Urban Sustainability Transitions in the Building Sector

Insights from contrasting contexts: Freiburg and Brisbane

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List of abbreviations and acronyms

ABS: Australian Bureau of Statistics
AGDF: Australian Green Development Forum
BCA: Building Code Australia
BCC: Brisbane City Council
CBD: Central Business District
COAG: Council of Australian Governments
EnEV: Energieeinsparverordnung (Energy Saving Ordinance)
EU: European Union
FR EH: Freiburg Energy House
FR LEH: Freiburg Low-Energy House
GBCA: Australian Green Building Council
GFC: Global Financial Crisis
HeizAnlV: Heizungsanlagen-Verordnung (Heating Systems Ordinance)
HIA: Housing Industry Association
IEA: International Energy Agency
IPCC: Intergovernmental Panel on Climate Change
ISES: International Solar Energy Society
KfW: Kreditanstalt für Wiederaufbau (German Development Bank)
LGA: Local Government Area
NABERS: National Australian Built Environment Rating System
NatHERS: Nationwide House Energy Rating Scheme
NCC: National Construction Code
OECD: Organisation for Economic Co-operation and Development
PCA: Property Council of Australia
QDC: Queensland Development Code
QLD Gov: Queensland State Government
SEQ: South East Queensland
UDIA: Urban Development Institute of Australia
UN: United Nations
UNEP: United Nations Environment Programme
UQ: University of Queensland
WärmeSchV: Wärmeschutzverordnung (Thermal Insulation Ordinance)
WBGU: Wissenschaftlicher Beirat der Bundesregierung

CHAPTER 1: Introduction

During the last few years, transformations towards more sustainable modes of production and consumption became a key societal issue. Actions towards climate change mitigation and low-carbon economies have been discussed across academic disciplines and politics. International organisations such as the United Nations (UN), the Intergovernmental Panel on Climate Change (IPCC) and independent scientific advisory boards have articulated the need for significant socio-economic shifts to face challenges of environmental degradation, global warming and the growing demand for fossil energy sources (e.g. German Advisory Council on Global Change (WBGU), 2016). Against this backdrop of the urgent need for actions to initiate change to mitigate greenhouse gas emissions, support renewable energy and new economic practices, the urban context has been identified as significant (Bulkeley et al., 2011; Frantzeskaki et al., 2017; Moore et al., 2018).

Cities are more and more understood as the key arenas and seedbeds to initiate actions for sustainability transitions towards systemic low-carbon transitions in fields such as energy, food, waste, mobility, housing and urban green. Cities and their institutional contexts continually influence urban development processes through planning guidelines and mechanisms, funding and incentives. Academic, political and private sectors are increasingly looking for applicable low-carbon solutions and meaningful policy recommendations in city contexts. There is agreement that new forms of collaboration between a wide range of stakeholders is needed to activate the 'transformative power' of cities, and catalyse innovative and context-specific approaches (WBGU, 2016). Therefore, an understanding of best practices in sustainable forerunner cities – but, also processes of resistance in 'lagger' cities – has high relevance in academia and policy-making.

To deliver policy recommendations, the great challenge is to develop a broader understanding of complexity and patterns of socio-technical transitions in city contexts. Urban sustainability transitions are the result of a combination of technological innovations, political interventions and socio-economic practices. These shifts are non-linear co-evolutionary processes that usually develop over longer time periods, typically over two or three decades (Geels, 2002). Since the early 2000s, research on socio-technical change in the sustainability context has been conducted in the research area of Transition Studies (e.g. Berkhout et al., 2004; Elzen et al., 2004; Geels, 2002; Kemp and Rotmans, 2004). However, questions of spatiality, temporality, and how economic and socio-political processes interact have been largely neglected in transition research (Coenen et al., 2015; Gibbs and O'Neill, 2017). Explanations are lacking as to why transition dynamics vary in

different spatial contexts. New perspectives are required to gain further knowledge about how sustainability transitions are embedded in specific spatiotemporal contexts (Murphy, 2015). Particularly, the dynamic interplay of changed practices, socio-political processes and related driving and resisting actors needs further attention. Surprisingly, geographical concepts have been widely neglected to conceptualise urban sustainability transitions, even though the lack of socio-spatial contextualisation has been articulated by a number of scholars (Binz et al., 2014; Coenen and Truffer, 2012; Geels, 2012; Truffer et al., 2015).

The potentials of bringing together approaches of Transition Studies and Geography have been considered in literature that can be framed as the 'Geography of Sustainability Transitions' (Hansen and Coenen, 2015; Murphy, 2015). Scholars have emphasised the importance of a relational understanding of space, and the understanding in how actors, networks, grassroots movements and policies are embedded in sustainability transition processes. Concurrently, other contributions focus on the role of changed socio-economic practices in the context of environmental technologies (Faller, 2016; Faller and Schulz, 2017). These theoretical thoughts outline a new geographical research agenda beyond the framework of the much-noticed 'Multi-level perspective' (MLP) in Transition Studies (Geels, 2002). This dissertation draws on these conceptual approaches and seeks to further develop the conceptual debate by bridging approaches of Economic Geography, which traditionally consider the interplay of economic development and innovations in temporal and spatial settings.

The built environment has largely been neglected in sustainability transition research, even though buildings are significant contributors to human-related greenhouse gas emissions (IPCC, 2014). Transitions from conventional towards resource-efficient modes of building and construction are playing an increasingly important role in international public debates on climate change and resource efficiency (United Nations Environment Programme (UNEP), 2014). At the highest international levels, the crucial role of a greener built environment and related policy support is discussed in the context of urban and regional climate change adaptation strategies (UNEP, 2014). While there are diverse definitions, green building is generally understood as the alternative practice of creating resource-efficient and healthier approaches for building design, construction, renovation, operation and maintenance. The key goal of a broader implementation of 'green' architectural principles (e.g. solar, passive or low-energy design) and 'low-carbon' building technologies and materials is reducing energy consumption and greenhouse gas emissions in buildings (IPCC, 2007; UNEP, 2011). Energy-efficient building concepts such as solar-, passive- or low-energy design receive a lot of attention and are more common. Why green building principles are adapted unequally in different city contexts is widely unknown.

1.1 Objectives of the dissertation

The key objectives of this dissertation are the development of a wider understanding of processes and dynamics of urban sustainability transition by, first, developing new conceptual approaches and, then, providing in-depth empirical insights of sustainability transitions in the building sector using the two contrasting case studies: Freiburg (Germany) and Brisbane (Australia).

Why and how green building transitions occur and develop unequally from city to city is the overarching question of this dissertation. The key goal is to trace back the context-specific key pathways in the cities' building sectors and, thus, develop a further understanding of successful transitions and processes of resistance. The core of the case study analysis focuses on the identification and the analyses of the dynamic interplay of building practices, governance processes and actors. To understand the driving and resisting processes, the involved actors – and, therefore, the directions of change and resistance – is key to adding knowledge to the debates around spatial and temporal aspects in urban sustainability transitions. Drawing on the premise that 'history matters' in explaining current processes in city contexts, an important goal of the dissertation is to trace processes of change at different historical stages and phases. The understanding of city contexts as non-static but highly dynamic and ongoing is increasingly important for city researchers as well as policy-makers who can influence processes of change through planning guidelines, incentives or regulation.

Therefore, this dissertation seeks to add knowledge to the debates around spatio-temporal aspects in urban sustainability transitions by tracing back the pathways of 'green building' in the contrasting city contexts. The main goal is to identify and analyse the following research entities and their interplay:

- changes in building and construction practice
- driving and resisting actors
- the institutional influence (policy decisions, including regulation, guidelines, planning mechanisms)
- directions of transitions (grassroots movement 'bottom up' or policy 'top down').

1.2 The case studies

The two contrasting city contexts provide the unique opportunity to unpack and understand 'success factors' on one hand and processes of resistance on the other hand. While the 'green' forerunner city Freiburg has experienced significant shifts from

conventional building practices towards 'low-energy' and 'passive houses' building concepts, Brisbane can be understood as a sustainability 'lagger' in the building sector.

Freiburg

Located in the south-west of Germany at the edge of the Black Forest, and with a population of about 230,000, Freiburg has received numerous awards for its environmental initiatives in urban sustainability and environment during the last decades. As a result, academic contributions have been published on Freiburg's various urban transition processes in transport, urban planning, waste management, and energy efficiency (e.g. Hall, 2014; Späth & Ornetzeder, 2017; Späth & Rohracher, 2011). Even though green building is a key characterictic of Freiburg's image as a green city, a detailed analysis of the city's green building pathways is lacking in the literature.

The case study of green building transitions in Freiburg gives the opportunity to analyse long-term urban transition pathways. The origins of green building in Freiburg can be traced to the 1970s, when innovative architects and engineers started niche experiments. In the early 1990s, the city of Freiburg introduced and incrementally improved low-energy requirements for new buildings on city-owned properties – a process that was largly supported by a wide range of actors. After continual policy support through the 2000s, all new building projects in Freiburg have had to reach strict requirements which almost meet the 'passive house' standard.

How these socio-technical transitions were driven from a bottom-up grassroots movement towards a top-down policy process is the core of the case study analysis. Tracing the city's long-term evolution and different phases of green building practices and the interrelations with urban goverance processes allows the identification of the main drivers, directions, negotiation processes and learning processes (technological and institutional) within the city's pathways.

Brisbane

The contrasting city context of Brisbane provides the opportunity to explore challenges and resistance in green building pathways.

With a population of about 2.3 million, Brisbane is Australia's third-largest metropolitain area, the capital of Queensland and the administrative centre of the Brisbane City Council

and the Queensland State Government. In contrast to Freiburg, Brisbane's history of green building is comparably short and characterised by discontinuity, lock-ins and resistance. Even though knowledge of energy-efficient building design has been gained since the 1960s in Brisbane's academic sphere, alternative building practices never became common practice in the building and construction industry, nor a key topic in the public sector. Therefore, the Brisbane case study provided valuable insights into a sustainability latecomer city and its ambivalent sustainability transition processes. Tracing the processes and drivers in the residential and commercial building sector can provide insights into the roles of the public and private sector.

1.3 Research questions

A number of questions need to be answered to further understand the role of spatial contexts and temporality in sustainability transitions: When, where, why and how do transitions happen? What explains the diverging development of changed practices towards sustainability from place to place? Why are there forerunner places with significant shifts towards new socio-technical structures while there are also places that are lagging? What are the context-specific conditions and pathways that lead to change or resistance?

To find explanations for successful and challenging green building pathways, including interactions between technological and institutional-political logics, this dissertation seeks to find answers for the following key research questions:

(1) What are significant shifts in the context of green building (e.g. building projects, policies, economics)?
(2) In the case study contexts, who are the driving actors or resisting actors in the building sector?
(3) To which extend do policy-making processes play a role in driving transitions in the local building sector?
(4) What were important learning processes / processes of resistance within the transition pathways?

To gain in-depth knowledge about the processes over time, and involved actors and their interests in the context of both cities' green building pathways, this dissertation is conceptualised as a qualitative research design. The empirical data used for this dissertation is based on expert/stakeholder workshops, document analysis and expert/stakeholder interviews.

1.4 Structure of the dissertation

This dissertation is based on four journal articles which are integrated in the following five chapters. Chapter 2 outlines the theoretical and conceptual background of this dissertation based on the journal article “Lost in Transition? Directions for an Economic Geography of Urban Sustainability Transitions”. Chapter 3 presents the methodological approaches, with a focus on interactive learning processes through expert/stakeholder workshops. This approach is explained through the publication “Interactive knowledge generation in urban green building transitions”. The case study research is provided in Chapters 4 and 5. Based on the article “Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany)”, Chapter 4 outlines the context in Freiburg, and focuses on success factors of urban green building transitions. Chapter 5 is based on the article “Ambivalent urban sustainability transitions: Insights from Brisbane’s building sector”, which discusses the processes of resistance in the urban context of Brisbane. Finally, Chapter 6 concludes this dissertation by discussing the results and providing an outlook in further research opportunities.

CHAPTER 2: Conceptual Framework

Lost in Transition? Directions for an Economic Geography of Urban Sustainability Transitions.

Fastenrath, S. & Braun, B.: Lost in Transition? Directions for an Economic Geography of Urban Sustainability Transitions.

With kind permission by MDPI.
This paper is under review in 'Sustainability'.

Abstract

Socio-technical transitions towards more sustainable modes of production and consumption are receiving increasing attention in the academic world and also from political and economic decision-makers. There is increasing demand for resource-efficient technologies and institutional innovations, particularly at the city level. However, it is widely unclear how processes of change evolve and develop and how they are embedded in different socio-spatial contexts. While numerous scholars have contributed to the vibrant research field around sustainability transitions, the geographical expertise largely has been ignored. The lack of knowledge about the role of spatial contexts, learning processes and the co-evolution of technological, economical and socio-political processes has been prominently addressed. Bridging approaches from Transition Studies and perspectives of Economic Geography, we present conceptual ideas for an evolutionary and relational understanding of urban sustainability transitions. The paper introduces new perspectives on sustainability transitions towards a better understanding of socio-spatial contexts.

2.1 Introduction

Socio-technical change in the sustainability context is increasingly receiving attention from a wide range of academic disciplines but also from public and private sectors. Cleaner and resource-efficient technologies and practices are required in contexts such as energy, transport, waste recycling, green space, agriculture, housing and construction. Within the debates about alternative modes of production and consumption, cities are understood as the key arenas for socio-technical change (Avelino & Wittmayer, 2017; Bulkeley, Castán Broto, & Maassen, 2011; Frantzeskaki et al., 2017b; WBGU, 2016). However, how sustainability transitions occur and develop, and how they are interrelated to economic and socio-political processes, is widely unclear (Coenen et al., 2015; Gibbs & O'Neill, 2017). A number of questions need to be answered to further understand spatiality and temporality in sustainability transitions: When, where, why and how do transitions happen? Why are there forerunner places with significant shifts towards new socio-technical structures while other places lag behind? What are the conditions and pathways that lead to change or resistance? What or who are the drivers and detractors?

New analytical perspectives and conceptual approaches are required to gain further knowledge about how the dynamics of sustainability transitions are embedded in specific spatiotemporal contexts (Murphy, 2015). A special focus needs to be drawn on the dynamic interplay of practices, institutional processes and related driving and hindering actors. It is surprising that geographical concepts largely have been neglected in transition research, even though the lack of socio-spatial contextualization has been acknowledged by a number of scholars (Binz et al., 2014; Coenen & Truffer, 2012; Geels, 2012; Truffer et al., 2015). The introduction of ideas for a 'Geography of Sustainability Transitions' (Hansen & Coenen, 2015; Murphy, 2015; Truffer & Coenen, 2012; Truffer et al., 2015) was an important first step towards an analysis of the contextualization of transitions. These articulated theoretical thoughts outlined a geographical research agenda beyond the vibrantly used heuristic framework of the 'Multi-level perspective' (MLP) in Transition Studies (Geels, 2002).

This paper aims to develop conceptual ideas considering economic geographic perspectives to overcome the "[…] naïve conceptualization of space, scale and power" (Truffer & Coenen, 2012, p. 15) in sustainability transition research. As various scholars suggest, combining approaches from Economic Geography and Transition Studies (TS) helps to understand and analyse socio-technical change and its embeddedness in socio-spatial structures (e.g. Boschma et al., 2017; Coenen et al., 2015; Truffer, 2008; Truffer & Coenen, 2012). Both heterogeneous research fields share a common understanding of

path dependencies, thinking of continuity of change, and the influence of institutional contexts.

Economic Geography concepts with an evolutionary and relational understanding of economic development (e.g. Jones, 2009) are most suitable to link these concepts. Nevertheless, these approaches need a more practice- and institutional oriented research focus in the sustainability transitions context. Jones and Murphy (2011, p. 371) argue that the focus on practices can "provide a grounded theoretical lens for understanding how a diverse range of processes and phenomena (e.g. learning, networks, governance, development, livelihood strategies) occur, evolve, and/or become transformed over time and in space". Moreover, a growing number of contributions emphasize the important role of actors and actor networks, grassroots movements and policy-makers as key drivers behind sustainability transition. Truffer and Coenen (2012, p. 15) refer to examples showing that "cities and regions can become powerful promoters of sustainability transitions when understood as relationally embedded actors and providing crucial resources for successful innovation processes". During the last few years, scholars have demonstrated empirical research on how pioneering socio-economic practices are driving environmental technologies (e.g. Faller, 2016; Faller & Schulz, 2017; Fastenrath & Braun, 2018).

The aim of this contribution is to shed light on urban sustainability transitions by bringing together approaches from Transition Studies and Economic Geography. In section 2, we trace the common grounds of both research fields in understanding and exploring socio-technical change before the paper will explore the distinctive nature of sustainability transitions. Economic Geography perspectives in the context of investigating sustainability transitions are discussed in section 2.1. In section 2.3, the paper presents conceptual ideas for analysing changed practices and related drivers and processes in urban sustainability transition processes. Section 2.4 provides concluding thoughts.

2.2 From Evolutionary Economics to a Geography of Sustainability Transitions

For more than two decades, research on socio-technical transitions has been conducted in the field of social study of technology (SST), better known as 'transition studies'. This popular multi-disciplinary research field has brought together insights from economics, innovation and technology studies, history, and social and political sciences. Scholars of transition studies particularly focus on a systemic understanding of technological change as a co-evolution of technologies but also of policies, user patterns, infrastructures and cultural discourses (Geels, 2012). Similar to approaches of 'Evolutionary Economic Geography' and 'Geographies of Innovation', the roots and central conceptual ideas go back to Evolutionary Economics (Dosi, 1982; Nelson & Winter, 1982). Evolutionary Economics emerged as an alternative conceptual idea to the static neoclassical, orthodox concepts of economic and technological change. The main goal of scholars at that time was to develop an "[…] evolutionary viewpoint as a possible framework for a more realistic economic theory of firm and industry behaviour" (Nelson & Winter, 1982, p. vii). Evolutionary Economists started to develop a more precise understanding of technological change and interrelated processes and mechanisms by which economies develop. A key idea was to trace past economic and other related processes to better understand current economic dynamics – in other words, 'history matters'. Similarly, the Economic Geographers Lloyd and Dicken (1977, p. 238) stated that "the economic landscape is the cumulative expression of decisions made at different points in time and under a variety of conditions".

Nelson and Winter (1982) introduced a new thinking about the drivers of innovation, technological change and decision-making processes. The authors explicitly responded to the lack of institutional and political considerations in economic research at that time. They argued that informal institutions, actors (single and groups), and policies are crucial factors for economic development. Moreover, they stated that "public law, policies, and organizations are an important part of the environment that shapes the evolution of private sector activities" (Nelson & Winter, 1982, p. 371). Based on a case study from the United States, Nelson and Winter explained their conclusions. By tracing back air quality regulations on different policy levels and interrelated changed economic practices from the 1950s to the 1970s, they emphasised the interactions between industry actors, policies and public administration. Reviewing this case study, Nelson and Winter stated that public policies also tend to follow certain trajectories. They argued that "policy

changes today might fruitfully be understood as evolving from a policy base that was itself the outcome of a sequence of earlier changes, and, in turn, as setting the stages for future evolutionary developments" (Nelson & Winter, 1982, p. 376). Since then, the understanding of economic development has been based on the assumption that economic action is embedded in institutional and social structures (Giddens, 1984; Granovetter, 1985). Concepts and empirical research of systems of innovation and technological change occurred (Dosi et al., 1988; Freeman, 1995; Lundvall, 1992). Scholars started to examine the interrelations between technological trajectories and institutional coordination.

The heterogeneous field of 'Transition Studies' occurred with a more technological focus (Geels, 2002; Kemp, 1994; Kemp et al., 1998; Rip & Kemp, 1998). Transitions are understood as socio-technical changes resulting in technological change that is socially embedded and follow certain pathways. Theoretical ideas are based on the premise that technological change is the result of the interactions of co-evolutionary and non-linear processes between a wide range of economic, socio-cultural, political and institutional spheres (Geels, 2012; Kemp et al., 1998). New products, services, business models, organisations completely or partly substitute existing ones (Grin et al., 2010). These interrelations are demonstrated in a number of historical and more recent examples such as shifts from sailing to steaming ship (Geels, 2002), from horse-drawn carriage to automobiles (Geels, 2005), or from cesspool to sewer systems (Geels, 2006). However, space and location have not been considered explicitly in the theoretical and empirical approaches in Transition Studies.

Sustainability Transitions

Since the 2000s, publications in Transition Studies are increasingly focused on socio-technological change in the environmental and sustainability context (Kemp & Rotmans, 2004; Smith, 2007; Smith et al., 2005). While there are various understandings, Markard et al. (2012, p. 955) define sustainability transitions as "transformations towards more sustainable modes of production and consumption". The goal of scholars in this research context is to understand shifts in the heterogeneous field known under different terms such as eco-innovations, green-, environment-, or clean technologies (Geels, 2011; Grin et al., 2010; Markard et al., 2012; Smith et al., 2010). Socio-technical processes have been addressed in a wide range of research areas such as renewable energy, agriculture, transport, waste recycling, water supply, and building and construction.

The major difference of sustainability transitions compared to conventional socio-technical transitions is the strong influence by a number of political, scientific and civil societal actors (Grin et al., 2010). Sustainability transitions are not solely economic or technology driven; they must be interpreted as the result of incremental socio-spatial dynamics influenced by normative expectations (Grin et al., 2010; Shove & Walker, 2007). Cooke (2010) identified a 'green turn' in innovation systems which is strongly driven by policies and societal powers. Policies (regulations, guidelines, incentives) are identified as important drivers for sustainability transitions. Also, Truffer and Coenen (2012, p. 12) argued that "sustainability transitions are by their very nature political projects". Therefore, innovative technologies and practices are increasingly understood and conceptualized as niche developments in 'protective spaces' where pioneers can experiment and learn under policy and societal protection (Smith & Raven, 2012).

Transitions in the sustainability context are progressively understood as highly embedded processes in specific socio-spatial contexts of places, regions or cities (Truffer et al., 2015). Urban case studies demonstrate how context-specific pathways of institutions, economic practices, political mechanisms, and driving and hindering actors influence the dynamics of sustainability transitions (Fastenrath & Braun, 2018). New technologies, lifestyles, economic practices, or policies can occur as a result of these processes (Truffer et al., 2015).

The Multi-level perspective

The most recognised concept and theoretical idea to explore phenomena in the field of socio-technological change is the Multi-level perspective (MLP) (e.g. Geels, 2002; Geels, 2011) (see fig. 2.1). The MLP "provides an overall view of the multi-dimensional complexity of changes in socio-technical systems" (Geels, 2010, p. 495). This heuristic framework was established to develop an understanding of long-term transition processes by explaining key processes and drivers behind socio-technical change. In the MLP, understanding transitions happens as a result of co-evolutionary interactions between three analytical levels (Geels, 2002): (1) A niche level, where innovations occur and build up momentum; (2) a socio-technical regime level where established structures and networks of actors, institutions and economic practices become stabilised over time; and (3) a landscape level, the wider context where large influencing factors such as global discourses occur (Geels, 2002).

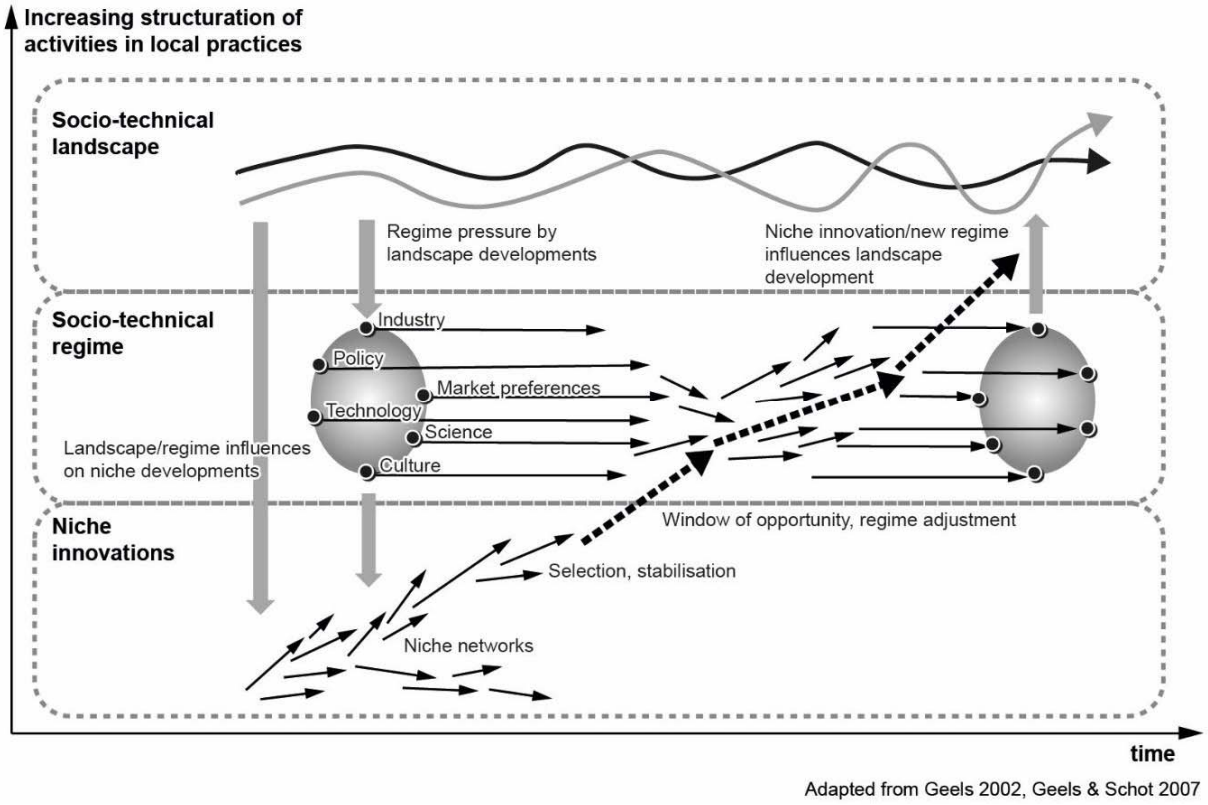

Figure 2.1: The Multi-level perspective (own figure)

The most important level in the MLP framework is the niche level. Geels explains niches as 'protected spaces' where (radical) innovations, pioneer projects and learning processes occur. These can result in new, stable socio-technical configurations at the regime level when powerful actors and networks accept these niche developments. The regime concept is understood as an interpretive analytical concept. While the analytical concept of the socio-technical system "refers to tangible and measurable elements" (Geels, 2012, p. 473) (e.g. market shares, regulations, consumption patterns), the regime is understood as a more intangible analytical entity. The socio-technical regime refers to the rules and routines in which actors are embedded and on which draw concrete actions.

However, as Smith et al. (2010, p. 436) argued, "this attractive big picture is not without its challenges". A general critical debate about the MLP framework occurred for a number of reasons (Shove & Walker, 2007). A core critique is the fuzzy heuristic and interpretative character and, therefore, empirical limitations. Apart from that, a general debate exists on epistemological aspects and the challenges in operationalizing concrete research objectives (Fuenfschilling & Truffer, 2014; Maassen, 2012; Markard & Truffer,

2008; Shove & Walker, 2007; Smith et al., 2010; Truffer, 2008); a number of those aspects are related to the sustainability context.

The dominant 'technocratic' understanding of innovation and of the niche-driven directions have been critically discussed (Geels, 2011; Smith et al., 2010; Truffer & Coenen, 2012). There is growing evidence that the normative character and the strong public interest in sustainability issues strongly leads to different logics of socio-technological and economic change. Thus, there is a need for a closer look at established policy and economic structures as drivers for change but also as detractors (Geels, 2014). While most studies explore successful green niche innovations, processes and actors at the regime level have been neglected. Concepts to operationalize regime-niche interactions are required to identify drivers, policy structures and power constellations (Smith et al., 2005). Therefore, it is crucial to gain knowledge about successful but also failed or distracted sustainability transitions. Institutional and economic path dependencies, interest structures, driving and hindering actors need to be identified. The dynamics and interactions within the regime but also between niche and regime require more scientific attention. This knowledge is critical to provide recommendations for policy-makers and industry actors (WBGU, 2011).

Scholars agree that exploring the socio-spatial and temporal contextualisation can help to better understand these interrelations (Geels, 2012; Hansen & Coenen, 2015). However, concepts in Transition Studies that offer a distinctive spatial perspective are still lacking. Perspectives of Economic Geography are predestined to add knowledge to how technological innovations, changed economic practices and processes are embedded in social, political and wider economic structures at different times (Bathelt & Glückler, 2012).

Bringing together viewpoints from Evolutionary Economic Geography (e.g. Boschma & Martin, 2010), Geography of Innovation (e.g. Asheim & Gertler, 2005) and Environmental Economic Geography (e.g. Braun, 2002; Braun et al., 2003; Patchell & Hayter, 2013; Soyez & Schulz, 2008) is valuable for developing new theoretical and conceptual approaches for sustainability-oriented transition research. We agree with Murphy who stated that the geographical perspective helps to "understand the development trajectories of cities, industries, production networks, and economies" (Murphy, 2015, p. 73).

2.2.1 Economic Geography perspectives on socio-technological change and sustainability

Since the 1990s, Economic Geographers and scholars from related disciplines enrich the debates on technological change with socio-spatial and evolutionary aspects (Amin, 1999; Morgan, 1997; Storper, 1997; Storper & Scott, 1995). These scholars developed a more socio-spatial understanding of economic development and, therefore, can be seen as the originators of an "evolutionary school of technological change" (Hassink & Shin, 2005, p. 571). Considering a relational and evolutionary approach of technological change, researchers explore path dependencies and learning processes within economic structures, predominantly in industrial production systems at the firm level (Amin & Thrift, 2000; Boschma & Lambooy, 1999; Maskell & Malmberg, 1999). Concepts such as 'innovative milieus' (Camagni, 1995) and 'clusters' (Porter, 1990) highlight the role of spatial contexts in innovation processes. In Economic Geography, institutions are increasingly understood as "central to the socio-cultural construction of the economic" (Martin, 2003, p. 77). The proximity of actors, embedded learning processes and institutional interactions have been identified as important drivers for innovation (Bathelt et al., 2004).

Many scholars agree that technological innovations are influenced by interactions within innovation systems (Revilla Diez & Kiese, 2009). Technological change and the interplay with institutions and organisational structures have been explored for systems at different spatial scales. Apart from 'national innovation systems' (Nelson, 1992), the concept of 'regional innovation systems' particularly has been conceptualized and empirically analysed (Asheim & Gertler, 2006; Asheim & Isaksen, 2002; Asheim & Coenen, 2005; Asheim & Smith, 2011; Cooke, 2008; Cooke et al., 1997). Regional innovation systems are understood as "economic and social interactions between agents, spanning the public and private sectors to engender and diffuse innovation within regions embedded in wider national and global systems" (Asheim & Smith, 2011, p. 878).

Synchronously, scholars within the broader field of 'Environmental Economic Geography' (EEG) contributed to the debate around technological innovations, environmental protection, institutions and knowledge creation (Braun, 2003, 2005; Braun et al., 2003; Gibbs, 2006; Gibbs & Healey, 1997; Hayter, 2008; Hayter & Le Heron, 2002a; Patchell & Hayter, 2013; Schulz, 2002, 2005; Soyez, 2002; Soyez & Schulz, 2008; Taylor, 1996). Conceptual and empirical approaches in EEG highlighted the important role of non-economic actors and drivers of 'greening' processes of firms, production networks, and industry sectors. The special context of green, eco, environmental or sustainability

innovations and the contextual interplay of regulation and industrial-environmental processes towards sustainability actions have been explored.

Hayter and Le Heron (2002b) argued that 'green-facilitative institutions' are likely to have different spatialities and temporalities compared to established institutions. The authors predicted a "transition from narrow economic and profit oriented technological focus to one that resolutely incorporates green dimensions in technological change" (Hayter & Le Heron, 2002b, p. 401). However, socio-political perspectives and the interplay of economic and institutional processes in eco-innovation research are still missing and have been continually articulated (Coenen et al., 2015; Fastenrath & Braun, 2018; Gibbs & O'Neill, 2017; Smith et al., 2010; Strambach & Pflitsch, 2017). The important role of EEG in sustainable development research and as an important emerging field in Economic Geography was emphasised by Aoyama et al. (2011).

Parallel to these ideas towards an Environmental Economic Geography, thoughts for an Evolutionary Economic Geography dominated the debates about spatial contextual aspects of technological change (Patchell & Hayter, 2013). The key concepts within this evolutionary approach, including 'path creation' (Garud & Karnoe, 2001; Simmie, 2013), 'path dependence' (Boschma & Frenken, 2006, 2011; Martin & Sunley, 2010), 'lock-in' (Boschma, 2005; Grabher, 1993; Hassink, 2005, 2010) and 'path plasticity' (Strambach & Halkier, 2013), help to understand interactions between economic, technological and institutional developments. Similar to approaches from Transition Studies, EEG has a co-evolutionary understanding of technologies, institutions and the dynamics of socio-technical change. The core understanding of most of these conceptual approaches is that economic evolution is based on ongoing processes and the "never-ending interplay of path dependence, path creation and path destruction that occurs as actors in different arenas reproduce, mindfully deviate from, and transform existing socio-economic-technological structures, socio-economic practices and development paths" (Martin & Sunley, 2006, p. 408). Bringing together these ideas, Simmie (2013) conceived an improved conceptual framework to explain socio-technical change, based on previous work on path creations (Garud & Karnoe, 2001; Garud et al., 2010) (see figure 2.2).

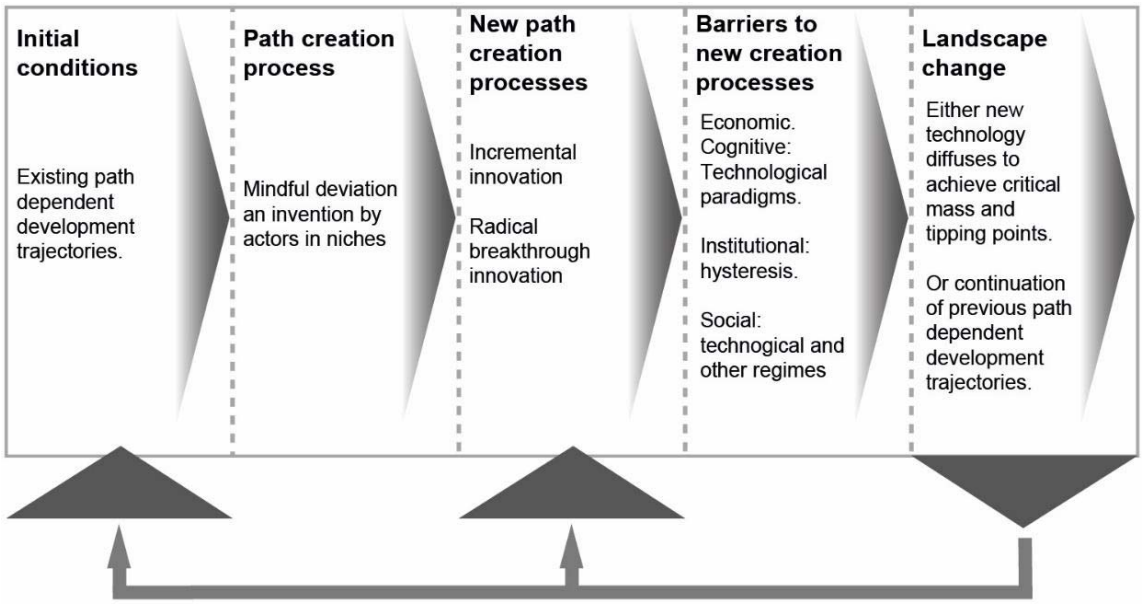

Figure 2.2: Path creation theory (Simmie, 2013)

The framework's core ideas of path creation help to conceptualize different processes and phases within sustainability transition pathways. However, new empirical perspectives are needed to understand in more detail the drivers and disruptions in sustainability transition pathways. In particular, it appears necessary to investigate how economic and institutional pathways are interwoven. Bridging ideas from Transition Studies and the three streams of Economic Geography is valuable for further sustainability transition research. There is a need to shift research from a dominant technological focus to a broader understanding of innovations which also include institutional and social innovations. The criticized firm- and technology-centred perspectives of innovation which are still often applied in research (e.g. Pike et al., 2009) have to be transformed to a more evolutionary practice- and policy-oriented perspective. Particularly economic sectors need to focus research policy regulations and public planning mechanisms such as urban infrastructures (water, energy, waste, transport) and building and construction. Innovation policies and power constellations are increasingly evaluated as important drivers for transformational change in the sustainability context (Coenen et al., 2015; Geels, 2014; WBGU, 2016).

2.3 Towards an Economic Geography of Urban Sustainability Transitions

Cities and city regions have been identified as important seedbeds and experimental arenas for sustainability transitions (Bulkeley, Castán Broto, Hodson, et al., 2011; Frantzeskaki et al., 2017a; Hodson & Marvin, 2010, 2012; Valderrama Pineda et al., 2017; WBGU, 2016). These discussions culminate with the transdisciplinary debate on climate change, resource efficiency, resilience, and energy transitions. Public administrations, NGOs, researchers and practitioners are looking for technological, political and organisational solutions to more sustainable modes of production and consumption.

However, research approaches for urban sustainability transitions are lacking. Indeed, theoretical and empirical research at the city level is challenging. Cities are embedded in wider complex political, economic and social systems at different scales, and every city is an irreducible individual case (Scott & Storper, 2015). To overcome these challenges is a major task for Geography and its sub-disciplines. Geography of Sustainability Transitions provides approaches to explain socio-spatial dynamics, power relations and political aspects to the geographical research agenda (Hansen & Coenen, 2015; Murphy, 2015; Truffer et al., 2015). Murphy (2015, p. 75) highlighted the special role of spatial contexts in which transitions are embedded: "[T]ransitions are shaped both by the ways in which socio-technical systems are embedded in particular territorial contexts, and by the multi-scalar relationships linking their heterogeneous elements to actors, materials, and forces situated or emanating from different locations or scales".

There is a growing number of publications exploring place specificity in sustainability transition processes. One group of scholars highlights the role of multi-scalar and trans-local aspects and exogenous forces in sustainability transitions (e.g. Binz et al., 2014; Cooke, 2011; Dewald & Fromhold-Eisebith, 2015). Apart from the discussion of spatial transferability of technological aspects, including adaptation processes from one place to another, changed practices, and single learning processes, scholars have presented ideas for 'policy mobility' (Affolderbach & Schulz, 2015; McCann, 2011; McCann & Ward, 2011; Peck & Theodor, 2010). The core idea behind these approaches is that, similarly to technologies and business models, policies and other institutional settings can also be adopted and reconfigured to other places. Other scholars emphasise the need for further considerations of endogenous processes at the city level and how exogenous factors have an impact on local processes, especially as urban sustainability transitions receive further attention (Gorissen et al., 2016; Hodson et al., 2017; Valderrama Pineda et al., 2017).

Nevertheless, most of these research approaches aim to explore innovations (technological or institutional) and its socio-spatial relations. Drawing on these

conceptual considerations as well as empirical insights into urban case studies on 'green building' transitions in Freiburg (Germany) (Fastenrath & Braun, 2018) and Brisbane (Australia) (Fastenrath & Braun 2018[2]), we suggest new ideas to conceptualise and analyse urban transitions processes. Without neglecting the exogenous influences on urban transitions, it is crucial to analyse the endogenous characteristics such as local policies (regulation, incentives, and guidelines), local learning processes and actors (driving and hindering/disrupting). In particular, identifying local and trans-local drivers and barriers is valuable to gain more knowledge on transition processes. We argue that agency and power, learning by doing/using, successful and disrupted transition processes and actors at different times in the past have an impact on developments in the present. This understanding of sustainability transitions should help researchers and also actors from the public and private sector support and steer sustainability transition dynamics. The in-depth knowledge of specific city contexts and its structures and developments is crucial to generate support by measures such as new policies, incentives, changed business models or industry practices.

Bringing together ideas of the Multi-level perspective and the different strands of Economic Geography can help to conceptualise the dynamic socio-spatial processes of sustainability transitions at the city level. Moving forward from these ideas, we suggest a new conceptual framework that understands sustainability transitions as changed practices in the broader socio-spatial context, including the interplay and outcome of political-institutional and economic and socio-cultural structures (see fig. 2.3). Within this framework, we suggest three analytical entities and their reciprocal interactions for urban sustainability transition research:

1) Pathways (technological and political-institutional)
2) Changing practices, processes of learning and hindrance
3) Actors/actor networks (private, public, individual, collective)

1) Pathways - Understanding the 'urban transition history'

As an important step towards a broader understanding and analysis of urban sustainability transitions, we suggest an analysis of pre-existing structures within sustainability transition pathways (Geels & Schot, 2007; Truffer & Coenen, 2012; Turnheim et al., 2015). Socio-technical transition processes usually happen over several decades. Changes in the sustainability context may occur faster. Considering the distinctive normative nature of sustainability transitions, the speed and the directions of

change are often explained by society-driven 'bottom-up' or/and policy-driven 'top-down' activities. Geels (2014) suggested that policy-making processes especially need a closer examination in their function as drivers or detractors of sustainability transitions. Therefore, the MLP understanding of niches as the most important level and generally as seedbed of technological innovation seems to be increasingly unsuitable for sustainability transition research.

We argue that socio-technological processes in urban settings follow context-specific logics and pathways, driven by the interplay of political-institutional, economic and socio-cultural structures. Sustainability transition pathways are non-linear and incremental developments; they are the result of negotiations, agency, adoption of technologies and practices. Place-specific economic and political logics can drive or hinder processes of change (Fastenrath & Braun, 2018). There is an increasing understanding that changes towards sustainability are often driven by institutional 'niches' and the interplay with context-specific actors. As Coutard and Rutherford (2010) highlighted, there is a lack of research on the outcomes of policies in urban transition contexts. During the last few years, new institutional understandings were introduced and explored. For instance, Nightingale (2017) discussed the struggles of power and politics and actors on different levels in local climate change adaptation. Also, interdisciplinary approaches such as 'evolutionary governance theory' (Van Assche et al., 2014) appear promising for further interdisciplinary transition research.

To understand how economic and policy trajectories are interlinked and drive or hinder transitions in urban contexts is a major task in transition research. Therefore, the analysis of different context-specific pathways of technological change in relation to institutional changes is crucial for an in-depth understanding of socio-technical change. Tracing back and exploring the dynamics, directions and interactions towards changed practices and routines in sustainability transitions context is a major challenge. First examples of urban case studies demonstrate the value of tracing back sustainability pathways. Burch (2017) provided insight into policy pathways (initiatives and regulation) and their outcomes on different sustainability areas in Vancouver. Fastenrath and Braun (2018) explored the interplay of policy pathways and changed practices in building and construction towards 'greener' outcomes in the forerunner city of Freiburg, Germany.

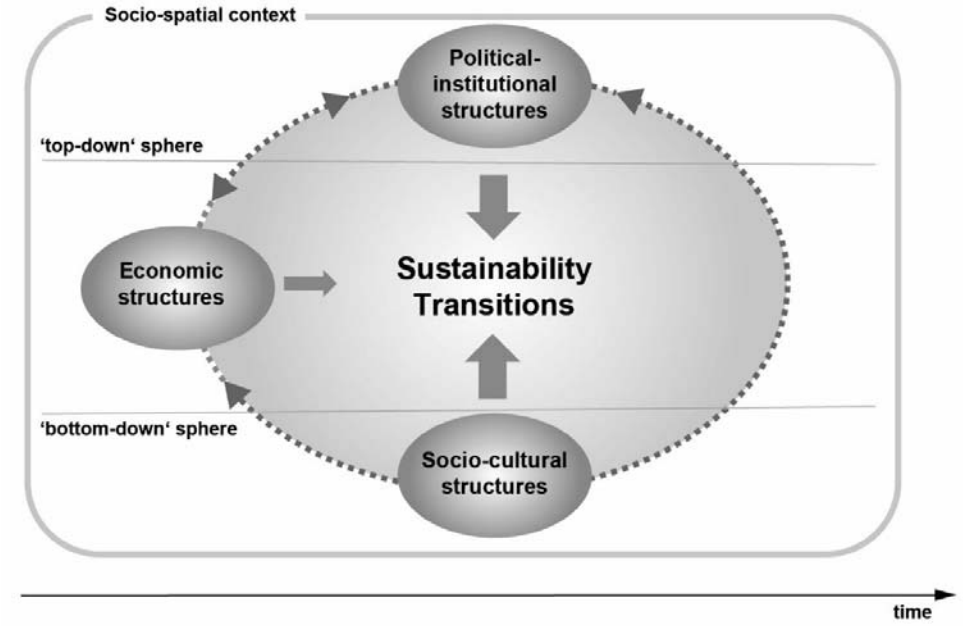

Figure 2.3: Sustainability Transitions dynamics (own figure)

Thus, we propose a stronger focus on interactions between technological use and adoption, and the outcome of learning processes in niches and in "business-as-usual regimes" (Murphy, 2015, p. 88). There is the need to look more closely at policy action and guidance, and the dynamics of economic change and power within established political-institutional and economic structures (Brown et al., 2013; Davies & Mullin, 2011; Geels 2014; Murphy, 2015; Smith & Raven, 2012).

2) Changed practices – understanding learning processes and resistance

To understand couplings, directions and the dynamics of sustainability, research needs to focus on how changing practices (technological, institutional) and learning processes are embedded in city contexts (Malmberg & Maskell, 2010; Shove & Walker, 2010). As Geels (2014) suggested, innovation processes and related 'learning by doing' and 'learning by using' needs to be scrutinized. Studies have demonstrated how changed practices and localized learning can be crucial for sustainability transition pathways on the local level (e.g. Faller & Schulz, 2017; Hargreaves et al., 2013; Malmberg & Maskell, 2010; Seyfang & Longhurst, 2016; Smedby & Neij, 2013). Pioneer projects are seen as important triggers

for 'preadaption' (Cook 2011) and as "stepping-stones between niche and mainstream" (Smith, 2007). Knowledge generation, spillovers, and specialised skills can be the result of policy action towards sustainability transitions. Apart from these 'bottom-up'-directed changes, there is also evidence that 'top-down'-directed local policies and regulation can evoke changed practices and create learning processes (Fastenrath & Braun, 2018).

An in-depth analysis of processes of change and transformation, and also of detractions, resistance and lock-in against sustainability-oriented shifts, is important to further understand the role of established structures (Corvellec et al., 2013; de Gooyert et al., 2016; Geels, 2014; Maassen, 2012). There is a lack of knowledge about processes when actors form a "core alliance at the regime level, oriented towards maintaining the status quo" (Geels, 2014, p. 6). Therefore, a changed focus is needed from how 'green' niches occur and develop towards a perspective of how established economic and political structures support but also hinder sustainability transitions (see fig. 2.4). It is essential that we identify learning processes as well as mechanisms of 'regime resistance' (Geels, 2014), lock-in (Maassen, 2012) and inconsistencies (Burch, 2017) within sustainability pathways. Particularly crucial fora better understanding of urban sustainability contexts is the role of policy action and the reciprocal interactions with learning processes, technological innovations and changed practices. Therefore, we need contrasting urban case studies to provide explanations for successful and unsuccessful transition processes.

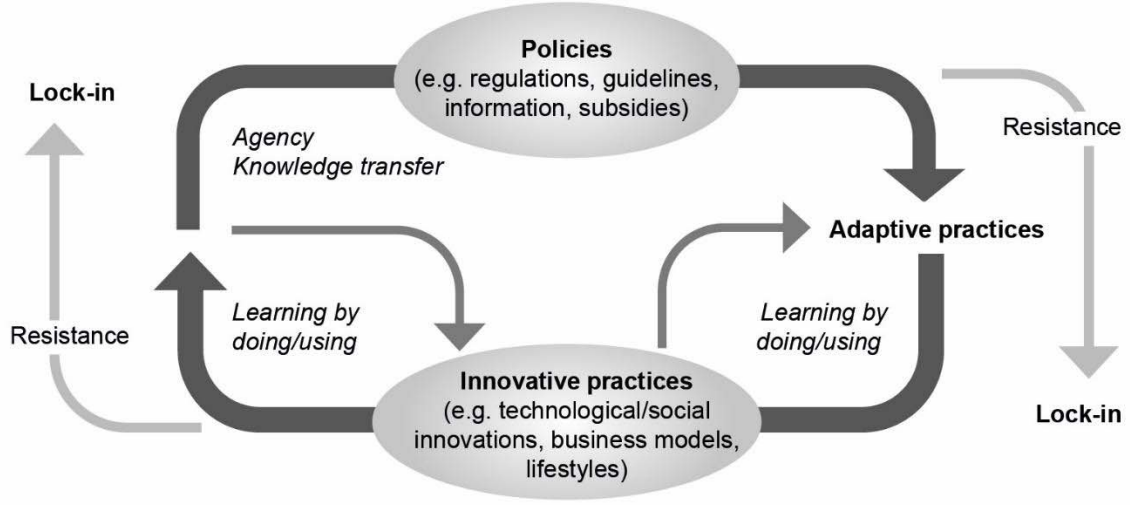

Figure 2.4: Practice change in sustainability transitions (own figure)

3) Actors – understanding the drivers and their interests

The heterogeneous field of actors in urban sustainability transitions is receiving more and more attention. Identifying and understanding the roles, interplay and interests of actors from public, private and academic sectors and civil society is becoming a key analytic object in transition research (see fig. 2.5). It is widely accepted that actors (individual and collective) play an important role when interacting with economic structures and also with the political and institutional context in innovation processes. Actors in city contexts can play a key role as catalysts for new practices, technologies and new narratives (Grin et al., 2017). Thus, there is an increasing number of publications focusing on actors and actor networks in urban sustainability transitions (e.g. Avelino & Wittmayer, 2017; Strambach & Pflitsch, 2017; Valderrama Pineda et al., 2017).

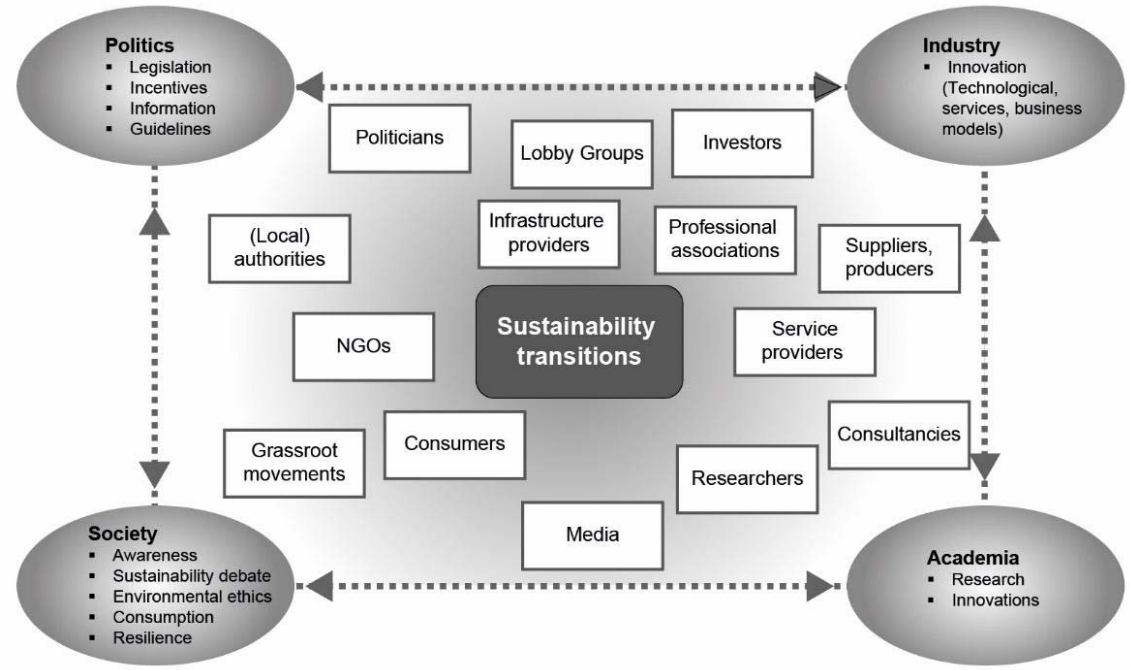

Figure 2.5: Key actors in urban sustainability transitions (own figure, adapted from Schulz 2002)

Studies have demonstrated how local actors such as city governments and its various city authorities (e.g. planning, transport, environment/sustainability, building and construction, disaster management) are able to drive 'top-down' socio-technical change through formal and informal institutions (e.g. Burch, 2017; Fastenrath & Braun, 2018). In

many countries, mechanisms of 'local self-government' allow city governments a leeway to develop innovative local policy initiatives, adapt ideas from other urban contexts, and support experimental projects.

On the other side, 'bottom-up' actors such as single pioneers or collectively organised grassroots movements have been identified as crucial drivers in urban transition processes (Wolfram, 2016). They can create knowledge through adoption of innovative socio-technical practices, 'niche experimentations' (Coenen et al., 2010) and learning by doing/using (Bulkeley, Castán Broto, & Maassen, 2011). Case studies have demonstrated that 'bottom-up' actors can be crucial by addressing interests, ideas and knowledge through agency as "transition agents" (Fastenrath & Braun, 2018). Fastenrath and Braun identified that significant changes occurred when actors such as single pioneers, networks or environmental citizen movements are able to interact with established political and economic structures. Another key finding was that the directions of urban transition processes can change over time. While an initial 'bottom-up' path could be identified, what occurred later in the process was a dominant 'top-down' path driven by politicians and city authorities.

Nevertheless, sustainability transition processes are not always success stories. There is a lack of research focusing on "transition detractors", actors which hinder or distract transition processes. For instance, an opportunity for further research is to look more closely at lobby groups and their interests as well as the interventions of political parties or public administrations. How and why successful sustainability strategies and "blocking-mechanisms" (Murphy, 2015, p. 88) occur and are embedded in the socio-spatial context needs to be highlighted in further transition research.

2.4 Conclusions

This paper introduced ideas for new perspectives on urban sustainability transitions. Our key goal was to provide alternatives which go beyond the prominent concept of the 'Multi-level perspective' introduced by scholars of transition studies (Geels, 2002). This theoretical approach has been criticized for its vague conceptual framework, operationalisation challenges and strong interpretative character (Smith et al., 2010). Moreover, the concept does not provide answers why and how transitions occur and develop unevenly in different spatial contexts. A geographical turn is required to

overcome the inadequate conceptualisation of space in transition research to better understand socio-economic processes in a relational understanding. Based on the introduced and much-noticed research agenda of a 'geography of sustainability transitions' (Hansen & Coenen, 2015; Murphy, 2015; Truffer & Coenen, 2012), this paper sheds light on possible directions towards research on socio-technical change.

In this paper we traced the common grounds and differences of Transition Studies and Economic Geography approaches which focus on socio-economic change. Since Nelson and Winter (1982) introduced ideas for a new understanding of temporality and drivers of economic processes, research on socio-technical processes has continually changed. In various scientific disciplines, the crucial role of actors, networks and institutions has been identified as an important force for economic and technological change. To cope with sustainability transitions, we argued that new concepts are required. The strong normative character of sustainability and its societal recognition leads to new processes of economic and technological changes. Changed economic and social practices towards more sustainable modes of production and consumption are often influenced by societal and political influencing factors that need stronger consideration. Thus, the understanding of innovations needs a change from a technocratic to a broader understanding of changed economic practices that also consider socio-cultural elements.

Over the last few years, a number of contributions have demonstrated that eco-/environmental innovations occur in the context of specific locations. Successful sustainability processes and actors in cities have become a vibrant research field. However, geographical concepts have been widely neglected in transition research. We argue that what is needed is a geographical research agenda that considers politics, power and non-economic actors as drivers and resistant forces of changed practices. To overcome these challenges, bridging ideas of Transition Studies and approaches from Geographies of innovation, Evolutionary Economic Geography and Environmental Economic Geography is highly valuable. Geographies of innovation provide insights into technological innovation processes, including considerations of agency and institutional processes at different spatial scales, particularly at the regional level. Concepts of Evolutionary Economic Geography receive much attention for their consideration of temporal and spatial contextualisation of industrial and technological change. Scholars from Environmental Economic Geography have highlighted environmental and sustainability issues at the firm and industry level. We argue that combining these related concepts helps to identify and analyse the dynamic interplay of changed socio-technological practices, institutional processes and related driving and hindering actors in sustainability transitions. Therefore, this paper suggests three analytical foci for further (urban) sustainability transition research:

1) key pathways, directions and interactions between technological and institutional-political and socio-cultural logics
2) processes of learning and resistance
3) actors (driving and resistant) and their interests.

Case studies are needed which highlight the importance of considering urban specificities in analysing socio-technical change. There is increasing evidence that the interplay between specific policies, learning processes and changed practices plays a decisive role. Geographical concepts can help to identify and analyse the dynamics, directions, actors, and processes of resistance and lock-in in urban transitions. The outcomes have implications for policy-makers and practitioners who should 'custom-tailor' and generate new pathways of governance and innovative practices. Apart from adapting blueprints of successful transition processes, decision-makers should also learn from unsucceful urban transition pathways. The deep analysis of urban contexts, including local knowledge, actors and existing sustainability paths should help to costum-tailor new approaches for policy making.

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CHAPTER 3: Methodology

3.1 Overview of methods and data

To cope with the research objectives and research questions of this dissertation, the empirical part follows a qualitative research design that considered a mixed methods approach. The design was chosen to best explore diverging perspectives on green building pathways of both case studies. This approach helped to gain in-depth insights beyond formal and statistical information. The triangulation of qualitative methods was valuable for collecting and interpreting data (Flick 2004, Mayring 2014, Schreier 2014). To ensure cogency of the qualitative research design, the dissertation took several sources into consideration and put them together in a chain of evidence (Yin 2014). For both case studies the following three empirical research steps were applied.

1) Workshops

The first step of data collection to develop a general understanding of key industry processes, actors and the political framework in the cities' building context was collected by transdisciplinary kick-off workshops. This participatory research approach was highly valuable in developing an understanding of the multiplicity of perspectives and the drivers behind green building pathways in the city contexts. The workshops, conducted as a variation of the 'World Café' concept were crucial in directing document analyses and semi-structured interviews. The workshop participants identified public policies, programs and guidelines that have been influencing the green building pathways in both cities. A detailed description about this first research step in both case studies as part of the GreenRegio project is outlined in chapter 3.2.

2) Documents Analysis

Information through documents (policy decisions and projects) to gain an understanding of the interplay of policy-making and transition processes in the building sector. The formal documents particularly helped in identifying timeframes, actors and shifts in political sustainability agendas. In Freiburg, policy decision making processes in the building sector were traced back to 1992 when stricter building regulations were introduced on the city level. In Brisbane, single policy and project documents helped to identify and understand changed sustainability agenda and processes of resistance. More

detailed information about the analysed documents and the process of analysis is explained in the case study chapters 4 and 5.

3) Interviews

The core of the empirical analysis of this dissertation are semi-structured, problem-centered interviews with stakeholders and experts to gain a detailed understanding of the decision making and learning processes which occur beyond the logics of formal documents. More information about the interview participants and the processes of analysis is given in the methods chapters within the case study chapters 4 and 5.

As an additional fourth step of the Freiburg case study, the research results were presented and discussed in a final workshop as part the GreenRegio project in April 2016 (see fig. 3.1). The validation of the results was a valuable last step of the research design as part of 'interactive knowledge generation'. Experts and stakeholders from public, private and academic sectors came together for the workshop and were able to comment and discuss the results. The additional last methodological step was a great trial for further transitions research. The results and conclusions of the Brisbane case study were discussed as single feedback conversations.

Figure 3.1: Final workshop in Freiburg (April 2016)

3.2 Interactive knowledge generation in urban green building transitions

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Abstract

Knowledge coproduction between practitioners and scientists offers promising opportunities for the emerging research field of the geography of sustainability transitions. Drawing on experiences from an international research project on urban green building transitions, this article explores the potentials and challenges of interactive and collaborative knowledge generation methods in understanding sustainability transitions. Our results show that ongoing engagement with local experts and practitioners through interactive World Café workshops and follow-up exchanges allows for a better understanding of the research context and knowledge exchange to all participants involved in the research process.

3.2.1 Introduction

Sustainability transitions are widely discussed and promoted both in policy and academic debates (Hansen and Coenen 2014; Murphy 2015). While definitions and interpretations differ, they usually postulate far-reaching changes to existing modes of production and consumption towards more environmentally friendly (low-carbon) and socially just alternatives (e.g. Markard, Raven, and Truffer 2012). Similarly broadly accepted are assumptions that these transitions can only be achieved through active engagement with a wide range of actors bringing together the expertise and knowledge of scientists, practitioners, civil society, and government representatives. These developments are linked to recent trends towards more participatory approaches both in policy-making and academia termed as "participatory turn" (Aldred 2010) or "communicative turn" (Pelzer, Geertmann, and van der Hejiden 2015).

While participatory and interactive research methods aren't new, the recent changes within the policy and scientific community mark a shift in objectives of and expectations towards knowledge co-production and interactive learning. The role of many academics and experts and the work they do has shifted from being one of knowledge generation (in its own right) to one of translating research into practice (Pain, Kesby, and Askins 2011), for example by empowering communities in the more classical sense of participatory research or by generating impact following more recent lines of argumentation. In both cases, one of the central goals of participatory research methods is to minimize power differences between researchers and research participants using a range of techniques and activities that allow the participants to become creators and co-creators of knowledge (Boylorn 2008).

In respect to complex topics such as environmental change and sustainability research, participatory methods can help incorporate diverse perspectives and knowledges into the research process and its translation and implementation. This article postulates the adoption of interactive and participatory methods as tools for knowledge generation and co-production within more traditional sub-disciplines such as economic geography and innovation studies that have recently developed strong interest in sustainability transition research. It uses the World Café method to highlight different dimensions of knowledge co-production and learning processes for and within urban green building transitions. Evidence was gained from a research project focused on identifing innovations and trajectories of sustainbility transitions in green building in four case study regions: Freiburg (GER), Luxembourg (LUX), Vancouver (CAN) and Brisbane (AUS).

Sustainability transitions are usually understood as longer-term processes that require time to fully transform (see e.g. Geels 2010). In respect to green building[1], the design, construction, and occupation of individual buildings involve a diversity of actors and usually require long timeframes particularly in respect to generating evidence of success (e.g. post-occupancy studies). Sustainability research, however, is usually bound to short funding periods and limited availability of researchers highlighting the need to improve knowledge generation and exchange amongst actors, particularly those involved in planning and implementing elements within sustainability transitions. In spatial terms, sustainability transitions are shaped by their specific context. Both dimensions are relevant to understanding the emergence, implementation, and spread of innovations in green building from the introduction of specific green technologies, design, and policies to the lived sustainabilities of people in their homes, work places, and other living environments.

The following section gives a brief overview over the origins and changed objectives of participatory research and knowledge co-production including different traditions within subdisciplines. It discusses the relevance and value of knowledge coproduction and interactive knowledge generation within sustainability transitions more generally and introduces the main characteristics of the World Café method. Section 3 discusses the potentials for knowledge co-production in the green building sector and its possible role in sustainability transitions. Section 4 discusses how the World Café approach can be used as a technique to mobilise stakeholders and engage in a reciprocal interaction on concrete topics. It further presents our practical knowledge gained during the application of the World Café format and reveals the value added provided by this participatory approach. The concluding section summarizes the main results and discusses potential shortcomings of and challenges for collaborative techniques.

3.2.2 Participatory research and knowledge co-production

Over the past decades, knowledge co-production – here to be understood as collaboration and reciprocity between researchers and non-academics – has gained particular momentum in the social sciences. Motivations and justifications for the incorporation of different methods of knowledge co-production at different stages of the research process

[1] We use 'green building' as umbrella term for all activities related to sustainable construction, i.e. the green building sector including the political and regulatory context. It is thus not limited to the physical building (i.e. a single residential or commercial project/neighborhood). The plural 'green buildings' is used to refer to the material outcome of green building processes.

have been largely driven by the objective to generate impact and relevance to "the real world" (Demeritt 2005; Pain and Kindon 2007; North 2013;) and to report back and offer practical application or "utilization" to real life challenges (Kindon, Pain, and Kesby 2007a; Hessels and van Lente 2008, 741; Martin 2010; Mason, Brown, and Pickerill 2013).
Collaborative research has been substantiated by different arguments ranging from the complex nature of reality compared to scientific theory (Callon 1999) and the existence of multiple epistemologies (Rydin 2007; Pohl et al. 2010) to more emancipatory and socially transformative positions adopted by (participatory) action research (PAR) (Brydon-Miller, Greenwood, and Maguire 2003; Kindon, Pain, and Kesby 2007b). The latter, in particular, have been linked to critical reflections on the positions of researchers and research participants and underlying power imbalances. The very different motivations and starting points for participatory research have resulted in a variety of methods (Delphi discussions, World Cafés, future workshops, backcasting, etc.).

The World Café method developed out of spontaneous small table conversations that replaced traditional large-circle discussions (The World Café 2016). It provides a group environment which encourages an open dialogue between participants by relying on unconstrained and interactive conversations. Participants are split across tables of four to five (The World Café 2015) where they are invited to tackle a specific question. Participants then progress through several conversation rounds with additional questions, as they are asked to circulate and mix across the tables. The content of each conversation round is retained and passed on to the next group by a fixed table host, and eventually complemented by a final plenary discussion to ensure sharing and connecting of the information amongst the totality of participants.

This "recombination" of knowledge (Brown 2001, 3) stimulates reflexive processes amongst participants, progressively leading to the emergence of shared patterns. The group's collective understanding of an issue can thus be mobilised, including tacit knowledge, allowing ownership of the results (Brown 2001; Fouché and Light 2011; Prewitt 2011).
The originality to other group interventions lies within the method's attempt to convey the atmosphere of a café setting through the use of symbolic items like tablecloths, the availability of drinks and food, or even the more playful possibility to visualize ideas directly on paper tablecloths (see Vida Estacio and Karic 2015's detailed account of a World Café implementation). This framing encourages participants to act as they would during an informal and relaxed meeting at a café (Jorgenson and Steier 2013), enhancing a dialogic process of "shar[ing] openly, listen[ing] without judgement and [M] accept[ing] diverse opinions" rather than mere discussions, whose "purpose [M] is to make a point,

convince others or win a verbal battle" (Prewitt 2011, 190-191). Admittedly, the challenge of creating a "relaxed" atmosphere varies with the conflictuality of the topics at stake.

World Cafés and other participatory methods are anchored in different epistemologies and are bearing different normative underpinnings and legitimation, which present challenges to researchers who seek to select appropriate approaches (Cook et al. 2013; Mason, Brown, and Pickerill. 2013; North 2013; Wynne-Jones, North, and Routledge 2013; Saija 2014). Inspired by work in related disciplines, participatory approaches have significantly taken up in human geography around the mid-2000s. In their work, Kesby, Kindon, and Pain (2007; Kesby 2007; Kinpaisby 2008) have promoted contributions to "participatory geographies" in response to (poststructuralist) critics of power and tyranny in participatory approaches (see also Cameron and Gibson 2005; Enns, Bersaglio, and Kepe 2014).

Calling upon critical geographies, political engagement of researchers and researchers turned activists (Chatterton 2008; Chatterton, Fuller, and Routledge 2007) contributors have argued in favour of a reflexive engagement with the political place embeddedness of participation, in order to " 'conscienticize' " the participants (and the researcher) on "the forces affecting their lives" (Kindon, Pain, and Kesby 2009, 90). Collaborative research builds on a variety of disciplinary traditions and methodological approaches, mainly used in critical and engaged research (Hagey 1997; Brydon-Miller, Greenwood, and Maguire 2003; Kindon Pain, and Kesby 2007b; Reason and Breadbury 2008). Development and feminist studies share a long history of critical engagement with the role of the researcher in relation to the "researched" community. In development geography, collaborative approaches have especially been assessed with regards to governance and intercultural dimensions (overviews in Kapoor 2005; Enns, Bersaglio, and Kepe 2014), contributing to vivid discussions and early adoption of the decisively more normative approach of PAR, which is purposively seeking to empower and improve the lives of local communities.

Corresponding scholarly debates on the methodological implications particularly include reflections on social justice and ethical aspects of the interaction with indigenous communities (e.g. Johnston-Goodstar 2013; Pyles 2015) as well as facets of depoliticisation (Korf 2010).
Feminist theories similarly share a long history of critical engagement with the role of the researcher – usually perceived as predominantly male – within the process of knowledge generation and associated values, perceptions, knowledge, and interpretations (Gibson-Graham 1994; Gatenby and Humphries 2000; Cameron and Gibson 2005). With the commitment to empower women and other disadvantaged and marginalized groups, feminist research has strengthened participatory approaches through an emphasis on

diversity and equity (e.g., ethnicity, sexuality, class) stressing the political dimension of participatory research (Reinharz 1992).

Outside of the academy, expectations of the role and contribution of research have similarly shifted towards increased collaboration between researchers and research participants. Over the past few years, government agencies and the larger funding community have increasingly demanded statements of impact and transferability of research as part of funding proposals (Demeritt 2005; Pain, Kesby, and Askins 2011; North 2013). Participatory approaches including interdisciplinary collaboration and engagement of researchers with non-academic constitutencies are seen as central elements to generating impact in particular in respect to wicked problems and big challenges such as global climate change. For example, the German Advisory Council on Global Change (WGBU), the International Energy Agency (IEA), or the Organisation for Economic Cooperation and Development (IEA/OECD 2013, 217) have argued that collaboration between government, academia, industry, and citizens is essential to the generation of "systemic, reflexive and anticipative knowledge" (WBGU 2011, 321) and a transition towards low-carbon economies.

This understanding of research obviously draws on sustainability sciences' call for a different "scientific practice which can cope with uncertainty, with value plurality, and with the decision-stakes of the various stakeholders of the problem at hand" (Hessels and van Lente 2008, 744; Brundiers, Wiek, and Kay 2013). Due to sustainability's complex, dynamic, and uncertain interactions with broader social, economic, and physical processes (Funtowitcz and Ravetz 1993; Blackstock, Kelly, and Horsey 2007; Lang et al. 2012) proponents have argued for research favouring pluridisciplinarity and social learning objectives, understood as "knowledge produced in the course of acting" (Steyaert and Jiggins 2007, 727). In this sense, knowledge has to be generated through interactions and dialogue between diverse experiences, values, and worldviews (Kates et al. 2001; Blackstock, Kelly, and Horsey 2007; Steyaert and Jiggins 2007; Lang et al. 2012). Accordingly, research participants are not just considered as holding situated knowledge but also as political actors representing specific and at times conflicting stakes in the issue at hand (Funtowitcz and Ravetz 1993; Lang et al. 2012; Seijger et al. 2015).

3.2.3 Co-production in (or for?) green building transitions

The sustainable building sector is a rapidly growing and promising transition field (IEA/OECD 2013; IPCC 2014). Green (or sustainable) buildings have been identified as one of the most significant, cheapest, and fastest approaches to reduce greenhouse gas

emissions at the local scale (Cidell 2009; UNEP 2011). In most industrialised countries, the energy consumption of buildings accounts for approximately one third of greenhouse gas emissions alone (e.g. Noble 2004 on Australia) and this is not accounting for building materials and CO2 emissions during construction. Transitions in green buildings are driven by the adoption of green technologies (e.g., lighting, insulation in walls, high-efficiency windows), experiments with zero-carbon, passive, and energy-plus houses, design strategies but also by new institutional arrangements including regulatory innovations (e.g. building codes), incentive schemes, other support mechanisms, and changes in user behaviour. In order to understand how green innovations in the building sector emerge and become mainstreamed, we focus on context specific (local) learning paths and development trajectories, that is the co-evolution of diverse factors and actors that have been instrumental in the materialisation of sustainable building trajectories in particular places and over time. We look more specifically at four selected city regions including Freiburg and Vancouver with longer histories of green building and Luxembourg and Brisbane that are more recent actors in green building transitions.

Green building transitions involve a wide range of actors from the corporate, public, and civil society realms. While the multiplicity of interests, and sometimes competing interpretations at work in sustainable transformations are characteristic to many other sectors (see for instance Bawden 1997 on agricultural systems; or Cook et al. 2013 on water catchment management), the fast growing literature on urban sustainability transitions has emphasized the sheer number of greening strategies and approaches taken by different groups of actors within and between cities (Guy and Marvin 2001; Bulkeley et al. 2011; North 2013). Sustainability research needs to take into account this plurality of perspectives and knowledges in order to understand the drivers behind green building transitions – the how(s) and why(s) of specific developments in different places. An important aspect here is to avoid general assumptions of transferable, definite, and linear path developments often generated through vested interests and political strategies in sustainability debates (e.g. city marketing) and consider contingencies and contestations including a multiplicity of actors (Affolderbach and Schulz 2015).

As previously highlighted, participatory research methods promise to generate more rich and diverse knowledge that offers higher social accountability of the research in terms of transparency, problem orientation, and tangible societal relevance. They can offer valuable tools for sustainability transitions in general and green building research more specifically as they allow to “open up for many voices in knowledge construction” (Borg et al. 2012) and hence account for different realities, interests and strategies but also technical complexities and knowledges involved. Seen as more inclusive and socially just approach, participatiory research corresponds with contemporary understandings of

sustainability even though – comparable to different forms of sustainability (e.g. weak to strong) – objectives, intensity, and inclusivity of participation may vary (Blackstock, Kelly, and Horsey 2007; Kindon 2010; Martin 2010; Wynne-Jones, North, and Routledge 2013).

Participatory research offers not only a more "engaged" approach to research but also requires a different attitude and behaviour of the researcher(s), including ethical obligations on raised expectations and returns towards the "researched" community (Kindon, Pain, and Kesby 2007a; Kindon 2010; Mason, Brown, and Pickerill 2013). The researcher-"researched" relationship develops from generating knowledge "on" to knowledge created "with" or even "by" research participants. In addition, it allows room for transformative reflexivity "in which both researcher and "researched" reflect on their (mis)understandings and negotiate the meanings of information generated together" (Kindon 2010, 264).

In respect to our research objectives, we were challenged with the task of gaining a detailed and pluralistic understanding of the sustainable building context in each of the studied city regions. This required a critical review of the respective achievements and agendas of different public, private, and non-governmental institutions in order to accurately identify and map factors of the past and on-going transition processes, while avoiding the trap of linear pre-determined representations.

Our need to include a large range of actors in each case study region to grasp the more diffuse relationships, connections but also diverging views and interests between them, drew us towards more collaborative and interactive research methods. In contrast to participatory approaches in their more normative and emancipatory sense (as in PAR), where researchers are joining particular communities with which they co-produce knowledge to serve practical needs, we started from an inversed logic (Fig 3.2) aimed at achieving a learned outcome, but also critical and pluralised outcomes through "interactive transition research" (ITR).

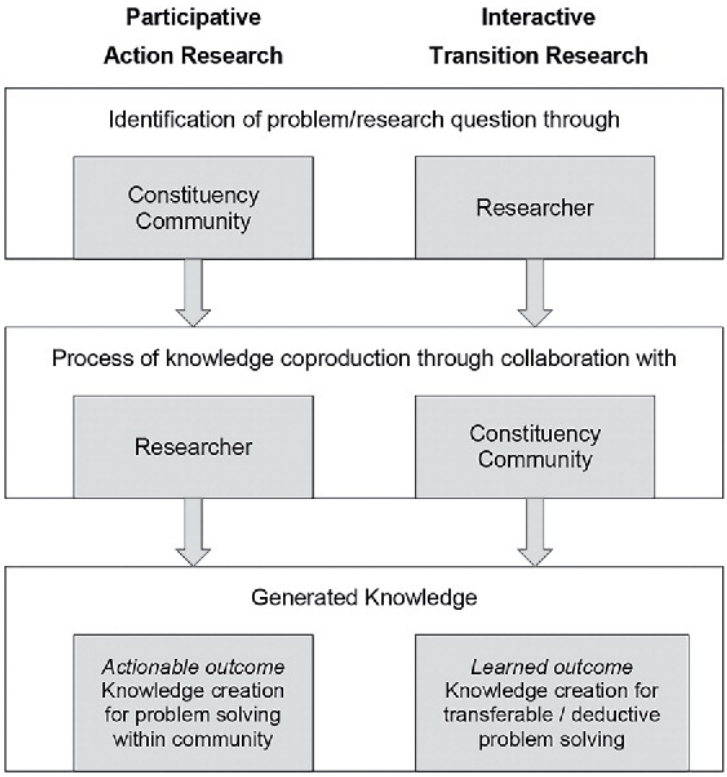

Figure 3.2: Imperatives and objectives in participative research and interactive transition research

As such, we applied a research-driven, learning, and knowledge generating perspective rather than the normative "development driven [empowerment] approach" (Borg et al. 2012, 729, quoting Martin and Sherington 1997, 197) which is central to PAR. While this allowed us to broaden and pluralise the views and interpretations obtained in the data in order to effectively analyse and retrace the phenomena under study, it further ensured platforms for encountering and reporting back to and within the participating community. In both the PAR and the ITR approach, knowledge is not evenly distributed amongst the participating individuals.

Assymetries in individual knowledge and a varying willingness to share particular parts of that knowledge might lead to biases in the knowledge co-generation process. The latter might thus be influenced by the role of "knowledge brokers", intentionally or unintentionally directing the topical agenda setting and dominating the discussions. Our approach also differs from the primarily normative and social change orientation of transition management research, in which the researcher and the "researched" use collective foresights and participative vision building to initiate a desired change (Loorbach 2007; Wittmayer et al. 2013), with techniques like backcasting, scenarios (e.g.

Elzen et al. 2004; Eames and Egmose 2011), or "experiments" aimed at socially embedding sustainable innovations (Kivisaari, Lovio, and Väyrynen 2004).

Research participants thus turned from an object of study, or key source of information, to collaborators who co-create and benefit from new knowledge through interaction with the researchers but also with their involved peers. This allowed us to establish a positive, non-hierarchical relationship with what Sheridan et al. (2010, 34) call "local intelligence" in a way that would avoid feelings of "unreciprocal [M] knowledge extraction" (Newton and Parfitt 2011, 76). Despite the frequently criticized tendency to "value-ladenness" of participatory approaches (Weingart 1997) and potential problems related to "language" incompatibilities between researchers and practitioners (Kieser and Leiner 2012), we see promising collaborative tools when tackling sustainable development policies as the methods allow to reach further than with traditional interview or focus group techniques, while keeping in mind that "they are not a substitute for more in-depth social research methods" (Kindon 2010, 272). To co-produce knowledge with our "researched" community we hosted workshops with a range of local sustainable building practitioners in the form of World Café events.

3.2.4 Knowledge co-production at the coffee table: The World Café approach

With the exception of a few reflexive contributions (Aldred 2010; Jorgenson and Steier 2013; Prewitt 2011), the relatively low number of publications on the World Café method provides descriptive accounts on its application to specific projects. This leaves the reader with a rather "fragmented" (Aldred 2010, 57) and patchy impression: World Cafés are used by public, private, and non-governmental organisations in very different contexts and for diverse objectives. Different aims include learning (Anderson 2011), empowering communities (Sheridan et al. 2010; Fouché and Light 2011; for a critical discussion see also Aldred 2010), facilitating collaboration and communication within an organisation (Tan and Brown 2005; Prewitt 2011), stimulating innovation, networking, and relationship building (Fouché and Light 2011), or even improving sales of a product (Aldred 2010, quoting Brown and Isaacs 2005). The versatility and adaptability of the World Café approach is further illustrated by the different labels in use to designate variations of the method, including for instance the Knowledge Café, Conversation Café or Innovation Café. If these different applications highlight the method's popularity and

success amongst practitioners, they also illustrate its appropriation within what Aldred (2010, 62) calls the "participation industry".

Despite these critiques and reflecting on our experience using the method, we would like to advocate for a flexible use of different Café-inspired research methods, bearing in mind its key premise and objectives. The common denominator of the different usages of Café-style methods within the literature resides in its potential to encourage effective participation of a diversity of participants by breaking with their cognitive understanding of usual meeting forms (Jorgenson and Steier 2013; Prewitt 2011). More specifically, it allows "ordinary interactional routines [to be] suspended" (Jorgenson and Steier 2013, 390), most notably hierarchical relationships (see Tan and Brown's 2005 account of the use of World Cafés within the Singapore Police Force), thus opening the way towards more diversified, inclusive, and changing understandings of a specific topic. Our experience shows that participants tend to leave their usual "role" more easily in a World Café than in a more formal setting. It is important to keep in mind that these methods are rooted in constructivist philosophy. The aim of using such group intervention is to grasp the diversity of perspectives held by the involved participants, thus "construct[ing] distinctive versions of the 'lay views' [rather than] over-stating consensuality" (Aldred 2010, 62-63).

As the broad range of applications illustrates, the World Café method offers room for adaptation to different research and practice objectives. The practical and contextual knowledge generated allows for a range of potential follow-up utilisations for researcher and "researched" alike. We join Fouché and Light's (2011) pledge to open up the discussion to the "value" of the World Café and its four main objectives:

> (1) Applying constructive dialogue principles allows access to more tacit forms of knowledge, offering an effective way to collect data.
>
> (2) Bringing together a diverse population with shared interest in specific topics can eventually have integrative effects on participants, fostering the emergence of a shared culture in an organisation or initiating the building of networks and connexions useful to a specific community.
>
> (3) Collective discoveries through "cross-pollinating" ideas (Tan and Brown 2005, 84) and identifying larger patterns can lead to innovative solutions and ease the way towards consensus building.
>
> (4) Collaborative learning through sharing insights can offer interesting potentials in terms of capacity building.

These objectives or effects are central to but now exclusively covered by the World Café approach. Other participatory methods such as future workshops, planning cells, open spaces bear the same potential but were considered less suitable for the purpose of our research mostly for practical reasons such as moderation skills, feasibility and size of the events. In the specific context of our research project on green building transitions, we invited a range of local experts, including practitioners and scholars in the field of green building to attend a locally held World Café workshop in order to define meaning and understand various facets and underlying mechanisms of sustainable building. Our main objectives were:

- To gather different understandings of the transition towards sustainable building;
- To identify common patterns in terms of particularly significant factors; and
- To capture tacit knowledge, harder to grasp through document analysis.

For each workshop, we set up three discussion rounds, respectively focused on a specific dimension of the sustainable building sector following the project's coevolutionary approach: actors and organisations, building projects, and framework conditions (encompassing institutional aspects like legislation, socio-economic aspects, etc.). Following returns on the first Café experience, we added a fourth discussion table addressing challenges and barriers to the development of sustainable building practices (Table 3.1).

We encountered some difficulties to reach an interactive dialogue at some of the tables where participants' contributions remained quite detached from each other. Some participants even expressed the feeling of having repeated themselves between successive rounds. Both issues may relate to the thematic proximity of the chosen discussion topics, which may though be difficult to avoid. Brown (2001) and Prewitt (2011) emphasized the importance to carefully craft Café questions and the central role and facilitation skills of the Café host(s), to manage emerging group dynamics. The maturity of the community dealing with the subject at stake during the Café might also be given explanatory power, as we noticed stronger dynamics at work in Freiburg and Vancouver characterized by a longer record of climate change mitigation in the building sector.

Workshop	Number of participants (+ researchers)	Sectors represented/ affiliations	Key topics/focuses
Vancouver 8 November 2013	14 (+5)	Architects, engineer and design firms, developers, think tanks, research institutes, nongovernmental organizations, municipality, energy provider	• History of environmental activism and advocacy (e.g., Greenpeace, David Suzuki) resulting in an environmentally aware public • Strong influence through individual leaders particularly linked to the University of British Columbia • Vancouver-specific urban design and planning • Recent political leadership with strong environmental agenda
Luxembourg 29 January 2014	27 (+7)	Architects, engineer and design firms, private and public developers, interest and professional associations, research institutes, nongovernmental organizations, ministries (sustainability, economy, housing), national energy consultancy	• Key role of legislation on energy efficiency (especially European Union directives) • Strong technological and innovation focus • Need for increased streamlining and coordination among (public) actors and procedures • Numerous private and corporate initiatives • Call for better advertisement of achievements (building projects) • Overall top-down, policy-led approach
Freiburg 12 February 2014	10 (+7)	Architects, engineer and design firms, public developers, research institutes, municipality, energy provider	• Key role of environmentally sensitive and engaged population • Good connections and exchange platforms between a wide range of actors (public, nongovernmental organizations, research centers) • Early (1990s) energy efficiency legislation and consequent application in two public developments (Vauban & Rieselfeld) as key motors • Call for thematic renewal and enlargement of green building understanding and especially a more visionary approach from the policy side
Brisbane 27 March 2014	10 (+5)	Architects, engineering and design firms, research institutes, nongovernmental organizations, municipality, state ministry, regional administration	• Policy discontinuity on different policy levels (policy changes after government changes) • Short-term "thinking" of different industry actors (builders, developers, investors) • Market-based changes toward "greener" office buildings in and around the central business district

Table 3.1: Composition and themes of research project's World Cafe workshops

We followed up on the World Café exchange through the dissemination of a report summarising the main outcomes in form of a questionnaire, asking participants to critically re-assess and validate the transition factors that had emerged. We used the input to identify a number of key aspects for in-depth qualitative case studies in each of the four city regions, covering selected green building policies and programmes, influential organisations and actors, as well as specific built environment projects. The selection was backed through document analysis (e.g. policy programmes, strategy and position papers but also media reporting) and semi-structured interviews with key individuals. The World Cafés further provided us with a list of relevant interview partners, necessary background knowledge, and contact to central figures in our research field, which proved helpful to get

access to further interview participants. Towards the end of the research project, outcomes and results of these steps were presented in Luxembourg and Freiburg inviting all experts solicited, notably to critically assess, review, and validate findings, but also to disseminate and ensure transmission of the results to eventually allow for further utilisation within the community2.

Collaborative research thus requires a high commitment of the participants and their availability over the project's life span (North 2013). In order to facilitate buy-in to our research endeavour, participants of the World Café were kept informed about the project's advances and were solicited when strategic decisions were taken, major methodological problems had to be overcome, and when preliminary findings were available for evaluation. We used the method not only as a first step to gather a large amount of information but also as accompanying and strengthening framework for subsequent case studies and their in-depth analysis, relying on the techniques to gather, filter, and analyse findings, which were then fed back to participants and become subject to critical discussion.

3.2.5 Discussion and Outlook

Co-productive methods offer an effective way to access a large amount of relevant and diversified information within the time-constraints of funded research projects. The dialogic processes of World Café techniques allow the generation of diverse knowledges that undergo critical and reflexive review from the participating experts while being collected. Traditional inquiry methods could not have provided similar insights within a single research step. While our research design was originally driven by an interest in knowledge production from a researcher's perspective, our project experience confirms mutual benefits for researchers and participants alike, as it is precisely through coproduced reflections in changed researcher-"researched" relationships that opportunities to produce differentiated and relevant knowledge(s) emerged. On the one hand, "classical epistemological realms and corresponding roles of academic and non-academic actors" (Pohl et al. 2010, 269) became blurred in the workshop settings. On the other hand, this led to new insights and generated new knowledge for all sides including new connections of knowledge exchange between the four case study regions.

[2] Due to time constraints of project collaborators, no workshops were held in Vancouver and Brisbane.

Knowledge production evolved from a one-directional provision of information to the research team towards more interactive exchanges encouraging social learning processes. One challenge for us was to maintain ongoing information flow and engagement. For example, due to time constraints (both of the researchers and the project funding period), workshops to feedback preliminary findings were only held in Luxembourg and Freiburg. In one of our case studies, the relatively novel emergence of the sustainable building sector implied a large number of actors, without clear organizational patterns and established networks yet. In this case, Café participants were especially keen on discussing obstacles to sustainable building transitions and used the event and consequent report produced by the researchers as an exchange platform to bring together positions and formulate action points, hence building capacities amongst participants and producing directly actionable knowledge. In Freiburg and Vancouver, the dialogic and unconstrained atmosphere of the events triggered critical and self-reflective discussions within the already well connected practitioner community on the need for renewal and strengthening of local sustainable building practices, for instance through increased social benefits. Accordingly, geographical differences between the case studies became evident through identification of local specificities and geographically specific developments as highlighted in Table 3.1 (last column).

One hurdle encountered in the process related to the selection and representativeness of participants. Notwithstanding our efforts, the non-governmental sector proved surprisingly difficult to engage within one of our case study regions where many invited workshop participants showed "symptoms" of being overly solicited given the international interest in this case. This definitively limited the representativeness of the workshop's composition, despite the method's participative and constructivist premises, and rejoins theoretical discussion about the "power effects" and "tyranny" of participation (Cameron and Gibson 2005; Kesby, Kindon, and Pain 2007; Kinpaisby 2008; Enns, Bersaglio, and Kepe 2014). Similarly, the ability of researchers using collaborative research approaches to facilitate and mediate so as to ensure discussions remain truly open to all participants should not be underestimated. However, the risk of individuals to dominate conversations and leave less room for expression to others can be easily circumvented in World Café settings by encouraging participants to move across tables. The combination with follow-up questionnaires further offered participants another opportunity to express aspects they might not have had the chance to articulate during the event. While the discussed approach generated knowledge including successes and failures of green building transitions, it did not directly provide actionable outcomes. It rather laid foundations for collaborative problem-solving through the creation of exchange networks that could be utilized in the future, for example, through joint projects focused on solving identified problems.

Collaborative methods have particularly much to offer to sustainability research that inevitably involve a wide range of (at times contested) interests and stakes over long periods of time. While participatory methods in their most comprehensive definition are focused on problem-solving through identifying ideal scenarios (e.g., Delphi, scenario planning), community-building, and actionable outcomes ready to be applied, the proposed interactive research-driven approach can help identify opportunities and challenges in green building transitions and generate knowledge and understanding relevant to future decision-making challenges. Interactive research can offer numerous tangible benefits including new platforms of knowledge exchange, stimulation for differentiated understandings through cross-pollination, as well as higher reflexivity and robustness of findings through numerous feedback loops between researchers and "researched".

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CHAPTER 4: Case Study of Freiburg

Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany)

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Abstract

This paper examines the urban contextualisation of sustainability transitions in the building sector by analysing the interplay of building practices, actors and policy regulation. The 'Green City' of Freiburg (Germany) is used as a case study to illustrate how the transitions pathways of energy-efficient building and construction are distinct results of local innovative practice-driven 'bottom-up' and policy-driven 'top-down' processes. Since the early 1990s, the Freiburg low-energy building standard for new residential buildings played a key role as a catalyst for 'learning by doing' processes and a broader adoption of green building practices. How these changes in policy and practice developed over time is highlighted and discussed. The paper looks beyond success factors by identifying challenges, veto actors and vested interests in the context of urban sustainability transitions. Our findings clearly show that 'learning by doing' and 'learning by using' need to be more thoroughly considered in urban sustainability transitions research and local policy actions.

4.1 Introduction

The building sector plays an important role in the public and academic debates on climate change adaptation and energy transitions. The Intergovernmental Panel on Climate Change (IPCC) and the United Nations Environmental Program (UNEP) specifically highlight the significance of buildings in the context of climate protection and energy efficiency (IPCC, 2014; UNEP, 2011). One-third of the global final energy is consumed in buildings (IEA, 2013). To increase energy-efficiency in the building sector, the wide adoption of 'green' building and construction principles is essential.

It is commonly accepted that a fundamental socio-technical transition is required to reach more sustainable or environmentally friendly modes of production and consumption (Markard, Raven & Truffer, 2012; WBGU, 2011). Thus, next to innovative building designs, efficient materials and technologies (for example, insulation, solar hot water systems or integration of renewable energy), supporting policies, and new forms of business practices and services are necessary to drive sustainability transitions in the building sector. As a result, sustainable building designs and construction concepts such as low-energy buildings, passive houses, and plus energy buildings are becoming increasingly common.

Policies in many developed countries support green building transitions by introducing or improving building codes, subsidy schemes, or other incentives within different policy levels. The city scale plays an important role as a seedbed and experimental arena for sustainability transitions (Affolderbach & Schulz, 2016; Bulkeley, 2006; Bulkeley, Castán Broto, Hodson & Marvin, 2011; Cooke, 2011; Hodson & Marvin, 2010, 2012). An increasing number of cities are responding to the debate on climate change and energy transitions, and seek to govern sustainability transitions by adopting energy-efficiency approaches in the built environment.

'Best practice' examples, such as the 'Green City' of Freiburg, are often used as 'role models' and blueprints for implementing urban sustainability approaches (Hall, 2014). However, is a 'copy and paste' of urban sustainability transitions in the building sector applicable to different urban contexts? It is still unclear how and why 'urban green building transitions' occur (Preller, Affolderbach, Schulz, Fastenrath & Braun, 2016) and develop over time, and to what extent past decisions, processes and events play a decisive role in specific urban contexts. We seek to contribute empirical insights to this research gap by examining and analysing the development of energy-efficient building in the City of Freiburg by tracing back key transition pathways in the building sector, specifically focusing on the reciprocal

interactions between three analytical entities: changing building practices, policies and actors.

4.1.1 Urban sustainability transition pathways

Theoretical approaches in the research field of social studies of technology (SST or 'transition studies') and economic geography help to understand socio-technical transitions as the dynamic interplay and co-evolution of technological, socio-economic and institutional processes. While conventional socio-technical transitions are often analysed by market-driven technological niche innovations, sustainability transitions can also be understood as incremental processes driven by normative motives which affect the economy and garner policy support (see Smith, Voß & Grin, 2010; Truffer & Coenen, 2012). Acknowledging the importance of actors, policy action and governance (Brown, Farrelly & Loorbach, 2013; Geels 2014; Hiner, 2015; Rutherford & Coutard, 2014; Seyfang & Longhurst, 2013), and the dynamics of change and power within policy regimes (Cooke, 2011; Davies & Mullin, 2011; Smith & Raven, 2012) is required to understand new forms of socio-technical change in the sustainability context.

Other contributions highlight the important role of experimentation and changed practices (Barr, Gilg & Shaw, 2011; Faller, 2016), learning processes (Coenen, Raven & Verbong, 2010; Malmberg & Maskell, 2010; Shove & Walker, 2010) and 'adaptation pathways' (Wise et al., 2014). Bridging these foci, Turnheim et al. (2015) suggest 'transitions pathways' as a suitable analytical framework to analyse processes of sustainability transitions. Based on the ideas of Geels and Schot (2007), 'transition pathways' are described as "an outcome of interactions in multiple levels of structuration in socio-technical systems" (Turnheim et al., 2015, p. 243). However, the 'territorial embeddedness' (Coenen & Truffer, 2012) has been widely neglected as an important explanatory factor.

As a result, a 'geographical turn' has emerged in transition research. Coenen, Benneworth and Truffer (2012) introduced the 'geography of transitions' to fill the existing knowledge gap regarding spatial, institutional and temporal aspects (Bridge, Bouzarovski, Bradshaw & Eyre, 2013; Coenen et al., 2012; Hansen & Coenen, 2015; Lawhon & Murphy, 2012; Markard et al., 2012; Rutherford & Coutard, 2014; Truffer & Coenen, 2012). While there is a broad consensus about the important role of place-specificity in sustainability transitions (Hansen & Coenen, 2015), there is a lack of knowledge about how place-specificity influence transition processes. Rutherford and Coutard (2014, p. 1368) highlight that urban transition research needs stronger consideration of "particular

histories, temporalities and rhythms of socio-technical change". Introducing the 'geography of sustainability transitions', Hansen and Coenen (2015) emphasise the significant role of co-evolutionary processes and place-specificity at the local level in the sustainability context.

As a result of these debates, there is an increasing interest in concepts of evolutionary economic geography (EEG) which consider the reciprocal interactions between economic, technical and institutional forces (Garud & Karnoe, 2001), and characteristics of location and time (Schamp, 2012). The concepts of 'path dependency' and 'path creation' (Boschma & Frenken, 2006; Essletzbichler, 2015; Garud & Karnoe, 2001; Martin & Sunley, 2010a, 2010b), alongside a co-evolutionary understanding of technologies and institutions, are helpful approaches to better conceptualise the dynamics of ongoing socio-technical change in a spatial perspective. A main goal of EEG approaches is the precise understanding of processes and mechanisms by which the economy self-transforms itself from within (Witt, 2003).

Based on work in evolutionary economics and the idea that 'history matters' (Nelson & Winter, 1982), 'path creation' is understood as a process that is influenced by the interactions of historical events and 'embedded agents' (Garud & Karnoe, 2001). The main argument is that it is important to study the evolution of a location's economy to better understand its present dynamics. In this sense, we argue that it is crucial to consider the urban transition history in order to understand the reciprocal interactions and the co-evolution of different sustainability transition processes over time. Special attention has to be drawn to 'governance paths' (Van Assche, Beunen & Duineveld, 2014), 'backcasting analysis' of spatial development processes (Haslauer, 2015) and local learning processes.

Linked to these ideas of co-evolution, the concept of 'path plasticity' has been introduced recently. This approach focuses on 'continuity of change' and 'institutional dynamics' (Strambach, 2010; Strambach & Halkier, 2013). We argue that the focus on continuity helps to understand how sustainability transitions are embedded in cities and city regions, because urban and regional development are also characterised by continual changes in policies, actors, and the built environment. Thus, the understanding of 'urban transition pathways' (Coenen & Truffer, 2012) as ongoing processes which transform 'pre-existing socio-economic structures' (Martin & Sunley, 2006) helps to analyse the new dynamics and interactions between niche innovations and established structures of 'socio-technical regimes' (Geels 2014; Turnheim et al., 2015).

4.1.2 Research questions, research design and data sources

We aim to contribute to the debate of place-specificity and path dependencies in urban sustainability transitions. Providing empirical insights from successful transitions in the model city of Freiburg, our main research questions in this paper are: How and why did the sustainability transition pathways in Freiburg's building and construction sector occur and develop over time? What role did the specific local context play in the different stages of this process? To answer these questions we focus on four major research objectives by tracing back key transition pathways in Freiburg. First, we identify turning points and significant changes in practice in the context of Freiburg's building sector. Second, we seek to identify key driving actors, who actively participate in the transition process as 'transition agents'. To avoid telling an overly simplified linear success story, we also elaborate the role of veto actors – 'transition's detractors' – and their divergent interests. Third, we focus on the policy paths related to the building sector by analysing how far 'green building' policies and regulations have driven sustainability transitions. Fourth, we assess how these analytical entities – practices, actors and policies/regulations – are interwoven and co-evolved.

The results presented in this paper are based on a mixed methods approach that includes expert workshops, policy document analyses, and stakeholder interviews. Key actors, demonstration projects, and institutional settings in the context of Freiburg's building sector were identified through a workshop conducted in February 2014. Using an interactive and participatory approach (Preller et al., 2016), twelve participating experts shared their views about the development of 'green' building in Freiburg. Based on the workshop outcomes, a secondary data analysis followed with a focus on local policy documents related to the Freiburg low energy building standards. To trace back, identify and understand the key influential factors of this regulation policy, a content analysis of more than 50 documents of Freiburg's 'City Council decisions' (Gemeinderatsbeschlüsse) and official media announcements was conducted. Key analytical themes in this document analysis were actors (transition agents and veto actors), details about the city's low-energy standards, learning processes, and challenges faced.

In addition, 27 semi-structured, problem-centred interviews were conducted with key actors to gain a detailed understanding of the decision making and learning processes which occur beyond what is written in formal documents. The interviews were conducted between September 2014 and March 2015. Participants were both current and former employees of Freiburg's city administration, representatives of locally based organisations and professional associations linked to the building sector, Freiburg's energy agency, building cooperatives, local policy, and research institutes. All interviews

were audio-recorded and transcribed. To ensure anonymity, the participant's names were coded. The codes can be found at the end of this paper. Quotes from interviews have been translated from German to English for the purposes of this paper. Major empirical findings were presented and discussed in a second workshop which took place in Freiburg in April 2016. During the workshop, the key results presented in this contribution were validated by 11 locally based experts and stakeholders.

4.1.3 The 'Green City' Freiburg as a case study

The Freiburg case study provides the rare opportunity to review long-term urban sustainability transitions in the building sector. Since the 1970s, Freiburg has been a forerunner city in energy-efficient building (Fastenrath, 2015). The city has a population of 230,000 (2015) and is located at the edge of the Black forest in the South-West of Germany within the federal state of Baden-Württemberg (see Fig 4.1). In the early 1990s, Freiburg became internationally renowned as a model city for green and sustainable development. Policy makers, practitioners and researchers from all over the world visit the city's 'green' flagship projects: the 'eco'-districts 'Rieselfeld' and 'Vauban' or the recently renovated high-rise buildings in 'Weingarten'. Freiburg's City Council has received a number of national and international awards for environmental protection and sustainable urban development. In addition to innovative approaches in public transport, energy production, and waste recycling, there is general agreement that Freiburg is a best-practice example for sustainable urban planning, including strict low-energy building regulations (Hall, 2014; Medearis & Daseking, 2012).

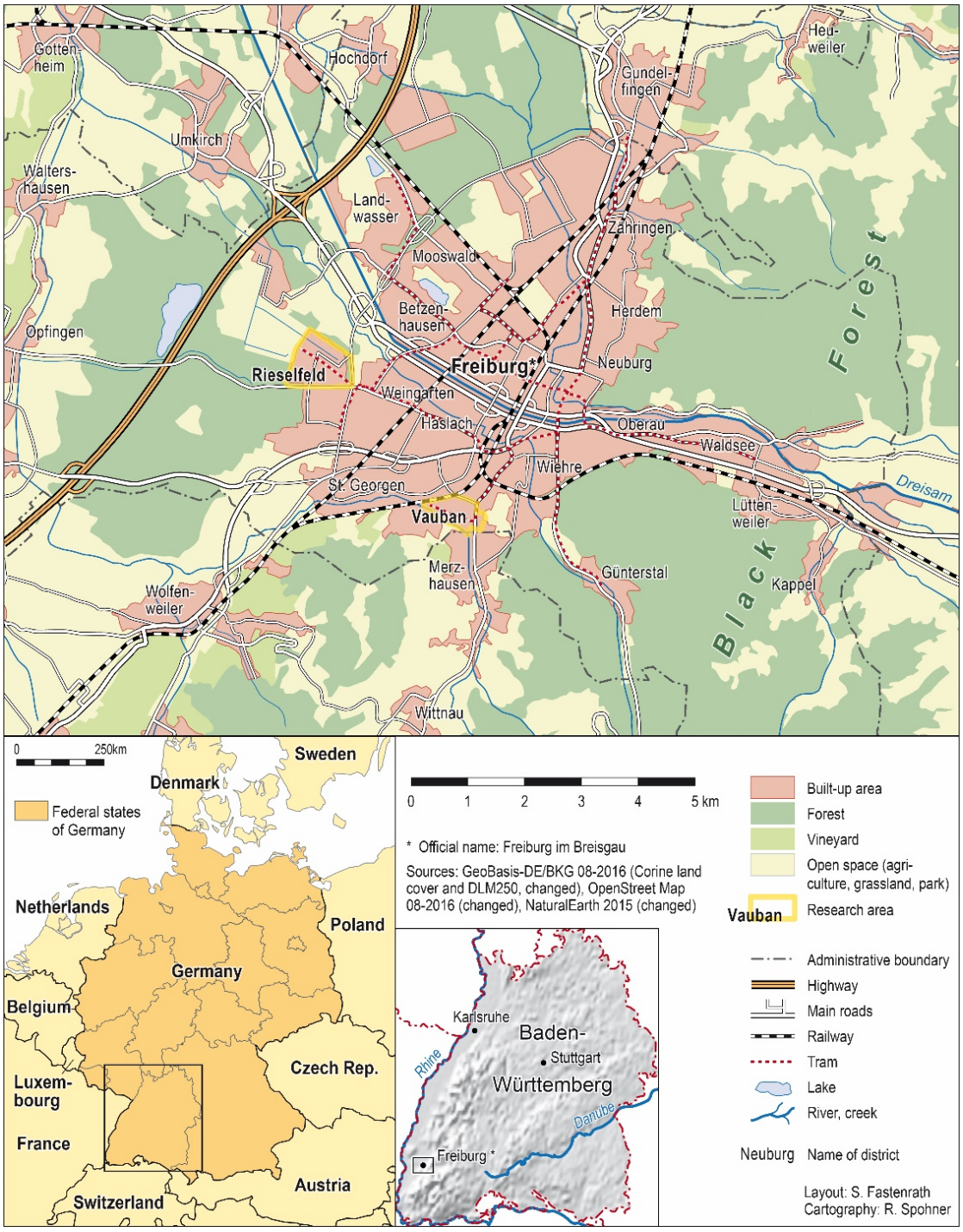


Figure 4.1: The geographical context of Freiburg

4.2 Sustainability transitions in Freiburg's building sector

4.2.1 Initial phase: from grassroots movements to experimental projects (1970-1985)

The origins of Freiburg's 'green' building pathway can be traced back to the mid-1970s when a heterogeneous group of environmental and anti-nuclear activists successfully protested against a federal state government planned nuclear power plant in Whyl, a small rural community located 20 km north of Freiburg. Many interviewees as well as researchers (Frey, 2011; Späth & Rohracher, 2011) and Freiburg's city authority (City Freiburg, 2011b) highlight the influential role of these protests as the 'birthplace' of the region's environment movement. A representative of the city's planning authority shed light on these 'bottom-up' driven dynamics:

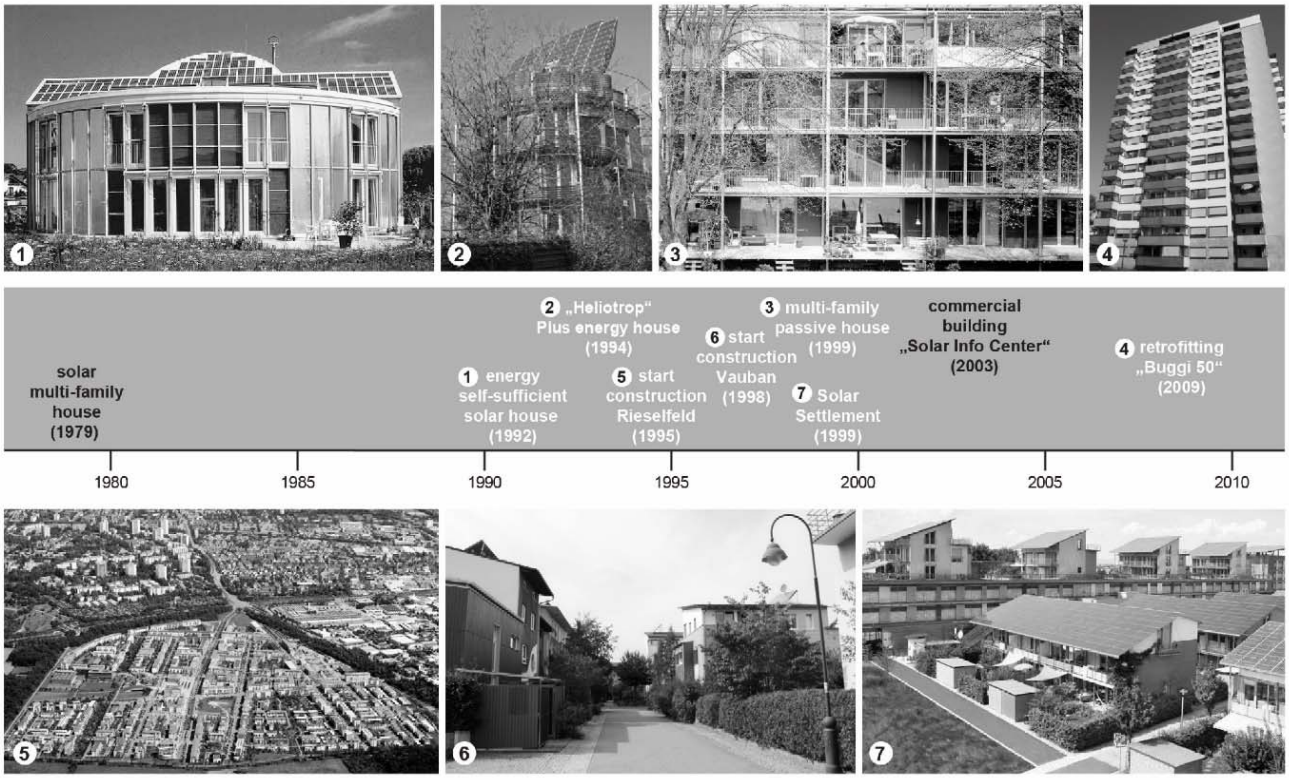
> *"As a result of the protests these people thought about the energy supply of the future" (FR-Adm5).*

Freiburg-based solar architecture pioneers contributed to innovative building projects. In 1979, one of the early experimental demonstration projects was the multi-family building 'Solarhaus' in Freiburg-Tiengen which was realised by the 'Freiburger Stadtbau', the communal housing provider. Concurrently, informal and formal networks of environment activist, pioneers and academics but also citizens interested in environmental and energy topics formed Freiburg's 'energy and environment scene'. Interviewees often mentioned the local 'environmental scene', 'energy scene' or simply 'the scene' as an important driver of sustainability transitions in the building sector (FR-Adm1, FR-Adm4, FR-Adm5, FR-Adm6, FR-Con2, FR-Pa2, FR-Re1). A number of working groups, organisations and research institutions were founded in this context, such as the Institute for Applied Ecology (Ökoinstitut e.V.) which started operations in 1977 and still plays an important role in Freiburg's urban sustainability policy through consultation and guidance. The institute's engineers and social scientists outlined new forms of energy production and energy-efficiency through solar building design, and highlighted the important role of energy concepts on the local and regional scale.

Another internationally known research institute was founded in 1981, the *Fraunhofer Institute for Solar Energy Systems ISE*, which was the first non-university institution for applied solar energy research in Europe. The 'solar building' working group within the

institute was specialised on research within the field of energy-efficient building and construction. In 1992, as a result of experiments, 'learning by using' and collective forms of knowledge creation, the institute first demonstrated that an energy self-sufficient solar building can be technically realised (see fig. 4.2, Image 1). The applied character of the Fraunhofer Institute fostered the dialogue between researchers, practitioners and the city administration. An interviewee consequently remarked that Freiburg's early pioneering role was the result of strong *"interactions between research and other actors in the city"* (FR-Re1).

The continuous completion of important demonstration projects in Freiburg is illustrated in Figure 4.2. In 1979, the ongoing development path of 'localised learning by doing' started with the 'Solarhaus' – an early pioneer project that considered more stringent insulation of the building's envelope and the integration of a photovoltaic system. The most recent 'green' flagship project is the high-rise building 'Buggi 50', a passive house retrofit (see fig. 4.2, Image 4).



Photos:
Fraunhofer ISE (1), C. Hulke (2), S. Fastenrath (3, 4, 6), City Freiburg (5), Rolf Disch SolarArchitektur (7)

Figure 4.2: Key building projects in Freiburg

4.2.2 Take-off phase: 'window of opportunity' (1986-1992)

In response to the nuclear disaster of Chernobyl in 1986, Freiburg's City Council and the city administration became active drivers of urban sustainability transitions (FR-Con3). The municipal environmental protection agency, established after Chernobyl, outlined a long-term oriented 'communal energy concept' which was based on three pillars: energy conservation, production of renewable energy, and the development of environmentally friendly technologies. The pillar of energy conservation was strongly linked to energy-efficient building design and effective insulation of buildings (City Freiburg, 1997b).
Interviewees highlight the special role of the local 'Energy Transition Committee' *(Energiewende-Komitee)*, a citizen movement essentially initiated by employees of the Institute for Applied Ecology (FR-Adm4, FR-Adm5, FR-Con3). As Sennekamp (2013) stated, this group was able to prepare strategies and had the power to implement important actions into the local politics. The broad adoption of energy-efficient building and solar architecture into urban planning were central thoughts of the group (Energiewende-Komitee, 1990).

The debate surrounding energy-efficiency in the building sector coincided with an enormous demand for housing in Freiburg in the late 1980s and early 1990s (FR-Adm4, FR-Adm5, FR-Pa2). The introduction of locally developed building energy standards was the result of this dynamic interplay.

While there was a political consensus about a new inner city residential development in the former French military area of Vauban, a long public debate followed around the development of a new residential area in Rieselfeld, a former sewage farm outside the urban fabric. Freiburg's energy and environment movement, City Councilors linked to the Green Party, as well as the Social Democratic Party (SPD) did not support this new development. Their opposition was mostly based on concerns about urban sprawl and its environmental implications.

Rolf Böhme, Freiburg's social democratic Lord Mayor at the time, described this debate as a conflict between ecology and social issues (Böhme, 2009). Other decision makers who were part of this process explained that this debate was strongly influenced by the controversial debate about "social responsibility vs. ecological responsibility" (FR-Adm9, FR-Pa2). The pressure of the so-called "Anti-Rieselfeld movement" was enormous. The strong positions of the 'bottom-up' movement were crucial in negotiation processes for the new development Rieselfeld. Compromises and negotiations had to be made, Böhme recapitulated in his book on his experience as Lord Mayor (Böhme, 2009). The Green and SPD parties put forward a bill in the City Council for low-energy building regulations (see

City Freiburg, 1992). In 1991, the debate ended when the City Council finally decided to develop 80 hectares of the Rieselfeld area. A key participant in the Rieselfeld conflict, and an important sustainability transition agent in Freiburg, explained that this decision was a result of complex bargaining processes.

> *"After a referendum and discussions about the environmental impact of the Rieselfeld development, he (the Lord Mayor) realised that if he makes concessions, he can break the resistance a little. […] And concessions meant for us: Okay, let us talk about energy and environmental requirements in such a new development area" (FR-Con3).*

In 1992, a large majority of City Councillors voted for the Freiburg low-energy house standard, (LEH). As a result, Freiburg introduced its own energy requirements for buildings – one of the first cities in Germany to do so. This development was, and continues to be widely viewed as path breaking and an important milestone in the transformation of Freiburg's building sector (FR-Adm4, Fr-Adm5, Fr-Con3, FR-Re1). The main differences compared to conventional building regulations by federal law was the improvement the Freiburg standards demanded in terms of the thermal insulation of the building envelope, the avoidance of thermal bridges and the optimisation of the use of passive solar energy. The standard for new residential buildings on public land required a maximum 65 kwh/m^2*a for heating energy consumption (City Freiburg, 1992). These requirements were significantly stricter than the federal building regulations of the time (see Figure 4.3). Two key political arguments on which the decision was legitimised were the relatively low requirements on the federal level and the technical feasibility of low-energy buildings. Energy-efficiency was firstly introduced to federal building codes by the thermal insulation ordinance (WärmeSchV) in the mid-1970s and renewed in 1982. Further arguments within the decision making process were based on experience and practice in Freiburg but also on examples of other city or state initiatives. The long-term goal, noted in the policy decision paper (City Freiburg, 1992), was the gradual establishment of zero-energy buildings.

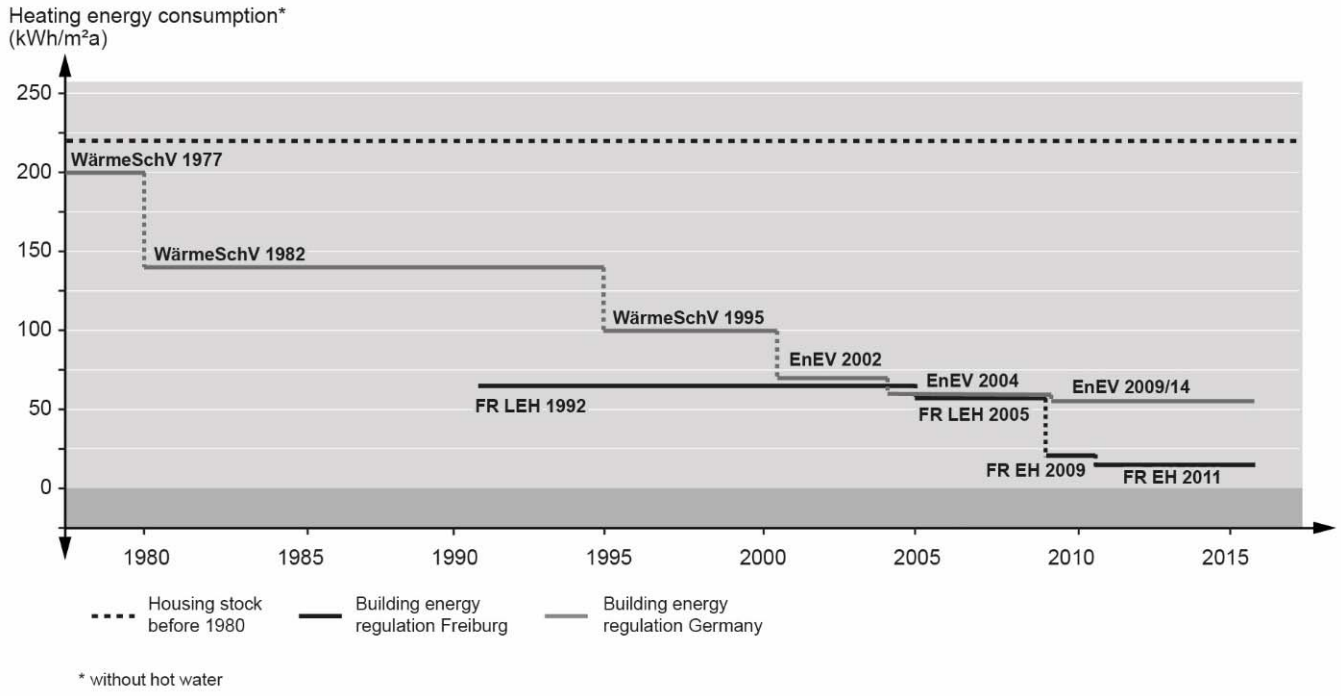


Figure 4.3: Pathways of building energy regulation in Germany and Freiburg

4.2.3 Rieselfeld: the sustainability transition testbed (1993-2003)

Freiburg's LEH standard was implemented in private law contracts between the city administration and land purchasers. Within the framework of German federal law, this process was challenging because energy requirements at that time could not be fixed in urban development or zoning plans. As a result, the city's building authority was responsible to review the targeted energy consumption as part of the building permit. The regulation was first adopted in practice in some smaller developments in 1993 and 1994. However, the large Rieselfeld urban development (see fig. 4.2, Image 5; fig. 4.4) was the first essential testbed for the new building requirements and innovative 'niche' building projects (FR-Adm5). An interviewee explained that *"these people (the energy scene), which already had detailed thoughts, finally had a playground where they could implement things."* (FR-Adm5).

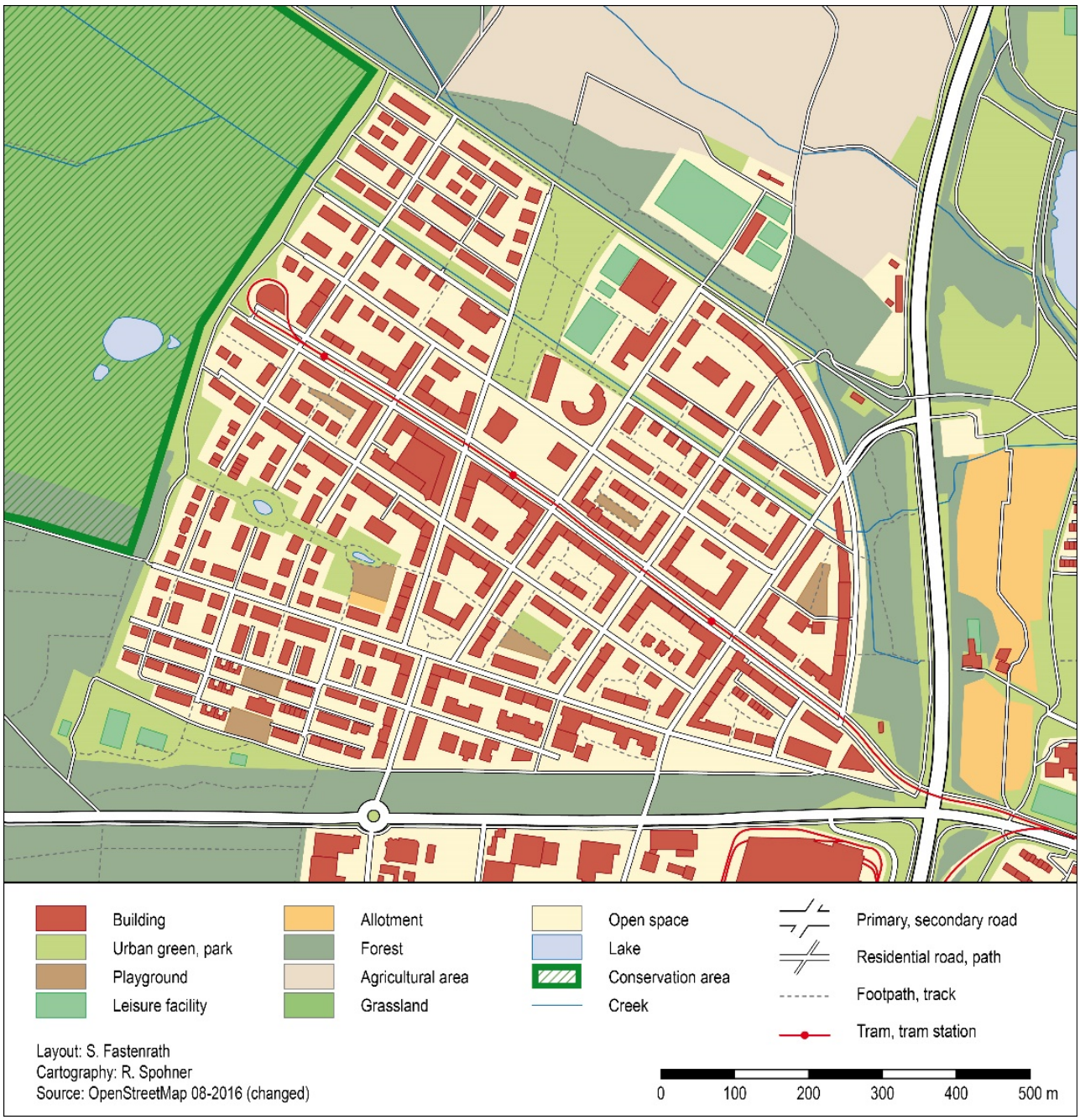


Figure 4.4: The Rieselfeld district

Rieselfeld was developed in a predominantly block structure (see fig. 4.4), with buildings heights of four to five storeys. The energy requirements of the FR NEH 1992 were integrated late and abruptly, after the basic planning of the district was already completed (FR-Adm9, FR-Pa1). One of the responsible planners made clear that it was a challenge

and pioneering work to integrate the new energy requirements into the planning process, stating that: "No one knew how to do that, no architect, no planner, no heating engineer, no developer" (FR-Pa1). A representative of a Freiburg based professional association described the situation as follows:

> *"Before (the introduction of the FR NEH 1992), everyone said, it is unthinkable, it will not work. […] but then it worked without any problems. From today's perspective, it is not rocket science to make that work, it is about behavioural changes. You have to consider things and the building processes have to be clear"* (FR-Pa2).

Several interview partners stressed that local developers, architects, and craftspersons1 were sceptical about the Freiburg building standard. While developers were largely concerned about increasing costs for low-energy buildings, architects and craftspersons worried about the translation of the standards from theory into practice. Builders and craftspersons had to work closer together to ensure an airtight building envelope by considering new requirements for building shell, roof, facade and windows.

Sample tests conducted after the first building phases revealed that some buildings did not reach the requirements. The block structure adopted in the urban development plan was one reason for this. A leading architect explained that it was very challenging to reach the energy standards in the north-east corner of a block, because *"large areas of the buildings do not have solar energy input or just low energy input"* (FR-Pa1). However, the city administration argued that the problems were based on lack of knowledge of architects and builders or basically a lack of will to implement the new regulations properly (City Freiburg, 1997a). As a result, the city administration installed a contact person in the Project Group Rieselfeld in 1998 to coordinate the work, to foster communication between builders, architects, investors and craftspersons, to provide advice during the building process and to monitor the results. The core principle of the Project Group Rieselfeld was "communication instead of sanctions" (FR-Adm6, FR-Adm9). This effectively helped to monitor challenges and learning processes as well as to transfer these into feedback loops for further improvements of the standard (FR-Adm9).

While there were pioneer architects and craftspersons creating innovative projects, the main driver for sustainability transitions in the building sector within this period of time was the City of Freiburg in fostering niche concepts through regulation. Highly motivated staff in the administration and interdepartmental cooperation were essential to this. The

[1] The collective term 'craftspersons' is used for skilled professionals such as builders, carpenters, electricians, painters, bricklayers, roofers, plumbers.

learning processes and feedback loops in Rieselfeld were also crucial for the development in Vauban, where construction started in 1998. The Vauban chief planner stated *"without Rieselfeld we couldn't have planned Vauban. […] Rieselfeld was a sort of icebreaker."* (FR-Adm10).

4.2.4 Vauban: from low-energy buildings to plus-energy neighbourhood (1998-2003)

The Vauban planners, architects, and craftsperson substantially benefited from the learning processes in Rieselfeld. Similar to the Rieselfeld development, a key goal of the city planners was inclusive citizen participation during the development of Vauban (see also Kronsell, 2013). Citizen associations such as the 'Forum Vauban' were actively involved in the conception of the development plan of the Vauban district. Initiatives to introduce stricter building standards and to push towards passive house level came out of these movements (FR-Adm10). As one of the planners explained:

> *"In the context of the marketing process 1997/1998, the first people came, who were interwoven with these green thoughts, much more than we were in the city administration, who said: Why are we doing low-energy buildings? Let us build passive houses in the entire area." (FR-Adm10).*

Within the standard, passive houses are based on the efficiency of the airtightness of the building fabric and require a maximum heating energy of 15 kwh/m^2*a. The City Council decided against a compulsory new passive house standard but supported more ambitious homeowners and developers in Vauban by giving them preference in the land purchasing procedures (City Freiburg, 1997a). As a result, some areas in Vauban were developed according to an unofficial 'improved' FR NEH 1997 standard (see fig. 4.5). These buildings typically reached energy consumptions under 30 kwh/m^2*a based on passive house elements such as higher energy efficiency through insulation, triple-glazed windows, avoiding building shadings, and ventilation systems with heat-recovery (City Freiburg, 1997a). At least 200 units were built with de-facto passive house standard in Vauban, including the first multi-family passive house in Germany (see City Freiburg, 2014).

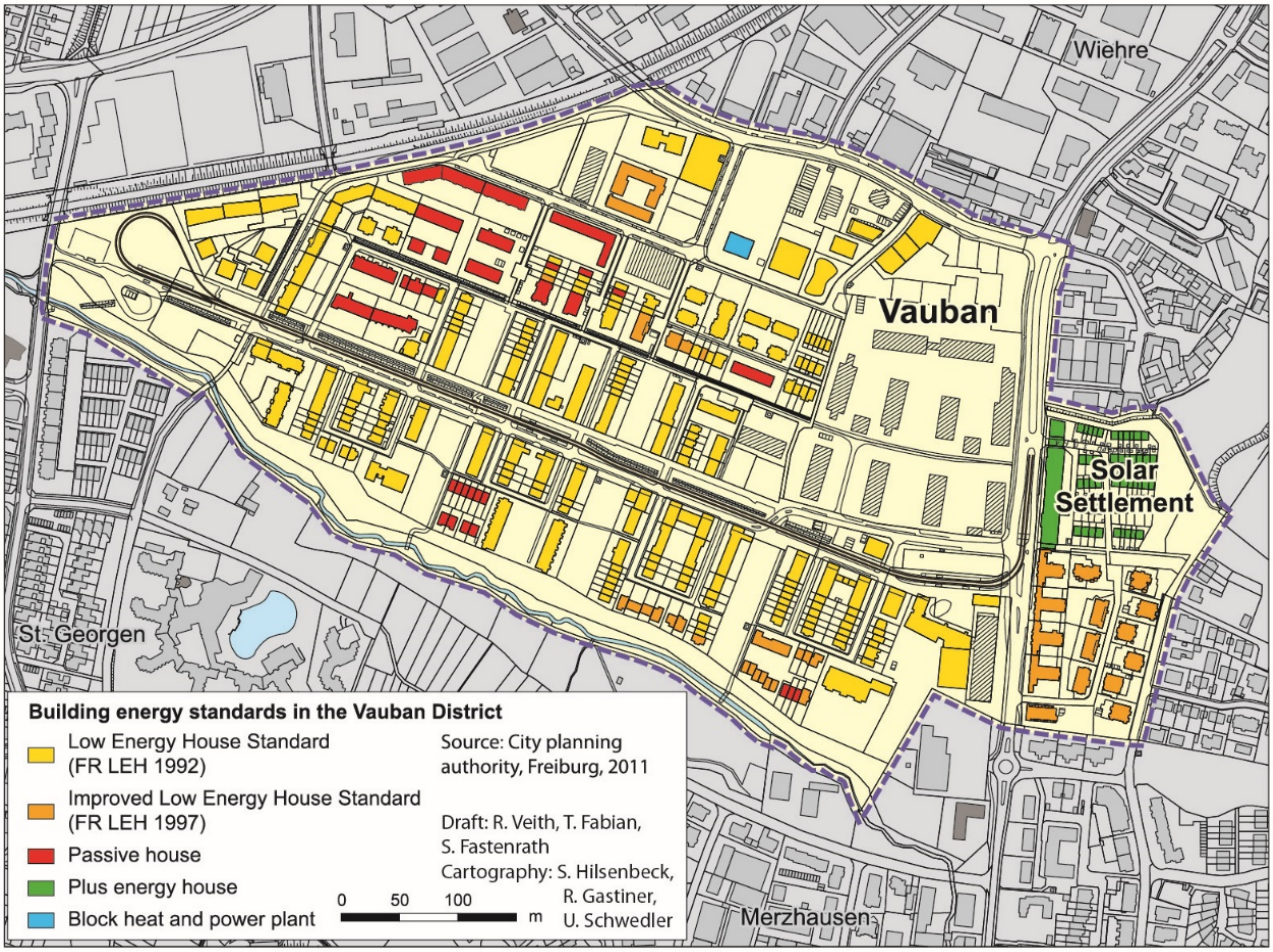


Figure 4.5: Realised building energy standards in the Vauban district

In addition to passive houses, a 'plus-energy neighbourhood' is part of the Vauban development. The so-called 'Solar Settlement' was initiated and developed by the Freiburg based solar-architect pioneer Rolf Disch. He developed an ensemble of 59 multi-storey townhouses and a commercial building named the 'Sun Ship'. Large photovoltaic systems on the roofs were installed on each building. A driver for this development, as well as the incremental market formation of Photovoltaic in Germany, was the feed-in tariff for renewable energy, which was introduced by the German Federal Government in 2000.

The solar settlement, finished in 2006, is the result of learning processes the architect made in other preliminary projects, such as the 'Heliotrop' building, the first plus-energy building worldwide (see fig. 4.2, Image 1). A representative of the city planning authority argues that this development was crucial for later policy actions: *"[...] there was this effect that the city administration and the City Council became more courageous because of*

these flagship projects such as the Solar Settlement and privately initiated passive houses in Vauban" (FR-Adm5).

The mixture of building types in Vauban is the result of a continual policy support combined with incremental socio-technological transitions from low-energy buildings, to passive houses and eventually plus-energy buildings. Furthermore, Vauban and Rieselfeld were a result of strong bottom-up processes. The personal effort and the will of individuals for transition action were essential drivers for Freiburg's ambitious energy standards and many innovative building projects in the two urban development areas (FR-Adm1, FR-Adm4, FR-Pa1). This 'learning by planning' approach was a crucial factor for the transition progress from low-energy building to plus-energy houses. A stakeholder highlighted this:

> *"The standards in Vauban and Rieselfeld were strongly promoted by the people who wanted to build there. […] these wishes were brought from the outside into politics" (FR-Pa1).*

4.2.5 Transition reversal: 'Top down' transitions – the starting shot for a policy-driven path (2004-2007)

The strong bottom-up movement and support for 'green' building of the 1990s changed to a more top-down driven transition paths in the mid-2000s. Local politicians and the city administration gradually became the key drivers for continual changes in the local building sector. Since 2002, the key drivers for urban sustainability transitions in Freiburg have been the Green Party and Dieter Salomon, the first Green Lord Mayor in a larger German city. Freiburg's decision makers strived to maintain their leadership role in the energy-efficient building sector. The main political goal was to keep the Freiburg building standards a step ahead of the rest of the country (City Freiburg, 2005). As a result, the new building standard FR NEH 2005 was introduced as a reaction to wider political developments on the German federal and the EU level (see Figure 4.6). Key interview quotes in this context demonstrate this clear political aim:

> *"The origin was political impetus. […] This became its own dynamic, even in the administration. […] During the last 10, 15 years the impetus came mostly from administration, but we ran into open doors in the political scene."* (FR-Adm5).

"When the EnEV (Energy Saving Ordinance) came, the goal was to undercut 30 percent of the requirements of the EnEV. […] That was simply political will." (FR-Adm6).

The developments were strongly motivated by several policy actions at the Federal and European policy level, as well as the funding programs of the Kreditanstalt für Wiederaufbau (KfW) – the German government owned development bank. The EU introduced the 'Directive on Energy Performance of Buildings' 2002/91/EC in 2002 (see fig. 4.6). The Directive advised the EU member countries to improve their building regulation policy. As a result, the German government renewed the national building codes by introducing the 'Energy Saving Ordinance' (Energieeinsparverordnung, EnEV). The EnEV replaced the former 'Thermal Insulation Ordinance' (Wärmeschutzverordnung, WärmeSchV) and the 'Heating Systems Ordinance' (Heizungsanlagen-Verordnung, HeizAnlV). The new building regulation set much stricter energy performance requirements for new buildings. Furthermore, the German government initiated a number of funding programs for energy efficient building developed and administrated by the KfW. The KfW has offered loans for low-energy building projects since 2002, ranging in scale from small detached houses to larger building projects. These changes on the federal policy level significantly influenced the transition path in Freiburg (see fig. 4.6).

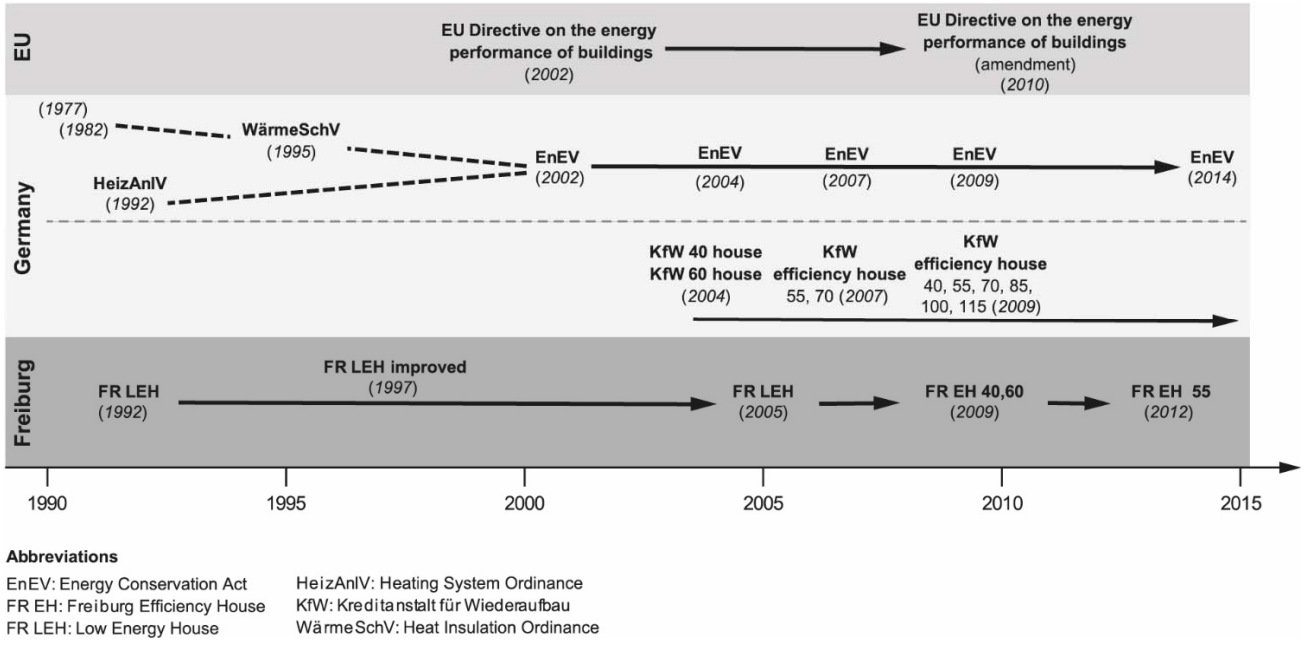


Figure 4.6: Governance pathways in the building sector: EU, German federal government and City of Freiburg

4.2.6 'Green mainstreaming': strict energy requirements for all new residential building projects (2008-2016)

While the energy requirements of the FR LEH 2005 did not entirely reform the former FR LEH 1992, significant changes were implemented in 2008 when Freiburg's City Council approved the gradual amendment for two new standards, the 'Freiburg efficiency house 40 and 60' (*Freiburger Effizienzhaus*, FR EH 40 & 60). FR EH 40 was set for building projects by the city's own real estate company and main housing provider (*Freiburger Stadtbau*) and six smaller pilot building projects on city own land. This standard was comparable to the 'KfW 40 house' that required passive house elements such as low heating energy consumption based on high efficient insulation, triple glazed windows, and a ventilation system with heat recovery.

The FR EH 60 was another example of a path-breaking policy innovation. For the first time, local energy requirements were prescribed for building projects on private property. The respective buildings were required to reach the energy standards of KfW 55 (City Freiburg, 2008). The requirements were enforced through 'urban planning contracts' (*Städtebauliche Verträge*). This novelty was possible after the City Council voted for new 'local planning guidelines' (*Freiburger Baulandpolitische Grundsätze*). The city policy consisted of a set of local planning principles that included aspects such as planning procedures, financing or usage of solar energy (City Freiburg, 2009a, 2009b). Since then, solar and passive building design aspects have been continually incorporated in Freiburg's land use planning processes (see Hoppe, 2013). Thus, 'green' energy-efficient building evolved from a niche phenomenon to mainstream practice. An underlying driver for these developments were substantial changes in the 'Federal Building Code' in 2004 *(Baugesetzbuch*, BauGB), when climate protection became an important factor in German land use planning laws (FR-Adm4, FR-Adm8). As a consequence, German municipalities were able to introduce energy-related building regulations into zoning and urban development plans.

The most recent developments of Freiburg's standards are the result of long debates and bargaining processes between the local political parties and the city administration (environment protection and urban planning authority), and the 'Association of Freiburg's property developers and investors' (*Vereinigung Freiburger Wohnungs- und Gewerbeunternehmen e.V.*), the 'professional associations of trades and crafts' (*Handwerkskammer Freiburg*) and architects (*Architektenkammer Baden-Württemberg*), and local banks (FR-Adm4, FR-Adm5, FR-Adm8). Criticisms have consistently centred on increasing construction costs which are linked to strict building

requirements (FR-Adm1, FR-Pa1). Although the most recent changes in the low-energy building standards were accepted in 2005 by all these stakeholder groups. A reason for the decision were the special real estate market mechanisms in Freiburg. The local property and building industry, the main veto actor, as well as the crafts industry have profited from high prices (FR-Adm4, FR-Adm5, FR-Adm8). The following interview quote capture this:

> *"[…] to sell apartments in Freiburg is no problem. No matter how expensive they are, because of the tight housing market. […] We said: Set the standards as high as you want, then we can try out things here. Otherwise we will talk about it for the next 10 years and discuss about if it works or not. […] We weren't afraid and positioned us at the front. We get a wonderful green halo – what you definitely need in Freiburg." (FR-Pa2).*

4.2.7 Going too far? Increasing skepticism against over-ambitious building standards

Since 2011, when the FR EH 40 and 60 standards were eventually superseded by the Freiburg Effizienzhaus 55 (FR EH 55) (City Freiburg, 2011a), there has been an ongoing debate about the local building regulations. First, the logic of a high standard to reach passive house requirements for all residential building projects in the city are questioned by practitioners, but also by the employees in the city administration (FR-Adm4, FR-Adm8, FR-Pa1, FR-Pa2). While Freiburg based architects generally support green building principles, a number of individual architects are critical of the standards. They essentially question the logic of a strict standard that is applied to all building projects without considering the context of the buildings' location. A leading Freiburg architect who participated in the latest negotiating processes of the standards explained that a more flexible regulation is needed to be responsive to site specificity or other unavoidable constraints such as orientation limitations, overshadowing, or topography (FR-Pa1).
Second, decision makers in the city administration and leading practitioners criticise the top-down mentality in the local politics. Interviewees explained that the race for green leadership has limits and further transitions need the participation of all stakeholders. Numerous interviewees reflected on these concerns of top-down directions driven by Freiburg's policy makers:

"At the moment we have the feeling that we reached a limit. With the next improvement of the EnEV (in 2016) we can't keep following our 30 percent goal. We are almost doing passive houses. How passive should it be?" (FR-Adm5).

"It is not a fast-selling item. You need constantly driving forces on different levels: Politics, administration, economy, craftsperson and also in the community. But if all this comes together, pressure can be built up. As you can see, there are always phases with no progress. It is important to provide know-how, education, training, so that the people know how to do it" (FR-Adm4).

4.3 Conclusion

Drawing on the debates of place-time specificity, learning processes and governance in the vibrant research field of the 'geography of sustainability transitions' (Hansen & Coenen, 2015), the aim of this paper was to provide empirical insights of successful urban 'sustainability transition pathways' (Turnheim et al., 2015) in the building sector. The case study of Freiburg, globally recognised as a sustainable model city, gives the rare opportunity to review long-term transition processes from conventional building practices to low-energy buildings, passive houses and plus-energy buildings. In the early 1990s, the city was one of the first German cities that introduced low-energy building regulations. These standards have been continually emended. All new residential building projects are required to abide by the strict city own low-energy requirements since 2009, which almost meet the high energy performance standards of the passive house. Tracing back the urban sustainability pathway by analysing the interplay of significant changes in related policy actions, building practice, and involved key actors, we identified two main directions:

1. An initial 'bottom-up' path, based on niche initiatives manly driven by pioneers, early adopters, the local 'environmental and energy movement'; and newly established research institutes from the 1970s to the 1990s; and
2. a 'top-down' path, based on regime initiatives essentially driven by continual political will and a dedicated city administration since the 2000s.

Both directions are strongly connected by 'niche-regime interactions' (Turnheim et al., 2015). We demonstrated that energy-efficient building occurred as 'local niche experimentation' (Coenen et al., 2010) and has – over time – incrementally developed into mainstream policy and practice. These changes were, and continue to be, strongly

embedded in the specific urban context and the result of co-evolutionary, but non-linear transition processes. Our analysis shows that grassroots movements and local knowledge creation were important drivers for initial sustainability transition phases. Applied research, innovative building projects and the widespread adaptation of new materials and practices resulted in locally based knowledge networks. 'Path creations' based on learning processes with multiple feed-back loops, constant negotiations, path dependencies, events, driving and opponent actors, characterise the changes in Freiburg's building sector.

'Transition agents' – experts, practitioners and representatives of citizen movements – were able to translate this 'know-how' and expectations into the local policy making forefront. Interactions between 'transition agents' and policy makers were crucial for the introduction of policy regulations which were in turn the result of intense bargaining processes. Since the 1990s, the continuity of Freiburg's strict local building regulations, plays a key role as 'niche protection' mechanism and catalyst for continual 'learning by doing' processes. Architects, builders, planners and craftspersons were forced to change their routines by adopting new materials, technologies and practices. However, we also identified limits of sustainability transition and increasing criticism against politically dominated 'top-down' governance. We agree with Geels (2014), who suggests a shift in transition research in the sustainability context to better understand the institutional context of transitions. The perspective must change from rather rigid approaches which are solely focused on technological innovations, towards more open approaches focusing on the interplay of governance and 'learning by doing/using'.

Our case study exemplifies how complex, protracted and challenging urban sustainability transition dynamics can be. Because of this, we argue that a simple 'copy and paste' of best practices is not suitable for 'urban green building transitions'. This has implications for urban governance but also for future urban sustainability transition research. Policy makers should 'custom-tailor' and create new pathways of governance and triggering innovative transition approaches by seriously considering local conditions, already existing sustainability paths and the integration of local knowledge and actors. Our contribution demonstrates how important a detailed process tracing and an analysis of co-evolutionary developments are to understand urban sustainability transition pathways. Nevertheless, there is a need for further in-depth analyses of the contexts and dynamics of urban transitions to better understand patterns of technological transformations and its social, institutional and economic drivers and implications. In addition to further research of best practices and model cases, there is the need for contrasting case study research around cities where sustainability transitions are hindered by 'regime resistance' (Geels 2014).

4.4 Notes

Interviewee codes

FR-Adm = City administration (current and former employee)
FR-Con = Consultancy
FR-Pa = Professional association
FR-Prac = Practitioner (e.g. architect, engineer)
FR-Re = Researcher

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CHAPTER 5: Case Study of Brisbane

Ambivalent urban sustainability transitions: Insights from Brisbane's building sector

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Abstract

Cities are suggested as being the key level for shifts towards more sustainable modes of production and consumption. The building sector with its significant carbon footprint plays an important role in urban climate change adaptation strategies. Using the case study of Brisbane (Australia), the paper examines the place-specific contextualisation of green building transitions by analysing the co-evolution and interplay of building practices, policy making and involved actors. Drawing on theoretical approaches of Transition Studies and Evolutionary Economic Geography, we trace back and analyse policy and economic trajectories focusing on formative and hindering processes. The paper discusses ambivalent pathways and 'regime resistance' caused by local economic and political specificities. The analysis illustrates how crucial the continual support from both policy makers and industry actors can be when economic market mechanisms do not drive sustainability transitions. Regime actors can play a powerful role as 'transition detractors' and can determine the dynamics and the scope of sustainability transitions.

5.1 Introduction

Cities are increasingly understood as the key level for addressing climate change and as loci for action towards low-carbon solutions (Bulkeley et al., 2014; Hodson et al., 2017; IPCC, 2014; Loorbach et al., 2016; OECD/IEA, 2016). Scientific advisory bodies such as the German Advisory Council on Global Change (WBGU, 2016) highlight the 'transformative power' of cities as far as sustainability is concerned. Related to these understandings, sustainability transitions – socio-technical shifts from conventional towards more sustainable modes of production and consumption (Markard et al., 2012) – have been predominantly analysed and interpreted on a national level (Hodson et al., 2017). However, the role of place specificity in the sustainability context remains underdeveloped (Coenen et al., 2012; Hansen and Coenen, 2015; Murphy, 2015; Nicolosi and Feola, 2016). It is widely unclear how and why sustainability transitions occur, develop and vary in different urban contexts, even though the origins are often identified on the local level (Geels, 2011).

While a growing body of literature helps in understanding 'successful' shifts, explanations for slow or distracted sustainability transitions remain largely unexamined. In other words, apart from research on model cities and 'best practice', more solid empirical research considering path dependencies, barriers and resistance is needed (de Gooyert et al., 2016; Geels, 2014; Maassen, 2012). Research is particularly lacking on 'transition resistant' city contexts for innovative practices (technological and institutional) that do not gain momentum, are delayed or distracted. We argue that a city's specific and distinctive political, economic and technological pathways and their interrelated co-evolution need to be investigated further to better understand current dynamics, drivers and barriers in urban sustainable development.

This paper contributes to closing this research gap by providing empirical insights from a case study of green building transitions in Brisbane (Australia). In contrast to global forerunner cities such as Freiburg in Germany or Vancouver in Canada, Brisbane can be seen as a 'latecomer' due to a relatively slow uptake of 'green building' practices. The building and construction sector has a significant carbon footprint and therefore plays an important role in climate change adaptation strategies (IPCC, 2014; OECD/IEA, 2013; UNEP, 2011). Surprisingly, relatively little academic literature has been published in this field. While there is increasing interest in different aspects of sustainability processes in the building sector (Cidell, 2014; Faulconbridge, 2013; Gibbs and O'Neill, 2014; Smith, 2007), in-depth analyses at the city level are still lacking. This paper examines how and why green building practices develop and what barriers exist at the city level.

Investigating this issue is not only relevant for further research but also for practitioners and policy makers seeking to take action on different urban sustainability areas.
The city context of Brisbane provides the opportunity to explore pathways of green building practices, in both residential and commercial sectors, with a special focus on barriers and distractions. Following a transdisciplinary approach, which combines expert knowledge from public, private and academic sectors, policy document analysis and secondary statistical data, this paper traces back Brisbane's green building pathways. We particularly focus on changed practices and the interrelated institutional, economic and political city context. More specifically, the paper examines the following research questions:

(1) What are significant changes in practice in Brisbane's building sector; when and why did changes occur or were hindered?
(2) Who are the key actors actively participating in these processes; who drives or resists sustainability transitions?
(3) How are policy making processes (e.g. regulations, incentives, guidelines) interrelated to practices in the building sector?
(4) What are significant barriers and challenges in transitioning Brisbane´s building sector?

The paper is structured as follows: Section 2 covers a brief discussion of the literature on urban sustainability transitions and the conceptual approaches used for this paper. An overview and the relevance of the building sector is provided in Section 3 before the case study Brisbane and the broader context are introduced in Section 4. Section 5 outlines the methodical approaches applied in this paper. The research results are presented in Section 6 by tracing back and analysing the different phases of Brisbane's green building pathway. A final discussion, conclusions and an outlook for further research completes this paper in Section 7.

5.2 Urban sustainability transitions

Publications in the vibrant research field of urban sustainability transitions have started to explore cities as important arenas for grassroots movements (e.g. Wolfram, 2016), experimental niche developments, learning by doing and governance (Bulkeley et al., 2011; Nevens et al., 2013; WBGU, 2016). Even though cities are always embedded in wider political, economic and social systems at different scales, every city is an irreducible individual case (Scott and Storper, 2015). For this reason, place dependency is receiving increasing attention as an important conceptual and analytical aspect in sustainability transition research (Haarstad, 2016; Hodson et al., 2017; Nicolosi and Feola, 2016).

Following critique on the interpretative flexibility (Smith et al., 2010) and the "missing or naïve conceptualizations of space" (Coenen et al., 2012) in concepts of Transition Studies (TS), the debates have resulted in a geographical and relational turn. Contributions in the recently established research field of the 'Geography of Sustainability Transitions' by (Hansen and Coenen, 2015) aim to add geographical and relational knowledge to established TS approaches (Bridge et al., 2013; Markard et al., 2012; Truffer and Coenen, 2012). This approach implies that places should be understood as important contexts where socio-technological change is embedded in power structures and institutions (Murphy, 2015). Cities or city regions are seedbeds of social interactions, institutions and political action. They have their own economic bases, structures of governance, planning regulations, infrastructures, cultural norms and traditions (Storper, 2013).

As Grin et al. (2010) state, socio-technical changes towards sustainable development underlie distinct normative expectations and characteristics. Sustainability transitions are not solely economic or technology driven, they must be interpreted as the result of socio-spatial dynamics (Murphy 2015). Not only transition politics but also interactions between policy and economic structures play an important role in socio-technological change and must be further explored. Therefore, scholars are increasingly bringing together TS approaches (predominantly the 'multi-level perspective' and 'transition management') and Economic Geography (Boschma et al., 2017; Fastenrath and Braun, 2016; Gibbs and O'Neill, 2015).

Approaches from Evolutionary Economic Geography such as 'path creation' (Garud and Karnoe, 2001) and 'path dependency' (Boschma and Frenken, 2006; Martin and Sunley, 2010) are helpful in better conceptualising the dynamics of socio-technical change in light of a co-evolutionary understanding of technology and institutions. To understand and steer current socio-technological changes, 'urban sustainability transition history' must be analysed. Conceptualising and analysing pre-existing socio-economic-technological structures (Martin and Sunley, 2006) as non-linear sustainability transition pathways (Turnheim et al., 2015) helps when exploring the dynamics and interactions between practices and adaptations of innovative and established structures of so-called 'socio-technical regimes' (Geels and Schot, 2007). The geographical perspective in transition research helps in "understand[ing] the development trajectories of cities, industries, production networks, and economies" (Murphy, 2015).

Spatial and relational perspectives are also a support when tracing back processes of resistance (de Gooyert et al., 2016; Geels, 2014) and lock-in against sustainability-oriented shifts (Corvellec et al., 2013; Maassen, 2012; de Gooyert et al., 2016; Geels 2014). These processes, which occur when policy makers and economic actors form a "core alliance at the regime level, oriented towards maintaining the status quo" (Geels, 2014),

are under-researched. A changed focus from niche developments to the regime level is required to explore and understand barriers in sustainability transitions. Place-specific economic logics, hindering processes and 'transition detractors' need to be identified (Fastenrath and Braun, 2016). Therefore, further research needs to shed light on institutions, actors and inter-actor tension, interests and the outcomes of policies (Coutard and Rutherford, 2010; Gorissen et al., 2016). Accordingly, this paper considers place-specific institutional processes in sustainability transitions in Brisbane's building sector.

5.3 Green building transitions

The built environment is a significant contributor to human-related greenhouse gas emissions (IPCC, 2014), and buildings are increasingly seen as both a major cause and a solution to climate change. Transitions from conventional towards sustainable modes of building and construction are therefore playing an increasingly important role in international public debates on climate change and resource efficiency (UNEP, 2014). In countries of the 'global north', most of the energy consumed in buildings is used for space heating or cooling, followed by water heating and usage of electric appliances (OECD/IEA, 2013) (see Fig. 5.1). On intergovernmental levels, the significance of a more sustainable built environment and related policy support is discussed in the context of urban and regional climate change adaptation strategies (UNEP, 2014).

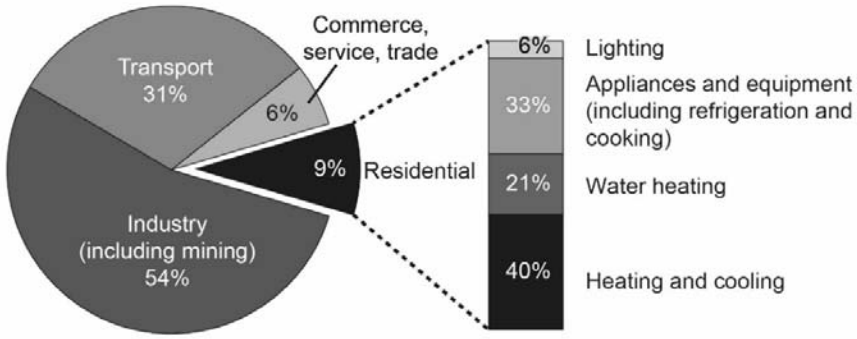

Fig. 5.1: Energy consumption in Australia by main sectors (left) and the residential sector (right) in 2013 (own figure, data source: AUSGov 2015)

While there are diverse approaches and interpretations, green building is commonly understood as the practice of creating resource-efficient and healthier approaches for building design, construction, renovation, operation and maintenance. The adoption of 'green' architectural principles (e.g. solar, passive or low-energy design) and 'low-carbon'

building technologies and materials generally reduces the energy consumption and greenhouse gas emissions in buildings (IPCC, 2007; UNEP, 2011). The (IPCC, 2007) recommends two main shifts to achieve greener, more resource-efficient buildings: (1) reduce heating, cooling and lighting loads (2) increase efficiency of appliances, heating and cooling equipment and ventilation. To achieve these goals, building design and urban planning principles have to be considered for different locations and climates (Bauer et al., 2013). In warmer climates, green building includes a number of aspects: building shape, orientation, internal room layout, insulation, using highly reflective building materials, shading, windows with a low solar heat gain and utilizing thermal mass (IPCC, 2007; Szokolay, 2014).

Renewable energy, such as installations of photovoltaic panels (PV) or solar hot water systems, further reduces the energy consumption in buildings. Stakeholders in the building and construction sector (architects, engineers, developers, builders, craftspersons, manufacturers) are incrementally changing routines towards 'greener' modes of production, building design, construction and operation. The drivers and the logic behind these processes of change follow different speeds and patterns with different driving and hindering actors and diverging political and industry influences. While city regions with longer histories of green building transitions can be identified, e.g. Freiburg (Germany) and Vancouver (Canada), there are also latecomers such as Luxembourg or Brisbane (Fastenrath and Braun, 2016; Preller et al., 2017). The case study of Brisbane permits a better understanding of the delays and the interrelated challenges in sustainability transition pathways over time.

5.4 Brisbane as a case study

Brisbane, Australia´s third largest city, is the capital of Queensland and the administrative centre of the Brisbane City Council (BCC) and the Queensland State Government (QLD Gov). The city, proclaiming itself as 'Australia's New World City', is an important location for regional offices of multinational enterprises. Brisbane is more renowned for its mostly pleasant subtropical climate and lifestyles than for being a green front runner city. Its history of greening the built environment is comparably short. Brisbane's building sector has been strongly influenced and characterised by rapid population growth. During the last decades, the metropolitan area experienced growth rates of more than two percent annually. Besides brownfield developments in the inner city, new, large, master-planned communities have been initiated in Greater Brisbane and the neighbouring Local Government Areas (LGAs) of the Sunshine Coast and the Gold Coast (see Fig. 5.2). In 2016, 2.3 million people lived in Greater Brisbane, accounting for almost half of Queensland's population of 4.78 million (ABS, 2016). Between 2000 and 2015, homes for more than

500,000 residents were provided (ABS, 2016). The QLD Gov's latest regional plan estimates that the population of South East Queensland will increase by 2 million people until the 2040s (QLDGov, 2016). The fast-growing urbanisation process in South East Queensland presents both a challenge and an opportunity for transitioning the building and construction sector. Practitioners and policy makers can significantly influence and determine the impacts of current and future developments in the building sector.

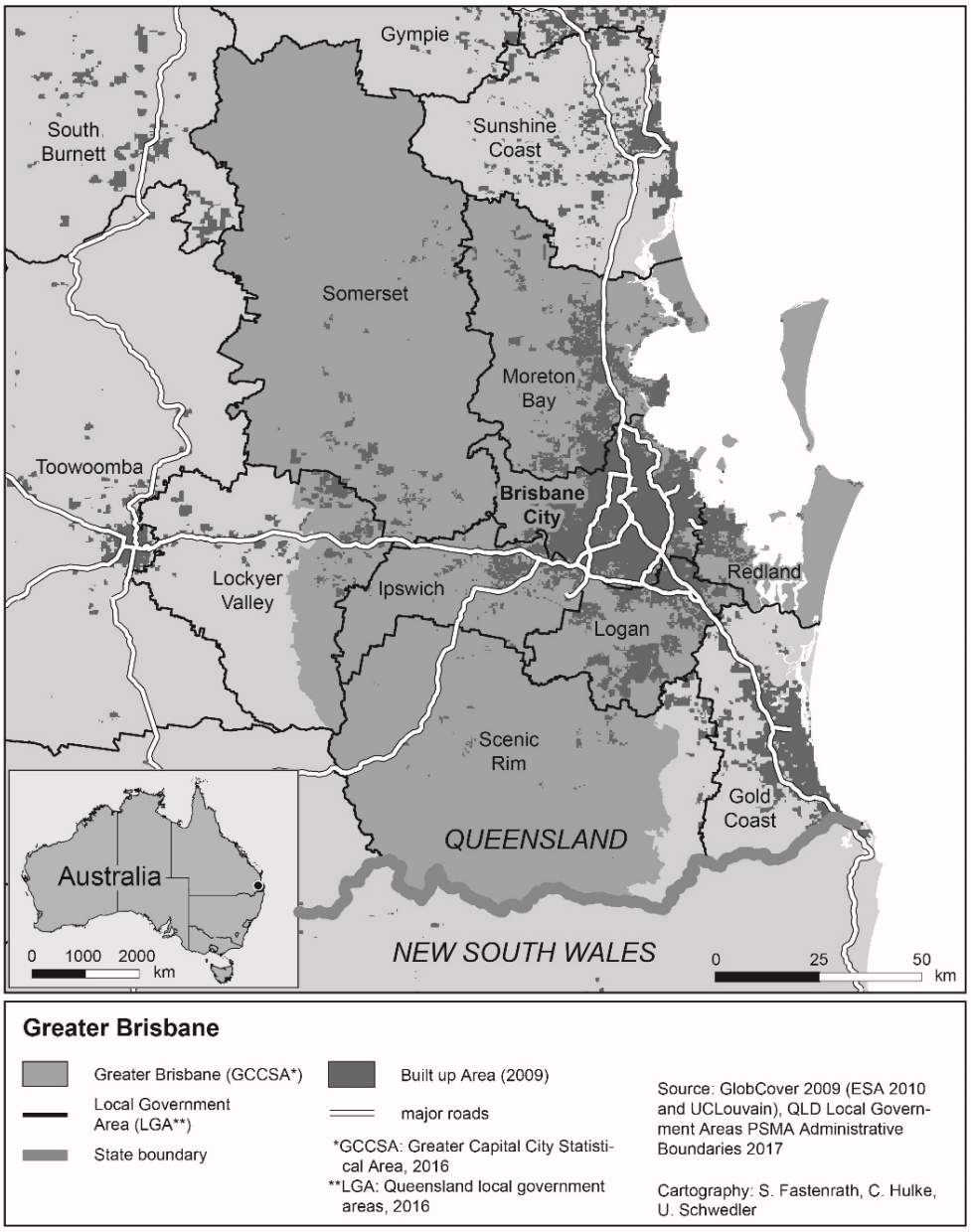

Figure 5.2: Greater Brisbane, administrative and statistical boundaries

5.5 Methods

The findings presented in this paper are based on a qualitative research design that includes three interlinked methodical approaches: an interactive workshop, policy document analysis and interviewing. The triangulation of empirical methods is helpful when collecting and interpreting primary data (Flick, 2004). To ensure validity of the qualitative research design, we took these multiple sources into consideration and put them together in a chain of evidence (Yin 2014). This approach allowed us to explore different perspectives on the complex research topic. The three research steps will be described in this section.

The data collection started with an interdisciplinary kick-off workshop to develop a general understanding of key industry processes, actors and the political framework of Brisbane's building context. Ten local experts and stakeholders from public, private and academic sectors shared their insights at the workshop in March 2014. The invited participants were architects, consultants (engineering, building design, eco-tech industry), representatives of the BCC and non-governmental organisations and researchers. Using the 'World Café' workshop approach, the participants discussed four main topics in the context of transitioning Brisbane's building sector: actors, innovative local building projects, policy framework conditions, challenges and barriers. This participatory research approach was highly valuable in developing an understanding of the multiplicity of perspectives and the drivers behind green building pathways in Brisbane (more details about the workshop see Preller et al., 2017). The information gained through the workshop was written in a report, which was later sent to the participants for further commenting and validation.

This first research step was fundamental in directing and developing the ensuing policy document analysis and the semi-structured interviews. The workshop participants identified 34 public policies, programs and guidelines, which were mostly released by the BCC and the QLD Gov. Relevant documents, either from official websites or provided by interviewees, were reviewed. To gain an understanding of the interplay of policy-making processes and the building sector, a document analysis was conducted. Those documents helped in identifying timeframes, driving and hindering actors and shifts in political sustainability agendas.

As a third step and core element of our research design, we conducted 27 qualitative interviews in April 2014 and June-July 2015. The key goal was to gain insights from different professional perspectives. Interviewees were identified through snowballing (Clifford et al. 2016); most of the interview respondents were top-decision makers in the

administration or in Brisbane's building and construction industry. The semi-structured interview approach (Flick, 2014) helped us to gain in-depth expert and practitioner knowledge. Long-term developments, vested interests, decision making processes, the role of policy making and barriers were identified by interviewing a wide range of stakeholders affiliated to public, private and academic sectors. To ensure anonymity in this paper, the interviewee's names have been given codes (see Table 1).

Stakeholder group	Description	Interviewee-code	Number of interviews
Practitioners	Architects, engineers, planners, cost managers, general managers, craftspersons, product manufacturers	BR-Prac (1-7)	7
Lobby group	Officials of property and building industry organisations	BR-Lob (1-5)	5
Administration	Employees BCC, QLD Gov (former and current from different authorities)	BR-Adm (1-6)	6
Consultancy	Managers of small, medium and large enterprises	BR-Con (1-5)	5
Professional association	Representatives of building, architecture, engineering professionals	BR-Pa (1-2)	2
Research	Universities	BR-Re (1-2)	2
			27

Table 5.1: Overview of interviews

The average interview time was about an hour; the total recording time of all interviews was 29 hours and 49 minutes. All interviews were audio recorded, transcribed, and exported to MAXQDA, a software for computer-assisted data analysis that helps to structure and code large interview data sources. A qualitative content analysis was used for evaluating and interpreting the interview data (Mayring, 2014; Schreier, 2014). While the method does not generate statistically representative data, researchers have the opportunity to explore complex issues that are hard to quantify, such as vested interests, strategies and informal interactions between stakeholders. The transcribed interview data was manually coded, sub-coded and then categorised (see Saldana, 2016) in several rounds by focusing on the following main research topics: processes, barriers and challenges, temporal and spatial aspects, policies, actors and green building aspects.

Bringing together the three methodological perspectives was highly valuable in reconstructing Brisbane's green building pathway and in evaluating challenges and overviewing the complex interplay of place-specific processes at different times.

5.6. Results

Based on the primary data gained through expert and stakeholder knowledge and also on the secondary research obtained via policy documents/reports, literature review and statistics, this section describes and explains Brisbane's green building transitions in four phases. A closer look at current challenges and barriers in the residential building sector is provided at the end of this section.

5.6.1 Early experimental phase (1960s-1980s)

The starting point and first phase of Brisbane's green building pathway can be traced back to the 1960s. At that time, Brisbane was an important location for knowledge generation and experimentation in the fields of solar energy and solar building design (BR-Con1, BR-Pa2, BR- BR-Prac3, Prac5, BR-Re1). Research and experimental projects at the University of Queensland (UQ) were internationally recognised. UQ researchers, many of them members of the international 'Association for Applied Solar Energy' and later 'International Solar Energy Society' (ISES), worked on solar building designs (Baverstock and Gaynor, 2010). A frequently mentioned researcher in solar energy and building design was Steven Szokolay, whose contributions have been published internationally (Szokolay, 1975). An interviewed expert and decision maker in Brisbane's development industry highlighted his pioneer role:

> *"[…] he was a big promoter of solar back in the 1970s […] but he was just 30 years ahead of his time. If he would have been around 20 years later, he might have been a huge impact on Brisbane." (BR-Prac5).*

The locally gained expert knowledge about green and solar building principles did not form into a green building grassroots movement in Brisbane at that time. The actors, mostly researchers, were not able to influence the wider societal and political sphere or the mainstream building and construction industry in Brisbane. Therefore, this early initial green building path formation can be interpreted as dead-end path. Until today, influential bottom-up structures with driving actors from research and civil society cannot be identified in the city.

5.6.2 Policy path creation and local window of opportunity (1990s)

After the first phase, green building became more discussed in the 1990s. Policy-driven initiatives were shaped to support changes towards sustainability in the building and construction sector. As interviewees explained, energy efficiency, ecology and sustainability did not play a big role in planning policies until the 1980s (e.g. BR-Con2). A BCC planner described the inadequate role of sustainability in city planning policies: *"Before the early 1990s the word 'environment' did not exist in Queensland [planning] statutes"* (BR-Adm3). The key policy initiative that changed this situation was the 'National strategy for ecological sustainable development', released in 1992 by the Council of Australian Governments (COAG), on the federal level. Workshop participants and interviewees emphasised the initiative as the beginning of green building policies in Australia. A stakeholder related to Brisbane's property development industry shed light on these first important policy initiatives:

> *"Sustainability, or as it was called ecologically sustainable development, was a sort of the forefront of thinking around public policy in urban planning in Australia and there was sort of a parallel process. I guess, through the 1990s there was greater interest in green building." (BR-Prac5).*

As our policy document analysis showed, a number of initiatives were started to increase energy efficiency of residential and commercial buildings and domestic appliances in the 1990s. A key political objective was to influence householders to reduce the use of energy and to change to energy sources with lower greenhouse gas emissions (COAG 1992). As a consequence, the development and implementation of a national House Energy Rating Scheme was targeted. Furthermore, the Building Code Australia (BCA) (since 2011, National Construction Code (NCC)), which sets provisions for the minimum design and construction of buildings throughout Australia, was renewed and adopted by the state governments in 1993 and 1996. Concurrently, sustainability policies at the state level were introduced: the Queensland Environmental Protection Act in 1994 and the Integrated Planning Act in 1997. Eventually, the window of opportunity opened for local policy action. These policy initiatives encouraged the local councils to implement sustainability initiatives. As a result, BCC officers in the former 'sustainability unit' conceptualised a building rating tool, a city own House Code and an Energy Efficiency Code as part of the 'Brisbane City Plan 2000' (BR-Adm3, BR-Con2, BR-Prac2).

5.6.3 Ambivalent sustainability transitions (2000s)

The innovative ideas of building codes as part of the city plan were accepted by the BCC but not approved by the higher-level planning authorities of the QLD Gov. An interviewee who participated in the negotiations underlined the critical role of the state government but also of lobby groups linked to building and property industry:

> *"The Brisbane City Council wanted to push things but then realised that the state government was going to block it. Stakeholders, like UDIA [Urban Development Institute of Australia], Master Builders and HIA [Housing Industry Association], particularly HIA, didn't want the Brisbane City Council to put in place something like that. They didn't want their members to face another restriction." (BR-Con2).*

Numerous interviewees and workshop participants highlighted these powerful lobby organisations and also the state government as veto actors in Brisbane's building and construction context. However, Brisbane's city administration continued to be a strong supporter of transitioning the building sector. Ambitious sustainability goals were driven under Labor Party lord mayors and also the Liberal Party Lord Mayor, Campbell Newman (2004 - 2008), who had to govern with a labor-dominated cabinet during his first four years in office. New approaches in urban planning (smaller lots, performance based planning concepts) and support for usage of renewable energies and water efficiency were introduced. Also, other City Councils in South East Queensland started to support green building actively by providing guidelines and bringing together different stakeholders. A number of smaller demonstration projects in the residential sector were developed. Interviewees agreed that key industry actors, particularly big property development companies, began to discuss green building "as part of their philosophy" (BR-Prac6). Nevertheless, the mainstreaming of greener building practices did not occur for either greener homes or commercial buildings.

This status quo changed significantly in the mid-2000s, as stakeholders and experts with different backgrounds agree (e.g. BR-Adm1, BR-Prac1, BR-Prac6, BR-Re1). The BCC and the QLD Gov administration provided guidelines and economic incentives for greener buildings, especially in the commercial sector. The BCC's report 'Our shared vision - Living in Brisbane 2026' (BCC, 2006) explicitly highlights the crucial role of a "well-designed and responsive built environment". The 'Plan for Action on Climate Change and Energy 2007' (BCC, 2007a), underlined the ambitious goals in addressing climate change at that time. Key objectives were the reduction of greenhouse gas emissions by 50 percent and a carbon neutral City Council by 2026. Through implementing a 'sustainable built environment policy' for its own and leased buildings, the BCC demonstrated leadership.

The document states that the design and construction of the office buildings should provide vast quantities of materials and increased energy efficiency (BCC, 2007b). Furthermore, the BCC supported investors by providing economic incentives and reduced infrastructure charges (BR-Adm3, BR-Pa1).

A 'green building boom' in the commercial building sector occurred in Brisbane in the years following the release of the document (BR-Adm1, BR-Adm5, BR-Prac2). While the influence of BCC's policy support on this development is hard to measure and debated by many experts, they widely agree that the key driver was the Australian Green Building Council (GBCA) and its 'Green Star' certification. The certification tool is seen an important catalyst for new pathways in Australia's building and construction sector (BR-Lob3, BR-Prac3, BR-Prac4, BR-Prac5, BR-Prac6). One of the stakeholders highlighted the special role of the GBCA as follows:

> *"A lot of the activities have been driven through the GBCA, particularly in the commercial building sector. I think that is a really important piece of the puzzle in terms of how the industry decided to respond to the challenge in sustainability and climate, because effectively that body set up to be the industry's self-regulator." (BR-Lob3).*

To validate the interview statements about the 'green office building boom' and the development of 'GreenStar' certifications in Brisbane, we evaluated secondary data provided by the GBCA project directory website.1 The data provide details about the type of certifications and about locational and temporal aspects of the certified projects. According to the GBCA point category, projects are certified as four ('Best Practice'), five ('Australian Excellence') or six ('World Leadership') 'GreenStar' point. Our analysis of the place and time of certified projects confirmed the experts' and stakeholders' statements. After a slow start during the first years, a strong uptake of certified green building projects occurred in 2008 and 2009 (see Fig. 5.3). Since then, the total number of certifications has continually increased.

[1] http://www.gbca.org.au/project-directory.asp

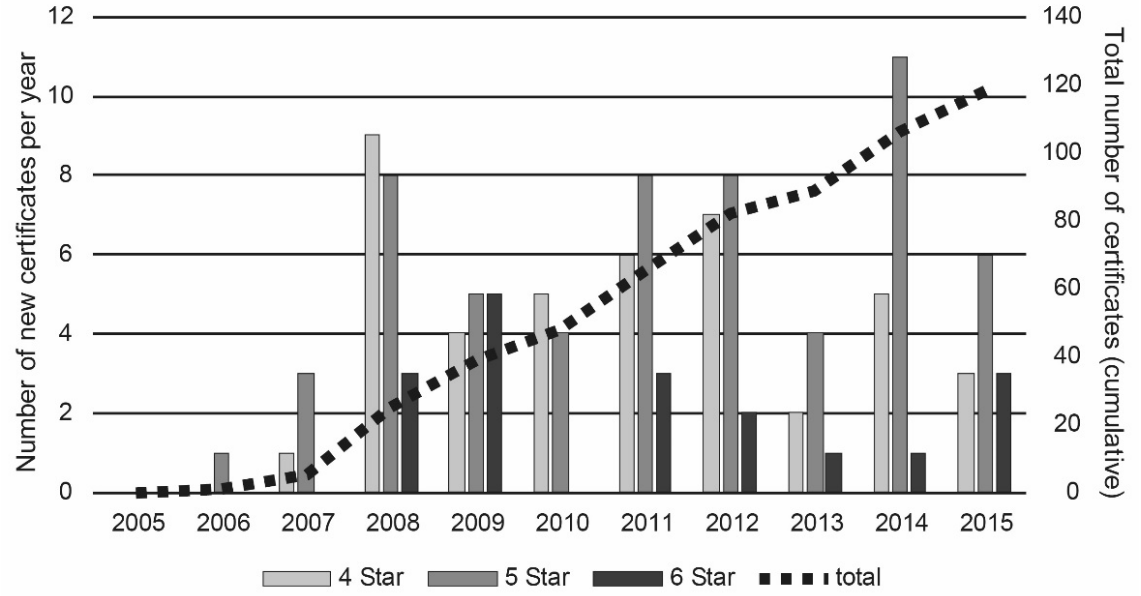

Figure 5.3: Green Star certificates (4, 5 and 6 stars) in the City of Brisbane 2005-2015. (Own figure, data source: GBCA 2016)

The political influence in the uptake of greener office buildings is debated, with experts and stakeholders claiming that the development was based on property market mechanisms mainly driven by industry actors. The adoption of 'GreenStar' certification coincided with the industry support for greener buildings by the 'Property Council of Australia' (PCA), a strong lobby group of the property industry. PCA's property ratings, which are important for the value and the leasing of office buildings, were linked to the 'GreenStar' rating tools (BR-Lob2, BR-Lob3 BR-Prac1). Interviewees highlighted the PCA 'sustainability parameters', which were added to the 'Guide to Office Building Quality' in 2006 and further improved in 2011 (BR-Lob3). The guide was used to classify office space into grades – from Premium to A, B, C or D Grade. As a result, 'GreenStar' ratings became an important benchmark for new 'Premium Grade' buildings in the CBDs and inner city suburbs (PCA, 2006). As stakeholders and experts explained, 'Premium' buildings are expected to bring reduced vacancies and a higher return on investment. Green office buildings were also becoming more prestigious and were commonly utilised as central marketing tools to increase the building and rental values (BR-Lob3). Long-term thinking of large institutional investors and of developers are seen as important influencing factors in transitioning the commercial building sector since the mid-2000s.

The results of our analysis of the locations of 'GreenStar' certifications in Brisbane support the assumption of an interrelation between 'GreenStar' and PCA's ratings. Most of the certified projects are located in Brisbane's Central Business District and surrounding inner city districts, the preferred office locations for Premium and A-grade buildings (see Fig. 5.4).

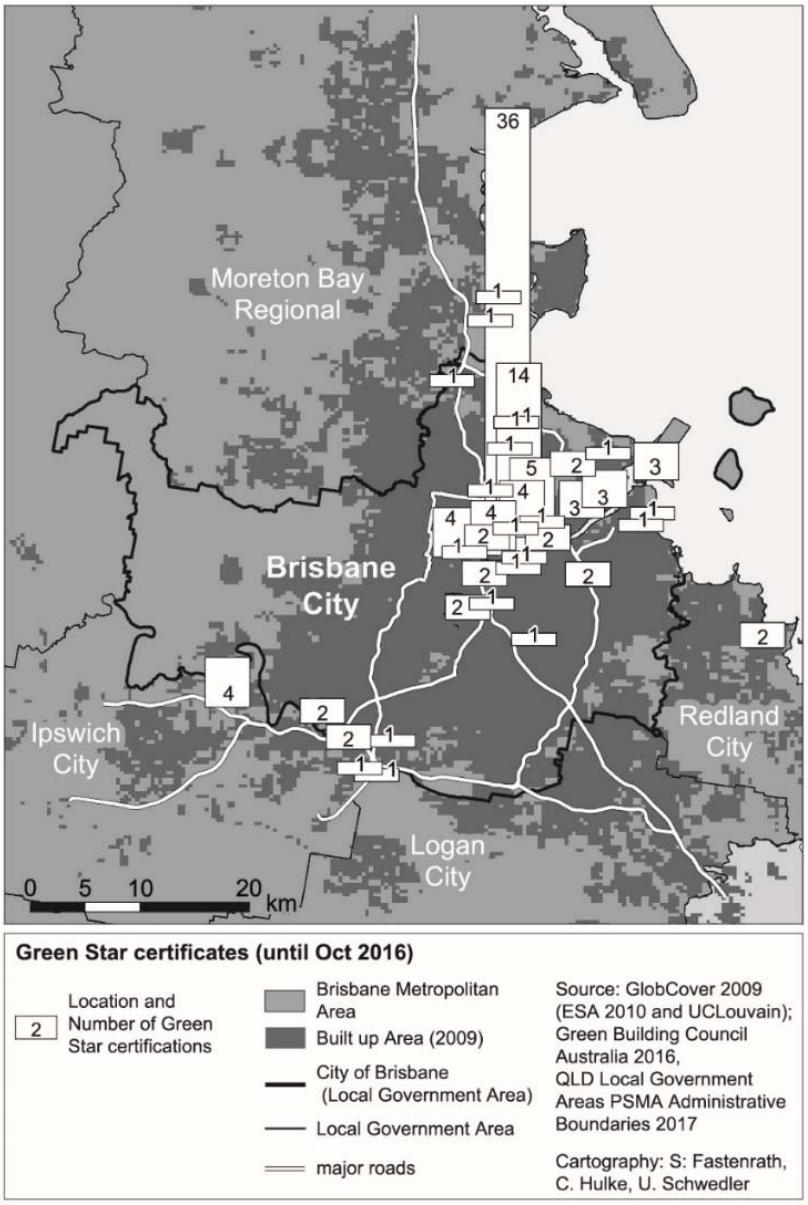

Figure 5.4: Locations of Green Star certified projects in Brisbane

Experts and stakeholders agree that the support from both private and public sectors for green building (commercial and residential) lost momentum at the end of the 2000s. Two

causes could be identified for this turn. First, the global financial crisis (GFC) of 2007-2009, which led to decreasing investments in building and construction in the following years. Second, the BCC elections in 2008, when Campbell Newman was re-elected as Lord Major and the Liberal Party held a majority position in the council. The strong economic focus of the party's policy agenda was widely seen as a major barrier for continuing the green building pathway in Brisbane.

5.6.4 Path disruptions through regime resistance (2010s)

The conflicts in the city's agenda setting between economic and sustainability actions turned out to be more critical when Brisbane's Lord Mayor became Queensland's Premier Minister by forming a majority government of the Liberal National Party in 2012. As a result, the policy objectives shifted to an almost exclusively economic focus. When the QLD Gov and the BCC stopped a number of sustainability programs and related working groups, the green building pathway was disrupted. By using the argument of saving costs and tax payers money, programs such as the 'Climate Smart Home Service' were discontinued as part of the government's plan "to get this state back on track" (QLDGov, 2012). This program was originally conceptualised as a service for homeowners to improve their energy and water efficiency through consultation of qualified tradespersons. Concurrently, the QLD Gov's 'Office of Clean Energy' was closed, an office that coordinated programs in the field of renewable energy and energy efficiency. The requirements for new homes to include rainwater tanks and energy efficient hot water systems were scrapped (QLDGov, 2013). Furthermore, the leadership role in greening government buildings was abolished. The goal of greening own or rented buildings and the application of 'GreenStar' certifications were widely neglected both by the state government administration under the Liberal National Party and also by the BCC. As a BCC employee explained, the guidelines for the city's buildings where softened at that time:

> *"We should apply for best practice. […] It is not written in that policy 'you must' or 'you have to' apply to certain GreenStar standards or NABERS [National Australian Built Environment Rating System]. What is best practice? It is very open, vague, non-committal." (BR-Adm6)*

A number of experts, stakeholders, and also GBCA officials review these policy distractions at that time as critical (GBCA, 2015). However, despite the lack of political support, the commercial building sector is continually changing towards more

sustainable modes. In contrast, the residential sector lags behind. Key stakeholders explained that the demand for sustainable homes remains on a low level, particularly in new master-planned communities.

5.6.5 Challenges and barriers in the residential building sector

In contrast to the distinct 'greening' processes in the office building sector, homes in Brisbane are still not substantially sustainable. New master-planned communities are widely seen as an important transition field. These areas, comprising homes for often more than 5,000 new residents, offer the opportunity to establish more sustainable building principles and infrastructures from scratch. However, the interviews with stakeholders shed light on the complexity and the challenges in transitioning the residential sector in Brisbane. These insights provided details about the process chain from planning processes to new buildings in master-planned communities (see Fig. 5.5). By exploring responsible stakeholders, key barriers, and proposed changes at different stages of the process chain, we identified systemic and institutional path dependencies that make significant changes towards greener homes difficult.

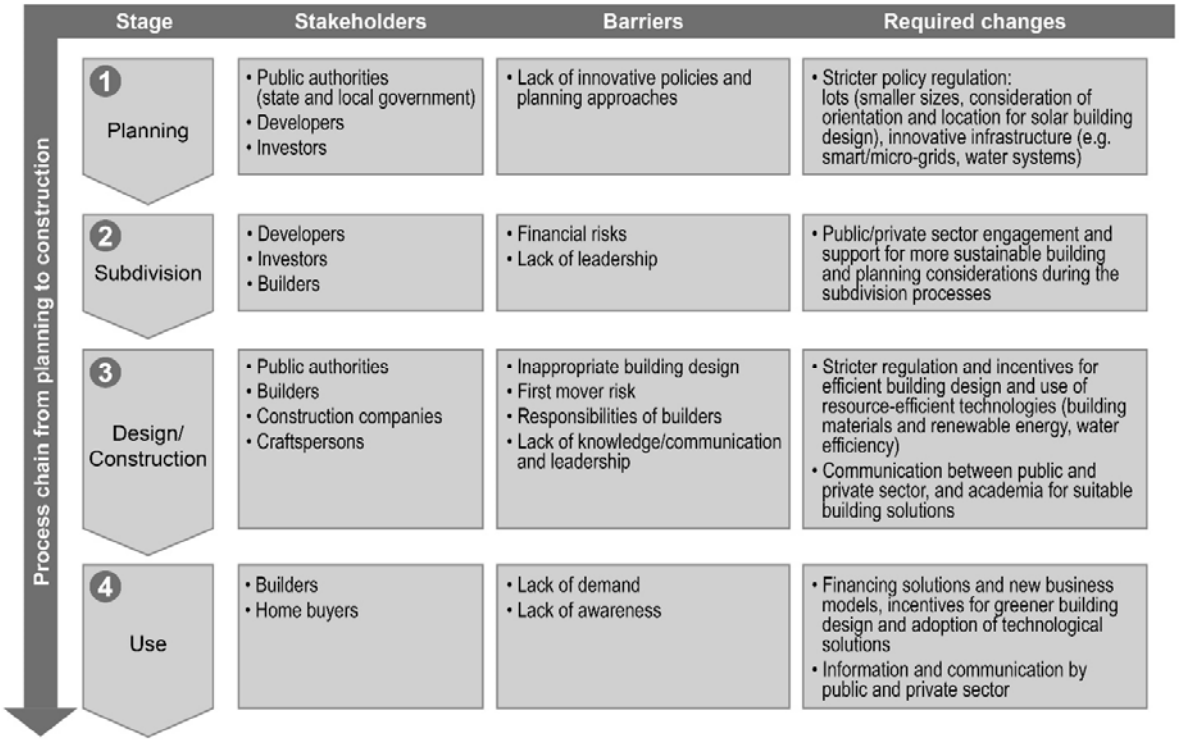

Figure 5.5: Process chain of residential buildings in master-planned communities (Own figure, slightly adapted from UNEP 2014, based on expert and stakeholder interviews)

We identified three major stakeholder groups that could potentially influence changes at different stages of the process chain: Policy makers (politicians and different public authorities), building and property industry actors (developers, builders, tradespersons) and home buyers. At the first and second stage, property developers and public authorities could enable transition processes during the planning stages and the subdivision of land. These most powerful actors are able to define the orientation of lots and the utilisation of innovative infrastructure. However, as a representative of a property developer explained, the developer's influence on the building design is usually limited:

> *"[...] we don't necessarily deliver the built form outcome. Our business is based on the land, selling land basically. So other people come along and then build buildings on that, whether they are consumers, builders, small developers and so forth." (BR-Prac5)*

While the builders, often small or medium-sized enterprises, generally decide about the building designs, features and materials, the home buyers decide about design variations that are offered in the builder's portfolio. The demand for green homes is continually low. A representative of a builder's lobby group made clear that particularly smaller companies are not willing to face early mover risks and adopt green building solutions without any cost-advantage (BR-Lob5). Affordability and the additional costs for home buyers were often reviewed as a great barrier for shifts in this sector (e.g. BR-Lob2, BR-Lob4, BR-Lob5, BR-Prac1, BR-Prac5).

In light of all stakeholder perspectives and interests in the residential building sector, the situation must be interpreted as a dilemma. Even though experts and stakeholders widely agree that the residential building sector is lagging behind and sustainability transitions are required, both policy makers and industry actors resist innovative forms of building regulation and planning approaches. The situation can be understood as an industry-policy lock-in: both sides identified the other side as the one responsible for driving sustainability forward. The debates about transitioning the residential building sector are dominated by the discussion on whether the sector needs to be driven by a regulatory push or by industry-driven demonstration projects.

One group of interviewees argued that, to push the industry actors to change their practices, resource efficiency and solar building design need to be more strictly regulated (e.g. BR-Lob2). The National Construction Code (NCC), 'Section J' (mandatory component of the NCC) and the Nationwide House Energy Rating Scheme, which set minimal energy-efficiency requirements for new homes, are seen as critical in coping with subtropical building design (BR-Adm6, BR-Prac1, BR-Prac3, BR-Prac6, BR-Lob2). Other interviewees argued that changes need to be driven by market mechanisms and demonstration projects. The GBCA's rating scheme for precincts, neighbourhoods and communities,

released in 2016, raised many experts' and stakeholders' expectations. Hence, the GBCA may play a driving role as a transition agent again. Nevertheless, a majority of stakeholders assumed that significant changes in the residential building sector need to be achieved through a combination of policy regulation, the support of different industry actors and increased awareness of home buyers (e.g. BR-Con1, BR-Lob2).

5.7. Discussion and conclusions

Drawing on the vibrant debates on urban sustainability transitions (Hodson et al., 2017), this paper sheds light on the building sector with a special focus on detractions and challenges. While there is a growing body of literature on successful urban transitions, the case of Brisbane provides findings on a contrasting example. The analysis offers insights into ambivalent 'sustainability transition pathways' (Turnheim et al., 2015) and processes of 'regime resistance' (Geels, 2014). Based on expert and stakeholder knowledge and policy document analysis, the paper exemplifies the importance of considering place-time specificity for a deeper understanding of urban transition processes.

By tracing back Brisbane's green building trajectories, the paper provides in-depth insights into co-evolutionary dynamics in building practices, involved actors and interrelations within the institutional, economic and socio-political city context. The case study demonstrates how complex and distracted urban transition dynamics can be and how they vary at different times. We identified four transition phases with diverging processes, drivers and distractors.

First, Brisbane's green building pathway started early with university research and experimental projects on solar building design and energy efficiency in the 1960s and 1970s. Even though the innovative research was globally recognised in academia, the knowledge gained did not result in a broad uptake of innovative practices in the local building and construction industry. During this first phase, green building remained a niche phenomenon in both the residential and commercial building sectors. The reason can be found in the lack of societal driven bottom-up initiatives and the lack of driving 'transition agents' (Fastenrath and Braun, 2016). These missing structures might partly be a result of a lack of demonstration projects and 'learning by doing' in the first transition phase. The lack of persuasiveness and power of early adopters and innovators must be interpreted as an important piece of the puzzle in explaining current challenges in transitioning Brisbane's building sector.

Second, policy-driven top-down approaches appeared comparably late. First initiatives were developed during the 1990s, when climate change adaptation strategies, energy efficiency, and the role of the building sector became more discussed at different policy levels. New planning approaches, building guidelines and basic regulations came into being, and also the building and construction industry started to support sustainable practices by initiating demonstration projects in this second phase.
Third, green building practices and policies became a public issue during the 2000s. The BCC and also the QLD Gov demonstrated strong leadership by supporting green commercial and residential building projects. Ambivalent sustainability transition pathways evolved in the mid-2000s. While dynamics in the residential sector stagnated, a green office building boom occurred when a number of certified building projects were developed in Brisbane's Central Business District. While the effect of policy support is debated, the changes were certainly affected by property market mechanisms and industry actors focusing on long-term investments. The Green Building Council Australia played a crucial role as a 'transition agent' with its 'GreenStar' office building rating schemes.
The fourth phase is characterised by government changes from a Labor Party to a Liberal-National coalition at the local and later at the state government level. The anti-sustainability policy agenda and powerful lobby work by the building and property industry organisations must be interpreted as 'regime resistance' (Geels, 2014). They evoked disruptive policy trajectories and reinforced the low transition dynamics in the residential building sector. This contribution clearly evaluated processes of 'policy resistance' (de Gooyert et al., 2016) – the discontinuity and even pushing back of policies to initial settings – especially in the residential building sector.

The findings presented in this paper have a number of implications for further research but also provide practical insights for policy makers. Furthermore, our analysis demonstrates the importance of evaluating the heterogeneous interests and perspectives of stakeholders in the sustainability contexts. Moreover, the paper has identified driving 'transition agents' and 'transition detractors', shifts in building practices and interactions with policy and industry spheres. These findings should enable policy makers to consider specific urban conditions and the historic contexts to 'custom-tailor' sustainability actions and to create new pathways of governance. All stakeholders need to play an active role in identifying solutions towards transitioning the building sector. The applied transdisciplinary workshop concept, as part of our empirical research concepts, was highly valuable in bringing stakeholders and experts together and in generating local knowledge and ideas interactively (Preller et al., 2017). The limitation of this work derives from the lack of comparable case studies focusing on the challenges and disruptions in sustainability transitions in the building sector. Particularly a comparative

study including other large Australian capital cities such as Adelaide, Melbourne, Perth or Sydney would be helpful in identifying patterns and differences of green building transitions.

Place dependency must receive more attention as a conceptual and analytical aspect in transition research (Haarstad, 2016; Hodson et al., 2017; Nicolosi and Feola, 2016). Numerous opportunities exist for future research in the field of 'Geographies of Sustainability Transitions' (Hansen and Coenen, 2015) that would help in analysing socio-technical changes in different urban contexts and in other transition areas such as energy, transport, manufacturing or food production. To better understand technological transformations and its social, institutional and economic drivers and implications, there is a need for further in-depth analysis of urban contexts.

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CHAPTER 6: Concluding discussion

This dissertation contributes to the vibrant debates on urban sustainability transitions in three ways. First, it offers new perspectives on socio-technical change in the urban sustainability context by bridging conceptual approaches from Transitions Studies and Economic Geography, which shed light on the interplay of drivers, governance processes and changed practices. Second, using the context of the 'forerunner city' Freiburg (Germany) and the sustainability 'lagger' Brisbane (Australia) as case studies, this dissertation provides detailed insights into shifts in the building and construction sector – a long neglected sustainability transition field. Third, it demonstrates how important collaboration and interactive knowledge generation between a wide range of actors is to understanding processes of socio-technical change.

A theoretical goal of this dissertation is to provide wider perspectives beyond the concept of the 'Multi-level perspective' introduced by scholars of Transition Studies (e.g. Geels, 2002). This theoretical approach has been criticised for its open conceptual framework, challenges in operationalisation, and strong interpretative character (Smith et al., 2010). Moreover, the concept does not provide answers why and how transitions occur and develop unevenly in different spatial and temporal contexts. Therefore, this dissertation resonates with the debate of a 'geographical turn' in Transition Studies to better understand socio-economic processes in a relational understanding. Based on the first ideas of a 'Geography of Sustainability Transitions' (Hansen & Coenen, 2015; Murphy, 2015; Truffer & Coenen, 2012), this dissertation sheds light on the interplay of changed practices, governance processes and other drivers of sustainability transitions in specific spatial-temporal contexts.

A key goal of this dissertation is to add knowledge to the debates around spatial and temporal aspects in urban sustainability transitions by providing in-depth empirical insights of two urban contexts. By tracing back the green building pathways in both contexts, the key driving and resisting actors, the role of policy decision-making, and the directions of the transitions could be identified.

The results of the empirical research of this dissertation clearly demonstrate how urban sustainability transitions are contextually specific. Both city contexts, Freiburg (Germany) and Brisbane (Australia), evoke different co-evolutionary dynamics based on practices in the building sector, actors, directions of change and interrelations between these elements.

6.1 Reflections on the case study of Freiburg

The case study of Freiburg gave the rare opportunity to analyse long-term sustainability transitions from conventional building practices to passive houses and plus-energy buildings. Without neglecting critical aspects and feedback loops, the case study of Freiburg focused on this successful transition pathway. The goal was to understand the city's significant changes in the building sector by analysing the interplay of policy decisions, building practices, and involved actors. Two main directions of change could be identified: a 'bottom-up' directed pathway, initiated by pioneers, research institutions and early adopters; and a 'top-down' pathway, driven by policy-makers.

Freiburg's history of 'green' building started within niche developments in the late 1970s. Embedded in the critical debates about a state-planned nuclear power plant close to Freiburg, a strong anti-nuclear and environmental movement established in the city region. As an outcome of the discussions on energy efficiency and renewable energies, architects and engineers initiated innovative building projects considering solar architecture principles and the integration of renewable energy. Concurrently, experiments with low-carbon technologies and building-design and renewable-energy solutions were conducted at newly established research institutes in Freiburg. Influenced by a network of experts, first policy initiatives towards energy transitions were conceptualised by different city authorities. The local government became an active driver of transition processes in the late 1980s. Since then, energy efficiency in buildings has been a core element in Freiburg's sustainable urban development strategies. The city council, strongly influenced by the Green Party, benefited from the gained knowledge in energy and environmental issues. In 1992, the local government established Freiburg's low-energy building standards which were significantly stricter than federal standards.

The analysis shows that early grassroots movements were key for initial sustainability transitions. These early stages were characterised by 'path creations' through demonstration projects, experimentation, learning processes, and negotiations with policy-makers. As a result, the city was one of the first German cities to introduce stricter building regulations. These changes were strongly embedded in Freiburg's specific urban context and were the result of co-evolutionary processes. A key role was played by 'transition agents' – experts, practitioners and representatives of citizen movements who were able to bring expectations to the local policy. Interactions between these 'transition agents' and policy-makers were crucial for the development of policy regulations. The initially resistant group of local architects, builders, planners and craftspeople had to follow the new requirements and change their routines by adopting new materials, technologies and practices.

The introduction of the local building regulations and its amendments in the following years were strongly connected to the new built 'eco'-districts, Rieselfeld and Vauban. Both

neighbourhoods, mainly developed from the mid-1990s to mid-2000s, are globally recognised examples of sustainable urban development, particularly for energy-efficient building. The interplay of innovative policy-making, civic participation approaches, large-scale development projects, learning processes and the expertise from local experts were crucial factors at the time. Today, all new residential building projects are affected by the city's strict low-energy requirements which almost meet energy-performance standards of the 'passive house'.

The continuity of Freiburg's strict local building regulations was a key catalyst for continual 'learning by doing' processes. The two new developed districts in Freiburg, Rieselfeld and Vauban, were important testbeds for the innovative building regulation and further alternative low-energy building designs. Vauban's 'Solar Settlement', finalised in the mid-2000s, is internationally renowned and is an important destination for international 'green' tourists. Innovation processes toward further green building developments lost momentum. As local experts and stakeholders critically described, this might be a result of a dominant 'top-down' governance approach that left little room for 'bottom-up' innovation. They argue that the city council is less open to innovate and experiment, and consider pioneering ideas. Furthermore, critical voices appeared, pointing out the missing social sustainability aspects in Freiburg's greening processes (e.g. Freytag et al., 2014; Mössner, 2015). The challenges in linking environmental and social issues has developed as a key topic around sustainability in Freiburg. Research on possible negative social outcomes of 'greening' processes is increasingly discussed. In-depth analysis on who is or might be negatively affected by sustainability transitions is a promising research area for the future sustainability research.

6.2 Reflections on the case study of Brisbane

In contrast to the 'success stories' and deeper transition processes in Freiburg's building sector, the case study Brisbane sheds light on detractions and challenges. Responding to the growing body of literature dealing with successful urban transition pathways, the case of Brisbane provides insights on processes of resistance and challenges. The evolutionary perspective was helpful to outline how dynamics of change vary in different phases. Four transition phases with diverging processes, drivers or distracting actors could be identified.

Unexpectedly, green building was a topic in Brisbane's academic sphere back in the 1960s. Innovative research and experimentation in solar building design and energy efficiency at universities in Brisbane was globally recognised in academia in the 1960s and 1970s. However, the gained academic knowledge about energy-efficient building designs did not

result in wider considerations of innovative practices. Green building continued to be an experimental niche.

There was a distinct lack of bottom-up initiatives, including missing transition agents who drive ideas into the policy-making or industry spheres. Apart from single research projects, other demonstration projects and 'learning by doing' processes were hard to find in the first transition phase. Important grassroots movements, including local early adopters and researchers with the power to influence policy decisions, could not be identified.

This lack of powerful bottom-up drivers and, therefore, missing interactions with policy-makers may also explain the current challenges in transitioning Brisbane's building sector. Apart from missing 'bottom-up' structures, policy-driven 'top-down' approaches also appeared comparably late. The first policy initiatives that affect the building sector were developed during the 1990s, when the topics climate change and energy efficiency started to play a role and were discussed at different policy levels. As a result of these developments, first new planning approaches and building guidelines were introduced in Brisbane. Despite the lack of a strong sustainability-oriented 'bottom-up' movement and the lack of 'top-down' political support for green building, economic actors slowly started to drive changes in the built environment. Demonstration projects were initiated and driven by the local building and construction industry organisations to support and test alternative practices.

In the 2000s, green building practices gained more attention. The Brisbane City Council as well as authorities within the Queensland state government started to support green building projects, primarily in the commercial sector. A green office building 'boom' saw the construction of a number of certified green buildings in Brisbane's Central Business District. Identified as the dominant driving key actor, the Green Building Council of Australia played a crucial role as a 'transition agent'. The organisation introduced the 'GreenStar' ratings, a certification scheme for greener office buildings. Office buildings have become more prestigious and are understood as central marketing tools to increase building and rental values. Compared to typical office buildings in the 1980s and 1990s, newer commercial buildings consider resource efficiency through innovative building design (e.g. increased daylight usage, cross-ventilation), and the use of environmental technologies and materials (e.g. PV-installations, co- or tri-generation systems, water tanks, monitoring systems). Long-term thinking of investors and property developers, and the introduction of certification tools are seen as important factors for transitioning the office market. To what extent the policy support helped to gain momentum is debated. The interviews show that experts largely agree that changes were explicitly affected by property market mechanisms and by industry actors focusing on new business opportunities and long-term investments.

In contrast to these disrupting developments in the commercial building sector, the dynamics in the residential building market stagnated. There was little interest in new building practices and design (building shape, orientation, internal layout, ventilation) and the use of innovative materials and technologies (insulation, cooling/heating systems, integration of renewable energies). A number of hindering processes, interests and actors were identified and must be interpreted as causes for the ambivalent development: path dependencies, resistance, and lock-ins were found in all three analytical structures (political-institutional, economic and socio-cultural).

By analysing the political context of Brisbane's green building pathway, the discontinuity of policies supporting changes in the building sector was identified. The last phase of Brisbane's green building pathway is characterised by policy and industry resistance. Government changes, from the Labor Party to a Liberal–National coalition, at the local and, later, state level evoked significant shifts toward an anti-sustainability policy agenda. As a result of governmental change, long-term sustainability agendas, including incentives or guideline programs, have been distracted and, in some instances, retracted after elections. There is agreement that these policy discontinuities, as well as the strong lobby work of the building and property industry, lead to disrupted green building trajectories. These processes of political-institutional recurring resistance can be interpreted as institutional lock-ins.

Similarly to the policy sphere, short-term thinking and prioritising of economic factors as well as industry actors (property developers, builders, crafts) were identified as critical elements. Analysing the role of economic structures in greening the housing sector also showed that a number of sector specificities influence the sustainability transitions. For instance, the lack of innovative approaches and learning processes, professional education and skills, and availability of materials was identified as crucial to slow transition processes.

Also, civil society actors embedded in the city's socio-cultural structures demonstrated comparably weak support for a sustainability agenda. While a small number of local non-government organisations (NGOs) could be identified, a powerful 'bottom-up' environmental movement could not be identified. An important argument of industry actors is that the demand for sustainable homes is continually low. Experts and stakeholders agreed there is a general lack of awareness of environmental and sustainability topics in Brisbane. Home buyers tend to purchase the cheapest possible house, and are not willing to play the role as an early mover.

6.3 Reflections on the methodological approaches

The mixed methods approach was highly valuable to gain knowledge about urban sustainability transitions. The triangulation of data and insights through workshops, document analysis and semi-structured interviews provided a strong basis for interpretation.

In both case study cities, the first step – the kick-off workshops with stakeholders and experts in the building and construction context – was key to identifying key processes and involved actors, as well as temporal and spatial specificities. The method, conceptualised as co-production between practitioners and researchers, provides great opportunities for further research in the field of geography of sustainability transitions and neighbouring disciplines. The results demonstrated that continual engagement and exchange with local experts, policy-makers and practitioners leads to a better understanding of different perspectives of the topic, and also provides the opportunity for critical reflection and actions toward more environmentally friendly solutions and experimentation in urban contexts. As the results of this dissertation outline, participatory research and knowledge co-production can provide valuable scientific and societal outcomes. Interactions and dialogue between researchers and private- and public-sector actors can generate or further develop knowledge, values and skills. Further research could go a step further and develop approaches that capture the gained knowledge and understanding of problems by providing concepts for capacity building and solutions in the public and private sectors and, also, for communities.

The second methodical step, the analysis of formal institutional settings, aligned with qualitative interviews in the third step, an in-depth perspective on processes of change and the underlying causalities. Therefore, tacit knowledge and facts not chronicled in formal documents could be identified and interpreted. This was particularly important to understand processes of change in both case studies. In Freiburg, the processes of interaction between bottom-up and top-down spheres were identified through personal expert interviews. The described negotiation processes between activists and policy-makers for stricter building regulations was one example of this necessary step. The information on informal institutional processes could not have been gained solely by a document analysis.

6.4 Limitations

This dissertation provides several new insights in urban sustainability transitions; however, there are limitations. Even though both case study contexts are growing cities

in the Global North, the socio-economic, political, historical and cultural differences between these contexts in Germany and Australia are significant. The analysed processes in the building and construction sector in Freiburg and Brisbane are highly context-specific. Therefore, the findings do not allow for an evidence-based generalisation for other cities in Germany or Australia. Furthermore, limitation derives from the lack of comparable case studies focusing on resistance and challenges in sustainability transitions in the building sector. Further studies are crucial to identify patterns of green building transition processes.

Limitations also derived from urban complexities. City contexts are complex systems; a research approach that considers all processes that influence sustainability transitions is challenging. Nevertheless, the in-depth empirical work based on the triangulation of merely qualitative data provides a reliable basis for interpretation and explanations for both specific urban contexts. The combination of insights of expert/stakeholder workshops, policy documents and interviews as well as other secondary data such as industry reports was highly valuable to reduce complexity.

This dissertation focuses primarily on 'internal' sustainability transition processes of cities. However, there are certainly links to external processes and policy levels, networks and path dependencies. The growing literature on 'policy mobility' (e.g. Affolderbach & Schulz 2016) resonates with this debate and should be considered in further research on urban sustainability transitions.

6.5 Policy implications

The findings of this dissertation provide valuable insights for policy-making decisions. The analysis of the case studies demonstrates that the evaluation of diverging interests and perspectives in the sustainability context is key to understanding processes of change and resistance. The identification of established structures and local conditions and specific policy pathways, as well as driving 'transition agents' and resisting 'transition detractors', is important to initiate sustainability actions. The findings lead to the conclusion that a simple 'copy and paste' of best practices is not suitable to initiate or drive 'urban green building transitions'. Non-static, evolutionary thinking should play a bigger role in policy decisions. To create new pathways of change, policy-makers should trace historical processes of knowledge creation and decisions, and the role of specific actors to 'custom-tailor' solutions and supportive actions toward new ways of practice.

Furthermore, this dissertation provides insights about the directions of sustainability transitions. The 'success story' in Freiburg has shown that transition processes were

initially driven by 'bottom-up' initiatives and later by the interplay with 'top-down' policy support. 'Bottom-up' actors were crucial for addressing interests, ideas and knowledge through negotiations as 'transition agents'. Significant changes occurred when these actors were able to interact with established political and economic structures. This leads to two assumptions. City authorities should continually interact with bottom-up actors and structures, and protect these processes with policy instruments if necessary, especially when market mechanisms do not support transitions. However, more case studies are needed to validate the success of dynamic interplay of bottom-up niche developments and top-down processes. The Brisbane case demonstrates the challenge for sustainability transitions when there are neither society-driven 'bottom-up' nor policy-driven 'top-down' processes to trigger changes.

By staying open to innovative policies and demonstration projects, and learning from their success and failure, public sector actors perform a valuable role in promoting and encouraging sustainability transitions. This dissertation demonstrates the importance of collaboration between actors from the public, private and academic sectors in creating and transferring knowledge for socio-technical change. Instruments for exchange such as multi-stakeholder workshops, as explained in Chapter 3, have great potential for inclusive and collaborative policy decision-making.

6.6 Outlook for further urban sustainability transition research

Place-dependence and temporal aspects still need more attention in urban sustainability transition research. The ideas for a 'Geography of Sustainability Transitions' (Hansen and Coenen, 2015) help in analysing socio-technical changes in different urban contexts and in other transition areas such as energy, transport, manufacturing and food production. Further in-depth analysis of urban contexts is required to better understand technological transformation and its social, institutional and economic drivers and implications. The conceptual framework followed in this dissertation, along with the two contrasting urban contexts, help to gain new explorative insights and to pave the way for further urban sustainability transition research.

Comparative empirical research on green building transitions between the results in Freiburg and other German cities and also between the processes in Brisbane and other Australian cities would be highly useful to understand how green building transitions are embedded in other city contexts. New places, scalar dimensions, dynamics and processes need to be more keenly analysed. Particularly, trans-local perspectives and the 'mobility' of policies and alternative practices in the context of sustainability transitions would deliver new insights. Additionally, more knowledge is needed in the field of sustainability

transition processes in Global South city contexts, which are facing other challenges in transitioning sectors such as transport, energy, food production and housing. Comparative work on transitions in cities of the Global North and Global South would further enrich the debate.

Furthermore, examples and conceptual ideas of processes of 'learning by failing' are lacking. Therefore, apart from further work on 'best practice' examples and model cases, lenses should be developed on processes of resistance and 'failed' transitions. The debates should also be more open for social innovation, and avoid approaches with a solely technological focus. Open approaches that consider the interplay of governance processes, 'learning by doing' and changes in practices over time should be further considered. While tracing back transitions is helpful to identify path dependencies and lock-ins, a closer look on ongoing processes in experimentation or 'living labs' would help to understand transitions in real time and, also, actively influence and scale up transition processes.

Finally, in order to apply the new conceptual ideas, transdisciplinary research approaches are required to consider the complexity of urban sustainability transitions as well as to develop solutions and actions for policy-makers and practitioners. The demand for a transdisciplinary turn in urban transition research has been articulated in a number of publications (e.g. Preller et al., 2014; WBGU, 2016). In their edited book on 'urban sustainability transitions', Frantzeskaki et al. (2017a, p. 17) emphasised the importance of "[…] transdisciplinary explanations of urban sustainability transitions that co-create new knowledge to demystify context and its influence in how transitions roll out". Interactive research considering perspectives and in-depth insights into public, private and academic sectors is crucial for a broader contextual and spatial understanding in urban transition research.

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Summary

This dissertation contributes to the vibrant debates on the Geography of Sustainability Transitions in three ways. First, it offers new conceptual perspectives on socio-technical change by bridging approaches from Transition Studies and Economic Geography. The combination helps to shed light on the interplay of drivers, governance processes and changed economic practices. Second, using the 'forerunner city' Freiburg (Germany) and the 'sustainability lagger' Brisbane (Australia) as case studies, this dissertation provides detailed insights into sustainability transitions in local building and construction sectors – a largely neglected sustainability transition field. Third, it demonstrates how important collaboration and interactive knowledge production between a wide range of actors and stakeholders is to understand processes of change as well as providing knowledge for policy decision-making and guiding industry actors.

Drawing on the debates about a 'geographical turn' in transition research to better understand socio-economic processes, this dissertation pays special attention to spatio-temporal and relational aspects. Special attention is drawn to the interplay of changed practices, governance processes and the drivers and directions of urban sustainability transitions in these two specific spatial-temporal contexts. The results demonstrate how urban sustainability transitions are contextually specific. Freiburg and Brisbane stand for contrasting pathways based on their specific co-evolutionary dynamics in the building sector, including learning processes, policy support, and involved driving and resisting actors. The Freiburg case study demonstrates how transition pathways were initially driven by a strong grassroots movement from the 'bottom-up', then, at a later point, in the interplay of policy-driven 'top-down' processes. The Brisbane case study outlines a picture of an ambivalent development. While significant shifts in the commercial building sector can be identified, there is slow momentum in the residential sector.

This dissertation is based on a collection of four journal articles. Article 1, "Lost in Transition? Directions for an Economic Geography of Urban Sustainability Transitions", contributes to the theoretical and conceptual debates on sustainability transitions, and discusses ways of bridging concepts of Economic Geography and Transitions Studies. Article 2, "Interactive knowledge generation in urban green building transitions", provides methodological insights to the first empirical step of this dissertation – an interactive workshop concept that helped to gain knowledge interactively with a wide range of stakeholders. Article 3, "Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany)", offers a detailed analysis of green building transitions in the sustainability forerunner city of Freiburg. The article explains

the significant shifts in the local building sector toward increased energy-efficiency. Article 4, "Ambivalent urban sustainability transitions: Insights from Brisbane's building sector", sheds light on processes of resistance and challenges in urban sustainability transitions in the building sector.

Zusammenfassung

Die Dissertation trägt in dreierlei Weise zu den Debatten der Geography of Sustainability Transitions bei. Erstens zeigt die Dissertation durch die Kombination von Ansätzen aus Transition Studies und Wirtschaftsgeographie neue konzeptionelle Perspektiven zum Verständnis von sozio-technischem Wandel auf. Diese Blickwinkel ermöglichen es, das Zusammenspiel von treibendenden und bremsenden Akteuren, Governance-Prozessen und sich änderden ökonomischen Praktiken aufzuzeigen. Zweitens bietet die Dissertation mit den kontrastierenden urbanen Kontexten – der ‚grünen Modellstadt' Freiburg (Deutschland) und dem ‚Nachzügler' Brisbane (Australien) – detaillierte Einblicke in Transformationsprozesse im Bausektor, einem weitgehend vernachlässigten Untersuchungsfeld der Transformationsforschung. Drittens zeigt die Dissertation, wie bedeutend Kooperationen und interaktive Wissensgenerierung zwischen einer Vielzahl von Akteuren und Stakeholdern ist, um Transformationsprozesse zu verstehen, zum anderen aber auch um Wissen für politische Entscheidungsträger bereitzustellen.

Ausgehend von den Debatten zu einer ‚geographischen Wende' und den damit verbundenen veränderten Blickwinkeln auf sozio-ökonomische Prozesse in der Transformationsforschung, schenkt die Dissertation raum-zeitlichen und relationalen Aspekten besondere Aufmerksamkeit. Die Ergebnisse der beiden Fallstudien zeigen deutlich wie kontext-spezifisch urbane Transformationsprozesse zur Nachhaltigkeit sind. Die Beispiele Freiburg und Brisbane stehen für kontrastierende Entwicklungspfade mit unterschiedlich verlaufenden Phasen und co-evolutionären Dynamiken, angetrieben durch Lernprozesse, Aktivismus, Widerstand und politische Unterstützung. Die Fallstudie Freiburg zeigt, wie seit den 1970er Jahren Transformationen im lokalen Bausektor zunächst von einer gesellschaftlich angetrieben ‚bottom-up' Bewegung und zu einem späteren Zeitpunkt im Zusammenspiel mit politikgesteuerten ‚top-down-Prozessen' vorangetrieben wurden. Die Fallstudie Brisbane skizziert dagegen das Bild einer ambivalenten Entwicklung. Während im gewerblichen Sektor signifikante Veränderungen festzustellen sind, erfährt der Wohnsektor nur eine langsame Dynamik. Periodische Widerstände von politischen und wirtschaftlichen Akteuren können hier als Hauptursache ausgemacht werden.

Die Dissertation basiert auf einer Sammlung von vier Fachartikeln. Artikel 1, *Lost in Transition? New directions for an Economic Geography of Urban Sustainability Transitions*, trägt zu den theoretischen und konzeptionellen Debatten zu Sustainability Transitions bei und diskutiert Möglichkeiten Konzepte der Wirtschaftsgeographie und Transition Studies zu verbinden. Artikel 2, *Interactive knowledge generation in urban green building transitions*, liefert methodologische Einblicke in den ersten wichtigen Schritt der Dissertation, ein interaktives Workshop-Konzept, das dazu beitrug, Wissen interaktiv und Kooperation mit einer Vielzahl von Stakeholdern zu gewinnen. Artikel 3, *Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany)*, bietet eine detaillierte Analyse von Transformationspfaden im Bausektor in der ‚grünen' Vorreiterstadt Freiburg. Der Artikel liefert Erklärungen zu den dynamischen lokalen Veränderungen im lokalen Bausektor hin zu mehr Energieeffizienz. Artikel 4, *Ambivalent urban sustainability transitions: Insights from Brisbane's building sector*, beleuchtet vor allem Prozesse des Widerstands und Herausforderungen in urbanen Transformationen zur Nachhaltigkeit.

Appendix A

Interview guidelines (core questions)

1. Introduction

- What is your professional background (professional biography)?
- How and when did you first get interested in and/or involved in green building?
- What is your understanding of green/sustainable building (generally, and specifically regarding case study city region)?

2. Green building pathways in the case study city region and/or specific projects

2.1 General case study region and general understanding of participants' viewpoints regarding the specificities of the case study region and its evolution.

- When, and why did green building become a topic?
- How is green building generally understood/debated? (e.g. policy driven, grassroots, climate change mitigation, planning, resilience, marketing, etc.)
- Were there any key events or turning points in respect to green building? (e.g. key steps/developments)
- Who were/are the key actors in green building in the city region?
- Who were/are driving and resisting actors/stakeholders/networks?
- What were/are important driving or resisting factors/processes and main barriers/challenges?
- What were important learning processes?
- What were feedback loops?
- What are the sources of information, inspiration and reference (e.g. practices, technological innovations, standards, policies)?
- What were/are significant achievement(s) in the city-region (e.g. policy changes, demonstration processes)?
- Were there missed opportunities? Failed projects?
- What are the current trends?
- What is the outlook for future developments?

2.2 Specific projects/programs/policies

- What were the origins?
- What were the main objectives?
- What was/is your role?
- Who were the key actors/stakeholders in the project?
- What are the specificities/characteristics?
- Were there any role models and sources of inspiration? Any technological, organisational, policies, economic, social, ecological innovations?
- Success/non-success factors?
- Existing transfer/learning initiatives from case study?
- What development/future perspectives are there? Next steps?
- Would you do anything differently if you had to do it again?

Appendix B

Interviews, Case Study Freiburg

Interview Date	Affiliation	Sector	Code (no number)
08.09.2014	Freiburger Stadtbau GmbH	Semi-public	FR-Bus
09.09.2014	Stadt Freiburg, Umweltschutzamt (*Environmental Protection Authority*)	Public	FR-Adm
09.09.2014	Stadt Freiburg, Stadtplanungamt *(Planning Authority)*	Public	FR-Adm
10.09.2014	Stadt Freiburg, Umweltschutzamt (*Environmental Protection Authority*)	Public	FR-Adm
10.09.2014	Energieagentur Regio Freiburg GmbH *(Energy Agency)*	Semi-public	FR-Con
30.10.2014	Forum Weingarten e.V.	Civil Society	FR-NGO
30.10.2014	Fraunhofer-Institut für solare Energiesysteme ISE	Academia	FR-Re
31.10.2014	Energieagentur Regio Freiburg GmbH *(Energy Agency)*	Semi-public	FR-Con
17.11.2014	Stadt Freiburg, Umweltschutzamt (*Environmental Protection Authority*)	Public	FR-Adm
18.11.2014	Stadt Freiburg, Stadtplanungsamt, Stadtentwicklung *(Planning Authority)*	Public	FR-Adm
18.11.2014	STO AG	Private	FR-Bus
19.11.2014	Stadt Freiburg, Dezernat 3	Public	FR-Adm
19.11.2014	Stadt Freiburg, Stadtplanungsamt, Stadtentwicklung *(Planning Authority)*	Public	FR-Adm
20.11.2014	Architektenkammer Baden-Württemberg, Kammergruppe Freiburg	Private	FR-Pa
20.11.2014	Handwerkskammer Freiburg	Private	FR-Pa
17.12.2014	Wirtschaftsverband 100% Erneuerbare Energien, Solar Info Center	Private	FR-Con
18.02.2015	Stadt Freiburg, Stadtentwicklung *(Planning Authority)*	Public	FR-Adm
24.02.2015	Stadt Freiburg, Stadtplanungsamt *(Planning Authority)*	Public	FR-Adm
24.02.2015	Stadt Freiburg, Stadtentwicklung *(Planning Authority)*	Public	FR-Adm
25.02.2015	Bundesverband Baugemeinschaften e.V.	Private	FR-Prac
26.02.2015	Architekt	Private	FR-Prac
23.03.2015	STO AG	Private	FR-Prac
24.03.2015	Die Grünen	Politics	FR-Pol
24.03.2015	Architekt	Private	FR-Prac
26.03.2015	Klimabündnis Oberrhein e.V.	Private	FR-NGO

Interviews, Case Study Brisbane

Interview Date	Affiliation	Sector	Code (no number)
31.03.2014	Lend Lease	Private	BR-Prac
02.04.2014	Lend Lease	Private	BR-Prac
03.04.2014	Urban Development Institute Australia	Private	BR-Lob
04.04.2014	Brisbane City Council (former)	Public	BR-Adm
04.04.2014	Consultant, Green Building Council Australia, Brisbane City Council	Private	BR-Prac
24.06.2015	Net zero design	Private	BR-Re
29.06.2015	Queensland University of Technology (QUT)	Academia	BR-Re
30.06.2015	Greentag	Private	BR-Con
30.06.2015	Lend Lease	Private	BR-Prac
30.06.2015	DSGN Kartell	Private	BR-Prac
02.07.2015	Master Builders Queensland	Private	BR-Lob
08.07.2015	QUT, Engineers Australia	Academia	BR-Pa
09.07.2015	Australian Institute of Architecture	Private	BR-Pa
10.07.2015	Urban Development Institute Australia (UDIA)	Private	BR-Lob
10.07.2015	UDIA	Private	BR-Lob
13.07.2015	Brisbane City Council (Engineer), Sustainability	Public	BR-Adm
14.07.2015	Brisbane City Council - Manager City Planning & Economic Development	Public	BR-Adm
15.07.2015	QLD GOV, Department of Infrastructure, Local Government and Planning	Public	BR-Adm
15.07.2015	AECOM	Private	BR-Con
15.07.2015	AECOM	Private	BR-Con
16.07.2015	Brisbane City Council, Environmental Engineer	Public	BR-Adm
16.07.2015	Consultant Sustainability and Energy	Private	BR-Con
17.07.2015	AusIndustry	Semi-public	BR-Prac
20.07.2015	Brisbane City Council	Public	BR-Adm
20.07.2015	PDT Architects, Associate/Sustainability Lead	Private	BR-Prac
22.07.2015	Conrad Gargett Architects	Private	BR-Prac
22.07.2015	Brisbane Housing Cooperation (BHC)	Private	BR-Prac
23.07.2015	ARUP	Private	BR-Con
23.07.2015	Property Council of Australia	Private	BR-Lob
23.07.2015	Global Change Institute, University of Queensland	Academia	BR-Prac

Appendix C

Coding categories

A: PROCESSES

PATH CREATION and ACHIEVEMENTS
- Demonstration projects
- Policies (on different levels)

TEMPORAL ASPECTS

BARRIERS/CHALLENGES (incl. dependencies, lock-ins)
- Cost-benefits
- Energy prices / costs
- Resistance through lobby work
- Discontinuities (policies, industry support)
- Lack of Education and know-how
- Lack of materials

B: CONTEXT, SPATIAL SPECIFITIES

GEOGRAPHY

HISTORICAL

SOCIAL and POLTICAL STRUCTURE

EVENTS

C: GOVERNANCE/POLICIES/REGULATION/GUIDELINES

BUILDING CODES/REGULATION
- City/state/federal levels

D: ACTORS

PUBLIC

PRIVATE

NGO

ACADEMIA

E: GREEN BUILDING

DEFINITIONS/UNDERSTANDINGS

BUILDING AND CONSTRUCTION (Technological, materials)
- Building Design (Passive and solar)
- Orientation
- Shading
- Co-/Tri generation

Cooling
Energy storage
Energy-efficiency
Health, wellbeing, non-toxic, productivity
Heat pumps
Insulation/thermal performance
Lighting/LED
Ventilation (natural/cross Ventilation)
Solar energy, photovoltaic and solar panels
Water (efficiency, tanks)

Appendix D

Report GreenRegio workshop FREIBURG

(sent to workshop participants as part of the GreenRegio project)

Inhalt

Einleitung

Auf Einladung des Forschungsprojektes GreenRegio traf am 12. Februar 2014 Gruppe aus Teilnehmern zusammen, die mit der Thematik des nachhaltigen Bauens in Freiburg vertraut sind. Das Forschungsprojekt, gemeinsam durch die Deutsche Forschungsgemeinschaft (DFG) und den Fonds National de la Recherche Luxembourg (FNR) finanziert, befasst sich mit der Entstehung und den Treibern von Transitionsprozessen im Bereich des nachhaltigen Bauens in vier Untersuchungsräumen: Freiburg (D), Vancouver (CAN), Luxemburg (LUX) und Brisbane (AUS). Durch das Teilen ihrer Erfahrungen und Meinung, haben die aus dem privaten, akademischen und öffentlichen Bereich stammenden Teilnehmer dem gemeinsamen Forschungsteam aus Luxemburg (LUX) und Köln (D) erlaubt, ein besseres Verständnis zum Innovationskontext vom grünen Bauen in Freiburg zu erlangen. Die Gespräche wurden in leicht abgeänderter Form des „World Cafés“ zu vier unterschiedlichen Thematiken geführt: Akteure und Organisationen, Rahmenbedingungen, Schlüsselprojekte und schließlich Barrieren und Innovationen. Somit konnte das Forschungsteam eine detaillierte Bestandsaufnahme der Akteure, Initiativen und institutionellen Rahmenbedingungen zur Thematik des grünen Bauens in Freiburg aufbauen, aber auch besser zukünftige Entwicklungen und Herausforderungen erfassen.

1. Bestandsaufnahme

1.1 Wichtige Akteure und Organisationen

Zwei wichtige allgemeine Merkmale der Akteurs-Landschaft in Freiburg wurden von den Teilnehmern besonders hervorgehoben:

- Die intensive und breite Vernetzung verschiedener Akteure
- Eine besonders engagierte, aktive und interessierte Bürgerschaft, die als positiver Nährboden für nachhaltige Ideen gilt, sowie aber auch eine wichtige Rolle bei der Agendabildung spielt.

1.1.1 Öffentliche Akteure

- Gestaltungsbeirat
- Nachhaltigkeitsbeirat
- Stadtrat
- Stadtverwaltung (z.B. Umweltamt / Energiefachstelle / Nachhaltigkeitsma-nagement)
- Grüne Partei
- Umweltbürgermeister

1.1.2 Gruppen und Verbände

- Architektenkammer
- Baugruppen: u.a. Selbstorganisierte Unabhängige Siedlungsinitiative (S.U.S.I)
- Bildungsträger: WaldHaus, Ökostation
- Bund für Umwelt und Naturschutz Deutschland (BUND)- Ortsgruppe Frei-burg
- Bürgervereine der Stadtgebiete: u.a. Forum Vauban e.V.
- ECOtrinova e.V.
- Fesa e.V. (Förderverein Energie- und Solaragentur Regio Freiburg)
- International Council for Local Environmental Initiatives (ICLEI) - Büro Freiburg
- Klimabündnis Freiburg
- Mietshäuser Syndikat
- Naturschutzbund (NABU) - Gruppe Freiburg
- „Recht auf Stadt"-Netzwerk
- Solar-Bürger-Genossenschaft eG Freiburg

1.1.3 Forschungseinrichtungen

- Fraunhofer - Institut für Solare Energiesysteme ISE (ISE)
- Ökoinstitut
- Zentrum für Erneuerbare Energien (ZEE) – Universität Freiburg
- Passivhaus Institut (Darmstadt)

1.1.4 Unternehmen und private Akteure

- Baugenossenschaften (Bauverein Breisgau eG, Familienheim Freiburg eG und Heimbau Breisgau eG)
- Bauunternehmen und Entwickler
- Energieagentur Regio Freiburg
- Energiedienstleister und Versorger: u.a. Badenova und Stadtwerke
- Freiburg Wirtschaft Touristik und Messe (FWTM) & Green City Cluster
- Freiburger Stadtbau GmbH
- Handwerker
- Medien (Berichterstattungen über Freiburg)
- Pioniere in Architektur und Erneuerba-re Energien: Einzelpersonen mit Ideen und Visionen
- S.A.G. – Solarstrom AG
- Solar-Fabrik AG
- Verkehrsbetrieb

1.2 Institutionelle Rahmenbedingungen

1.2.1 Gesetzgebungen

Entwicklung der Energiestandards und „Freiburger Baulandpolitischen Grundsätze", als Institutionalisierung von Best Practice & Grundsätzen durch die Politik (auf Grundlage der Erfahrungen in Vauban und Rieselfeld):

- Einführung der Niedrigenergiehausstandards (1992), o Weiterentwicklung im Jahr 2005 (NEH- Standards 2005),
- BauGB Novellierung (2004) führte im Jahr 2007 zum Beschluss verstärkt Instrumente zum Klimaschutz in der Bauleitplanung zu integrieren,
- Einführung der Effizienzhausstandards 40 und 60 (Passivhausstandard) für Wohngebäude (2009),
- Zusammenführung zum Effizienzhaus-Standard 55 (2012) sowie Einführung des Effizienzhausstandard 70 für Büro- und Dienstleistungsgebäude
- Entwicklung und Auswirkungen auf der EnEV der EU-Gebäuderichtlinie „Nullemissionshaus" (2010)

1.2.2 Öffentliche Politiken

- Anwendung der Energiestandards durch Stadtbau
- Energieversorgungsplan 1986 und weitere Entwicklungen
- Fernwärme Abnahmeverpflichtung
- Freiburger Beteiligungshaushalt
- Freiburg Solarcity / Netzwerk SolarRegion Freiburg

- Klimaschutzkonzept und Zielsetzungen (1996)
  Fortschreibung (2007)
  Studie zur Klimaneutralität (2011)
- Bildungsprojekt Lernen Erleben in Freiburg (LEIF)
- Lokale Agenda 21
- Politik der Neubaugebiete
- Städtisches Quartiersmanagementkonzept
- Stadtmarketing: Freiburg Green City & Außendarstellung (u. a Teilnahme an Weltexpos, Medien, Tourismus)
- Stadtplanung: Fünf-Finger-Plan
- Städtisches Konzept Quartiersmanagement
- Unterstützung von Baugruppen
- Verkehrsentwicklungskonzept: u.a. Strassenbahnnetzwerk und Ausbau, Fußgängerzone, Radwege

1.2.3 Förderprogramme

- Bund-Länder-Förderprogramm „Soziale Stadt"
- Energieeffizienzförderungen FEW/Badenova: Solarthermie, Fotovoltaik, Wärmepumpen, Wärmenetz, Eigenständige Stromversorgung (u.a. KWK, BKHW), usw.
- Kreditanstalt für Wiederaufbau (KfW) Förderungen für energetische Neubauten & Stadtsanierung
- Städtisches Förderprogramm „Energiebewusst sanieren"

1.2.4 Weitere Initiativen

- Energie-Beratung durch FEW/Badenova & Energieagentur
- Initiativen des Netzwerkes „Wohnen ist Menschenrecht"
- Innovationsfond Badenova
- ZukunftsWerkstatt der Handwerkskammer Freiburg

1.2.5 Sozio-kulturelle Bedingungen

1.2.5.1 Besondere politische und gesellschaftliche Willensbildung

- Engagierte und organisierte Bürgerschaft mit einem starken Grundbewusstsein für Umweltschutz und Klimaschutz (nicht nur zu Bauthematiken), die sich für einen alternativen Lebensstil entschied und eine Anpassung des Umfeldes erwartet:
  - Widerstand Wyhl,
  - Umweltbewegung/Solarbewegung der 70er Jahre
  - Protestbewegung der 90er-Jahren
  - Verschiedene Bürgerinitiativen

Die Anfänge der „grünen" Ideen waren ungesteuert und nicht institutionalisiert: u.a. die Stadtverwaltung war zu Beginn kein aktiver Vermittler.
- „Konservative Grüne" Bürger: traditionelle und bodenständige Mentalität (Traditionsbewusstsein, Naturverbundheit, Heimatbewusstsein) durchsetzt von Alternativen und Innovativen Ambitionen.
- Wissenschaft und Bildungsinstitutionen in der Öffentlichkeit präsent
- Eigentumsbewusstsein der Bürger
- Identifikation der Bürger mit Freiburg als „Green City"
Dies führt zur Offenheit gegenüber der Zukunft aber auch zu Angst vor Veränderung, die manchmal zu Blockaden führen kann

1.2.5.2 Historischer Zufall / Pfadabhängigkeit

- Industrialisierungsverbot durch französische Besatzung
- Besondere geographische Lage der Stadt Freiburg
- Innovative Ambitionen & Innovationsbewusstsein: o Ansiedlung von „Green Industries" (z.B. Solarfabrik)
- Ansiedlung von „Green Research" (z.B. ISE)
- Innovationsfreudige Pioniere aus der Bürgerschaft

1.3 Bauprojekte

1.3.1 Einzelprojekte

- 70er – und 80er Jahre Solarhäuser (Einzelprojekte): z. B. Heliotrop – Rolf Disch
- Biogasanlage im Industriegebiet Nord (Mülldeponie Eichelbuck) - Gemeinschaftsprojekt ASF, Badenova, Remondis
- Diverse Baugruppenprojekte
- Holz-Passivhaus in Rieselfeld - Ingeborg-Drewitz-Allee (Übertragung Bauarbeiten EXPO 2010)
- Projekte des ISE: z.B. Energieautarkes Solarhaus
- Schwanenhof in Eichstetten am Kaiserstuhl (integratives Wohnmodell)

Im Bau oder in Planung

- Eissporthalle
- Erweiterung des Campus der Technischen Universität am Flughafengelände
- Neues Verwaltungszentrum im Stühlinger (Standort technisches Rathaus)
- Sanierung Universitätsbibliothek Freiburg
- Stadionbau
- Umgestaltung Platz der Synagoge
- HKW-Versorgung der Universität Freiburg

1.3.2 Stadtviertel

- Innenstadterhaltung und Raumgestaltung
- Quartier „Westlich der Merzhauser Straße"
- Rieselfeld
- Sanierungsgebiet Soziale Stadt Alt Haslach
- Sanierungsgebiet Soziale Stadt Weingarten West (u.a. Bugginger Strasse 50, Binzengrün 9, ...)
- Vauban o Passivhaus Wohnen & Arbeiten,
  Kleehäuser,
  Genova Wohngenossenschaft,
  Solarsiedlung, Stadthaus M1-Vauban,
  Grethergelände - Mietshäuser Syndikat,
  Sozial-Inklusives Wohnprojekt „VAUBANaise".

Im Bau oder in Planung

- Entwicklung Güterbahnhof Nord und Green City Tower
- Entwicklung Wohnbaugebiet Gutleutmatten in Haslach
- Green Industry Park (Initiative Stadt, Badenova, FWTM und Fraunhofer ISE)
- Neuer Stadtteil Dietenbach

2. Diskussionen

Unter den Teilnehmern herrschte weitgehende Übereinstimmung hinsichtlich der wahrgenommenen Barrieren und Hindernisse, die sich in die folgenden drei Gruppen einteilen lassen:

• organisatorisch / administrativ / prozedural
• mental
• sozial

Neben praktischen und strukturellen Problemen in Verwaltung und Baukoordination, wurde insgesamt ein zunehmend innovationsfeindliches Klima beschrieben, das auf fest etablierte Akteurs-konstellationen (inkl. dominanter Investoren/Bauträger) sowie eine wachsende „Selbstgefälligkeit" mancher Freiburger Akteure gegenüber dem Erreichten zurückgeführt wird. Mehrfach betont wurden auch soziale Versäumnisse: Hinsichtlich der Konzeption der Leuchtturmprojekte und in Bezug auf se-lektive zivilgesellschaftliche Partizipation.

2.1 Hemmung der Entwicklungsimpulse durch Routinen und Verfestigungen in politischen und gesellschaftlichen Strukturen

2.1.1 Politisches Sicherheitsdenken und fehlender Mut zum Neuen

- Strukturen sind in einer gewissen Weise verfestigt: In der Vergangenheit wurde die Bewegung, die aus der Mehrzahl der Bürger (Baugruppen) ausging von der Stadtverwaltung übernom-men, heute werden neue Impulse gebraucht.
- Dafür herrscht politisch jedoch eher eine gewisse „Selbstgefälligkeit" und „Bequemlichkeit" mit dem bereits Erreichten. Dies könnte dazu führen, das Freiburg durch innovativere Städte überholt werden könnte.
- Zwar kann diese Haltung darauf zurückgeführt werden, Fehler vermeiden zu wollen, jedoch lässt dieses „Sicherheitsdenken" wenig Raum für Neues oder „Unorthodoxes" in der Verwaltungspraxis, sowie für Innovation, neue Ideen oder Entwicklungsimpulse insgesamt.

Die Teilnehmer wünschten sich, dass neue Potenziale und Möglichkeiten besser genutzt werden, sodass sich Freiburg weiterentwickeln kann. Vorschläge beinhalteten u.a.: o Mehr Anreize , Anschübe, sowie aber auch Raum für Innovation schaffen,

- Vorhandenen Schlüsselprojekte weiterentwickeln und neue Potenziale nutzen, um weiterhin eine Vorreiterrolle zu spielen. Hier wurden vor allem Möglichkeiten im Be-reich der sozialen Nachhaltigkeit hervorgehoben (s. auch Punkt 2.3.1.),
- Nicht nur Leuchtturmprojekte entwickeln, sondern auch Mainstreamprojekte,
- Neue Impulse könnten eventuell auch von außen geholt werden,
- Bisherige Aktivitäten sollten geprüft und evaluiert werden.

2.1.2 Mangelnde Koordination und Zukunftsvisionen

- Zu wenig integratives Denken innerhalb der Stadtverwaltung (z.B. zwischen Stadtplanung und Umweltamt) bzw. zwischen verschiedenen Akteuren insgesamt führt zu einer mangelnde Ge-samtperspektive im Sinne von „Nachhaltigkeitsmanagement".
- Die Stadtverwaltung ist zu kompartimentalisiert und funktioniert über Säulendenken. Dadurch werden Querschnitthemen wie Nachhaltigkeit (inklusiv z.B. sozialer Aspekte) und vor allem deren komplexen Zusammenhängen zu wenig Rechnung getragen. Entsprechend wurde der Wunsch nach einer übergeordneten Vermittlungsinstanz mit „Ent-scheidungsvollmacht" geäußert.
- Dieser Mangel an interner Kommunikation wurde im Kontrast zur Stadtmarketingsstrategie und Labelling der „Geen City" nach aussen gestellt.
- Auch die Bereitschaft und der Wille mit Visionen und Zukunftsszenarien zu arbeiten, wurden bemängelt. Es gilt die „Legislaturperiodenhaltung", wodurch die nächsten Schritte im Bereich nachhaltiges Bauen unklar und tagesaktuelle Projekte wichtiger als Kontinuität sind.

- Eine bessere Einbeziehung des Umlandes wurde außerdem gewünscht, im Sinne der Integration verschiedener räumlicher Maßstabsebnen und der Generierung von Multiplikatoren-Effekten:
    - im regionalen Rahmen (Oberrhein-Rahmen),
    - im Sinne einer Agglomeration: aktuell besteht z.B. keine überstädtische Institution mit Entscheidungskompetenzen.

- Zwischen sektoralen Bereichen (produktivem Gewerbe, Handel, Dienstleistungen und Indust-rie) des grünen Bauens gestaltet sich die Koordination aktuell auch schwierig, angefangen mit den Fachjargons. Vernetzte Lösungen sind für Innovation wichtig und es sollten entsprechen-de Möglichkeiten zum Austausch geschafft werden.

2.1.3 Verfestigung der zivilgesellschaftlichen Akteurskonstellationen

In gewisser Weise wurde kein „Generationenwechsel" vollzogen: die kritische Masse der Vergangenheit müsste wieder angestoßen werden. Es fehlt jedoch die Mobilisierung einer neuen umweltbewussten Generation, die weiterhin als Motor für neue Ideen dienen könnte.
Die Teilnehmer haben auch unterstrichen, dass es schwierig ist „auf einem gedeihenden Feld etwas Neues hervortreten" zu lassen. Potenzial wird jedoch in Bewegungen wie z.B. der „Transition Town" gesehen, die den benötigten Pioniergeist verkörpern könnte.

2.1.4 Selektive Vertretung der Freiburger Gesellschaft

Zusätzlich wurden Versäumnisse und Schwierigkeiten in der Einbindung der Zivilgesellschaft hervorgehoben:

- Selektivität und Polarisierung bei der Einbindung der Bürgerschaft: politisch begünstigt und zu Wort kommt vorrangig eine wohlhabende Mittelschicht mit starker Umwelt-haltung. Die politische Teilhabe von anderen sozialen Schichten ist dadurch erschwert.
- Hinzu kommen allgemeine Fragen zur demokratisch und institutionell angebrachten Einbindung der Gesellschaft (Individuelle Interessen gegen gemeinschaftliche Interes-sen, Akademisches Expertentum gegen gesunden Menschenverstand und handwerk-liche Kompetenzen, neue Möglichkeiten durch Partizipation aber auch Blockierungs-potenziale, usw…)

Diese Herausforderungen werden jedoch als Chance gesehen, Freiburg durch eine abgeänder-te Gestaltung der Partizipation als Modell zu positionieren. Hierfür sollten u.a. neue Formen der zivilgesellschaftlichen Einbindung getestet werden (z.B. Quartiersdiskussionen) und auf die Einbindung „neuer" Akteure (wie z.B die IHK) geachtet werden, allen voran finanziell schwä-chere Bevölkerungsgruppen.

2.2 Prozedurale Hindernisse

Einige gesetzliche und prozedurale Hindernisse wurden hervorgehoben:

- Zu starre Regularien u.a. mit Blick auf die Energieeinsparverordnung (EnEV).
- Unklarheiten bei der Umsetzung der EU-Gebäuderichtlinie „Nullemissionshaus" (2010) und der entsprechenden Novellierung der EnEV (2014).
- §34-BauGB: Was passiert mit Neubauten in einem unbeplanten Innenbereich (Nachverdich-tung)? Wenig Vorgaben, außer die der EnEV.
- Unstetigkeit von Förderprogrammen, die zu mangelnder Planungssicherheit für die Akteure führt.
- Komplexität der Finanzierungsmöglichkeiten.
- Schnittstellen-Probleme zwischen verschieden Förderebenen bei Projektförderungen, z.B.: Deutsche Bahn/Stadt Freiburg, Bund/Stadt Freiburg.

2.3 Neue Schwerpunkte setzen

2.3.1 Soziale Aspekte stärker in der Vordergrund bringen

In Freiburg besteht ein Mangel an bezahlbarem Wohnraum, der zu Konflikten zwischen Gewerbe und Wohnen führt, sowie auch zu Konflikten im sozialen Bereich. Die Debatten bleiben jedoch vorrangig ökonomisch und auf Rentabilitätsaspekte fokussiert, während Diskussionen über Alternativen fehlen. Vor allem eine Verknüpfung mit den „Freiburger Baustandards" wird nicht geleistet.

Auch politisch stehen soziale Aspekte im Hintergrund - „sozial" wird eher als Bürgerschaftli-ches Engagement verstanden.

- In diesem Kontext besteht auch verschärfte Kritik gegenüber der Privatisierung des städti-schen Wohnungsbestands.
- Auch die Kommerzialisierung der Wissenschaft in Richtung von Technologien, Life Sciences und Produkten trägt zu dieser Tendenz bei.
- Als Lösungsansätze forderten die Teilnehmer u.a.
    - Ein Umnutzungsverbot,
    - Leerstandmanagement,
    - Die Schaffung von günstigen, energetisch vorbildlichen Gebäuden/Sanierungen (wie z.B. auf dem Gelände der Polizeiakademie),
    - Eine bessere Haltung der Balance zwischen sozialer Verträglichkeit und Investment durch Investoren.
- Im Bereich des nachhaltigen Bauens könnte ein stärkerer Fokus auf soziale Aspekte (gegen-über nur architektonische und technische Aspekte) eine Chance zur Erneuerung für Freiburg sein. In Freiburg besteht bereits langjährige Erfahrung über das tägliche

Leben in nachhaltigen Stadtquartieren, wodurch sich die Stadt von anderen Standorten abheben kann.

- Über Quartiersmanagement, wie z.B. in Rieselfeld, sollte vor allem versucht werden, verschie-dene Lebensformen zusammenzubringen und soziale Mischung voranzutreiben. Ein weiteres Beispiel von ökologisch-sozialem Bauen könnten integrierte und intergenerationelle (Kontext des demographischen Wandels) Wohnprojekte sein.

2.3.2 Bestands- und Sanierungsfragen berücksichtigen

Im Kontext der Verringerung der verfügbaren Bauflächen in Freiburg sowie zur Reduzierung der anhaltenden Suburbanisierung stellt die nachhaltige Gestaltung des Baubestands eine größere Herausforderung als Neubautätigkeiten dar.

Insofern wurde bei Energieeffizienzfragen eine erhöhte Integration und Berücksichtigung des Gebäudebestandes gewünscht.
Dies beinhaltet u.a.:

- Abbau von Sanierungshemmnissen und Transaktionskosten, sowie die Schaffung von Sanierungsanreizen (z.B. bei Wärmekosten),
- Erweiterung der Sanierungskenntnisse.
- Beschränkte Handlungsspielräume beim Bauen im Gebäudebestand, u.a. auch Herausforde-rungen beim Erhalt historischer Gebäude und der Berücksichtigung des Denkmalschutzes wurden aber hervorgehoben.

2.3.3 Breitere Zusammenhänge als Energieeffizienz berücksichtigen

Es wurde unterstrichen, dass neben reiner Energieeffizienz weitere Aspekte zur Thematik des Grünen Bauens verstärkt berücksichtigt werden sollten: o Aspekte zur Erhöhung der Dichte („Stadt der kurzen Wege"),

- Themen wie graue Energie,
- Fragen und Analysen zu Nutzerverhalten / „Rebound-Effekte",
- Reduzierungen (Wachstumsfetischismus in Frage stellen),
- Wiedernutzung der Gebäude (Umnutzung statt neu bauen / Modularität und Flexibilität in der Architektur berücksichtigen).

Betrachtung des Kontextes in größeren Maßstäben (nicht nur auf Gebäudeebene):

- Gesamtbetrachtung aller Komponenten: Gewerbe, Nahversorgung, Schule, Transport, usw.,
- Nullemissionsstadt anstatt nur Nullenergiehaus,
- Schwerpunktsetzung auf stadtteilorientierte Projekte.

Report GreenRegio workshop BRISBANE

(sent to workshop participants as part of the GreenRegio project)

Content

Introduction

The Brisbane GreenRegio expert-workshop took place on 27 March 2014. Brisbane's green building experts were invited to discuss green building processes in the region. The workshop was central to the international research project "Green building in regional strategies for sustainability", conducted by the Universities of Cologne and Luxembourg (funded by the German Research Foundation and the National Research Fund Luxembourg). The project's main research objective is to analyse drivers and the emergence of innovative sustainability transitions in the building sector in four international case study regions: Brisbane (AUS), Freiburg (GER), Luxembourg (LUX) and Vancouver (CAN).

Ten workshop participants, representing different perspectives (architecture, industry, urban planning, consultancy, policy and research) supported the research team to understand the context of Brisbane's green building innovations by sharing their expert knowledge as well as their personal experience. A modified version of the World Café, an established workshop method, structured the group discussions on four key issues: actors and organisations; framework conditions; key projects; challenges and barriers. Based on the results of the workshop, a first overview of actors, initiatives and institutional frameworks of Brisbane's green building context has been developed. Furthermore, the results help identify in-depth micro-case studies conducted within the next phase of the research project. Future developments of and challenges to Brisbane's green building sector were also part of the discussion. This report summarises the input generated at the workshop in Brisbane as presented by the participants.

1. Actors and institutions

1.1 Important actors

The workshop participants mentioned a number of different local, state and national actors and institutions which were or still are involved in Brisbane's green building processes. Discussants identified the private sector (e.g. developers, consultants, financers, certifiers, professional/industry institutions) as a key actor in promoting green building. The emergence and the role of the Green Building Council Australia (GBCA) and its "Green Star" rating tool were also seen as an important factor.

The Brisbane City Council as well as the inter-municipal constellations of South East Queensland (SEQ) Regional Association of Councils and SEQ Council of Mayors were identified as central political actors. Emphasised was the driving role of Brisbane City Council [under Labor Party (until 2004) and Liberal Party (until 2008)] and the Queensland Government under Labor Party (until 2012). Some participants highlighted Brisbane City Council's environmental grant projects as particularly influential on environmental innovations. Leading politicians (e.g. former lord mayors and premiers) were named as individual actors driving green building. The role of the current governments of Brisbane and Queensland were acknowledged and seen as more favourable than the federal government, but also described as "good evils". The special but changing role of the federal and state government organisations/agencies was mentioned and discussed during the workshop. Some discussants commented on the increasing neo-liberal and decreasing environmental agenda closing down federal and state agencies and projects.

Other influential public actors in Brisbane's green building context are universities, other research facilities, think tanks, and NGOs. While frequently mentioned, they were considered much less consistent in pushing a green building agenda due to dependence on changing availability of research funding and the temporary nature of research projects.

The following actors were identified during workshop discussions:

1.2 Public sector actors

- Brisbane City Council
- COAG (Council of Australian Governments)
- Federal Governmental Mayor Cities Unit (closed)
- Federal Government [different sectors, departments, e.g. Australian Greenhouse Office (AGO), Clean Energy Regulator, Department of Climate Change and Energy Efficiency (closed), NATHERS (Department of Industry)]

- Queensland Government [different sectors, departments: e.g. Building and Construction Commission (BSA), Environment Protection Authority (EPA) and DSITIA (Qld Gov. Department of Science, Information Technology, Innovation and Arts), Queensland Building Construction Commission (QBCC)]
- SEQ Council of Mayors
- SEQROC (South East Qld Regional Organisation of Councils)

1.3 Groups and organisations

- Australian Green Development Forum (AGDF)
- Australian Sustainable Built Environment Council (ASBEC)
- Australian Institute of Architects

- Green Building Council Australia (GBCA)
- Green Cross
- International Council for Local Environmental Initiatives (ICLEI)
- The Infrastructure Sustainability Council of Australia (ISCA)
- Australian Institute of Building (AIB)
- Chartered Institute of Building (CIOB)
- Royal Institution of Chartered Surveyors (RICS)

1.4 Industry associations
- Clean Energy Council (CEC)
- Housing Industry Association (HIA)
- Master Builders Australia (MBA)
- Planning Institute Australia (PIA)
- Property Council of Australia

1.5 Research facilities
- University of Queensland (UQ)
- Queensland University of Technology (QUT)
- Griffith University
- Commonwealth Scientific & Industrial Research Organisation (CSIRO)
- Beyond Zero Emissions (BZE)

1.6 Companies and private sector actors
- Energex
- Consultancies (environmental/engineering) e.g. Arup, Maunsell AECOM, Cundalls, RPS
- Developers (e.g. Lend Lease, Stockland, Leighton, Thiess, Sekisui House)
- Architects (e.g. BVN Donovan Hill)

2. Institutional framework and incentive programs

2.1 Legislation
- National Construction Code (NCC) [former Building Code of Australia (BCA)]
- Building Codes Queensland (Dep. of Housing and Public Works)
- Commercial Building sustainability requirements [Qld State Gov. pre 2012]
- National Construction Code (NCC)
- *Property and Motor Dealers Act 2000*
- *Queensland Building Act 1975*
- *Queensland Building and Construction Commission Act 1991*
- *Queensland Building and Construction Commission Regulation 2003*
- *SEQ Regional Planning Act*
- Sustainability declaration (for selling houses – replaced 2012)
- *Sustainability Planning Act 2009* [currently being replaced]

2.2 Public policy
- Brisbane "Sustainable home"
    - - Brisbane City Council's "million trees program"
    - - Brisbane City Council's "sustainable homes" program
    - - Brisbane City Council's "City Smart"

    - - Brisbane City Council's "Busway development"
    - - Brisbane City Council's "City Centre Master Plan"
    - - Brisbane City Council's "City Plan 2000"
    - - Brisbane City Council's "Creek Catchments Program"
    - - Brisbane City Council's "Suburban Centre Improvement Projects"

- Brisbane Lord Mayor's "Sustainability Grants"
- Carbon tax (older) (federal)
- Federal Gov. "The Energy Efficient Homes Package" (Home Insulation Program, Solar Hot Water Rebate Program)
- National Greenhouse Energy reporting (NGER) Scheme
- Premier's Sustainability Awards
    - - Qld Gov.: "Smart & Sustainable Home" Program
    - - QLD Gov. "Queensland climate change strategy 2007: a low-carbon future"
    - - QLD Gov. Development Code

2.3 Support and subsidy programs
    - - Brisbane City Council's sustainability incentive scheme (now discontinued)
    - - Brisbane City Councils's "Sustainability Grant Program"
- Carbon tax (older) [federal]
- Qld Gov.:
    - Smart Futures Fund - Smart Futures Fellowships
    - - QLD Sustainability Report Card for selling houses
- Qld Solar/Photovoltaic subsidy (feed-in tariffs/rebate system) for residential housing (now limited)

2.4 Other initiatives/events
- Architectural awards (by Australian Institute of Architects)
- Building Energy Rating Scheme (BERS)
- Beyond Zero Emission Action Plan
- Earth Charter (local initiatives) – Australia-Pacific Earth Charter Festival in Brisbane in 2010
- Energy Efficiency Opportunities (EEO)
- Green Living Program (Master Builders)
- Green Star [developed by GBCA]
- Greensmart Program [developed by HIA]
- National Australian Built Environment Rating System (NABERS)
- Nationwide House Energy Rating Scheme (NatHERS)
- Woodford Festival

3. Built Environment

3.1 Single building projects
- 275 George St.
- 400 George St. (Qld Department of Public Works)
- 55 Elizabeth Street (commercial office building)
- Advanced Engineering Building (UQ)
- Brisbane Square (Brisbane City Council and Brisbane Square Library)
- Currumbin Eco Village
- Dandiiri Contact Centre [former: JCC (Joint Contact Centre)]

- Energex Building (Teneriffe)
- Global Change Institute (UQ)
- Kelvin Grove Urban Village (QUT buildings)
- PA (Princess Alexandra) Hospital
- Santos Building, 32 Turbot Street
- Science & Engineering Center (QUT)
- Translational Research Institute (TRI) BUILDING (hospital/medical research centre)
- Wesley House (Ann St.)
- Magistrates' Court building (George + Roma St.)
- Port of Brisbane (Port Central 1)

Under construction / in planning process
- 1 William St. (new Qld Gov. building)
- 53 Albert St. (carpark conversion into office) [Retrofitting]
- 58–66 Abbotsford Road (Bowen Hills)
- Botanica Residences (South Brisbane)
- Brisbane City Council's District Cooling (Infrastructure project in the context of "City smart")

3.2 Large scale projects
- Green Square buildings (Fortitude Valley)
- Hamilton North Shore
- Fitzgibbon Chase
- Currumbin Eco Village
- Coolum Eco Industrial Park

4. Discussion

In the workshop, participants discussed a number of challenges and barriers to Brisbane's green building processes. Five main challenges and barriers for current green building developments were emphasised:

- governmental changes (federal, state and city); Liberal–National Coalition, with market-based focus, discontinuing environmental, energy and innovation policies

- unclear regulations / over-regulations in the building sector

- weak demand for green buildings; thereby restrained behavior of investors, builders and other actors in the building sector

- (relatively) low energy costs, thereby fewer incentives for energy savings

- public awareness of environmental issues / climate change

4.1 Policy framework

Policy issues were identified as an important field within the context of challenges and barriers in Brisbane's green building sector. Policy trajectories are often disrupted because of political changes (from Labor to Liberal–National Party) at all government levels. This causes unpredictable mid- or long-term conditions in the building sector. The commitment of former governments (federal and state), in particular on regulations for building energy performance, strongly impacted the commercial building market. High standards for government buildings should have put pressure on developers' low building standards. The hard cut of a number of programs and departments [directly or indirectly related to green building such as energy efficiency and reducing carbon emissions] evoked uncertainty in the building sector. Some workshop participants argued that actions like the planned federal carbon tax push-back are counterproductive. After years of political support for sustainability transitions and green building (e.g. grants and incentives for insulation, PV installation and the commitment to new "green" public buildings), investors currently do not have security in planning processes. Grants and tax advantages are currently not transparent, but are still important factors for investment decision-making in the building sector. Furthermore, innovations or new developments in green building technology and cross-disciplinary research were said to be slow. Other discussants highlighted the reduced financial support for basic research in different fields of green building. Despite governmental changes, the discussants identified fragmented – and, in some parts, confusing – green building policy regulations. Both under-regulation and, in other instances, over-regulation were highlighted. Revisions, streamlining of existing rules, and implementing fast-track procedures were said to be necessary. According to many workshop participants, current governments are averse to changing these circumstances. The lack of strong present government drivers and integrative/cross-sectoral approaches (silo thinking) was acknowledged. Launched initiatives such as the building information management (BIM) were only seen as partly helpful. On the regional level, the Brisbane City Council was identified as an important actor in Brisbane's green building sector. The role of the current city council, however, was described as more passive. Statements like "City Council relying a lot on the will of developers, rather than working in partnership with them" were listed. The leadership roles of Sydney and Melbourne in the context of urban sustainability issues was acknowledged, including possible spill-over effects in green building policy to Brisbane.

4.2 Green building market

Workshop participants listed a number of influential or hindering factors of Brisbane's current green building context: the dominance of private actors (investors, developers, builders and financial services) and their conservative investment strategies; their limited role as market drivers; and a lack of demand for energy efficient buildings. While there is a moderate demand for green commercial/office buildings, interest in residential building sector is comparatively low. "Green" residential projects in Brisbane such as Fitzgibbon Chase are rare. The main reason for this, according to the discussants, is the short-term profit orientation of investors and developers. A lack of long-term cost monitoring and life-cycle cost analysis, including secondary public benefits (e.g. job creation), public health and a lack of international orientation were also

identified. Some participants highlighted the missing flagship projects in Brisbane and the operating "big pioneers". Path dependencies in the sector and relatively low sensitivity in sustainability issues were mentioned, as well as general miscommunication with the public. Also remarked upon were negative lobbying and the difficult marketing of green building, for example, the "greenwashing" character of projects. The still relatively low energy costs, due to low-priced coal provided by powerful coal firms in Queensland, are one of the main barriers to faster transition processes. Furthermore, workshop participants criticised the continued lack of alternative/innovative (financial) business models in the building sector. Retrofitting of buildings and social/affordable housing in the green building sector are future challenges.

4.3 Certification and rating tools

Different certification/rating tools (Green Star, NABERS and NatHERS) were identified as important green building drivers. Besides the positive development in this field, the rating systems require further improvements. The partly complex and heterogeneous standards for different fields, especially the "flexibility" of some tools, were criticised. For instance, investors and builders develop cost-effective strategies with little impact on energy efficiency to obtain high ratings for commercial buildings (e.g. bike parking vs. installation of new technology for air conditioning).

4.4 Technology

Technological challenges were considered to be main barriers of green building implementation. The lack of materials, design and professional construction and operational skills were stated as important challenges in the green building market. For example, workshop experts saw difficulties in operation of passive energy buildings due to cooling requirements in the subtropical climate. Future challenges include retrofitting of existing buildings (e.g. 53 Albert Street), optimisation of building operations (advanced, controlled and intelligent), and use of locally produced and embodied energy. Next to the optimisation of buildings, there are also opportunities for synergies between buildings. Furthermore, the prefabrication sector, which promises high quality and lower prices, is still underrated.

4.5 Public sustainability awareness

While green building became more established in the commercial building sector over recent years, the residential sector did not accept many green construction innovations. The lack of demand in private residential green buildings is a result of specific Australian consumer choices characterised by generally low environmental awareness, a materialistic lifestyle and a distinct preference for home ownership. Relatively low electricity prices, missing incentives to save electricity, and added costs for green building render rethinking of current practices, in particular for home buyers who value location and short-term financial returns over environmental impact; building "green" is still perceived as a "luxury add-on". Location and short-term financial returns are more important to home buyers than ecological sustainability. On the other hand, some participants suggested that there are "seasonal" shifts in public interest for environmental sustainability. Public awareness increases in times of environmental

disasters. Queensland's heavy flood in 2010/2011 and, to a larger extent, the drought period from 2003 to 2009 had a significant impact on public opinion and policy actions (e.g. SEQ Regional Plan). West End community gardening, Fourth Acre Community Networks and North East Street Farms (community gardens on flood lands) were mentioned as positive examples of public engagement and community action.

Appendix E

Own contributions made to publications

All four journal articles, as part of this dissertation, were peer-reviewed in international journals. I am the first author of three of the four journal articles (Chapter 2, 4, 5).

Lost in Transition? Directions for an Economic Geography of Urban Sustainability Transitions (chapter 2), Authors: Fastenrath, S. & Braun, B.
Under review in *Sustainability*, MDPI.

Interactive knowledge generation in urban green building transitions (chapter 3), Authors: Preller, B., Affolderbach, J., Schulz, C., Fastenrath, S., Braun, B.
Published in *The Professional Geographer*, 2017, 69(2), 214-224.

Sustainability transition pathways in the building sector: Energy-efficient building in Freiburg (Germany) (chapter 4), Authors: Fastenrath, S. & Braun, B.
Published in *Applied Geography*, 2018, 90. 339-349.

Ambivalent urban sustainability transitions: Insights from Brisbane's building sector (chapter 5), Authors: Fastenrath, S. & Braun, B.
Published in *Journal of Cleaner Production*, 2018, 176. 581-589.

I have contributed to these articles in the following ways:

- Literature review
- Organisation, implementation and analysis of expert/stakeholder workshops in Freiburg and Brisbane (Australia)
- Acquisition of interview partners
- Archive work and document analysis
- Conducting 58 interviews in Freiburg and Brisbane with experts/stakeholders from private, public and academic sectors in the context of administration/policy-making, architecture, construction, real estate, associations and organisations. The vast majority of interviews were conducted with decision-makers
- Transcription of interview material or supervision of transcription work by student assistants
- Qualitative data analysis of interviews with the software MAXQDA
- Designing and creating illustrations and tables
- Independent writing of the manuscripts and revisions under supervision of Prof. Dr. Boris Braun

The additional forth article, “Interactive knowledge generation in urban green building transitions” (Chapter 3), has a shared authorship under the lead of Bérénice Preller who was the major contributor. I contributed to the abstract and the chapters 3.2.1, 3.2.3 in highlighting the role of participatory approaches in the geography of sustainability transition research, the importance of green building transitions, and the conception and explanatory outcomes of the workshops in Freiburg and Brisbane. I also provided information (workshop details and outcomes in Freiburg and Brisbane) for figure 3.2.

All empirical processes of this dissertation including workshops, data collection and analysis were part of the project “Green building in regional strategies for sustainability: multi-actor governance and innovative building technologies in Europe, Australia and Canada (GreenRegio)”, which was funded by the German Research Foundation (DFG-Deutsche Forschungsgemeinschaft, BR 1678 12-1).

Appendix F

Eigenständigkeitserklärung gem. §4(1)9

Ich versichere, dass ich die von mir vorgelegte Dissertation

Urban Sustainability Transitions in the Building Sector.
Insights from contrasting contexts: Freiburg and Brisbane

selbständig angefertigt, die benutzten Quellen und Hilfsmittel vollständig angegeben und die Stellen der Arbeit – einschließlich Tabellen, Karten und Abbildungen –, die anderen Werken im Wortlaut oder dem Sinn nach entnommen sind, in jedem Einzelfall als Entlehnung kenntlich gemacht habe; dass diese Dissertation noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie – abgesehen von unten angegebenen Teilpublikationen – noch nicht veröffentlicht worden ist, sowie, dass ich eine solche Veröffentlichung vor Abschluss des Promotionsverfahrens nicht vornehmen werde. Die Bestimmungen der Promotionsordnung sind mir bekannt. Die von mir vorgelegte Dissertation ist von Prof. Dr. Boris Braun betreut worden.

Köln, 20.07.2018

Sebastian Fastenrath