETs. First, respondents were asked to

Table 3 Interview schedule

Interview schedule
Background
<ul style="list-style-type: none"> ➤ History of organisational engagement on climate and energy issues? ➤ What are the key organisational priorities for low-carbon development in energy systems?
Energy and climate politics in city
<ul style="list-style-type: none"> ➤ What are considerations impacting on energy policymaking in city? <ul style="list-style-type: none"> • Political structure and situation • Climate and environmental issue • Economic development • Social concern ➤ What do you think is the role of city actors and their dynamics in shaping the processes? <ul style="list-style-type: none"> • Government sector (e.g. local authorities, policy makers, etc.) • Energy production sector (e.g. energy companies, labor unions, etc.) • Energy consumption sector (e.g. industries, firms, households etc.) • Civil society (e.g. climate and environment-focused NGOs, advocacy groups etc.) ➤ Which sector(s) (or specific institution) do you work with often? What are key arrangements and collaborations between these sectors?
Urban energy assets and energy options
<ul style="list-style-type: none"> ➤ What do you see as the connection between energy assets and decision making for energy options? How are they shaped and being shaped? <ul style="list-style-type: none"> • Energy infrastructure and major consumers (industries) in city • Energy regulatory and institutional instruments applying to city • Raw material and resource for city's own energy production ➤ Do you think the existing configurations are favorable/ unfavorable for renewable energy (RE) development in the city?
Role of city and city-region-nation connections
<ul style="list-style-type: none"> ➤ What is the capacity of city itself in undertaking energy transitions? ➤ Meaning of city in contributing to climate change goals at different scales – city itself; regional; national and international ➤ Concerning climate and energy issues, what sectors or institutions do you network with regionally? How does this enable energy transitions? ➤ Are you involved in any city-regional/ metropolitan projects or networks addressing the following issues? What are the key collaborations and the impetus? <ul style="list-style-type: none"> • Electricity or raw material supply (physical supply networks) • Production and industry development for RE (institutional networks) ➤ What do you think is the impact of such a connection on energy governance?

present their viewpoints about policymaking for the city's energy transitions regarding political structure and situation; climate and environmental concerns; economic development; and social consideration. Second, the interviewees responded about their roles as urban actors in shaping the UET processes and their interactions with other actors and the key arrangements and collaborations between the responding institutions and other actors.

In relation to urban energy assets and options, the questions were formulated to address a gap in knowledge where materiality issues were rarely addressed in discourses of decision making for UETs. Questions were designed to gather information about how stakeholders consider 'materiality' elements in the arena of urban energy (namely, existing infrastructural and institutional configurations, major energy producers and consumers, energy regulatory and institutional instruments and resource endowment and availability) and the connections with policymaking regarding urban energy options, in particular RE development.

Finally, for the role of the city and city-region-nation connections, questions sought to identify respondent's perspectives about the city's role in driving change in urban energy system within the city-region-national context and particularly city-regional connections. Interviewees were asked about their views on the role of the city regarding energy transitions and climate change, as well as reflections on their experiences in city-regional cooperation, if any. This enables exploration of existing collaborations in urban-rural energy supply and demand issues and the underlying motivations of these networks.

Phase 3: Data analysis and presentation

Transcripts were first prepared from interviews for data analysis. The data were coded using NVivo 12 qualitative data analysis software. This also involved drawing on the written sources identified through desk research in phase 1. The process was an integral part of analysis in outlining patterns and relationships in each case, as well as differences between the two cases. For example, how the role of same type of actor is described differently in two cities or how certain visions for change are more popular in one city than another.

The initial approach of coding was to develop analytic codes that reflect the key topics of the research. For example, for the dimension of energy and climate politics in the city, the analytic codes include governance approaches, interactions between actors, role of actors and visions (See Figure 1 for codes in other dimensions). This exercise of coding is useful to reduce the data into smaller packages and organise the data according to the topics of concern for this research (Hay, 2016).

The second approach of coding was to develop codes according to distinctive features in each case. For example, in the case of Hamburg, there are a number of non-government actors and major events in the context of energy and climate change that were mentioned frequently by interviewees. Some codes in relation to the case of Hamburg are shown as an example in Figure 2.

Name	Files	References	Created On	Created By
Description		0	4/09/2018	T
1 Governance approaches	5	10	4/09/2018	T
Demand-side management	14	52	8/10/2018	T
Energy provision framework	10	20	4/09/2018	T
Funding	6	14	8/10/2018	T
Plan, policy and regulation	20	77	4/09/2018	T
Climate Action Plan	9	37	8/10/2018	T
1 Interactions between actors	24	202	4/09/2018	T
1 Role of actors	8	35	4/09/2018	T
Academic	3	6	4/09/2018	T
Business	20	79	4/09/2018	T
Energy	20	65	4/09/2018	T
General public	20	100	4/09/2018	T
Government	23	153	4/09/2018	T
NGO	19	92	4/09/2018	T
1 Vision	18	79	4/09/2018	T
Energy security	4	6	8/10/2018	T
Individual, behavioral changes	5	8	8/10/2018	T
International, global	7	13	8/10/2018	T
Regionality	9	21	8/10/2018	T
2 Materiality	5	10	4/09/2018	T
Energy resource	13	28	4/09/2018	T
Power plant & operation	16	56	4/09/2018	T
Technology & know-how	5	7	4/09/2018	T
3 City-region-nation connections	16	27	4/09/2018	T

Figure 1 Codebook according to the dimensions of research

Features of Hamburg		2	18	14/08/201	T
Events		0	0	4/09/2018	T
2010 Moorburg power plant		2	2	11/09/201	T
2011 European Green Capital		2	3	15/08/201	T
2013 Referendum		11	50	14/08/201	T
2013 Remunicipalization Grids		2	9	11/09/201	T
2015 Energienetzbeirat		7	12	14/08/201	T
2016 NEW 4.0		4	5	7/09/2018	T
2017 Tschuess Kohle		6	32	14/08/201	T
Non-governmental actors		0	0	4/09/2018	T
BUND		3	6	4/09/2018	T
Energienetz		2	8	4/09/2018	T
Energietisch		2	2	4/09/2018	T
Hamburg Energie		5	10	4/09/2018	T
HK24		2	11	7/09/2018	T
Stromnetz HH		3	12	4/09/2018	T
Trade unions or Ver.di		2	13	10/09/201	T
Vattenfall		10	50	4/09/2018	T
Zukunftsrat		2	7	6/09/2018	T

Figure 2 Codes according to the features of Hamburg

4. Overview of the publications

4.1. Contribution of the individual papers

This thesis seeks to understand the role of cities in enabling change in urban energy systems in the context of climate change. This is explored through the research questions concerning drivers, processes and pathways for UETs. To address the research questions, this thesis draws on in-depth case studies of Hamburg and Hong Kong and explores the climate and energy politics of the two cities and how they overcome barriers or open up opportunities for change. As this is a cumulative thesis, the research findings are presented in the following original publications, which are referred to in the text as paper 1, paper 2 and paper 3 and attached in the Appendix.

Paper 1 and paper 2 address the governance of UETs and climate change in relation to

Paper 1: Cheung, Tracy Ting Ting and Oßenbrügge, Jürgen (2020). Governing urban energy transitions and climate change: Actions, relations and local dependencies in Germany. *Energy Research & Social Science*, 69 (101728). DOI: <https://doi.org/10.1016/j.erss.2020.101728>

Paper 2: Cheung, Tracy Ting Ting and Fuller, Sara (under review). Rethinking the potential of collaboration for urban climate governance: the case of Hong Kong. *Area*. Manuscript submitted June 2020; revision submitted December 2020.

Paper 3: Cheung, Tracy Ting Ting, Fuller, Sara and Oßenbrügge, Jürgen (ready to submit). Mobilising change in cities: a capacity framework for understanding urban energy transition pathways.

interests, actors, materialities and implications, and present empirical findings of each case individually. Paper 3 provides a theoretical consideration of the role of cities in mobilising transformative change and adopts a concept of capacity to explain transition pathways for energy and climate change in cities. Together, the three papers and this thesis broaden understandings of the initiatives, capacities and limitations for city-driven transitions for energy and climate change.

Table 4 Contribution of the individual papers

	Outlet journal (and its focus)	Contribution to PhD thesis	Role of empirical cases	Personal role in developing and writing
Paper 1	Energy Research & Social Science (Interdisciplinary studies of energy systems and society)	Presenting an analytical framework engaging aspects of actions, relations and local dependencies with characteristics of material-related political processes in governing UET	Transition narrative of Hamburg concerning local energy-climate politics, general aspects of the German energy transition, and energy materiality	Lead authorship: Conception (85%); Data collection (100%); Analysis (100%); Writing (95%)
Paper 2	Area (key debates within and beyond the discipline of geography)	Assessing types of collaboration that are structured by regulations, oriented to policy goals, and emerge as everyday practices in governing issues of climate change and energy within cities	Transition narrative of Hong Kong concerning motivations for collaboration, types of collaboration, and outcomes of collaboration for climate action in the city	Lead authorship: Conception (85%); Data collection (100%); Analysis (100%); Writing (80%)
Paper 3	To be confirmed (tentatively a journal focusing on urban studies)	Offering a framework that connects the concept of capacity with the literature on UETs to explain transition pathways for energy and climate change in cities	Cases of Hamburg and Hong Kong to articulate the capacity framework in practice	Lead authorship: Conception (85%); Data collection (100%); Analysis (100%); Writing (90%)

Table 4 demonstrates how each individual paper contributes to the research aim by addressing the research questions as well as contributing to interdisciplinary debates of UETs as per the selected journal. These include studies of energy systems and society, geography and urban studies. All of the papers are the outcome of collaborative work between myself and the supervisors of this thesis Prof Dr Jürgen Oßenbrügge (papers 1 and 3) and Dr Sara Fuller (papers 2 and 3). In my role as the first author in the three papers, I was responsible for the empirical research and analysis, and the major part of conception, development and writing process.

4.2. Background of the cases of Hamburg and Hong Kong

To demonstrate how the three papers contribute to the research focus on city-driven energy transitions, it is necessary to have a better understanding of the cases of Hamburg and Hong Kong. There are three main reasons that Hamburg and Hong Kong were selected as vital cases to study.

First, Hamburg and Hong Kong demonstrate certain types of political autonomy and capacity in driving change for energy and climate change. For example, both city governments of Hamburg and Hong Kong have a special constitutional status:

Hamburg is a federal state (*Bundesland*) of Germany; and Hong Kong is a special administrative region of China, under the ‘one country, two systems’ constitutional principle. Their juridical positions allow the city governments to possess different degrees of autonomy in policymaking, compared to other cities in the country – Hamburg possesses powers of a region; Hong Kong possesses many powers of a national state (Holley & Lecavalier, 2017). As a result, they are less dependent on policymaking at higher levels (in particular for Hong Kong) and other regions (for both

Hamburg and Hong Kong) that are different to the usual top-down relationships. For example, in the context of climate change, the cities can set their own climate goals and determine particular fields for local action. Their political specificities do not mean that wider political relationship can be ignored (i.e. Hamburg and Germany/ the European Union; Hong Kong and China) as they do also play a significant role in the cities' energy systems, as noted below, but the empirical studies are primarily concerned with change *within* the two cities. The analysis of climate and energy politics in the two cities thus broadens understandings of initiatives and capacities for the discussion of city-driven energy transitions.

Second, both cities demonstrate specific features of urban energy demand and provision. As some of the most developed and populated cities in Germany and China, there is significant pressure for Hamburg (with 1.8 million inhabitants) and Hong Kong (with 7.8 million inhabitants) to take action to transform their energy systems responding to their energy demands and associated carbon emissions. For example, carbon emissions per capita were about 9 metric tons in Hamburg in 2018 (statistic from Statistikamt Nord) and about 6 metric tons in Hong Kong in 2016 (statistic from The World Bank). However, both cities are tied to the relationship with their surrounding territories for energy and fuels imports that in turn limit their capacity to decarbonise the energy system through supply-side management strategies. In particular, local electricity production supports only about 20% of local demand in Hamburg (statistic from Länderarbeitskreis Energiebilanzen). 23% of electricity used in Hong Kong comes from the Daya Bay nuclear power plant in Guangdong (the neighbouring region of Hong Kong) and Hong Kong has to rely on natural gas supplies from mainland China (Holley & Lecavalier, 2017). In addressing climate change, both

city governments have drawn up plans for renewable energy as viable alternatives to fossil fuels in decarbonising their local electricity production. Nevertheless, from their energy statistics, there have not been expansive RE developments in the energy mix after their endeavours. This demonstrates some of the challenges and constraints that cities are facing in response to their energy demands and climate change pressures. As such, the exploration of how cities overcome barriers or take up opportunities for change can shed light on the ways in which the city can act to drive transitions for energy and climate change.

Third, there are major events and actors that serve as useful entry points to understand the process of change in the two cities. For example, presented by the mayor of Hamburg in the middle of the 2000s, Ole von Beust (CDU), Hamburg was declared to be “a model region in climate action” (Hamburg Ministry for Urban Development and Environment, 2008, p. 1). This led to critical steps on policymaking and alliance formation (e.g. the first climate action plan of Hamburg and the first coalition with the Green Party (2008-2010)). Apart from the political motivation, there has also been strong driving force coming from socio-ecological movements, where some civil society actors and groups have attempted to advocate for environmental-friendly initiatives and contest inadequacies in the city’s energy-climate policy (Becker et al., 2016). One key legislative success was to force the city government to buy back the privatised energy grids through a referendum in 2013. In Hong Kong, several regulatory and policy initiatives have been introduced in the context of energy and climate change in recent years: the Scheme of Control Agreements to regulate energy supply and efficiency and Hong Kong’s Climate Action Plan 2030+ to address the challenges of climate mitigation and adaption. Another major event was the newly

launched Feed in Tariff scheme, which targets smaller-scale developers from households, businesses and non-profit organisations with rooftop solar panel systems of up to one MW.

Overall, the examples of both cases here begin to illustrate and explain the distinct narratives for transformative change in the two cities. The exploration of their narratives for energy transitions is not to compare the two cases, but to provide deeper insights resolution on how city-driven change proceeds within different urban energy systems in practice.

4.3. Synthesis of the papers

The thesis now turns to demonstrate how the three papers contribute to addressing the research questions.

Taking up the first question *what are the interests and incentives of cities driving UETs?*, Paper 1 demonstrates how political orientations and practices of Hamburg's energy transition were shaped and reshaped by the prospects of German Energiewende (energy transition), local political desire to address climate change and the strong interest of civil society in environmental issues. Paper 2 shows how the energy transition in Hong Kong is driven by the incremental pressure of addressing climate change. This driver is further discussed in paper 3 by illustrating how the debates about UETs in Hong Kong primarily focus on the discourse around the mix of energy sources for electricity generation.

In relation to the question of *how are they reflected and embedded in urban configurations such as infrastructure and institutions?*, Paper 1 demonstrates how infrastructure offers technical options and solutions for energy supply and demand for

UETs to take place, through the example of renewable energy generation from a Hamburg-owned utility Hamburg Energie. The case also shows how the ongoing debate on energy supply in Hamburg is framed by the construction and transformation of a coal-fired power plant in Hamburg-Moorburg. In this sense, paper 1 highlights a need to look carefully at both material path dependencies and options for change within urban energy systems, and how these might reconfigure and re-orientate the transition pathways in cities. Paper 2 explains how energy transition in Hong Kong is constrained by the regulatory Scheme of Control Agreements (SCAs). This institutional arrangement creates a robust energy system, where there are fewer opportunities for innovative alternatives, in particular local renewable energy.

Taking into account both questions concerning interests, incentives and urban configurations for change, paper 3 narrows down the discussion to consider what can be changed in the urban energy system and how cities are framing their approaches towards low-carbon energy. Some elements concerning perspectives, knowledge, options for change and action fields for transitions are discussed under the dimension of capacity. In particular, paper 3 highlights the needs to take into account both opportunities and dependencies for change in relation to the materiality for energy (e.g. existing infrastructure, resource availability, technology accessibility etc.) in leading to certain modifications or new material arrangements for energy (e.g. modes of governing, energy activities and advancements, policies and regulations etc.).

Concerning the second question, *who are the crucial actors and what role they play in driving UETs?*, paper 1 highlights how the Hamburg transition process is shaped and re-shaped by the shifting priorities of high-level city politicians on climate change, as

well as persistent challenges from energy companies and local activists. In particular, the eventuation of an UET in Hamburg is subject to the strong capacities of civil society actors/coalitions to intervene in the transition process through campaigns and advocacy (papers 1 and 3). One key legislative success was to force the city government to buy back privatised energy grids through a referendum in 2013. Other civil society interventions include promoting alternative organisational modes for energy generation and ownership.

Considering the role of actors and their interests, paper 2 shows the multiple actors involved in shaping climate policies and practices in Hong Kong, including the public, private and civil society sectors. In particular, paper 3 focuses on the city government, as a key political actor, and highlights its lack of commitment to combating climate change and the absence of leadership capacity in tackling transformative change. Apart from the role of actors in regulation, policy development and everyday practices, paper 2 offers insights into the shifting roles and responsibilities of actors across different modes of governance.

To address the question of *how do interactions between actors shape the processes and practices of UETs?*, paper 1 provides a new perspective on the nonlinear dynamics between actors in the governance of UET. For example, how actors respond to the actions taken by others, as well as how they learn from the experience. Through looking at the evolving dynamics with the aspect of learning for change, paper 1 suggests that the response and learning capacities of actors over time explain how momentum for UETs is created, maintained and lost. Paper 1 also takes into account the dynamics of politics and materiality and outlines three characteristics of material-

related political processes: mobilisation (the deployment of energy's materials to shape the transition practices and processes), intervention (interdependencies between materiality and urban energy politics) and meaning (the intangible aspect of materiality). These materiality categories are a useful means of grasping the evolving, material and political nature of UETs.

Paper 2 explores the interactions between actors by identifying three different types of collaboration: collaboration structured by regulations; collaboration oriented to policy goals; and collaboration emerging as everyday policy work. Collaboration is seen as necessary for driving climate action in Hong Kong and is shaped by three key factors: the expertise of actors, the size of the community, and the political landscape of the energy-climate sector in the city. The recognition of multiple types of collaboration enhances understandings of how collaboration opens up different modes of climate governance within cities. Paper 2 particularly highlights the challenge of overcoming uneven power relationships in collaboration. In the context of Hong Kong, while collaborative practices enable a more extensive representation of previously absent actors (e.g. environmental NGOs), they are still marginalised, and their actions are constrained by the leadership of dominant actors (e.g. the government and the two utilities).

Paper 3 focuses in depth on the role of actors and their interactions, by exploring who has capacity to make decisions for cities and enable urban change. It demonstrates the importance of addressing the capacity of both governmental and non-governmental stakeholders and their potential to mobilise resources for action and intervention (e.g. financial resources, administrative competence, skills, knowledge and experience,

etc.). In relation to actor dynamics, it is also significant to develop capacity in terms of a wide and active inclusion of stakeholders, as well as proactive and effective actor networks. Paper 3 highlights that the development of UETs is political and subject to forms of compromises, collaborations and trade-offs in which actors maintain and create capacity and coordination. In this sense, it is critical to reflect on the power dynamics between actors with different interests in terms of whose notion(s) of energy matters (more/ the most) in decision-making within the transition processes.

In response to the last question of *what are the implications of these drivers and processes for UET pathways in cities?*, paper 1 demonstrates how place-specific actions and power relations constitute, construct and contest the pathway for city-driven transitions. The idea of locality was a leitmotif of the debates and negotiations over the low-carbon future of Hamburg (paper 1). Some illustrations include the city government demonstrating political autonomy through local climate and energy plans and financial competence in realising climate projects through the 'climate aspiration of Hamburg' discourse. The notion of locality in Paper 1 highlights that UETs are creating a specific and novel political arena with their own self-regulated dynamics, resulting in local solutions for both the governance and materiality of urban energy systems. Paper 3 demonstrates how the array of interventions mobilised successfully by powerful actors and proactive actor-network constellations in the city creates an innovative means to strengthen capacity, particularly in terms of non-state actors, preventing a further locked-in energy system and promoting space for innovative activities. This trend is albeit an ongoing learning process in which changes in power dynamics for decision-making and the outcomes from new forms of participatory channels (e.g. the Energy Advisory Council (*Energienetzbeirat*) and the client advisory

board of Hamburg Energie) are uncertain. Overall, the sequence of changes points to the emergence of the city's transition pathway towards a more open and experimental path in the future.

Paper 2 focuses on the modes of collaboration in Hong Kong and challenges the assumption that collaboration always brings positive outcomes in mobilising action for climate change. It highlights that regulatory forms of collaboration are more able to influence outcomes, but those outcomes might not necessarily be favourable for climate change. Moreover, while policy-oriented and everyday forms of collaboration encourage wider participation, the outcomes of these participatory modes of governance are incremental and are heavily dependent on government policy.

Although collaboration is positioned as a mechanism to respond to the needs of different stakeholders by drawing them together, this assumption does not address the rigid power dynamics at play. Instead, it is apparent that collaboration can further entrench these power imbalances when it is the sole mechanism for non-governmental actors to influence policy under existing political circumstances. Paper 3 highlights that political dynamics within the rigid energy system in Hong Kong appear to be the most influential factor for the city to mobilise change (or not change). Apart from a lack of willingness for change within the political system discussed previously, the ongoing democracy movement means that the city government has become a 'toxic brand' where the implementation of any institutional arrangement has become unprecedentedly difficult. The issues thus demonstrate how politics come to matter in terms of how multiple political conflicts become a major obstacle to the likely effectiveness and flexibility of the city's transition pathway.

5. Conclusion: the role of cities in enabling change for low-carbon development

Inspired by the call for an urban transformation to a ‘low-carbon’ and ‘more sustainable’ development for the future, this thesis contributes to a deeper understanding of the role of cities in enabling change to address climate change.

Considering urban energy transitions (UETs) as an analytical frame, this thesis explores the drivers, processes and pathways for low-carbon energy transformations within cities. It focuses on the cases of Hamburg and Hong Kong and explores initiatives, capacities and limitations in driving change for transformation within the two cities.

The empirical research explores the distinct narratives for transformative change in the two cities through the dimensions of energy and climate politics, urban energy assets and options and role of city-region-nation connections. This section presents the overall conclusions and opportunities for future research.

Drivers, processes and pathways for city-driven transitions

The thesis demonstrates the multiple visions for change and the ways in which these visions are being articulated in the context of Hamburg and Hong Kong. Consistent with the literature, the cases of Hamburg and Hong Kong illustrate how the visions for change influence the discourse and approaches for implementing and achieving low-carbon energy (Rutter & Keirstead, 2012). For example, as explored through the cases of Hamburg and Hong Kong, the cities’ visions of energy transition are led by political, economic and socio-ecological interests, as well as technological and institutional options. Although the focus in the thesis is primarily on energy and climate change, the

findings demonstrate that decarbonisation is only one of many crucial aspects determining how urban energy systems could be transformed.

The thesis suggests the roles of a wide range of urban actors, and their capacity to create spaces for intervention, need to be taken into account for a better understanding of “where, how and by whom energy system change is being (or might be) done” (p.174) (Rutherford & Jaglin, 2015, original emphasis). While there are multiple actors involved in shaping climate policies and practices, including the public, private and civil society sectors, the thesis also offers insights into the shifting roles and responsibilities of actors across different modes of governance. Taking the local-oriented focus for change into account, the thesis suggests that research on ‘actors’ in cities should be further distilled and argues for a more context-specific approach to outline the different motives, interests and powers of actors/ coalitions across levels of government and various agencies in cities.

Concerning the articulation of visions for change, the thesis also highlights the significance of materiality in terms of both material path dependencies and options for change within the urban energy systems. Consistent with the energy materiality literature (Bulkeley et al., 2016; Haarstad, 2016; Kuzemko & Britton, 2020; Latham et al., 2008; Rutherford, 2014; Tozer, 2019; e.g. Van Veelen et al., 2019), change entails the consideration of technical options and solutions in energy supply and use alongside other specific material changes. In this sense, the materiality aspects are creating both opportunities and dependencies for change.

In this context, the work of actors is embedded or constrained by local spatial-material configurations and institutional frameworks (Basu et al., 2019). The thesis

demonstrates how the concept of local dependencies influences how and in which areas actions take place, by whom and for what ends. This more local-oriented focus for change is apparent in driving UETs in the Hamburg context. The notion of locality thus highlights that UETs are creating a specific political arena with their own self-regulated dynamics, resulting in local solutions, governance modes and materialities of the urban energy system.

This thesis takes up a governance dimension of inter-actor relations and highlights the nonlinear dynamics between actors in shaping the process of UETs. The research examines various technical and political measures taken by urban actors in an ongoing process of experimenting, navigating, and re-positioning to achieve certain ends (Paul, 2018; Wittmayer et al., 2017). Mobilising change within cities is thus a complex process in which multiple factors and dynamics are at play. These issues relate to the questions of who is acting, what kind of power dynamics exist, and which local contexts are considered. As illustrated in the empirical cases, powerful actors and dynamics, as well as urban politics appear to be the most crucial factors to explain the process of change.

To understand the complexity of actions, relations and local dependencies in shaping transition processes, the thesis links governance issues to materiality categories and presents an analytical framework (presented in paper 1). Contributing to the energy materiality literature (Bulkeley et al., 2016; Haarstad, 2016; Kuzemko & Britton, 2020; Latham et al., 2008; Rutherford, 2014; Tozer, 2019; e.g. Van Veelen et al., 2019), the framework emphasises three characteristics of material-related political processes of mobilisation, intervention and meaning. This improved framework allows for more

systematic analysis and provides a heuristic evaluation to discuss and explain the ongoing process of UET explicitly. Through the application to the case of Hamburg, this thesis builds up understandings of path dependencies by exploring the inter-relations in a learning context, with an added emphasis on how earlier material-related decisions partly contribute to shifting political interests and transition orientations.

This thesis also broadens understandings about how different modes of governance can impact the potential of cities to take action on climate change (presented in paper 2) (Bulkeley & Kern, 2006). Through analysing the process of collaboration, the thesis provides insights into how actors and relationships are situated within different collaborative practices (collaboration structured by regulations; collaboration oriented to policy goals; and collaboration emerging as everyday policy work). The thesis highlights the importance of recognising the diverse roles of actors, ongoing power imbalances and their shifting governance spaces for intervention within climate governance. Drawing from the case of Hong Kong, although collaboration is well intentioned, in practice it may only have limited impacts on low-carbon urban transformations.

Finally, resonating with the work of UET scholars, the thesis highlights how the drivers and processes for UETs are shaped by governance, politics, spatial-material configurations and socio-technical relations (Basu et al., 2019; Rutherford, 2014; Rutherford & Jaglin, 2015). To understand how and why change happens in cities given the complexity of urban systems, the thesis offers a novel framework that connects capacity with the literature on UETs (presented in paper 3). The framework takes a critical perspective and identifies three dimensions of capacity: capacity for what,

capacity of whom and how capacity is developed. It argues that the concept of capacity is significant as a lens to explore the complexity of change and explain transition pathways for energy and climate change in cities (Rosenbloom, 2017). As explored through the cases of Hamburg and Hong Kong, the capacity that cities have to act independently is constrained. For example, their capacity to change things is dependent on dynamics in terms of politics, governance structures and ownership, options for energy and technology, existing infrastructure, and city-regional relations. In this sense, change within cities might be less about promoting radical reform, but more (re-)arrangements to address a combination of needs. While cities are not going to be a magic solution for driving climate transformation, they can still play a role in shifting some of these dynamics. While what has been achieved might seem to be marginal and not yet overcoming the major constraints, progress is still being made.

Limitations of the current study and recommendations for future research

The thesis concludes by raising additional research directions for the empirical cases and promising avenues for further research on city-driven transitions.

First, further research on the empirical cases is necessary. The empirical findings highlight the cases of Hamburg and Hong Kong share similarities but have different transition pathways. Hamburg is in the process of building up an innovative energy system while Hong Kong is struggling to mobilise change in a highly regulated energy system. The Hamburg case offers insights into an emerging governance mode of UETs that includes a greater variety of stakeholders and is more open to different options in energy-climate policy, perhaps common across many European cities. Although Hamburg's energy transition gives civil society actors more opportunities to promote

their ideas, some structural elements are still missing to support a new regime for this more-decentralised mode of decision-making. Further research is needed to explore more closely the links between the governance modes of UETs and their outcomes.

In Hong Kong, political dynamics appear to be the most influential factor for the city to mobilise change (or not change) within the rigid energy system. Apart from a lack of willingness for change within the political system, the increasing trust gap between the Hong Kong public and Chinese government since the pro-democracy protests in 2014 brings another layer of complexity and uncertainty to the city's options for change in the energy system (Holley & Lecavalier, 2017). Furthermore, the ongoing democracy movement means that the city government has become a 'toxic brand' where the implementation of any institutional arrangement has become unprecedentedly difficult (Hamlett, 2020). Future research should therefore reflect on how climate politics in Hong Kong are situated within the wider political relationship between Hong Kong and China, in particular the implications of the rapidly changing political context of Hong Kong.

Second, there is scope for further research that draws attention to other dynamics of city-driven energy transition, such as the dimension of urban-rural relations (Bulkeley & Betsill, 2005; Haarstad, 2016; Kuzemko & Britton, 2020; Truffer & Coenen, 2012). For example, we have discussed how Hamburg and Hong Kong are tied to the relationship with their surrounding territories for energy and fuels imports. It is thus crucial to consider how regional socio-technical configurations and potentials for change might influence path dependencies and lock-ins in urban energy systems (Truffer & Coenen, 2012). The issue also acknowledges the implications of energy transitions to the socio-

economic development of both regions and cities. From the empirical research, there are agreements signed between Hong Kong and Guangdong Province (the adjacent region of China) for natural gas and nuclear energy supply to Hong Kong and collaboration Hong Kong - Guangdong Joint Working Group on Sustainable Development and Environmental Protection. There is also regional collaboration initiated by Hamburg - Hamburg Metropolitan Region, in particular the recent innovation project between Hamburg and Schleswig-Holstein (Norddeutsche EnergieWende 4.0). However, due to the limitations of this thesis, this evolution of urban governance beyond its traditional boundaries has not been fully explored (Acuto, 2013). Therefore, there is scope to explore how to manage these new institutional forms of governance that extend across conventional political boundaries and to consider how such forms of urban-rural interaction could provide new opportunities, in particular for authorities, to recast their management approaches for low-carbon development.

6. References

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Original research article

Governing urban energy transitions and climate change: Actions, relations and local dependencies in Germany

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ABSTRACT

Urban energy transitions as responses to climate change imperatives have become a significant means in local politics and sustainability strategies. This paper seeks to understand the complexity of actions, relations and local dependencies within the governance of urban energy systems in shaping the transition processes. We present an analytical framework engaging the governance aspects with characteristics of material-related political processes, and apply it to our case study of the city of Hamburg, Germany. We interrogate the city's transition pathway in the context of local energy-climate politics, general aspects of the German energy transition, and energy materiality. This paper builds up understandings of path dependencies by exploring the interrelations between important elements of the urban energy system and the material-related political processes in a learning context. Drawing on the Hamburg case, we suggest a more context-specific way to outline the different motives, interests and powers of actors/coalitions in cities. This paper reveals the learning and experimenting capacities of actors as a means of understanding the conditions and roles of cities to make structural changes for transition. Finally, city-driven transitions should further expand from the translation of 'global problem, local solution', to a more local-oriented focus. The notion of locality highlights that urban energy transition is creating a special political arena with its own and self-regulated dynamics, and resulting in local solutions for both the governance mode and materiality of the urban energy system.

1. Introduction

Low-carbon energy transition has been strongly promoted as an important approach in response to the climate change imperative. Recognising the urban systems, spaces and societies, policy actors, urban practitioners, and scholars have begun to emphasise the role of cities in building a sustainable future¹. In this context, one valuable perspective is the urban energy transitions (UETs) literature, which considers the inherent relationship between transformations of energy systems on one hand and urban change towards sustainability on the other. This paper focuses on the governance of UETs and climate change. We argue that the implementation of UETs is subject to not only the government decisions and actions to facilitate the translation of 'global problem, local solution'. Instead, the governance of UETs and climate change is a more complex process, which concerns various actors and their inter-actor relations, and local specificities and trajectories of the energy system leading to distinct outcomes.

The research field of UETs is inter-disciplinary, in which scholars from multiple disciplines like geography, science and technology, urban studies and energy policy have been contributing to the debate of the governing issues of UETs and relating it to their disciplinary approaches (see also [3–6]). To capture this inter-disciplinary debate, our conceptual framework encompasses perspectives of urban geography, urban energy policy and transition governance research. We highlight the central governance aspects of transition processes. Previous research has already highlighted the dominant role of urban political actors and policymakers in translating the global climate goals into the context of cities [7,8]. A few recent studies have also considered the growing role of urban non-state actors (e.g. local energy utilities, energy cooperatives, NGOs, activists and grassroots) (see also [9–11]), particularly within the emerging spaces of energy democracy [5]. These two bodies of literature show that transition governance is influenced by the decision-making of both state and non-state actors, and the extent to which they create different consensual and confrontational

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¹ For example, the United Nations [1]'s *New Urban Agenda*, the IPCC's *Cities and Climate Change Science* conference in 2018 and the Urban Climate Change Research Network [2]'s *Second Assessment Report on Climate Change and Cities*.

forms of inter-actor relations. In this context, how urban actors respond and learn to create spaces for intervention within the ongoing and contested transition process is of interest [4,12–15]. Furthermore, we argue that local responses are critically shaped by those urban actors who actively engage with the local context.

To illustrate the argument this paper draws on the recent literature considering the relationship between urban energy politics and the materiality of urban energy systems [5,16–18]. From this we assume that governance modes of transformation processes not only have to take political issues into account (e.g. the identification of powerful actors, agenda settings, institutional arrangements or negotiation processes), but also the existing and proposed mix of energy supply and use, as well as its related infrastructure. We emphasise three characteristics of material-related political processes, and term them as mobilisation (the deployment of energy's materials to shape the transition practices and processes), intervention (interdependencies between materiality and urban energy politics) and meaning (the intangible aspect of materiality). We argue that, to capture the evolving, material, and political nature of UETs, these three categories need to be taken into account. Subsequently, we present an analytical framework engaging the central governance aspects of UETs with the materiality categories, and apply it to our case study.

This paper draws on an in-depth case study of Hamburg, the second-largest city in Germany. There are three main reasons we have selected Hamburg as a vital case to study. Firstly, the local development of Hamburg has been influenced by national debates and strategies on the prospects of German *Energiewende* (energy transition) since the beginning of the new millennium. As Hamburg received one of the first 'European Green Capital' awards from the European Commission in 2011, this paper offers insights into how the city government integrates the German and European energy-climate agendas into local strategies. Secondly, the Hamburg case demonstrates a variety of initiatives and capacities of city-driven energy transitions. For example, being a *Bundesland* (state) of Germany, the Hamburg government possesses more power and autonomy over policymaking (e.g. setting its own climate goals and determining particular fields for local action), compared to other municipal cities in Germany, such as Frankfurt and Munich. Thirdly, Hamburg has a long history of political debates and social movements on ecological issues, dating back to the anti-nuclear protests in the 1970s and 80s [19]. Such a background constitutes and empowers a wide range of civil society actors and groups who advocate for environmental-friendly initiatives and contest inadequacies in the city's energy-climate policy today [20]. The socio-political culture of Hamburg, therefore, broadens the understanding of how socio-ecological interests and self-regulation capacities intervene in a city's transition process [21].

2. Capturing the evolving, material and political nature of urban energy transitions

Energy transition is a political approach to transforming the system that responds explicitly to energy-related goals within the climate change imperative. In the urban context, this transformation refers to a process of negotiations and coordination between various actors and their inter-actor relations, in steering energy provision and consumption. Conceptually this paper encompasses perspectives of urban geography, urban energy policy and transition governance research to analyse the divergences, tensions and disputes in facilitating the objectives of energy transitions into local actions. Primarily the governance aspects are related to actions of individuals, groups and organisations (G1) and their inter-relations in forming coalitions, confrontational groups and parties (G2), and other forms of local dependencies (G3) that together shape the processes of urban energy transitions (UETs). We argue that these three central governance aspects constitute a significant part of the UET pathway and influence policy outcomes to achieve climate goals (Section 2.1). To capture the

evolving, material and political nature of UETs, we establish an analytical framework emphasising material-related processes of mobilisation (M1), intervention (M2) and meaning (M3) (Section 2.2). Subsequently, we present a conceptual integration of the above and our approach to analysing the case study of Hamburg (Section 2.3).

2.1. Central governance aspects of UET

2.1.1. Actions taken by urban, state and non-state actors (G1)

Actions that enable energy transitions in cities are subject to different motives, interests and powers. A great deal of research focuses on the role of urban political actors and policymakers by analysing political will, financial and human resources, and technological options on the multiple levels of top-down governance [22–24]. However, the governance of UETs also requires a consideration of actors from the civil society and energy companies, and their interventions (e.g. advocacy, campaigning, strategic projects, and feedback over policy orientations, resources and outcomes) [4,14,25]. This is particularly true when divergences, tensions and disputes emerge over the consequences of transition processes. For instance, the role of energy utilities is highly relevant when the state becomes less prominent in governing the energy system because of a trend towards privatisation of state energy-related assets [19,26]. Furthermore, the role of civil society actors and groups with different social interests on how energy should be produced and consumed in the cities is also significant to the transition processes [27]. This understanding aligns with the influence and power of social interests gained in the emerging spaces of energy democracy [5], especially in Europe and North America. Therefore, rather than a policy-focused description, a narrative which includes actions and capacities of non-state actors could provide more comprehensive insight to evaluate the performance of energy transitions in cities.

2.1.2. Inter-actor relations over time (G2)

This issue links to insights from transition studies that have identified opportunities and challenges in changing actor relations and the associated implications of these relations on the processes of transition governance. Understanding transition governance within a significant period is not solely about labelling stronger/weaker actors or winners/losers in a particular policy or debate. It is more important to identify how the urban actors attempt to create opportunities to incorporate and translate their energy-climate notions, and how their intervention, reaction and even re-positioning, matter to critical stages of transition processes [14]. As Wittmayer, et al. [15] argued, "[i]t also allows understanding transition governance as a continuous searching, learning and experimenting process through which roles are (re-)negotiated over a period of time and in which actors use roles to reach certain ends" (p. 53). It is, therefore, necessary to explore actors' decision-making, and the extent that their decision-making creates different forms of inter-actor relations over time.

Inter-actor responding and learning capacities refer to the actors' ability to respond rapidly to the actions of others and their capacity to learn from that experience. The notions resonate with the work of Da Silva, et al. [23] about adaptive capacity, which they have defined as the competence "to internalise past experience and failures, and use such experience to avoid repeating past mistakes and exercise caution in future decisions" (p. 135). In this context, the past/present consensual and confrontational interactions within "an incremental process of experimentation and learning" (p. 732) [11] are significant to (re-)orientate the transition pathway (i.e. by generating new forms of co-operation/alliances or inciting conflicts in the present/future). In short, an analysis of the forms of inter-actor relations and the nonlinear relations over time provides a detailed, insightful contribution in understanding how the transition process evolves from the time-space dynamics between actors.

2.1.3. Local dependencies (G3)

Local dependencies seek to capture the forms of local embeddedness of actions and inter-relations. Scholars have demonstrated how the global/national issues of climate change and energy transitions are “interpreted, translated and grounded in the locally specific policy responses and practices in cities” (p.174) [4]. Local actors thus frame and position the broader challenges within the existing institutional and governance arrangements, considering the local dependencies as contextual factors for formulating and implementing policies. This way of thinking runs the risk of downplaying the local-focus initiatives and the local geography for energy systems that the actors/coalitions in cities take into account [28]. Urban policy responses are not only dependent on national standards, but they are also subject to the evaluation of how changes in the energy systems link to other local political issues, for example, implications regarding competitive (dis-)advantages and local public acceptance. Some authors have observed, “a return to the late 19th century model of local utilities”, in which the transition focus is (re-)embedded within the urban fabric including “a greater awareness of local energy geography” (p.79, original emphasis) [27]. Thus, an important research task is to explore how the local-specific interests and local forms of self-regulation shape and reshape the policies and processes of energy transitions in cities.

2.2. Understanding governance issues from materiality perspectives

Our analytical framework is built upon the recent literature considering the relationship between urban energy politics and the materiality of urban energy systems. Energy materiality is referred to as both a condition and an outcome of the political processes of UETs [5,16,18,29–32]. That means, on the one hand, the existing energy’s materials (such as qualities and options of energy infrastructures and technologies, and regulations and forms of governance) are not only objects but also active in framing the political actions and debates on UETs. On the other hand, the material arrangements are path dependent on earlier decision-making and will be continuously shaped and reshaped by the ongoing urban energy politics. In this sense, the materiality perspectives offer an entry point into the specific political processes, which lead to certain material-related configurations and consequences for UETs. Considering the analytical capacity of materiality perspectives, we emphasise three characteristics of material-related political processes, and term them as mobilisation (M1), intervention (M2) and meaning (M3). We argue that these materiality categories are useful means of grasping the complex UET processes, and outline an analytical framework through which they can be reconciled with the central governance aspects of UETs that we highlighted in Section 2.1.

Mobilisation (M1) refers to the deployment of energy’s materials to shape the practices and processes of UET. Previous studies on technological transitions provided insights about those material aspects that are path dependent and configured systematically, in offering options for transitions in the energy systems of supply, distribution and production [33,34]. These aspects are considered here to understand how urban processes evolve in the (pre-existing) material arrangements for energy [3,17,31,32,35]. In particular, Van Veelen, et al. [5] have highlighted the deployment of energy’s materials in enacting participation and enabling capacity building to organise participatory flows and relations within the practices and processes of UETs. The

mobilisation of materiality within the governance of urban energy systems, therefore, allows us to understand the evolution of socio-technical trajectories [30]. In particular, the trajectories involve the participation of actors and their capacities to undertake actions, co-ordinate actors and form alliances.

Intervention (M2) focuses on “the more than-technical ways in which materials reframe, guide and lock in political and social patterns” (p.3) [5]. This perspective should reveal “the ways in which politics made material and the ways in which materiality makes politics” (p.1713) [18]. The interdependencies between materiality and urban energy politics illustrate, “issues of agency (who, or what can act) and power (the capacity to affect the actions of other agencies and, to a certain extent, to be affected by the activity of those agencies)” (p.64) [29]. The intervention of materiality, therefore, reveals the decision-making of actors, as well as certain forms of inter-actor relations in constituting, constructing or contesting pathways for UETs. The intervention perspective also allows us to address the competences of self-regulation in shaping and reshaping the policies and processes of UETs.

Meaning (M3) acknowledges the intangible aspect of materiality in shaping the transition processes. This perspective investigates how the symbolic values of energy’s materials are connected with factors such as desire, emotions and (future) visions. These meanings may be used as strategic tools by different actors to support or obstruct different interests around certain decision-making and planning processes [3,16]. For example, studies of Not-In-My-Back-Yard activism have shown that emotions are actively played upon by oppositional groups to drive reactions to infrastructure such as wind farms [36]. The interrogation of meaning thus enables us to understand the social construction of attitudes and behaviours of individuals and actors, and the tensions between certain social or environmental positions to development in practice [37]. The meaning perspective, allows us to explore how particular representations of actors and actions, norms of alliances, as well as local identity matter to the UET processes.

2.3. Concept of case study and data collection

In linking the central governance aspects of UETs to materiality categories, we established an analytical framework (Table 1) and applied it to the case study of Hamburg. The case study draws on a review of the city’s energy and climate statistics, policy reports and grey literature within the last 20–25 years, in particular the Hamburg climate action plans (Section 3.1). Additionally, 19 semi-structured interviews were conducted in 2015 (n = 7) and 2018 (n = 12) in English with local informants from the city government, political parties, energy companies and entrepreneurs, civil society groups, environmental NGOs, and universities. Alongside organisation specific responses, some participants represented their overlapping roles as experts, representatives, and activists involved in environmental campaigns. When quoted in this paper, the respective role of the participant is provided in line with position statements. Some interview approaches were adopted to expand the breadth and depth of the data collected: repeat interviews (n = 3) were undertaken to capture the participants’ experiences and perceptions over time; arguments raised in one interview were ‘tested’, or ‘responded to’ in subsequent interviews. Then, the qualitative data was organised and presented thematically using Huang, et al. [38]’s method of coding.

In empirical terms, scholars have focused on the social movements

Table 1

Urban energy transitions: Governance aspects from materiality perspectives with coding in brackets.

	Actors/Actions (G1)	Inter-actor relations (G2)	Local dependencies (G3)
Mobilisation (M1)	Capacities to undertake actions and coordinate actors (M1G1)	Alliance formation (M1G2)	Building local trajectories (M1G3)
Intervention (M2)	Decision-making of actors (M2G1)	Forms of inter-actor relations (M2G2)	Competencies for self-regulation (M2G3)
Meaning (M3)	Representations of actors and actions (M3G1)	Norms of alliances (M3G2)	Local identity ‘our city – our transitions’ (M3G3)

Table 2
Climate action plans and the climate mitigation targets in Hamburg.

Climate Action Plan	First released	Climate mitigation target in Hamburg			
		by 2012/base year	by 2020/base year	by 2030/base year	by 2050/base year
<i>Klimaschutzkonzept 2007–2012</i> (CAP 1)	21 Aug 2007	2 million tons CO ₂ /2007	40% GHGs/1990		80% GHGs/1990
<i>Masterplan Klimaschutz</i> (CAP 2)	25 Jun 2013		2 million tons CO ₂ /2013		
<i>Hamburger Klimaplan</i> (CAP 3a)	8 Dec 2015		2 million tons CO ₂ /2012	50% CO ₂ /1990	At least 80% CO ₂ /1990
<i>Hamburger Klimaplan</i> (CAP 3b)	3 Dec 2019			55% CO ₂ /1990	At least 95% CO ₂ /1990

in Hamburg within the context of energy infrastructure ownership and governance, and in comparison to other German cities [19,20]. While we find the emphasis on the social-political nexus in driving radical change for transformation useful, we argue that such processes need to be understood through the underlying energy systems, concerning both path dependencies and options for change, within the urban arena in a more holistic way. Our approach to analysing the Hamburg case included two key steps. Firstly, we highlighted the materiality shifts of the city's energy system, to provide insights into the transition process in Hamburg. We referred to these as 'transition narratives' (Section 3.2), which exemplify continuities, decisive processes, conflicts and turning points. Secondly, we attempted to generalise the empirical findings from the narratives to provide a broader understanding of the case study (Section 3.3).

3. From 'transition in Hamburg' to 'Hamburg's transition': The politics of energy provision and distribution

3.1. Climate policies and energy transition in Hamburg

Environmental protection has been a distinct policy field in Hamburg since the early 1980s when a new ministry was set up following severe pollution incidents that occurred in the city. In the 1990s, that rationale extended to a proactive one, as urban and environmental policies started to address the challenges emerging from the thinking around 'sustainability', with the development of Local Agenda 21. Considered as a significant milestone, Hamburg signed the 'Charter of European Cities and Towns Towards Sustainability' (also known as the Aalborg Charter) in 1996, which was at that time one of the most important commitments of European cities towards sustainable development.

Attempts to mitigate climate change became an urban issue in the new millennium shortly after the introduction of federal laws to promote renewable energies. Since then, the Hamburg government has presented three climate action plans (CAP 1 to 3) [39–42] to fulfil national requirements (Table 2). Though the timeline of the plans and the official rhetoric around them may appear constant, the city's climate policies have remained fluid from their inception until today. Embedded in general political initiatives of climate change, the city's energy transition pathway has witnessed several critical materiality shifts in its energy system. These shifts have revolved around energy infrastructure ownership, centralised energy supply and energy sources and have become a central topic to the divergences, tensions and disputes over the city's energy governance. The consequences of the materiality shifts characterise crucial governance features for the city's transition pathway. Using five transition narratives, we attempt to capture the energy transition process of Hamburg.

3.2. Transition narratives

3.2.1. Privatisation of Hamburg energy system

The shifting ownership of the Hamburg main energy enterprise from a state, to a private, monopolised energy provider reconfigured the decisive roles of and relations between stakeholders in the governance of the city's energy supply in the early 2000s. For many years, the

energy system in Hamburg followed the old structure from the 20th century, in which a monopolised, municipal enterprise Hamburgische Electricitäts-Werke AG (HEW) had owned and run the city's main energy plants and grids. However, the subsequent reform of liberalising energy markets in Europe drove the Hamburg state to privatise HEW to reduce the public debt and limit state-led economic activities. After an acquisition process between 1999 and 2002, HEW's electricity and district heating branches merged with the Swedish energy company Vattenfall, which includes the local electricity and district heating grids, as well as two main energy plants in Hamburg-Tiefstack² and Wedel³. Furthermore, Vattenfall also inherited HEW's customer base of more than 70% of households in Hamburg (Vattenfall representative, interview, June 2018). While electricity and district heating contributed to about 60% of energy-related carbon emissions in Hamburg⁴, the shift in ownership of the main energy infrastructure not only mattered to the city's energy supply but also influenced the actor roles and dynamics of the city's energy-climate governance.

After the city government transferred its leverage capacities and management controls to Vattenfall, local NGOs and technicians of the HEW were doubtful whether the Swedish-based company would be willing to regard their business interests to be compatible with the local stakeholders' concerns (M2G1). As a former HEW high-profile representative, who pinpointed the gap between the company's decision and acting in the city's interest over the energy infrastructure, recalled,

Swedish people decided something for Hamburg, but German people worked differently...The facilities (of grids) in Hamburg are old now. Vattenfall didn't invest (on local infrastructure), now we have to renew all kinds of cables, transformers, etc. (interview, June 2018)

Similarly, several respondents from local NGOs expressed doubt about the environmental position of the company (as a business selling energy for profit) within a normative of decarbonisation of the city (interviews, June–July 2018) (M2G1). Therefore, the divergence on who (the state or private companies) should govern, and how to integrate the local interests in the management of energy infrastructure emerged and remained significant for the subsequent development. The privatisation of HEW politicised the city's low-carbon transition process as the shifting ownership resulted in a change in decision-making of the city's energy system. More specifically, this change was in material dimensions, including improved technological standards and reduced carbon emissions. Furthermore, the local stakeholders demonstrated their concerns about having a foreign company in the city's energy governance. They felt it might undermine the local interests and the city's self-regulation competencies (M2G3, M3G3). These diverging notions of energy and climate by various stakeholders became more obvious during the subsequent planning and construction of a new Vattenfall-initiated coal-fired power plant in Hamburg-Moorburg (narrative 2).

² Tiefstack power plant with capacity of 260 MW (electricity) and 423 MW (district heating) [43].

³ Wedel power plant with capacity of 321 MW (electricity) and 955 MW (district heating) [44].

⁴ Percentage calculated based on data from Länderarbeitskreis Energiebilanzen [45].

3.2.2. A new coal-fired power plant in Hamburg-Moorburg

At the beginning of the new millennium, it became clear that Germany would phase out nuclear energy within a few decades. In response to this federal decision several energy companies proposed to build 30 new coal-fired power plants in Germany [46]. It inevitably led to new forms of protest against using coal to secure future energy supplies, similar to those protests that occurred against nuclear power plants in the 1970s and 80s. Hamburg was one of the prominent places for this conflict across Germany. Soon after taking the primary control over local energy production, Vattenfall planned to construct a new coal-fired energy station⁵ at the site of a decommissioned power plant in Moorburg in 2004. According to Vattenfall [47], the intended investment was “explicitly encouraged” by the Christian Democratic Union (CDU)-led government at that time to ensure a “long-term supply of district heating to the city”, before Vattenfall made its development application to the government in 2006. However, after the public announcement of its construction and operation plans, the new coal-fired energy station was strongly contested by the environmental groups and the Green Party in Hamburg. The situation came to a head when the CDU and the Green Party tried to set up a coalition following the Hamburg state election in 2008. As a result, Vattenfall was required to fulfil additional ecological requirements to be granted its permits, including cooling water treatments and measures to safeguard the fish stocks. The Vattenfall group’s response to the additional requirements led to a judicial proceeding at the High Administrative Court of Hamburg as they entered into a critical *investor-state* claim against the German federal government under the Energy Charter Treaty. A preliminary settlement was reached in 2010, which “obliged the Hamburg government to drop its additional environmental requirements and issue the contested permits required for the plant to proceed” [48]. The construction of the Moorburg power plant was eventually approved in August 2010, and has been fully operational since 2015 with a heating capacity of 30 MW (less than the original plan) and an electricity capacity of 1654 MW (roughly as planned) [49]. However, the judicial proceeding regarding the Moorburg plant’s adherence to strong restrictions and additional cooling technologies is still ongoing [50].

Within the Moorburg dispute, the city government and Vattenfall deployed significant material steps to shore up their positions. The succeeding CDU-Green government laid stricter ecological criteria to mitigate the impact of the Moorburg construction and established *Hamburg Energie* to offset their loss after the setback in the legal conflict with Vattenfall. The foundation of *Hamburg Energie*, as a new state-owned energy company at the final stage of the Moorburg dispute in 2009, was strongly driven by the Green Party. The new energy company allowed the city to reduce its actual carbon emissions through its business orientation of renewable energy. More importantly, as the city government claimed, the company allowed them to resume their business control over the energy market to replace fossil fuels with renewables [51] (M1G1). The material steps taken by the city government and Vattenfall to intervene in the Moorburg construction illustrate their capacity to respond to the actions of the others and thereby reshape their positions within the continuing politics of transition (M2G2).

As a consequence, the symbolic values of the Moorburg construction dispute had a negative impact on the environmental representations of both Vattenfall and the city government (M3G1). Being the developer of the carbon-emitting coal-fired power plant, the extreme response of Vattenfall during the dispute mobilised opinions and created a ‘climate-obstacle’ business image. As explained and evaluated by a Vattenfall representative,

Perhaps the Moorburg decision was not in line with the majority of

⁵ The original plan of the Moorburg energy station was to have “two block-units, with a combined production capacity of max. 1730 MW electricity or max. 650 MW district heating” [47]

Hamburg population. The conflict is still influencing on our public perception and our standing in the city nowadays (interview, June 2018)

The climate-unfriendly outcome of constructing one of the largest coal-fired power plants in Germany also brought the ecological credentials of Hamburg and its government into question. Contrary to the local ‘climate’ expectation, the existence of Moorburg stimulated divergent views on who and how to transform the energy system to enable the city to achieve its climate goals. Two different, partly opposing, political reactions came out of the Moorburg dispute. The first, a top down reaction, attempts to present a climate-friendly city and change political priorities (narrative 3). The other, a more bottom up reaction, relates to a growing social movement aiming to re-municipalise the city’s energy system (narrative 4).

3.2.3. Branding the climate-friendly city and shifting priorities

During the Moorburg dispute, the city government was delegitimised in the field of environmental protection. However, by the middle of the 2000s, Hamburg entered the realm of climate change after the city government started to demonstrate its strong political desire to address the issue. The mayor of Hamburg at that time, Ole von Beust (CDU), tried to follow the political path of the chancellor of Germany, Angela Merkel (CDU), in the field. His declaration of making Hamburg “a model region in climate action” (p.1) led to critical steps on policymaking and alliance formation [52].

The first climate action plan of Hamburg (CAP 1) was one of the first documents to address the challenges of climate mitigation on the urban level in Germany. Furthermore, the mayor set up an international forum ‘Hamburg City Climate Conference’ within the framework of the Covenant of Mayors and in cooperation with the European Commission in 2009, which issued the ‘Declaration of the Hamburg City Climate Conference’. With such a background, it was no surprise that the conservative CDU formed the first coalition with the Green Party (2008–2010) on the state level. The city’s climate action efforts were later recognised with the European Green Capital 2011 award. In this phase, which we refer to as the ‘climate aspiration of Hamburg’, the strong local leadership played a crucial role in the initial processes of policymaking around climate change in Hamburg. The ruling political parties placed their attention on policy and allocated resources to local trajectory building associated with climate change and networking to enact local participation and enable capacity building of both local and international alliances (M1G2, M1G3). These works have created an important political field with ambitious climate goals at a rather early date in Hamburg, in comparison to other German and European cities.

Nevertheless, the city struggled to maintain the political momentum for a low-carbon transition, particularly after a change of ruling parties where climate change became less of a political priority. Since 2011, the leading political party changed to Social Democrat (SPD)⁶. The SPD showed less interest in the environment sector than housing and social issues and intended to keep Vattenfall as a central player in the city’s energy system. The stalemate of ‘less-ambitious’ climate momentum can be illustrated by the reduction in climate funds and the challenge of personnel resources within the city’s climate authority Coordination Centre for Climate Issues (Climate Centre). Both climate funds and personnel resources were deployed in CAP 1 to kick-off climate-oriented projects⁷ and coordinate works between ministries and departments of the government (M1G1). However, compared to the “generous” amount of 25 million euros per year in CAP 1, the allocated governmental budget was reduced to 13.4 million euros in CAP 2 (2013–2014) and less than 7 million euros in CAP 3a (2015–2016)

⁶ SPD (after the Hamburg state election of Feb 20, 2011) and SPD-Green Party (after Feb 15, 2015)

⁷ In 2008 and 2012, 150 projects in sectors like buildings, mobility and energy (10 sectors in total) for climate protection received a total subsidy of 118.5 million euros.

(Climate Centre official, interview, January 2015). Despite the initial optimism that the funded projects could be eventually self-financed and more third-party funding could come from the higher-levels (e.g. the EU and the federal government) and private sectors, there was uncertainty if the projects could be sustained without the government funds and whether the objectives of other funding sources would align with the city's climate notions. Furthermore, during the SPD-led government (2011–2015), the Climate Centre fell under the supervision of the Ministry for Urban Development and Environment, in which the climate interests were overlooked, compared to the higher-prioritised housing sector (Climate Centre official, repeat interview, July 2018).

This political disregard not only has influenced the succeeding climate plans negatively but also highlighted that the SPD-government underestimated the power of a bottom-up movement with respect to climate change mitigation. The inconsistent energy policies in the previous years (narrative 1 and 2), the disregard of climate issues, as well as the attempt to keep Vattenfall as a central player during the governing term of SPD, have become a catalyst for a new social movement toward alternative governance options in the city's energy system for its energy-climate future (narrative 4).

3.2.4. Referendum to re-municipalise energy grids

The referendum to re-municipalise the Hamburg grids marks a critical governance turning point for the city's transition pathway. On 22 September 2013, the election day for the 18th Bundestag of Germany, voters in Hamburg were provided with a referendum ballot paper to decide the city's energy-climate future. It was a simple statement – “demanding the transition of the city's grids into public ownership, and a socially just, climate compatible and democratically controlled energy provision from renewable sources as a mandatory target” (p.8, original English translation) [19]. The ruling SPD-government was against this and wanted to keep Vattenfall as a central player in the city's energy system. However, after receiving a 50.9% endorsement during the referendum, the city government was obligated to implement the statement mentioned in the ballot paper. The city government had already acquired a 25.1% shareholding on energy distribution grids, however, was forced to negotiate with Vattenfall to acquire the remaining 74.9% of electricity and district heating grids, and E.ON Hanse for the gas grid. The consequences of this referendum reconfigured the power relations between actors in the city's energy-climate governance.

Since the anti-nuclear movement in the 1970s and 80s, the Hamburg-civil society has encompassed several local agencies that possess strong capacities to politicise their notions of energy and climate through mobilising campaigns and creating collaborative networks. As one of these networks, the coalition *UNSER HAMBURG – UNSER NETZ* (Our Hamburg Our Grid), initiated by the Friends of the Earth (*BUND*), the Consumer Advice Centre (*Verbraucherzentrale*) and the charity organisation of the Protestant-Lutheran Church (*Diakonie*), has been established as a citizen's initiative to campaign for (new) public ownership of energy grids (M1G2). During the referendum campaign, the supporting activists framed the ‘public’ ownership of the city's grids as environmental initiatives, which helped the city to return to its climate trajectory. Considering “energy is a public good”, they anticipated that the re-municipalisation of the energy infrastructure could be a critical, first step, which gives foundation to transform the energy system and makes it more climate-friendly and sustainable (*UNSER HAMBURG – UNSER NETZ* activist, repeat interview, June 2018) (M3G1). This notion became more significant when the activists took the opportunity to polarise the debate of grid ownership as ‘public and climate-friendly’ or ‘private and not climate-friendly’. In particular, they divided the ‘yes’ and ‘no’ alliances by referring to Vattenfall as a ‘climate-obstacle’ in the ‘no’ alliance, which negatively represents the old system of fossil fuels, as well as capitalism (M3G2). The meaning of energy infrastructure ownership was actively played upon by the supporting activists to shape the norms of the alliances and create the bipolarised distinction between alliances. Although there was no causal

relationship between public ownership and decarbonisation, the success of the referendum demonstrates the social desire of climate action and the capacities of the supporting activists to complement this desire in their campaign initiatives.

As a result of the referendum, the civil society actors, in particular, the activists involved in the referendum, became more prominent in the city's energy-climate governance through the discussion platform of *Energiernetzbeirat* (Energy Advisory Council). The Council was founded by political actors to allow the Hamburg society to be involved in the implementation process after the referendum. The Council created an open platform, for 20 board members, including both politicians and local, non-state actors from various sectors⁸, as well as regular public audience⁹. For the first time, the Council created a new self-regulation channel for the local actors to engage with the agenda setting process in the city's energy politics (M2G3). The governance of energy-climate issues in Hamburg thereby operates in a more-decentralised form of interaction. The success of the referendum within the Hamburg context and the consequence of an increasing representation of local civil society actors offers insight into how a more ‘Hamburg’ response starts steering the city's transition process (narrative 5).

3.2.5. District heating plan and anti-coal movement

Achieving a more ‘Hamburg’ response in the energy-climate governance becomes significant when considering a recent plan for district heating in Hamburg. The plan was plagued by the controversy associated with the future of the coal-fired Moorburg plant. During a meeting of the Energy Advisory Council in November 2017, the environment senator presented a plan for renewable district heating, with a desirable option of constructing new grids and acquiring heating sources from the South of Elbe in Hamburg [54]. Around the same time, the government was negotiating with Vattenfall about the purchase price of district heating grid, where a rumour surfaced about the actual value of the heating grid to be less than the earlier agreed upon price¹⁰. Even though the Moorburg plant was not part of the central district heating network, its proximity to the other energy infrastructure meant that the plan could technically utilise waste heat, or even acquire district heating from Moorburg (Energy Advisory Council board member, interview, June 2018). Inevitably, there was speculation that a compromise to connect Moorburg into the district heating would emerge from the deal. The district heating issue demonstrates how the local infrastructure associated with energy grids and power plants continuously became the focus of discourses for many years in the city's energy-climate governance.

Similar to the approach undertaken in the 2013 referendum, a new alliance of environmental activists and representatives from societal organisations (including some of the leading activists of the 2013 referendum) formed a new citizen's initiative *Tschuess Kohle* (Bye Coal, TK) (M1G2). Framing itself as an anti-coal alliance, TK campaigned to end Moorburg through a timetable of coal-free district heating by 2025 and electricity by 2030 (M3G2). In doing so, TK sought to amend the Hamburg Climate Protection Law (*Hamburgischen Klimaschutzgesetz*) to create a regulatory barrier for the potential connection of Moorburg (M2G3). Between February and June 2018, the initiative collected 22,500 signatures from the Hamburg citizens in support of their intention and submitted it to the Hamburg Parliament. TK not only demonstrates again the capacities of the local civil society actors in

⁸ The Council should consist 6 from political parties represented in the Parliament, 4 from the sector of economy, 3 from labour unions, 4 from environmental organisations, 2 from science, and 1 from Consumer Advice Centre [53].

⁹ The Council was set to meet minimum two times per year. Between April 28, 2016 and October 24, 2019, 21 meetings had been held.

¹⁰ Instantly after the referendum in 2013, the price for district heating had been agreed between the city government and Vattenfall for a minimum of 950 million Euros.

mobilising campaigns and forming alliances, but its creation also underpins the self-regulation competencies within the constitutional context of Hamburg.

Within the anti-coal campaign, the notion of ‘Hamburg’s transition’ continues to play a crucial role in at least two ways (M3G3). The first is related to the composition of the TK initiative, which only allows ‘Hamburg-focused’ stakeholders to be part of the executive committee. As a TK activist explained,

NGOs who work nationally or internationally should not decide what we do here for Hamburg because it (the TK initiative) is a Hamburg case. This initiative is only for Hamburg. Only Hamburg people could be part of the initiative and sign (TK activist 2, interview, June 2018)

The second is the ‘massive, dirty power plant’ of Moorburg, which was continuously placed in a central position of the campaign, pushing the perception that ‘Hamburg is not in a right direction of being climate-friendly’. The campaign attempted to provoke an emotional response and generate a local awareness to change the status quo in the energy system (M1G3). Learning from the experience in the 2013 referendum, Vattenfall responded cautiously to the TK campaign and hoped to reshape the company image through declaring their interest of “fossil-fuel-free in one-generation” by attempting to remove themselves from the situation (Vattenfall representative, interview, June 2018) (M2G2). The energy company expected to operate the Moorburg plant for 30 more years, in which they had already invested 2.8 billion euros. However, the existence of such a massive, carbon-emitting power plant demonstrates a continuation of the conflicts and uncertainties within the city’s energy-climate governance. It will very likely be another controversial discussion around infrastructure ownership, centralised energy supply and energy sources. This suggestion is already evident in a very recent plan presented by the city government to convert one Moorburg coal unit to gas and for Hamburg to become an innovation centre for renewables, specifically in hydrogen technology in Germany [55].

3.3. Discussion: Lessons learned from the Hamburg case

The Hamburg case zooms in on the intersections between local energy-climate politics, general aspects of the German energy transition, and materiality, specifically energy infrastructure and environmental protection. Through our analytical framework, the transition narratives of Hamburg outline three distinct characteristics of the processes of UETs: (1) a place or an arena where complex interactions come together, (2) leading to special dynamics of action, reaction, learning and experimenting, (3) resulting in place specific outcomes within the context of general trends of energy transition.

(1) A place or an arena where complex interactions come together

The Hamburg case demonstrates how the inter-relations between energy materiality and the material-related political processes across different spatial scales of global, national and urban have significant implications for energy transitions in cities. We argue that we have to conceptualise UET as being a complex political arena concerning the materiality aspects of the energy systems. Consistent with the energy materiality literature [e.g. 5, 16, 18, 29–32], on the one hand, we should acknowledge the significance of the urban energy systems, which offer technical options and solutions in energy supply and use for UETs to take place (e.g. the renewable energy generation from *Hamburg Energie*). On the other hand, the governance of UETs creates specific material changes in the energy systems (e.g. the discussion to end/transform Moorburg through political processes). More importantly, this paper builds up understandings of path dependencies by exploring the inter-relations in a learning context, with an added emphasis on how earlier material-related decisions partly contribute to shifting political interests and transition orientations. For example, the ongoing debate on the energy supply in Hamburg is framed by the existing

energy’s materials and the prospects for decarbonising the city’s energy system, and is continuously led by the experiences and outcomes of previous conflicts. Therefore, this paper highlights a need to look carefully at both material path dependencies and options for change within the urban energy systems, and how these might configure and re-orientate the transition pathways in cities.

(2) Special dynamics of action, reaction, learning and experimenting

The Hamburg case offers diverging insights into the place specific dynamics of action, reaction, learning, and experimenting within the UET process. For example, the governance dimension of actors/actions (i.e. M1G1, M2G1, and M3G1) demonstrates how the political orientations and practices of local energy transition were shaped and reshaped by shifting priorities of federal legislation and high-level city politicians, as well as persistent challenges from energy companies and local activists. In particular, the capacities of local actors from the civil society to politicise their energy-climate notions in the existing governance arrangements drew our attention. However, we do believe their capacities are subject to the local contexts of the city’s constitutional governance structure, the incremental socio-political tensions on climate change and a long history of political debates and social movements on ecological issues. The critical roles of a wide range of local, civil society actors, and their responses to create spaces for intervention, need to be taken into account for a better understanding of “where, how and by whom energy system change is being (or might be) done” (p.174) [4]. This paper also suggests that any further research on ‘actors’ in cities should be further distilled. Instead of the traditional distinctions of ‘state’ and ‘non-state’ actors, we argue for a more context-specific way to outline the different motives, interests and powers of actors/coalitions across levels of the government and various agencies in cities.

The governance dimension of inter-actor relations (i.e. M1G2, M2G2 and M3G2) also highlights a continuing perspective on the nonlinear dynamics between actors in the governance of UET. For example, how Hamburg actors respond to the actions taken by others (e.g. the stricter criteria laid by the city government to Vattenfall and the substantial establishment of *Hamburg Energie* during the Moorburg construction conflict), as well as how they learn from the experience (e.g. the re-positioning, ‘fossil-free’ approach of Vattenfall after the 2013 referendum). Although this paper does not find an answer to the evolving dynamics, it suggests that the responding and learning capacities of actors over time explain how momentum for UETs is created, maintained and lost. Various technical and political measures are taken by certain actors and political parties, in an ongoing process of experimenting, navigating, and re-positioning to achieve certain ends [10,15]. This paper, therefore, offers insights into the learning and experimenting capacities of actors as a means of understanding the conditions and roles of cities to make structural changes for transition.

(3) Place specific outcomes within the context of general trends of energy transition

The ‘locality’ was a leitmotif of the debates and negotiations over the low-carbon future of the Hamburg case, rather than a translation of global climate change imperative or national *Energiewende* to the local level. Through the governance dimension of local dependencies (i.e. M1G3, M2G3 and M3G3), the focus on *Hamburg’s energy* demonstrates how and in which areas the actions took place, by whom and to what ends. With its special constitutional status as a state, the Hamburg government demonstrates its political autonomy in developing local climate and energy plans and its financial competence in realising the climate projects during the ‘climate aspiration of Hamburg’. The Hamburg case later emphasises how local environmental initiatives matter to a city’s transition through creating a Hamburg-oriented renewable energy enterprise and acquiring the local energy grids.

Furthermore, the contested actions at both the 2013 referendum and the TK initiative were aimed at a Hamburg-oriented constitutional reform, to encourage a more socio-ecological framework for the energy transition in Hamburg. We, therefore, argue that city-driven transitions should further expand from the translation of ‘global problem, local solution’, to a more local-oriented focus. The notion of locality highlights that UET is creating a special political arena with its own and self-regulated dynamics, and resulting in local solutions for both the governance mode and materiality of the urban energy system.

4. Conclusion

Focusing on the governance of UETs and climate change, this paper has sought to understand the complexity of actions, relations and local dependencies within the governance of urban energy systems in shaping the transition processes. In relation to our analytical framework, which links the governance issues to materiality categories, the Hamburg case provides a better grasp on how place specific evolving actions and power relations constitute, construct and contest the pathway for city-driven transitions.

This paper proposes an analytical framework with three materiality categories to organise and present the case study of Hamburg. This improved framework allows for more systematic analysis and provides a heuristic evaluation to discuss and explain the ongoing process of UET explicitly. For example, as illustrated by the materiality perspectives, the in-part controversies of the Hamburg transition pathway have been and will very likely be central to the development of the city’s main power plants and energy grids. This is due to them contributing to a large proportion of the carbon emissions in the energy system and the considerable company investment in their development. These features raise important questions around how to modernise or re-construct the existing infrastructure in the urban energy system to align with the new (future) visions of UET. A limitation of this paper is that we only consider the analytical capacity of materiality perspectives. As such, the theoretical and conceptual understandings around materiality perspectives are open for further discussion. We, therefore, suggest a future study could further explore the use of materiality perspectives, to conceptualise the governance of UETs and climate change.

The Hamburg case offers insights into an emerging governance mode of UETs that includes a greater variety of stakeholders and is more open for different options in energy-climate policy, in particular, in European cities. The city’s energy transition pathway has witnessed shifting ownership from first a state, then a private, monopolised energy provider to a more open governance mode, with new forms of actor collaborations, power dynamics and local dependencies. The eventuation of UET in Hamburg is subject to the strong capacities of civil society actors/coalitions to intervene in the transition process through campaigns and advocacy. Although the UET gives civil society actors more opportunities to promote their ideas, the structural elements are still missing to outline a new regime for this more-decentralised mode of decision-making. Further research is needed to explore more closely the links between the governance modes of UETs and their outcomes. Future research could also examine the scope for compromises and trade-offs, to understand how the climate goals translate into collaborative actions in cities. The next more pressing question is how cities can transit more rapidly to respond to the threat of climate change within a small remaining carbon budget.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Rethinking the potential of collaboration for urban climate governance: the case of Hong Kong

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Abstract

Collaboration is strongly promoted as an effective means for cities to respond to climate change. While collaboration is perceived to offer opportunities to progress climate action in cities, little is known about how collaboration can enable low-carbon transformation in practice. Furthermore, while collaboration is largely framed as a positive endeavour, there is a need to more carefully explore the challenges and barriers that may arise. This paper explores the aims, processes and outcomes of collaboration within urban climate governance. Drawing on a policy review and semi-structured interviews, we present empirical findings from the case study of Hong Kong. This paper identifies three types of collaboration that are structured by regulations, oriented to policy goals, and emerge as everyday practices. The forms of collaboration within the city challenge the assumptions that collaboration always brings positive outcomes in mobilising action for climate change. While collaboration opens up different modes of governance within cities, the paper highlights significant barriers in terms of the diverse roles of actors, ongoing power imbalances and shifting governance spaces for intervention. Given the prevailing interest in working together, it is critical to review carefully how collaboration facilitates cities to achieve their climate goals and create momentum for action.

1. Introduction

In understanding how cities address the challenge of climate change, the idea of working together is strongly promoted by both scholars and policymakers. For example, in the UN's New Urban Agenda, keywords such as 'cooperation' (n=16), 'collaboration' (n=6) and 'coordination' (n=17) are highlighted frequently as strategies to achieve sustainability goals in urban spaces (UN-Habitat, 2017). In this context, numerous approaches towards collaboration emerge, such as planning and decision-making across levels of government, partnerships between governments, the private sector or civil society and sharing of best practice and policies through international dialogues.

While this promotion of collaborative governance is well intended and opens up multiple opportunities, there nonetheless remains a lack of clarity about how cities implement these collaborative strategies in practice and the impacts of such collaboration in enabling low carbon urban transformations. This is important as the processes and outcomes of collaboration might not always be smooth and positive and could create barriers for urban climate action (Acuto, 2013; Vasconcelos et al., 2013). This paper thus explores collaboration in urban climate governance as a means of understanding the different practices of working together that take place within cities and the implications for action towards climate change. We argue that collaboration opens up different modes of governance within cities but may not necessarily enable low-carbon transformation in practice.

To explore different modes of collaboration in urban climate governance, this paper draws on a case study of Hong Kong. The city has for many years attempted to derive electricity from renewable sources to reduce carbon emissions from the energy sector, which accounts for 70% of total emissions (Environment Bureau, 2017). Several regulatory and policy initiatives have been introduced: the Scheme of Control Agreements to regulate energy supply, the Feed in Tariff scheme to support small-scale renewable energy and Hong Kong's Climate Action Plan 2030+. In their design, these initiatives are underpinned by different modes of working together but questions remain about the extent to which these forms of collaboration are driving climate action. In this paper, we identify forms of collaboration that emerge through regulation, policy development and everyday practices. Our analysis finds that even though collaboration is seen as critical

by a wide variety of stakeholders, these forms of collaboration have only limited impacts on climate action in practice.

Climate politics in Hong Kong are situated within the wider political relationship between Hong Kong and China. Changes in this relationship may jeopardise the leadership and autonomy of the city government on climate issues, as well as collaborative relationships with non-governmental actors (see the work of Francesch-Huidobro, 2012; Holley & Lecavalier, 2017; Mah & Hills, 2016). While acknowledging this political context, this paper and the empirical findings are primarily concerned with urban climate governance *within* the city. It is beyond the scope of the current paper therefore to consider in detail the wider implications of the rapidly changing political context of Hong Kong. We of course acknowledge that climate action, and forms of collaboration, may be shaped differently in the future, a point which is worthy of future research.

The paper is structured as follows. It first reviews the literature about the aims, actors, processes and outcomes of collaboration in governing cities and climate change. It then introduces the methodology and case study of Hong Kong. Next, it presents the empirical findings regarding the motivations for collaboration, the types of collaboration that emerge and the implications of collaboration for climate action. The paper concludes by reflecting on how the case study of Hong Kong contributes to broader understandings of collaboration in urban climate governance.

2. Collaboration in urban climate governance

Cities around the world have adopted a variety of approaches towards governing climate change, ranging from measures with a technocratic focus to those more oriented towards politics and society. The idea of collaboration manifests in the planning, decision-making and implementation processes for climate policies and action. In this paper, we use the term to explore different practices of co-operation and co-ordination among actors within the city, which has emerged as an increasingly prominent way to govern cities and climate change. We draw together literature from urban geography, urban climate governance and public administration to outline the aims of collaboration, the types and roles of actors and the opportunities and challenges of collaboration in practice. Overall, this provides insights into how collaboration can mobilise action for climate change in cities.

Collaboration is increasingly positioned as a key mechanism to address climate change in the urban context. One of the aims of collaboration is to create opportunities for action through increased networking and meaningful engagement. For example, Leck and Simon (2013) highlight how co-ordination between governmental institutions and networks, comprising both government and non-governmental actors, strengthens knowledge and sharing of best practice. Stakeholders are able to tap into resources and expertise of communities and such networks ultimately enable greater influence on policymaking. Another aim of collaboration is to develop more democratic policy processes through expanding participation at the local level. For instance, within cities there has been an extension of governance to non-governmental actors (e.g. civil society groups, business sectors or academic stakeholders) to gain “a wider room for manoeuvre via transformative local agendas” (Acuto, 2013, p. 53). As climate change requires a series of cross-sectoral measures, there is an expectation that extensive stakeholder involvement can develop rapport to support decision-making and consensus-building and encourage effective and long-lasting implementation for local climate policy and action (Barton et al., 2015). Collaboration is thus, on the whole, largely framed as a positive endeavour. There has been less research exploring how collaboration may hinder or impede action on climate change, which is where this paper seeks to contribute.

In practice, collaboration takes multiple forms, with different types of actors and different kinds of governance arrangements. Public agencies, who are typical initiators or instigators of collaboration, have a role in leading by example, establishing regulations and policies, providing public services and supporting other urban actors (Ansell & Gash, 2007; Bulkeley et al., 2014). In this way, effective collaboration is underpinned by institutional capacity, political interest and leadership of local government entities. With the trend of neoliberal climate governance, the participation of non-state actors including individual and organisational actors has also become more prominent (Phelan et al., 2012). For example, private sector actors serve as service and infrastructure providers, particularly in controlling utilities, while civil society actors, such as community-based groups and environmental NGOs, seek to intervene around locally specific issues (Bulkeley et al., 2014). Furthermore, Ansell and Gash (2007, p. 546) suggest, “collaboration also implies that nonstate stakeholders will have real responsibility for policy outcomes”. As such, while all actors seem to play an important role in urban climate governance, it is necessary to explore how their roles are situated in multiple

forms of collaboration that might reconfigure the ways they operate and work together (Bulkeley & Kern, 2006).

The focus on collaborative relationships also brings into question how actors with divergent interests and power can work together. Much of the literature suggests that collaboration can leverage any power imbalance by representing and empowering the weaker or disadvantaged stakeholders (Ansell & Gash, 2007). For example, non-governmental agencies can put pressure on governments through lobbying, monitoring and campaigning in urban politics (Acuto, 2013; Bulkeley et al., 2018). Nevertheless, “whose visions of the low carbon city will be allowed to count” are largely dependent on the capacities the stakeholders hold and the governance spaces for intervention (McGuirk et al., 2014, p. 146). This raises questions about the extent to which collaboration can overcome power imbalances in practice and the broader implications for urban climate governance (Cheung & Oßenbrügge, 2020; Rutherford & Coutard, 2014).

Taken together, the issues of actor relationships and power dynamics draw attention to the challenges of developing collaboration to progress common goals and enable collective climate action in cities. Insights from the transnational city governance literature highlight the lengthy process of negotiation between actors with varying needs and priorities on climate change (Vasconcelos et al., 2013) and the lack of effective operational mechanisms which require “information sharing, communication and reciprocal learning” between participating agencies (Leck & Simon, 2013, p. 1235). In the context of collaboration in cities, consensus may be hard to come by in collective decision-making process, and coordination may be challenging to extend beyond the capacities of a local climate authority (Anguelovski & Carmin, 2011; Barton et al., 2015). These potential barriers could create profound challenges for low-carbon transformations in cities (Jaglin, 2014). These issues highlight the need to explore the processes of working together to understand opportunities for climate action in cities. More importantly, while collaboration appears to foster collective action for climate change, there is little research that explicitly interrogates the progress of promoting collaboration *within* cities (Leck & Simon, 2013). Therefore, here we examine different forms of collaboration and the outcomes of collaborative practices to offer wider insights into urban climate governance.

3. Methodology and case study

This paper presents a case study of the city of Hong Kong, with a focus on collaboration as part of wider urban climate governance arrangements. As a special administrative region (SAR) of China, the political structure of Hong Kong features an executive-led government. Most climate initiatives are led by the Environment Bureau (ENB) which has responsibilities for environmental protection, energy, climate change and sustainable development (Environment Bureau, 2018), while members of the Legislative Council (LegCo) perform checks and balances on executive decisions (Legislative Council, 2020). There are two de facto monopolies in the electricity market - CLP and HKE¹, which have dominated their demarcated geographical areas since electricity was first supplied to the city in the late 1800s and early 1900s. Environmental NGOs and business organisations also play a significant role in adopting voluntary actions and shaping the climate agenda for the city (Chu & Schroeder, 2010; Fuller, 2020).

Data collection comprised a policy review and 12 semi-structured interviews conducted in April-May 2018 with key stakeholders from government, the private sector, NGOs and other experts. Interviews explored the motivations for collaboration, the collaborative approaches undertaken and the outcomes of collaboration for climate action in the city. Interviews were analysed thematically using qualitative data analysis software. Interviews were conducted in both English and Cantonese; quotations presented below are either direct quotes or translations, as indicated in the text. We present the empirical findings below as a means of exploring different perspectives on the emergence of collaborative climate governance, identifying different types of collaboration, and reflecting on the wider implications of collaboration for climate action in the city.

4. Findings: collaboration and climate governance in Hong Kong

4.1 Motivations for collaboration

From the outset, it is apparent that collaboration is seen as necessary in Hong Kong and is shaped by three key factors: the expertise of actors, the size of the community, and the political landscape of the energy-climate sector in the city. First, collaboration enables the sharing of roles and responsibilities drawing on the different expertise of actors. For

¹ CLP Power Hong Kong Limited and Castle Peak Power Company Limited (referred to as CLP); and Hongkong Electric Company Limited and HK Electric Investments Limited (referred to as HKE).

example, the government recognised the importance of both government and non-governmental actors in promoting environmental awareness in the city:

“We communicate a lot with environmental NGOs. We work together on the topic with different approaches: some work can only be done by the government e.g. advertisements on TV; some can only be done by them, such as talking to local communities. We need work from both sides” (Interview, ENB officer [translation])

A similar rationale was proposed by an energy company:

“I think every stakeholder has a role. For example, environmental NGOs raise public awareness on energy saving. The government has the resources to play its role. We, as the private sector, have the knowledge and technology. There is no single solution to reduce carbon emissions, the 2-degree target can only be reached by carrying out many measures” (Interview, power utility [translation])

Secondly, the small number of active energy and climate stakeholders in the city makes collaboration even more important. One expert described the community as “a small ecosystem” (Interview, expert 2) in which people know and talk to each other frequently. Another expert further explained the rationale for working together:

“If every organization organises activities for their own sake or competes for the same resource, no synergy will be generated...So, for many of the stakeholders, also for the business sector, if they see an opportunity to work together, they will do that...They are quite clever and know when it is the right time to collaborate or work alone” (Interview, expert 3 [translation])

Finally, collaboration is particularly vital to the work of local environmental NGOs. Protest activities have little effectiveness in the political situation and therefore working in collaboration is the only feasible means of influencing policy, as noted:

“We do not position ourselves as pressure groups. It is of no use. If you use this kind of extreme approaches to pressurise the government, what they will do is to

try to hide, try not to address the issue. You want to form some kind of partnership, to make positive changes step by step. We didn't give them [the government and the power utilities] a hard time...We still criticise but don't have a very confronting position” (Interview, NGO 1)

Overall, while all actors see collaboration as essential, there are different views and motivations for working together. These differences in term of expertise, capacity and political power highlight unequal dynamics between actors which problematise how collaboration manifests in urban climate governance.

4.2 Types of collaboration

The empirical work highlights that there are different types of collaboration in Hong Kong. One way that collaboration happens is through regulatory arrangements which mandate the parties involved to achieve particular goals under specific terms and timeframes. In Hong Kong, the Scheme of Control Agreements (SCAs) have configured a collaborative relationship between the government and the two private utilities to ensure energy supply in the city. In this context, the government works as a gatekeeper to “regulate the electricity-related financial affairs” of the two energy service providers, as well as to “monitor their reliability and environmental performance in providing electricity” (Hong Kong SAR Government, 2019). The collaboration has been working well, as the power utility described:

“In general, we support the government policy, and I believe the government appreciates that. We are just doing practical things to satisfy the roadmap set by the government” (Interview, power utility [translation])

The contract underpinning the SCAs is renewed every 10-15 years but there is strong inertia to keep the relationship unchanged, as an expert stated:

“If things are broken, fix it. Now it is not broken, why fix it? They [the power utilities] want to do whatever they are told and they can agree upon... What is the incentive to change? Unless there's pressure from the government” (Interview, expert 2)

Another important form of regulatory collaboration in the city's energy sector is implemented through the *Feed in Tariff* (FiT) scheme for small-scale renewable energy (RE) installations. While the scheme is a stipulation of the recently negotiated SCAs (2019-2033), the arrangements are slightly different. The collaborative relationship reduces dependence on the two power utilities and instead the scheme targets smaller-scale developers from households, businesses and non-profit organisations with rooftop solar panel systems of up to one MW. Indeed, the two utilities are only responsible for enforcing the scheme by purchasing the electricity from these renewable energy developers, with the costs offset by the revenue from a certificate scheme. The government reviews FiT rates annually and offers technical and regulatory advice (Legislative Council Panel on Environmental Affairs, 2018). The majority of interviewees, both government and NGOs, felt that the scheme provides a productive form of collaboration between local energy producers and the two utilities to provide sustainable and affordable energy to the city.

A second type of collaboration is oriented around prescribed policy goals. This collaboration process is structured around policy development in which a mix of formal and informal practices are adopted. In Hong Kong, this collaboration is mostly initiated by the government. For example, within the current climate action plan (CAP), the government created the Steering Committee on Climate Change, which includes 16 governmental entities with the rhetoric of 'cross-sectoral' collaborative arrangements:

“The work for climate change includes carbon reduction, adaption and resilience, which exceed the capacity of ENB and require extra support from other departments. That's why we established a steering committee, led by the Chief Secretary for Administration [the second highest-ranking official of the government] so that the CAP is more comprehensive, with a wider workforce and a much higher level of governance, compared to the past” (Interview, ENB officer [translation])

However, despite this collaboration, carbon reduction in practice is still reliant on efforts from the electricity generation sector, which is solely under the remit of the ENB (Environment Bureau, 2017). Several respondents raised concerns that, without explicitly outlining the sectoral responsibilities and measures among the departments involved,

proactive moves by civil servants are unlikely, given the institutional inertia inherent to the city's political system. For example, one participant explained the risk-avoiding character of the government:

“The thing I see is very unfortunate. There is an incentive to do nothing...The government only does things when it really has to, and it does it in a very timid way...We also see them (the civil servants) protected or shielded to some extent from criticisms when things do not work out”. (Interview, expert 1)

Public consultation is also a common political practice of the government to build consensus and dialogue for collaboration. Within the *Public Consultation on Future Fuel Mix for Electricity Generation*, the government published a consultation document and invited submissions from both individuals and organisations on two mutually exclusive options: importing ‘greener’ electricity from China or generating local electricity from natural gas (Environment Bureau, 2015). In parallel, the government organised discussion forums and focus groups. The consultation attracted an overwhelming response of 86,128 submissions, and both the government and the power utilities used the consultation results to legitimise the new contract of SCAs. On one hand, the government claimed that the finalised SCAs “meet the public aspirations expressed during the public consultation” (Hong Kong SAR Government, 2017). On the other hand, the power utility said:

“The result of the consultation showed that people think the regulated, vertical-integrated energy provision services are performing well. People think this operating system is suitable for Hong Kong” (Interview, power utility [translation])

However, criticisms arose concerning the opaque decision-making process and the lack of influence of other stakeholders in the final decisions. This is evident through opposing views being ignored by the government, as the consultation report indicated:

The majority of the submissions from political parties and LegCo Members commented that there was not enough information for making a considered choice (p. 8)...most of the green groups and NGOs did not support either option. (p. 11) (Environment Bureau, 2015)

Finally, collaboration happens through multiple informal and ad hoc activities on a contingent and everyday level. This type of collaboration has no specific end-goal but serves to maintain relationships between stakeholders. This type of collaboration is seen as particularly critical for non-governmental actors. For instance, an NGO representative described part of their everyday policy work in building a continuing dialogue with the government and the power utilities:

“We keep engaging with the government. For example, we have regular meetings with the Environmental Protection Department. We are not only engaging with the policymakers, but also CLP and HKE. For example, in the FiT scheme, they invited us to join the focus group discussion and asked our opinions on price, payback period, also the regulation and other fine details” (Interview, NGO 5)

Similarly, a business association representative highlighted the importance of maintaining good relationships with the government throughout their operations, but also highlighted the challenges to enable policy change through this collaborative approach:

“We try to make a good dialogue with the government through events, workshops, internal or informal meetings. But, of course, the government sometimes was just pre-occupied. They were just thinking about their fundamental operation. Sometimes they have to turn down an invitation from us... we just continuously try to make it happen...It is hard and definitely, you have to be persistent” (Interview, business association 2)

Overall, there are various forms of collaboration that emerge through regulation, policy development and everyday practices. However, questions remain about the extent to which these forms of collaboration are driving climate action.

4.3 Outcomes of collaboration

While collaboration is perceived to be essential in Hong Kong, the interplay of the three forms of collaboration identified above are limited in their capacity to create meaningful action on climate change. There is a reliable and affordable energy supply system in Hong Kong given the stable, long-term relationship between the government and the two power

utilities. Although it fulfils the primary objectives, the regulatory nature of the SCAs limits the potential for radical innovation. One persistent critique is that the inherent financial mechanism of SCAs fails to promote electricity generation efficiency or encourage generation from renewable sources (Lam, 2004; Moss & Francesch-Huidobro, 2016). The new contract of SCAs (2019-2033) has now been implemented and the opportunities for decarbonising the energy sector are thus limited:

“We are now locked in until 2033 with the new SCAs...This city with 7 million people, with a significant volume of trade and transport sector, cannot live without electricity. So, reliability is still the centre point...But the incentive is not there. I think they miss the opportunity with this new agreement. They could have done something completely different” (Interview, expert 2)

Recently, some success on individual solar energy development through the FiT scheme has been observed when, in less than a year, the scheme attracted over 3500 applications (Chan, 2019). The collaborative arrangement of the FiT allows for representation of wider range of stakeholders (e.g. the smaller-scale RE developers and NGOs) who are excluded from the regulatory context of SCAs. Nonetheless, it was only implemented after being formally included in the new SCAs and will only account for a maximum of 1-1.5% of the city’s electricity demands (Environment Bureau, 2017). As such, it is unlikely that the scheme will make a significant change towards emissions reduction in the city:

“Hong Kong is a high-density city...We have no space for large-scale RE development. So, to reduce carbon emissions, the most feasible option is through the fuel mix...No matter how much effort we put on developing local RE. The contribution [via the FiT scheme] will be small as there are not many rooftops, which are feasible for solar panels installation in the city” (Interview, ENB officer [translation])

Moreover, there has been limited concrete action around climate change in the city, a point further accentuated by the voluntary nature of the climate policy. While there are participatory options for stakeholders through different platforms ranging from public consultations to informal meetings, these practices are insufficient to empower stakeholders to contribute and foster more collective actions. In particular, NGOs have

struggled to influence the policy agenda, as noted here regarding the difficulties of promoting solar energy as a new policy alternative:

“We organised a solar conference and shared our project of solar community...We tried to pull more people in, from the government to the LegCo...We have been...questioning KS Wong [the current Secretary for the Environment]... and having a press conference with the legislative councillors... [We’re] just like a group of bees urging the government to do something”
(Interview, NGO 3)

Overall, despite frequent interactions between the government and the non-governmental stakeholders during policy development, the outcomes still heavily rely on the government and because of this, have been limited in enabling concrete action.

5. Discussion and conclusion

This paper has sought to broaden understandings about how different forms of collaboration can impact the potential of cities to take action on climate change. Drawing on the case study of Hong Kong, the paper has identified three different types of collaboration: collaboration structured by regulations; collaboration oriented to policy goals; and collaboration emerging as everyday policy work. The recognition of these multiple forms of collaboration enhances understandings of how collaboration opens up different modes of climate governance within cities (Bulkeley & Kern, 2006). Each of these types of collaboration demonstrates different purposes, practices and outcomes with implications for enabling low-carbon transformation in practice. The paper highlights that regulatory forms of collaboration are more able to influence outcomes, but those outcomes might not necessarily be favourable for climate change. Moreover, while policy-oriented and everyday forms of collaboration encourage wider participation, the outcomes of these participatory modes of governance are incremental and are heavily dependent on government policy. Overall, the findings challenge the assumption that collaboration always brings positive outcomes in mobilising action for climate change.

Observing the process of collaboration also provides insights into how actors and relationships are situated within different collaborative practices. In line with Bulkeley et al. (2014), these forms of collaboration show the multiple actors involve in shaping

climate policies and practices, including the public, private and civil society sectors. More importantly, the paper offers deeper insights into the shifting roles and responsibilities of actors across different forms of collaboration. For example, the government serves as the gatekeeper in the SCAs, moderator in the FiT scheme and executor in the CAP. These heterogeneous dynamics influence the governance spaces that actors can operate within (McGuirk et al., 2014). In the regulatory mode, there is a rigid, locked-in relationship between actors, which achieves the primary objectives, but lacks flexibility and constrains innovation. The participatory practices ranging from public consultations to informal meetings include a wider variety of stakeholders but are unlikely to drive radical change for transformation. It is therefore critical to not only consider the actors involved in collaboration but to also explore the roles they play and the spaces they are able to influence intervene within different modes of governance as a means to enable concrete action on climate change in cities.

The key challenge of collaboration is to translate the practices of working together into outcomes, particularly where there are uneven power relationships. Consistent with the literature, while collaborative practices enable a more extensive representation of previously absent actors (e.g. environmental NGOs in the Hong Kong case), they are still marginalised, and their actions are constrained by the leadership of dominant actors (e.g. the government and the two utilities) (McGuirk et al., 2014). Although collaboration is positioned as a mechanism to respond to the needs of different stakeholders by drawing them together, this assumption does not address the rigid power dynamics at play (Ansell & Gash, 2007). Instead, it is apparent that collaboration can in fact further entrench these power imbalances when it is the sole mechanism for non-governmental actors to influence policy under the existing political circumstances. Therefore, the paper highlights a need to address how collaboration is situated alongside other forms of climate governance and how more equitable and efficient forms of climate action can be achieved.

By focusing on collaboration in urban climate governance, this paper offers new insights into how actors interact in response to climate challenges in cities. It highlights the importance of recognising the diverse roles of actors, ongoing power imbalances and their shifting governance spaces for intervention. As a result, although collaboration is well intentioned, in practice it may only have limited impacts on low-carbon urban transformations. More broadly, given the prevailing interest in working together, it is

critical to review carefully how collaboration can facilitate cities to achieve their climate goals and create momentum for action.

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Mobilising change in cities: a capacity framework for understanding urban energy transition pathways

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Abstract

The role of cities in mobilising transformative change has gained increasing attention in global discourses of climate change and sustainability. This raises the need to understand how and why change happens in cities, particularly given the complexity of urban systems. In this regard, capacity is an emergent concept and has been adopted to identify areas for change and assess the transformative potential of cities in practice. There is nonetheless a need to understand change more critically within cities and assess the extent to which capacity enables or constrains urban transformation. This paper takes a critical perspective and identifies three dimensions of capacity: capacity for what, capacity of whom and how capacity is developed. We use these dimensions to develop a framework that connects the concept of capacity with the literature on urban energy transitions. To demonstrate this approach in practice, we explore the cases of Hamburg and Hong Kong. Overall, we argue that capacity is a useful tool to explain transition pathways for energy and climate change in cities. While cities are not a magic solution for driving transformation, they can nonetheless play a role in enabling change subject to their politics, governance structures, infrastructure configurations and city-regional relations.

1 Introduction

In addressing the global agendas of climate change and sustainable development, the potential of cities to transform ‘unsustainable’ and ‘carbon-intensive’ systems is frequently emphasised by policymakers and scholars. In understanding what cities can contribute, “[t]here is no longer a question of whether cities are important for sustainable development, but rather why and how the urban condition affects our common future” (Parnell, 2016, p. 529). While cities are a central focus of global development discourse, it is nonetheless critical to assess the opportunities and constraints that cities face in mobilising transformative change. Managing change within cities is a complex process, which is subject to multiscalar, hierarchical, interconnected and multidimensional components leading to different decisions, dynamics and abilities to adapt and co-evolve (Basu et al., 2019). Addressing this complexity of urban systems requires specific attention to how and why change happens within cities.

It is increasingly suggested that one way of understanding how change happens in cities is through the concept of capacity. The term has been frequently adopted in discussions of global urban development. For example, the Policy Paper *Urban Governance, Capacity and Institutional Development* (2017), which was prepared for the United Nations’ Habitat III conference, highlighted a need for a ‘new’ urban governance to tackle global challenges, incorporating ideas of capacity. In a similar fashion, the flagship report *Humanity on the move: Unlocking the transformative power* from the German Advisory Council on Global Change also highlighted capacity as a ‘transformative power’ of cities to “promote fundamental change and go beyond incremental changes” for “successful transformation

towards sustainability” (Kraas et al., 2016, p. 357). Within these policy documents, the notion of capacity is used to outline areas for change in order to realise the transformative potential of cities. This approach towards capacity also emerges in scholarship dealing with environmental policies and practices. For example, within the literature on urban energy governance, capacity is adopted to explain the challenges and barriers faced by cities in decarbonising the energy sector, as well as identifying new spaces for urban politics and/or socio-technical change (Kuzemko & Britton, 2020). This approach particularly emphasises the capacity of local and urban actors “to shape, orient and effect locally specific interventions and change” (Rutherford & Jaglin, 2015, p. 174).

The usage of the concept in both the policy and academic literature highlights that capacity is instrumental as a means to understand transformation within cities. However, there is a need for more critical interrogation of the concept to more carefully analyse how change happens within cities and the extent to which capacity enables urban transformation. Moreover, interpretations of capacity emerge and unfold differently in sustainability contexts such as energy, water, housing and urban regeneration, which have its own institutional and spatial-material configurations, and relate to different transformative outcomes (Wolfram et al., 2019). As such, any interpretation of capacity must be situated within a particular context for change. In this paper, we outline key conceptual dimensions of capacity, develop a framework applying capacity to urban energy systems as a means to explore transition pathways and consider how this framework might apply to two cities: Hamburg and Hong Kong.

The paper proceeds in three key sections. Drawing on a range of literature, we first outline two key dimensions of capacity: capacity for what and capacity of whom. The first takes into

account what can be changed in cities and how cities are approaching and initiating change while the second explores who has capacity to make decisions for cities and enable urban change. These dimensions are interrelated as on the one hand, actors are exploring ways to align with (shifting) orientations for change while on the other hand, the drivers for change are also shaped and re-shaped by actors and their dynamics. We draw these two dimensions together to highlight a third dimension, namely the development of capacity, which relates to how change happens in practice.

We then turn to connect these three dimensions of capacity with the literature on urban energy transitions (UETs) to explore how capacity provides an important perspective for explaining change within urban energy systems. The UET literature considers how transition processes are shaped by governance, politics, spatial-material configurations and socio-technical relations (Basu et al., 2019; Rutherford, 2014; Rutherford & Jaglin, 2015). In this context, the idea of transition pathways is one way to explore the complexity of change as low-carbon transitions unfold (Rosenbloom, 2017). Stripple and Bulkeley (2019, p. 53) aptly express that decarbonisation pathways can be seen as “a logic and practice of wayfinding that is pursued with the intention of realising a response to climate change but is always bound up with other entities, goals and interests”. A focus on transition pathways thus supports analysis into different dimensions of change within urban energy systems and how capacity comes to matter in shaping this transformation. By focusing on the interplay between ideas of capacity and the UET literature we develop a framework which can be utilised to explain different transition pathways in cities.

To demonstrate this framework in practice, we explore the illustrative cases of Hamburg and Hong Kong that share similarities but have different transition pathways. Hamburg is in

the process of building up an innovative energy system while Hong Kong is struggling to mobilise change in a highly regulated energy system. We explore these cities as a means to demonstrate how transformation proceeds within different urban contexts in practice. The purpose is not to compare the two cases, but rather to provide insights into different components of the capacity framework. We then draw conclusions regarding the future relevance of capacity as a tool for energy systems change.

2 Conceptualisations of capacity: understanding change in cities

Capacity as a conceptual idea can generate explanations about how change happens.

Derived from Latin *capacitas* ('able to take in'), capacity generally refers to "the power, ability, or faculty for anything in particular", and that "the quality or condition of admitting or being open to action or treatment; capability, possibility" (Oxford English Dictionary). The idea of capacity is used differently across the social sciences, such as "the idea of development through overcoming crisis" in political science (Janicke, 2002, p. 12), or "the ability to generate an outcome or perform a task and also to learn, and the potential for growth and development" in development studies (Brown & Westaway, 2011, p. 322).

An emergent body of literature has started to conceptualise capacity in the context of cities and interrogate the mobilisation of capacity in pursuit of transformations towards sustainability goals (Broto et al., 2019; Hölscher et al., 2019; Strasser et al., 2019; Wolfram, 2016; Wolfram et al., 2019). In this context, capacity is broadly understood as "the collective ability of the stakeholders involved in urban development to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across multiple complex systems that constitute the cities they relate to" (Wolfram, 2016, p. 126). In this

sense, capacity provides an actor/ action-oriented perspective, as a way to identify important action fields and possibilities to enable sustainability transformations as well as overcome challenges within governance processes (Hölscher et al., 2019). Capacity is thus an attribute of collective actions that are navigated by multiple actors and their contingent interactions in order to reach sustainability goals (Strasser et al., 2019). It involves complex dynamics and processes and requires an examination of actors types and organisations, roles of actor networks, and mobilisations of activities in facilitating systematic changes for transformation (Brodnik & Brown, 2018; Hölscher et al., 2019). While the existing literature provides important insights into capacity as a means to achieve sustainability goals, there is nonetheless more conceptual work needed to narrow the framing of capacity and explore how this may be articulated in practice.

Below we draw on a range of literature to explore the ways in which capacity is mobilised as a means of promoting or constraining change within cities. We consider capacity at all levels of governance, connecting changes at the micro-level of the agency/ organisation, the meso level of network/ government and the macro level of the broader urban system. By looking into these multi-dimensional conceptualisations of capacity, we pinpoint and highlight the most significant components of capacity, necessary for understanding change within cities.

Capacity to manage organisational change

One idea of capacity considers managerial thinking around organisational change which is useful for understanding changes in the planning and development in cities. The field of literature stems from change management of business organisations. As Moran and Brightman (2001, p. 66) note, “change management is the process of continually renewing

an organization's direction, structure, and capabilities to serve the ever-changing needs of the marketplace, customers and employees". Capacity is thus considered as the way in which both organisational change and continuity are balanced, taking into account how change is built on existing resources and experiences in technology, personnel and knowledge (Garud & Nayyar, 1994). From this perspective, the ability of actors and the role they play *within* institutions in managing the complexities and path dependences of the change process are vital (Garud et al., 2007). Both organisational and urban transformation discourses share some similarities in "understanding change as a decentralised process that is brought about from within, rather than imposed from outside" (Broto et al., 2019, p. 451). However, the ways in which visions for change are formulated and progressed are rather more complex for the urban transformation process. Capacity needs to be considered heterogeneously concerning diverse spaces, systems and actors *within* the urban context, of which different, conflicting interests, viewpoints, powers and activities might shape and re-shape the process for change (Broto et al., 2019; Rutherford & Jaglin, 2015).

Capacity to build networks

Capacity to build networks considers the enabling power of actor networks in which actors come together and empower themselves in maximising benefits and creating new possibilities in urban and regional contexts. The process of empowerment can be found in the successful development of cluster initiatives, which have become a popular and fashionable notion to demonstrate the local competence of economic changes since the new millennium (Martin & Sunley, 2003). In the context of industries and businesses, a cluster is defined as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities"

(Porter, 2000, p. 15). Research on clusters argues that connections across firms and industries create sources of locational competitive advantage, which are fundamental to productivity and the capacity to innovate (ibid.). While there are critiques regarding the significance of clusters, in particular their influence on policymakers, clusters provide a useful illustration of how successful networks are formed between economic actors, enterprises and institutions with a shared interest in creating competence for change. Furthermore, the success of clusters is tied to branding, which is “based on an image of a high-productivity, knowledge-rich, decentralized, entrepreneurial and socially progressive economy within the reach of local policy-makers” (Martin & Sunley, 2003, p. 29). The issues here are important for thinking about how capacity is built up, by not only interest actors and groups in practice, but also as an ideological form for urban transformations.

Capacity to govern territorial entities

A further perspective on capacity considers the government and their role in managing change within cities. Drawing on debates of urban governance and urban regimes, this concept of capacity is closely linked to powers, competences and constellations of actors. The urban governance literature shifts attention away from a traditional perspective of urban politics concerning how particular political elites rule local states towards the collective endeavour of local government organisations in influencing institutional arrangements for change (Pierre, 1999). Correspondingly, the urban regime perspective identifies capacity as a democratic process in relation to debates, arrangements and outcomes of certain institutions, which are able to rearrange urban affairs. While urban governance is considered as a process of incorporating public and private interests, the capacity to act closely links to how (successful) those collaborative arrangements between

the public and private actors are in achieving collective goals (Mossberger & Stoker, 2001). For instance, Stone (1993, p. 6) highlights, “the effectiveness of local government depends greatly on the cooperation of nongovernmental actors and on the combination of state capacity with nongovernmental resources”. Furthermore, in coalition-building processes, political leadership needs to craft arrangements with some individuals, parties or organisations who might not be completely aligned, to form coalition partners in order to receive, enhance or maintain powers as part of the governing process to achieve certain aims (Stone, 1993). In this sense, capacity is associated with who is acting and what kind of relations emerge in achieving change on the ground.

Capacity to support innovation

A final iteration of capacity links to managerial thinking in supporting innovation and resisting old practices. Beyond the business literature and recommendations of consultancies for companies, managerial thinking is also found in the field of technological transitions. Drawing on the socio-technical and socio-ecological systems research, capacity is formulated by various components and their interactions to start at looking at windows of opportunity to build niches for change, take-off, accelerate and finally stabilise and embed to the system for transformation (Geels, 2002). In particular, Brodnik and Brown (2018) distinguish capacities at relevant transformative stages: introductory capacity (new practice and framings for collective action); diffusional capacity (to capitalise on the existing momentum and to facilitate practice proliferation); establishment capacity (to enable the stabilization of the system while retaining elements of the old practice to remain adaptive and flexible to future disturbances). These bodies of literature demonstrate a strong applied dimension to capacity, which is used as an overarching tool to identify successful types of

actors and participation, organisational and institutional restructuring, as well as changing narratives to legitimate transition outcomes. While there is no single pathway for change, capacity here is less a static concept, but rather a contingent assessment to evaluate strategic purposes, configurations and outcomes at different stages of the transformation trajectory.

Overall, this discussion of capacity from these different strands of literature highlights the value of using the concept to advance knowledge for urban transformations. It is first apparent that the literature conceives of change in different ways, namely:

- Change is driven by political, economic, technological, social-technical and sustainability interests.
- The process of change concerns governance, actor constellations, organisational management, innovation management or systematic changes.
- The outcomes of change are associated with decision-making, local competitiveness, institutional restructuring, new regimes and socio-political and social-technical implications.

Taken together, we use these components of capacity within the literature to draw out three key dimensions of relevance to understanding change within cities:

- Capacity for what: action field specifications; perspectives, knowledge, options for change; relations to other fields
- Capacity of whom: actors, powers, competences, dynamics; successful actor networks and empowerment; participation and inclusion

- How capacity is developed: internal restructuring including a broad variety of niches, opportunities for change, changes in regimes etc.; external factors supporting and hindering changes; visualisation and branding for change

These dimensions provide a useful entry point into research on the conditions, processes and progress for transformation within cities. The first, *capacity for what*, takes into account what can be changed in cities and how cities are approaching and initiating change. The second, *capacity of whom*, explores who has capacity to make decisions for cities and enable change on urban issues. These dimensions are interrelated as on the one hand, actors are exploring ways to align with (shifting) orientations for change while on the other hand, the drivers for change are also shaped and re-shaped by actors and their dynamics. Both aspects highlight the importance of looking into factors that influence the development of capacity. We draw these two dimensions together to highlight a third dimension, *the development of capacity*, which relates to how change happens in practice and in specific contexts.

3 Connecting capacity and urban energy transitions

This paper seeks to draw connections between ideas of capacity and urban energy transitions as a means to understand how transition pathways are shaped within cities. This section draws on the components of capacity identified in the previous section and connects them with the literature on urban energy transitions (UET) in order to develop a conceptual framework (Table 1). In so doing, we take up low-carbon energy as the transformative field for action and policy change, driven by climate change imperatives, and focus on the role of actors and politics in enabling or hindering change.

Table 1 Capacity framing and urban energy transitions

Dimension of capacity	Components of capacity	Relevant understandings in the UET literature
Capacity for what	<ul style="list-style-type: none"> • Perspectives, knowledge, options for change • Action fields, spaces for change • Relations to other action fields 	<ul style="list-style-type: none"> • Capacity to develop shared visions and drive envisioning-activities for energy systems • Capacity to identify action fields within the urban energy system (e.g. political, technological, material, institutional, socio-technical etc.) and consider options and dependencies for change • Capacity to consider relations to other fields and develop cross-sectoral approaches (e.g. energy and mobility, energy and housing)
Capacity of whom	<ul style="list-style-type: none"> • Who is acting, intrinsic power building, mobilisation of resources • Actor constellations, processes of empowerment, power dynamics • Local political fields, local configurations for change 	<ul style="list-style-type: none"> • Capacity of stakeholders to mobilise resources for action and intervention in the arena of urban energy (e.g. financial resources, administrative competence, skills, knowledge and experience, etc.) • Capacity of powerful actors and proactive actor networks to advocate their notions on energy • Capacity of local stakeholders to promote local-focus interests
How capacity is developed	<ul style="list-style-type: none"> • Path dependencies, co-evolutionary processes, multi-level governance • Learning for change • Visualisation and branding for change 	<ul style="list-style-type: none"> • Capacity is developed dynamically between capacity for what and capacity of whom • Capacity of learning through experimenting and exchanges to direct innovation for energy and promote new regimes and to reject conventional regimes and give up problematic traditions (e.g. the use of fossil fuels) • Capacity to visualise through forms of demonstration (e.g. branding of ‘smart’-, ‘eco’, or ‘green’ city/ energy systems; setting up ambitious and measurable targets of carbon emissions) in enhancing the rationality, normality and accountability of actions and work of actors

3.1 Capacity for what

Capacity for what considers what can be changed in the urban energy system and how cities are framing their approaches towards low-carbon energy. It concerns perspectives, action fields for transitions, and relationships to other action fields.

In response to the challenge of climate change, energy transitions within cities focus on ways to transform energy systems towards low-carbon development. There can be competition between different perspectives on how energy should be produced and consumed in cities. For example, research on energy governance investigates the tension between environmental sustainability (the use of renewable energies) and energy security (accessibility, affordability and reliability) within the decision-making of energy policy in cities (Holley & Lecavalier, 2017). Therefore, capacity is important to address issues of energy supply and use and develop shared visions and drive collaborative envisioning-activities in order to skilfully navigate opportunities for change (Strasser et al., 2019; Wolfram et al., 2019).

This issue then signals the necessity of identifying action fields for enabling such transitions. Scholars in the field of UETs highlight the translation of sustainability and climate-friendly notions through interventions regarding technological innovation, behavioural change, urban planning and policy, infrastructure and other energy-related contexts and practices (Basu et al., 2019; Rutherford & Coutard, 2014). Capacity for UET thus rests on the ability to identify those relevant elements for change and the dynamics within the respective action field as well as opportunities for change in political, material, institutional or other energy-related societal contexts. One important aspect concerns the role of the socio-technical

system in opening up windows of opportunity in translating certain climate notions. For example, the emerging material aspect of energy systems takes into account the inter-relationship between urban energy politics and materiality for energy (Kuzemko & Britton, 2020; Rutherford, 2014; Van Veelen et al., 2019). While agenda-setting for energy is conditioned or limited by the materiality for energy (e.g. existing infrastructure, resource availability, technology accessibility etc.), the political processes also lead to certain modifications or new material arrangements for energy (e.g. modes of governing, energy activities and advancements, policies and regulations etc.). In this sense, capacity needs to take into account both opportunities and dependencies for change.

This reminds us that not only is identifying the action field for climate change and energy important, but also interaction with other fields. In the context of promoting climate change in cities, the goal of decarbonisation is embedded in various policy sectors (e.g. environmental management, transport, buildings, industries, and land uses), which have their own viewpoints and strategies on solutions to climate change (Rutherford & Coutard, 2014). While energy is crucial for their operations, the notion of low-carbon energy also circulates in those fields of action and policymaking. For example, we can observe cities promoting electric vehicles, retrofitting existing buildings, encouraging advanced technology in industries etc. (Dowling et al., 2014; Haarstad, 2016). The relationship of energy to other fields is particularly important for those local governments, which have little or no responsibility for energy policy and decision-making (Kuzemko & Britton, 2020). In this case, policy intervention for energy is more complex and has to intervene in other policy areas that are relevant to pursuing low-carbon energy transitions. Taking into account the dynamic between energy and other action fields (e.g. energy and mobility, energy and

housing, etc.), capacity reveals the relevant goals, interventions and potential synergies that might arise from pluralistic thinking and activities.

3.2 Capacity of whom

Capacity of whom considers the actors involved and the dynamics in driving change within the arena of urban energy. It relates to the questions of who is acting, what kind of power dynamics exist, and which local contexts are considered.

In the urban energy governance literature, capacity of whom is concerned with the capacities and capabilities of actors who have “a vested stake in both how energy is produced and used, and how it intersects with a variety of broader urban functions and meanings” (Rutherford & Jaglin, 2015, p. 174). The set of stakeholders includes, but is not limited, to city government authorities, energy utilities, local interest groups, activists and residents (Cheung & Oßenbrügge, 2020). This perspective also considers the politics of materiality in terms of how actors mobilise resources for transformative actions and interventions (Avelino, 2017). For example, research on the conditions for accomplishing sustainability transitions governance focuses on various administrative and financial indicators to quantify government capacity in developing an urban sustainability agenda (Wang, 2020; Wei et al., 2015). In this way, capacity is reinforced as an instrument to support important place-based characteristics subject to formal governance in supporting transitions. However, ideas of capacity should not just be limited to government-led processes that may overlook the complex social-political and social-economic relationships in the realisation and contingency of UET (Grandin et al., 2018). It is, therefore, important to address the capacity of both governmental and non-governmental stakeholders and their

potential to mobilise resources for action and intervention (e.g. financial resources, administrative competence, skills, knowledge and experience, etc.)

This signals the importance of capacity in terms of wide and active inclusion of stakeholders, as well as proactive and effective actor networks and governance modes (Wolfram, 2016).

The development of UET is political and subject to forms of compromises, collaborations and trade-offs in which actors maintain and create capacity and coordination (Rutherford & Jaglin, 2015). Drawing on the previous discussion on successful actor networks in urban politics, capacity is the result of the process of empowerment in which actors with shared interests come together and build up intrinsic power (power to do and to change). However, any investigation of capacity should also acknowledge power imbalances in practice and the implications for governing energy issues (McGuirk et al., 2014; Rutherford & Coutard, 2014). Together, capacity concerns, “the type of power that effectuates deep and holistic urban change, resulting from particular forms of agency and interactions in a given institutional and spatial-material setting” (Wolfram et al., 2019, p. 440). The assessment and explanation of capacity should thereby reflect on the power dynamics between actors with different interests in terms of whose notion(s) of energy matters (more/ the most) to decision-making within the transition processes.

Research on UET also forges a localised perspective in which the work of actors is embedded or constrained by corresponding local spatial-material configurations and institutional frameworks (Basu et al., 2019; Cheung & Oßenbrügge, 2020). This perspective acknowledges that capacity manifests within a variety of urban contexts and the assessment of capacity is subject to local contexts of politics, institutions and fields for change. This is particularly important for urban energy supply and use in the context of decentralising

trends of policymaking and interventions, for example, the return to local utilities and the emergence of community energy initiatives (Becker, Kunze, et al., 2017; Rutter & Keirstead, 2012). More importantly, the focus on place-based characteristics of capacity offers an entry point to think about city-driven initiatives that are critical for the transformation processes: identifying action field cities can act autonomously and what kind of impetus for change cities might provide (Bulkeley et al., 2018).

3.3 How capacity is developed

The development of capacity is closely tied to the interplay between capacity for what and capacity of whom. Actors are exploring ways to align with the orientations of UET, and at the same time, the orientation and pathways for change are also being shaped and re-shaped by actors.

The literature highlights that UETs are path-dependent, where past decisions, trajectories, practices and materials shape contemporary dynamics and configure contemporary urban energy systems (Moss, 2014). The process of transition is also co-evolutionary between transformations of energy systems and urban change towards sustainability (i.e. practices and expectations of the use and supply of energy within cities) (Rutherford & Coutard, 2014). Considering capacity in the urban context also adds an extra layer of complexity in which local decisions might have to adapt to regional aspects of social-technical arrangements, institutions and infrastructure, as well as interventions from higher-level governance (Haarstad, 2016; Kuzemko & Britton, 2020). In the context of energy systems, urban capacity to act is thus associated with change and direction from a multi-level policy

context for climate change and energy, encompassing energy transmission networks and infrastructure, powerful state actors and national energy companies and so on.

A dynamic perspective on capacity draws attention to how capacity is sustained, expanded or diminished throughout the co-evolving process of UET. One useful illustration is the perspective of *learning for change* which is applied to reinforce positive feedback loops in the development processes of capacity (Wolfram, 2016). Learning here considers capacity as a process to build up momentum for UET, resulting from complex interactions of multiple actors and contextual dynamics. Taking up the work of Strasser et al. (2019, pp. 10-11), the perspective of learning includes reflecting on “experience of successes and failures in trying to challenge, alter, replace or provide alternatives to dominant institutions” (practising and experimenting) and “seek[ing] connections with others doing similar things elsewhere and learn through exchanges among peers” (exchanges). In the context of urban energy, a range of technological, political and societal measures, which could be demonstrated in new/ advanced technology, policy agendas, and campaigns, needs to be taken into account as an ongoing process of experimenting, navigating, and re-positioning to achieve (shifting) ends (Cheung & Oßenbrügge, 2020). Capacity is not only about directing innovation and promoting new regimes, but also rejecting conventional regimes and giving up problematic traditions. This understanding aligns with emerging energy-related social movements in opposing open-cast mining, coal-fired power plant development and privatisation of energy facilities (Becker et al., 2016). Taking into account the diversity of transition processes and their outcomes, capacity for UET is a contingent assessment to evaluate strategic purposes and decisive events at different stages of the transition trajectory.

It is worth highlighting that visualisation is also part of the development of capacity to convince people that the orientation for UET is rational, normative and achievable. In the context of urban climate governance, these visible forms of capacity come through charismatic leaders, innovative experiments, and best practices to facilitate transformations (Broto, 2017). In the climate change discourse, cities also set up measurable milestones and parameters such as CO₂ emissions reductions and installations of renewable energy, as common indicators of how successful they are or evidence to demonstrate that they are on the right track. Most commonly initiated by public authorities, they are important for inspiring interventions, setting the tone and structure for discourses and agendas, and promoting particular authoritative concepts and ideas (such as 'smart', 'eco', or 'green' city/ energy systems) (Haarstad, 2016). The observations also link to the rapid increase of branding in environmental urban policy, referring to "a variety of practices and tools used by political organisations and local governments to develop and market an image and set of values associated with their city, region or nation" (Andersson & James, 2018, p. 3438). Although branding as an instrumentalist approach appears to cover superficial policy changes that do little to enhance the sustainability of cities or address vital components for urban environmental politics, branding still represents an added meaning for promoting transitions in cities (Greenberg, 2015). Capacity to visualise through forms of demonstration is therefore important in enhancing the rationality, normality and accountability of actions and work of actors to some extent.

4 Articulating capacity: observations from Hamburg and Hong Kong

In this section, we apply our capacity framework to the cases of Hamburg and Hong Kong, to explore the process of transformation taking place. On paper, both cities seem to have significant autonomy and capacity for city-driven energy transitions given their special constitutional status: Hamburg is a federal state (*Bundesland*) of Germany; and Hong Kong is a special administrative region of China, under the ‘one country, two systems’ constitutional principle. Their juridical positions allow the city governments to possess different degrees of policy autonomy, compared to other cities in the country – Hamburg possesses powers of a region; Hong Kong possesses many powers of a national state (Cheung & Oßenbrügge, 2020; Holley & Lecavalier, 2017). As developed cities in Germany and China, there is significant pressure for Hamburg and Hong Kong to transform their energy systems responding to their intensive energy demands and the associated carbon emissions¹. However, both cities are tied to their surrounding territories for energy and fuels imports² that in turn limits their capacity to decarbonise their energy systems, in particular through supply-side management strategies³. Faced with this need to transform their energy systems, we offer an initial analysis of the cities of Hamburg and Hong Kong. We explore capacity for what in terms of how re-arrangements can be driven by the two cities to meet

¹ CO₂ per capita (in metric tons): about 9 in 2018 in Hamburg (see statistic of Statistikamt Nord) and about 6 in 2016 in Hong Kong (see statistic of The World Bank)

² Local electricity production supports about 20% of the demand in Hamburg. See statistic of (see statistic of Länderarbeitskreis Energiebilanzen). 23% of electricity in Hong Kong is imported from the Daya Bay nuclear power plant in Guangdong, China and Hong Kong has to rely on natural gas supplies from China (Holley & Lecavalier, 2017).

³ For example, both city governments had drawn up plan to take renewable energies as viable alternatives to fossil fuels in their local electricity production mix. However, from their energy statistics, there have not been expansive RE proportion in energy mix after their endeavors.

the emerging expectations for energy supply and use, and capacity of whom in terms of key actors and the dynamics of the two cities in promoting or constraining notions for energy. Then we draw some conclusions about how capacity is developed. In so doing, we suggest that these different aspects of capacity are meaningful in terms of understanding which practices are working well and what barriers need to be overcome in terms of shaping the transition pathway of both cities.

4.1 Capacity to deliver an innovative energy system in Hamburg

The pathway for energy transition in Hamburg is influenced by the prospect of German Energiewende to pursue the intended orientation of developing a non-nuclear and low-carbon energy system. Like many other German cities, the city has to integrate the initiatives of German Energiewende and roll out its agenda of transforming the energy system to align with these top-down ambition. Three action fields for change were identified within the German Energiewende, including phasing out of nuclear energy, reducing carbon emissions, as well as improving energy efficiency (Paul, 2018). To follow this route for change, capacity for what is demonstrated by several arrangements. For example, Hamburg witnessed permanent shut down of a nuclear power reactor in Krümmel (about 40km away from Hamburg), built one of the largest, most efficient coal-fired power plant in Germany and released the city's first climate action plan in the 2000s (Cheung & Oßenbrügge, 2020). While these arrangements in both political and technological forms demonstrate the capacity of the city to drive action for the shared vision of Energiewende, the city's transition pathway is highly subject to the existing socio-technical configurations for energy supply and use.

The city's decarbonisation pathway is bound up with pre-existing conditions and local interests of energy provision and demand. Being the second-largest city in Germany and with 1.8 million inhabitants, also one of the busiest ports in Europe, capacity for what to decarbonise the energy system also includes a crucial element of maintaining reliable energy supply for the city's economy. In Hamburg, the manufacturing industry, households, as well as commercial, trade and service industries account for more than 90% of the total energy demand. The metal industry represents about one-third of the city's electricity need and is particularly vulnerable to the changing stability of electricity supply, given its heavily energy-dependent production processes⁴. Apart from meeting the energy demand, the capacity for what is also strongly reliant on the energy systems of surrounding regions, namely Schleswig-Holstein, Lower Saxony and Mecklenburg-Vorpommern, to import energy to the city. In the field of renewable energy development, Hamburg also has a limited capacity for a shift towards significant local production of renewable energy. Instead, taking the dependency for change into account, the city focuses on the city-regional relationship through knowledge exchange platforms and cooperation activities, such as the Project Partnership North (*Projektpartnerschaft Nord*) in Hamburg Metropolitan Region (Jacuniak-Suda et al., 2015). The limitations for change here illustrate that the city's capacity for what is critical in terms of shaping the city's transition pathway.

This process of wayfinding in Hamburg is characterised by the strong interest of civil society in environmental issues. Capacity of whom refers to proactive environmental and social

⁴ The largest metal producers in Hamburg are the copper production and recycling company Aurubis AG and the aluminum manufacturer Trimet Aluminum AG.

organisations in politicising their notions of energy and climate through mobilising campaigns and creating collaborative networks (Cheung & Oßenbrügge, 2020). One key legislative success is to force the city government to buy back privatised energy grids through a referendum in 2013, in which the proactive actor network, initiated by the Friends of the Earth (BUND), the Consumer Advice Centre (Verbraucherzentrale) and the charity organisation of the Protestant-Lutheran Church (Diakonie), played the most significant role. Other civil society interventions include promoting alternative organisational modes for energy generation and ownership (Becker et al., 2017). For example, strongly driven by the Green Party, part of the government coalition at that time, a public utility Hamburg Energie was founded in the late 2000s. The company started with a clear business orientation toward providing 'climate friendly' energy to the urban population and later also included a participatory body through its client advisory board to include the voices of citizens and business clients (Becker et al., 2017). Responding to the pressure of a more public-inclusive form of energy-climate governance, the Energy Advisory Council (*Energienetzbeirat*) has an open platform for both politicians and non-state actors, as well as a public audience to engage with the city's energy policy agenda setting (Cheung & Oßenbrügge, 2020). The array of interventions mobilised successfully by powerful actors and proactive actor-network constellations of the city is creating an innovative means to strengthen capacity for whom, particularly in terms of non-state actors, preventing another locked-in energy system and promoting space for innovative activities. This trend is albeit in an ongoing learning process in which changes in power dynamics for decision-making and the outcomes from those participatory channels are uncertain. Overall, this sequence of

changes points to the emergence of the city's transition pathway towards a more open and experimental path in the future.

4.2 Capacity for mobilising change in a rigid energy system in Hong Kong

Debates about transition in Hong Kong primarily focus on the discourse around the mix of energy sources for electricity generation. The two primary factors driving this discourse are the phasing out of coal and meeting targets for improving air quality and reducing carbon emissions. Although the city is still dependent on coal-fired electricity (53%), it needs to take steps to shift to other fuels as new installations were not permitted after 1994 and existing coal-fired generation units are retired from 2017 (Environment Bureau, 2015). In the context of climate change, the city has set the target of reducing its carbon intensity by 65-70% by 2030. Taking into account that electricity generation represents 70% of the city's carbon emissions, supply-side management in the power sector is the most significant action field for change. The capacity for what takes the shape of supply-side strategies, for example, expanding natural gas usage on a larger-scale, promoting electricity generation efficiency and supporting solar PV installation from small to modest-sized (Environment Bureau, 2017). While the transition pathway of the city appears to be a clearly defined trajectory of what targets to meet and what action should be taken, there are other critical elements of capacity involved in shaping action.

The city's transition pathway is characterised by incremental adjustments, in which capacity for what is characterised by struggles of conflicting interests and expectations about how energy should be supplied. Being a highly populated city of 7.8 million inhabitants, the function of energy system has a consistent focus on providing reliable and low cost energy.

Faced with the need to meet the rising energy demand in the 1960s and 1970s, the city introduced the Scheme of Control Agreements (SCAs) to encourage utilities to invest in generation units and protect them from business risk, in return for providing high reliability and low tariff services (Moss & Francesch-Huidobro, 2016). While this institutional arrangement has a longstanding record, the SCAs provide only limited opportunities for the development of renewable energy in the city. For example, the city can only rely on the utilities to deploy more renewable sources by creating extra financial incentives (Holley & Lecavalier, 2017). However, the idea of subsidising renewable energy through electricity bills was rejected. To fill the gap of providing sustainable and affordable energy in Hong Kong, the Feed in Tariff (FiT) scheme for small-scale renewable energy is a newly launched program. Within the program, the utilities purchase electricity from decentralised developers, with the costs offset by the revenue from a Renewable Energy Certificate scheme. Although the FiT scheme is well supported by society, it was only implemented after being formally included in the new SCAs (2019-2033) and accounts for a maximum 1-1.5% of the city's electricity demands (Hong Kong SAR Government, 2017). While the development of the FiT scheme demonstrates the capacity for what to address different perspectives of energy supply and develop shared visions to provide sustainable and affordable energy in Hong Kong, it is a lengthy process with limited results. From this, we can observe that the city's transition pathway is locked in a robust energy system, which is less open for innovative alternatives.

Within this rigid energy system, capacity of whom – relating to political dynamics – appears to be the most influential factor for the city to mobilise change (or not change) in recent years. The city government has long been criticised for its lack of commitment to combating

climate change and the absence of leadership capacity (Francesch-Huidobro, 2014; Mah & Hills, 2016). Hong Kong launched its first Climate Action Plan in 2017, but it appears to be a mainly bureaucratic exercise as it is limited to conventional command-control measures (such as replacing coal with natural gas) and voluntary measures to encourage inputs from other sectors (such as buildings and transport) (Hong Kong SAR Government, 2017). Apart from a lack of willingness for change within the political system, the increasing trust gap between the Hong Kong public and Chinese government since the pro-democracy protests in 2014 brings another layer of complexity and uncertainty to the city's options for change in the energy system (Holley & Lecavalier, 2017). For instance, partly due to the resistance against more control from China over the local power sector, the option of purchasing renewable energy from mainland China was rejected in the most recent fuel mix consultation (Environment Bureau, 2015). Furthermore, the ongoing democracy movement means that the city government has become a 'toxic brand' where the implementation of any institutional arrangement has become unprecedentedly difficult (Hamlett, 2020). The diminishing capacity of key political actors also raises challenging questions for the city's future potential for change. These challenges highlight how politics come to matter in terms of how multiple political conflicts become a major obstacle to the likely effectiveness and flexibility of the city's transition pathway.

Overall, the Hamburg and Hong Kong cases demonstrate capacity as a useful tool to identify distinct pathways for energy transition in cities, characterised by existing socio-technical configurations, turning points, decisive events, powerful actors, proactive actor networks and political obstacles. Within the process of decarbonisation, the transition pathways of both cities are not only led by the discourse of climate change, but also the local

expectations of energy supply and use. For example, while there are discussions about carbon emissions reduction or renewable energy expansion in the energy sector, we observe the FiT scheme in Hong Kong promoting the competitive advantages of renewables and the contribution of Hamburg Energie to support local projects and modify energy facilities. The array of interventions combining politics, socio-technical and material perspectives results in distinct pathways for the two cities. Nevertheless, the two cities suggest that capacity of whom concerning drivers and barriers within politics is playing a more significant role in shaping the transition pathways. One possible reason is that momentum for change is more accurately linked to willingness and competence in multiple aspects of politics, finance or technology that allows actors to exert as much capacity as they can to mobilise new alternatives and reject the old regimes in building up a new transition pathway.

5 Conclusions

This paper set out to provide a framework to assess how and why change happens within cities. To do so, we draw together ideas of capacity and UET and present a novel framework. Capacity for what takes into account what can be changed in the urban energy system and how cities are initiating action for low-carbon energy. It concerns perspectives, knowledge, options for change, action fields for transitions, and relationships to other action fields. As explored through the cases of Hamburg and Hong Kong, the analysis of capacity for what illustrates how the cities' vision of energy transition is led by political, economic and socio-ecological interests, as well as technological and institutional options. Although our focus is primarily on energy and climate change, the findings demonstrate that decarbonisation is

only one of the many crucial aspects determining how energy should be provided and consumed in the cities.

Mobilising change within cities is thus a complex process in which multiple factors and dynamics are at play. Capacity of whom links to the actors involved and the dynamics in driving change within the arena of urban energy. It relates to the questions of who is acting, what kind of power dynamics exist, and which local contexts are considered. As illustrated in Hamburg and Hong Kong, capacity of whom in relation to powerful actors and dynamics, as well as urban politics appear to be more crucial for the process of change.

In relation to capacity development, the Hamburg case demonstrates not only the capacity of local actors to politicise their notions of energy and climate, but also the way in which such capacity can be expanded. For example, they are able to create more participatory channels after the 2013 referendum and the establishment of Hamburg Energie that leads to higher flexibility and adaptive capacity to mobilise change in the energy sector in the future. In Hong Kong, politics is becoming the most influential factor in driving change. The capacity of public institutions is fixed and constrained and not all topics become politicised. Perhaps a deficit of capacity can explain the dilemma of Hong Kong in taking a larger step forward. The capacity framework, therefore, draws out the complex processes in cities in terms of the driving factors and limitations of how change happens (or not) in cities.

The question remains about how capacity assists in understanding change in cities. Both cases suggest that the capacity cities have to act independently is very constrained. While both cities seem to be autonomous in some ways (e.g. having special constitutional status), what they can do to transform their energy systems for decarbonisation is quite limited.

Their capacity to change things is dependent on dynamics in terms of politics, governance structures and ownership, options for energy and technology, existing infrastructure, and city-regional relations. Furthermore, the specific configurations that might be changeable in one place would be untenable elsewhere (e.g. deregulating the privatised energy market in Hong Kong like in Hamburg). Faced with these potential constraints and challenges, change within cities might be less about promoting radical reform, but more (re-)arrangements to address a combination of needs. While cities are not going to be a magic solution for driving climate transformation, they can still play a role in shifting some of these dynamics. For example, both Hamburg and Hong Kong demonstrate a capacity to find spaces for incremental change (e.g. introducing the Energy Advisory Council in Hamburg and the FiT scheme in Hong Kong). While what has been achieved might seem to be marginal and not yet overcoming the major constraints, progress is still being made.

We conclude here with two important reflections. First, given the persistent interest in using capacity to understand the 'transformative power' of cities, this capacity framework takes the first step to outline opportunities for promoting change and identify barriers in the context of urban energy transitions. As such, we advocate for these specific dimensions of capacity to be articulated as a tool for politicians and urban practitioners to address the challenges of urban development. Second, we have only illustrated some components of capacity in our two selected cases. We believe that other components such as capacity of learning for change and capacity of visualisation and branding for change are also significant to mobilise change in cities. In this regard, current social movements like Fridays For Future and Black Lives Matter raise concerns about the commitment to change within society and

the ability to scale up change more broadly. Capacity is therefore essential in a changing world.

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Final Approval - Issues Addressed_5201800079(R)

Faculty of Arts Research Office <artsro@mq.edu.au>

Wed 2/28/2018 11:08 AM

To: Sara Fuller <sara.fuller@mq.edu.au>

Cc: Arts Research Office <artsro@mq.edu.au>; Ms Tracy Cheung <tracy.cheung@students.mq.edu.au>

Ethics Application Ref: (5201800079) - Final Approval

Dear Dr Fuller,

Re: ('The role of cities in low-carbon energy transitions')

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Arts Human Research Ethics Committee. Approval of the above application has been granted, effective (28/02/2018). This email constitutes ethical approval only.

If you intend to conduct research out of Australia you may require extra insurance and/or local ethics approval. Please contact Maggie Feng, Tax and Insurance Officer from OFS Business Services, on x1683 to advise further.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

<http://www.nhmrc.gov.au/files/nhmrc/publications/attachments/e72.pdf>.

The following personnel are authorised to conduct this research:

Dr Sara Fuller

Ms Tracy Cheung

Professor J?rgen O?enbr?gge

NB. STUDENTS: IT IS YOUR RESPONSIBILITY TO KEEP A COPY OF THIS APPROVAL EMAIL TO SUBMIT WITH YOUR THESIS.

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).
2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 28th February 2019

Progress Report 2 Due: 28th February 2020

Progress Report 3 Due: 28th February 2021

Progress Report 4 Due: 28th February 2022

Final Report Due: 28th February 2023

NB: If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

<https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources>

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

<https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources>

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

<https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central>

<https://www.mq.edu.au/research/ethics-integrity-and-policies/ethics/human-ethics/resources/research-ethics>

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of approval to an external organisation as evidence that you have approval, please do not hesitate to contact the Faculty of Arts Research Office at ArtsRO@mq.edu.au

Please retain a copy of this email as this is your official notification of ethics approval.

Yours sincerely

Dr Mianna Lotz
Chair, Faculty of Arts Human Research Ethics Committee
Level 2, The Australian Hearing Hub
16 University Avenue
Macquarie University
NSW 2109 Australia
Mianna.Lotz@mq.edu.au

Email: tracy.cheung@students.mq.edu.au

Phone: 0415 537 898

Supervisor: Dr Sara Fuller

HREC project number: 5201800079

Participant Information and Consent Form: The role of cities in low-carbon energy transitions

You are invited to participate in a study entitled 'The role of cities in low-carbon energy transitions'. The purpose of the research is to investigate how, in the context of increased energy needs and associated Greenhouse Gas emissions, cities can act to mitigate climate change, particularly in the area of energy systems. The study uses case studies of Hong Kong and Hamburg and involves speaking to representatives involved in low carbon development in both cities. In this capacity, your experiences are important and would provide a crucial input.

The study is being conducted by Ting Ting Tracy Cheung from the Department of Geography and Planning to meet the requirements of a joint PhD degree between Hamburg and Macquarie Universities. The project is being conducted under the supervision of Dr Sara Fuller (02 9850 8385, sara.fuller@mq.edu.au) from Macquarie University and Professor Jürgen Oßenbrügge from Hamburg University.

Participation in the study will involve taking part in an interview exploring the motivations and actions of your organisation in the context of low carbon development in Hong Kong and Hamburg. The interview will last 45-60 minutes and with your consent, will be audio recorded. No other people other than those listed here will have access to the data. The findings will be published as academic papers, a PhD thesis and presentations at conferences. Any information or personal details gathered in the course of the study are confidential, except as required by law. No individual will be identified in any publication of the results. A summary of the results of the data can be made available to you on request.

Participation in this study is entirely voluntary: you are not obliged to participate, and if you decide to participate, you are free to withdraw at any time without having to give a reason and without consequence.

I have read and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep.

- I agree to audio recording of my participation in an interview for this research.
- I would like to be contacted to receive a summary of the findings.

Participant's Name: _____

Participant's Signature: _____ Date: _____

Investigator's Name: _____

Investigator's Signature: _____ Date: _____

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics & Integrity (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

Declaration on oath

Hiermit erkläre ich an Eides statt, dass ich die vorliegende Dissertationsschrift selbst verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe.

I hereby declare upon oath that I have written the present dissertation independently and have not used further resources and aids than those stated

A handwritten signature in black ink, appearing to read 'Ting Ting Tracy Cheung'. The signature is stylized and cursive, with a large initial 'T' and 'C'.

Ting Ting Tracy Cheung

Sydney, 19 February 2021