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IMAGINING ENERGY TRANSITIONS: CARBON NEUTRALITY IN FINLAND

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ABSTRACT

In this dissertation, I examine how societal debates on energy policy and the necessity of energy transitions unfold in Finland. Transforming energy systems is acknowledged as one of the most important areas for action on climate change and numerous voices across the globe have called for radical shifts in current energy policies and practices. Simultaneously, discussions on energy policy revolve around futures – both expected and feared – and the measures required to attain them. Finland is an interesting context to study claims about change and transitions as it has both commitments to action on climate change as well as stable institutional structures that have been described as resistant to change.

My perspective on energy policy and governance is broad and I analyse various arenas where energy issues are debated. These include the Finnish Parliament and Helsinki City Council, the media and discussions amongst various actors attempting to influence energy policy and working at the science-policy interface. In my analysis, I show how Finnish energy policy actors are broadly committed to a sociotechnical imaginary of carbon neutrality, or a collectively held and publicly performed vision of a desirable future. In the imaginary, Finland is envisioned as a prosperous welfare society that has addressed climate change by attaining a balance between greenhouse gas emissions and removals. The imaginary of carbon neutrality is broad and interpretatively flexible, thus accommodating diverse views on what carbon neutrality can entail.

In the articles that comprise this dissertation, I engage with a wide range of literature from science and technology studies, sociotechnical transitions studies, social scientific studies on energy, institutional theory and analyses on science-society relations. Specifically in the thesis summary, I address a research gap within the literature on sociotechnical imaginaries, by examining how questions regarding scale, heterogeneity and mobility shape the co-production of imaginaries as well as enable and curtail the scope of agency. I build on a constructivist and interpretative approach to research and use a range of materials, such as interviews, documents, news articles, Parliamentary and City Council transcripts, press releases and participant observation. Empirically, I focus on the 2010s as the decade when a sociotechnical imaginary of carbon neutrality emerged and became consolidated in Finland.

In this thesis, I argue that sociotechnical imaginaries, in this case carbon neutrality, form the imaginative foundations of national policy debates that motivate and justify action, while simultaneously retaining space for negotiation on how to attain those futures. The empirical analysis demonstrates that there

is no overarching consensus in Finland over what carbon neutrality means and what practices it allows for. I demonstrate that the context where an imaginary is co-produced both enables and constrains the scope of possible political debate and action by requiring actors to formulate their views through interpretations of desirable pathways towards carbon neutrality.

I conclude that carbon neutrality is likely to persist as a widely shared sociotechnical imaginary in Finland due to the political possibilities for debate and compromise that it offers. At the same time, I propose that the concept of carbon neutrality will be increasingly challenged by questioning whose imaginary is it, what type of practices does it enable and how are different actions evaluated as carbon neutral. Likewise new concepts, such as climate emergency, are likely to challenge the imaginary of carbon neutrality. I conclude that such debates are both necessary and desirable as we collectively face, address and learn to live with climate change.

TIIVISTELMÄ

Tarkastelen tässä väitöstutkimuksessa suomalaista energiapolitiikkaa ja sen muutostarpeita koskevia yhteiskunnallisia keskusteluja. Suomessa on yhtäältä vahvat poliittiset sitoumukset toimia ilmastonmuutoksen hillitsemiseksi, toisaalta vakaat, muutosvastarintaisinkin pidetyt yhteiskunnalliset järjestelmät. Tästä asetelmasta käsin on mielenkiintoista tarkastella väitteitä muutoksen tarpeesta.

Näkökulmani energiapolitiikkaan ja -hallintaan on laaja, ja tarkastelen useita eri foorumeita, joissa keskustellaan energiasta ja energiapolitiikasta. Osoitan, että energiapolitiikan eri tahoilla on yhteinen näkemys toivotusta tulevaisuudesta, jossa Suomi on saavuttanut hiilineutraaliuden. Tämä muodostaa sosioteknisen kuvitelman, eli jaetun ja julkisesti esitetyn näkemyksen tavoittelemisen arvoisesta tulevaisuudesta. Kuvitelmassa Suomi nähdään menestyvänä hyvinvointivaltiona, joka on vastannut ilmastonmuutokseen saavuttamalla tasapainon tuotettujen ja ilmakehästä sidottujen kasvihuonekaasupäästöjen välillä. Samaan aikaan hiilineutraaliuden kuvitelma on tulkinnallisesti joustava ja mahdollistaa lukuisia eri näkemyksiä siitä, mitä hiilineutraalius yksityiskohtaisesti pitää sisällään.

Väitöstutkimukseni empiiriset artikkelit tuottavat uutta tietoa hyödyntäen muiden muassa tieteen- ja teknologiantutkimusta, sosioteknisten järjestelmien tutkimusta, yhteiskuntatieteellistä energiatutkimusta, instituutioteorioita sekä tieteen ja politiikan vuorovaikutuksen tutkimusta. Tarkastelemalla sosioteknisten kuvitelmien tasoja, moninaisuutta ja liikkuvuutta osoitan, miten sosiotekniset kuvitelmat sekä mahdollistavat että rajoittavat toimijuutta. Nojaan tutkimuksessa konstruktionistiseen ja tulkinnalliseen metodologiaan sekä hyödynnän laajoja tutkimusaineistoja (esimerkiksi haastatteluja, uutisartikkeleita ja poliittisia puheita). Tarkastelu ajoittuu 2010-luvulle – vuosikymmeneen, jolloin hiilineutraaliuden kuvitelma nousi ja vakiintui Suomessa.

Keskeinen väitteeni on, että sosiotekniset kuvitelmat, tässä tapauksessa hiilineutraaliuden kuvitelma, luovat perustan kansallisille keskusteluille tavoittelemisen arvoisesta tulevaisuudesta. Vaikka hiilineutraaliuden kuvitelma on Suomessa jaettu, maassa ei vallitse jaettua näkemystä siitä, mitä hiilineutraalius tarkoittaa ja minkälaisia käytäntöjä se mahdollistaa. Tulkinnallisesti väljä kuvitelma jättääkin tilaa keskustelulle erilaisista keinoista ja käytännöistä mielekkään tulevaisuuden saavuttamiseksi.

Tutkimukseni osoittaa, että hiilineutraalius tulee todennäköisesti säilymään laajasti hyväksyttynä sosioteknisenä kuvitelmana Suomessa, koska se

mahdollistaa sekä poliittisen keskustelun että kompromissien hakemisen. Samaan aikaan hiilineutraalius tullaan haastamaan eri suunnilta: kenen kuvitelma hiilineutraalius on, minkälaisia toimia se mahdollistaa ja miten eri toimia arvioidaan hiilineutraaleiksi? Tällaiset keskustelut ja haasteet ovat sekä olennaisia että toivottuja oppiessamme elämään ja toimimaan ilmastonmuutoksen kanssa.

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LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following publications:

- I Karhunmaa, K. 2019. Attaining carbon neutrality in Finnish Parliamentary and City Council debates, *Futures*, 109, 170-180. <https://doi.org/10.1016/j.futures.2018.10.009>
- II Kainiemi, L., Karhunmaa, K., and Eloneva, S. 2020. Renovation realities: Actors, institutional work and the struggle to transform Finnish energy policy, *Energy Research and Social Science*, 70, 101778. <https://doi.org/10.1016/j.erss.2020.101778>
- III Karhunmaa, K. 2020. Performing the linear model: The professor group on energy policy, *Environmental Science and Policy*, 114, 587-594. <https://doi.org/10.1016/j.envsci.2020.09.005>
- IV Antal, M., & Karhunmaa, K. 2018. The German energy transition in the British, Finnish and Hungarian news media, *Nature Energy*, 3(11), 994. <https://doi.org/10.1038/s41560-018-0248-3>

The publications are referred to in the text by their Roman numerals.

Author's contributions in co-authored publications

Kamilla Karhunmaa is the sole author of Articles I and III.

Article II was co-authored with Laura Kainiemi and Sanni Eloneva. The article was written by Laura Kainiemi and Kamilla Karhunmaa, with contributions from Sanni Eloneva. Laura Kainiemi coordinated the writing process and collected the supplementary material. The interviews were conducted by Kamilla Karhunmaa and Sanni Eloneva. Planning the interviews, coding and analysing the results and drafting the article were done in co-operation with all three authors, as an iterative process. The author has contributed to all sections in the manuscript.

Article IV was co-authored with Miklós Antal. The study has been designed and conducted together. Kamilla Karhunmaa collected and analysed the data on Finland. Miklós Antal collected and analysed the data on the UK and Hungary. The article has been written together. The author has contributed to all sections in the manuscript.

1 INTRODUCTION

Imagine a world where society's "Grand Challenges" have been solved. Climate change, solved. Biodiversity loss, solved. Inequality, solved. What does that world look like? How do we live? There is no single answer to these questions or one way of imagining the future. Answers are likely to be as diverse, complex and contingent as the people responding to these questions. Yet, at the same time, our world is constantly framed as one of grand challenges that not only can and should be solved, but that require solving *right now*. One of these grand challenges is the need for an energy transition, or a fundamental change in the ways we produce, distribute and consume energy. Calls to alter current energy practices and policies are heard from all corners of the globe, ranging from state leaders to heads of global energy giants to climate campaigners and grassroots activists. The need to change energy systems is further ingrained into both policy and research, which at the same time proclaim that *too little, too slowly* is happening in response to climate change (IPCC, 2018).

Meanwhile, energy systems, technologies, markets, infrastructures, practices of use and the politics of governance are in flux. Sociotechnical systems are not stable and inert, awaiting until solutions to grand challenges emerge from somewhere or are produced by research. Rather, energy systems are embedded in processes of change as well as contributing to those changes entangled with institutions, practices and politics. The last two decades have witnessed a dramatic rise in global renewable energy production in different parts of the world (IRENA, 2020). Decentralized energy production has increased through the uptake of new technologies, practices and regulation, while at the same time heavy pipes are sunk to the bottom of the Baltic Sea to deliver a secure supply of natural gas for energy provision in European countries.

Changes are visible at all levels, ranging from households and communities that adopt and tinker with novel technologies and old installations to large-scale infrastructure projects and global and local treaties that aim to govern such processes of change. These varied and contingent processes communicate how energy transitions are not single or universal developments that will play out in the same fashion across the globe. Instead, the identified diversity demonstrates the importance of examining how the need to alter energy production and consumption is translated into locally specific priorities and practices. Consequently, I view climate change and energy transitions as both ongoing processes of social and material change as well as processes of seeking to understand, contextualize and make sense of those changes. These are not separate and discrete processes, but are instead in dynamic interaction as new

technologies, practices and policies emerge, which, in turn, are interpreted and localized in specific contexts by different actors.

This dissertation focuses on societal discussions surrounding energy policy and transitions in Finland. To do so, I want to highlight two interlinked developments that have shaped debates on energy policy and transitions in Finland and more widely globally. First, I think it is reasonable to claim that the politics of climate change has moved on from an era of debating the uncertainty of science and the necessity of action to one of debating when, how, where and by whom action to mitigate and adapt to climate change needs to be taken. This shifts analyses to investigating both the politics of stability as well as the politics of advocating for and carving out change. Second, and in parallel, the governance of energy systems is increasingly attuned to different anticipatory techniques and imaginations of energy futures, such as scenarios that map out possible energy futures. Such visions are always partial and contextual in highlighting some aspects at the expense of others, as well as political and performative in shaping and constructing present realities (Brown and Michael, 2003; Longhurst and Chilvers, 2019).

Both of these developments shift societal debates towards valuing and evaluating current activities and practices against visions of the future – whether these are ominous images of a climate-wrecked future or bright images of a technologically-fixed future. Subsequently, to understand how notions of the future are made present today and how they shape discussions on when, how, where and by whom to act, it is necessary to analyse multiple sites where energy policy, transitions and futures are discussed. In this dissertation, such sites include political decision-making at multiple scales (Article I), the institutional contexts of attempting to influence energy policy (Article II), the arenas of science-policy interaction (Article III), and media discussions (Article IV).

In examining multiple arenas where energy policy and transitions are debated, I want to take a step back from discussing energy transitions as a grand challenge and seeking to provide correct answers or best practices to solve that challenge. Instead, I am interested in how conceptualizing energy transitions as a societal imperative transforms, enables and restricts the kinds of questions asked and the political positions taken. This requires adopting an analytic stance that is based neither on drawing images of a foreboding nor a bright future, but rather asking how those distinct futures are made present today and with what implications. To do so, I draw on science and technology studies (STS), particularly the concepts of co-production (Jasanoff, 2004) and sociotechnical imaginaries (Jasanoff and Kim, 2015), which are presented in greater depth in Chapter 2.

Research on sociotechnical imaginaries seeks to scrutinize how collective understandings and displays of the public good as well as promises of a desirable future shape current politics. Sociotechnical imaginaries are continuously negotiated and performed meanings about what realities exist now and how those realities ought to be in the future (Jasanoff, 2015a). The aim of this research is to present a nuanced and extensive analysis of the emergence and consolidation of a specific sociotechnical imaginary of carbon neutrality in Finland. Theoretically, I focus particularly on how questions related to scale, heterogeneity and mobility shape the co-production of sociotechnical imaginaries with desirable forms of governance, politics and action. In doing so, I contribute new knowledge to the analysis of sociotechnical imaginaries by showing how an imaginary sets the confines for national political debate on energy policies and practices, while simultaneously maintaining space and agency to debate and contest the appropriate policy means and political choices to attain that imaginary.

The analysis focuses on Finland during the early 2010s. Further, this dissertation zooms in on energy policy as a site of governance and particularly on changes in the electricity sector.¹ Finland is an interesting place for examining energy policy debates, the relationship between stability and change and how the necessity to address climate change unfolds, due to both the ambiguities and harmonies present in the institutional context and in political debates. On the one hand, Finland was amongst one of the first countries to adopt carbon neutrality targets in policy in 2019² and exhibits a commitment to addressing climate change. Likewise, while Finnish per capita energy consumption is very high, the majority of electricity is produced without fossil fuels, through renewable energy and nuclear energy. At the same time, new renewable energy industries, such as wind energy, and practices, such as supportive policy measures for decentralized renewable energy, have had difficulties gaining a foothold in Finland (Varho, Rikkonen and Rasi, 2016; Ratinen, 2019). Consequently, the governance of energy and climate policy has been described as stable, resistant to change and influenced by inside lobbying from incumbent industrial actors (e.g. Ruostetsaari, 2010; Kivimaa and Kern, 2016; Kainiemi, Eloneva and Levänen, 2019; Vesa, Gronow and Ylä-Anttila, 2020).

This context, where a commitment to addressing climate change is shared, yet institutional structures seem resistant to change, creates an interesting case for analysing how demands to change and transform energy policy are debated, locally contextualized, and how commitments to maintain stability play out. The analysed time period – the 2010s – further reflects a moment of emergence

¹ The focus on the electricity sector is discussed further in Chapter 3. The focus is warranted as the electricity sector has raised much interest from policy, the media and academia and has also been the source of future expectations regarding electrification and digitalization.

² Bhutan first set a carbon neutrality target in 2015, with Sweden following in 2017, Iceland and the Marshall Island in 2018 and Finland and a dozen other countries in 2019 (Darby and Gerretsen, 2021).

and consolidation, where commitments to carbon neutrality and net-zero were not as ubiquitous as of now. I give a more thorough overview of both the Finnish energy mix and the governance of energy in Chapter 3.

This dissertation consists of four independent empirical studies (Articles I-IV) on energy transition debates in Finland as well as this synthesizing summary. In presenting a synthesis, my aim is to draw some collective findings from the individual articles. As such, I realize that not all aspects of the empirical studies are covered in the summary and I direct the reader to the individual articles for a more thorough discussion of the individual studies' theoretical starting points, methodological choices, analyses and findings. To reflect upon and synthesize the findings from the empirical studies, I address the following research questions in this summary:

RQ1. How is the necessity of transforming energy systems debated and contextualized in Finnish energy policy discussions?

This question addresses how the ubiquitously voiced need to change the ways energy is produced and consumed plays out in Finland. As mentioned above, engaging with this question requires taking a broad view on energy policy debates and examining not only official sites of policy-making, such as Parliamentary and City Council debates (Article I), but also media discussions (Article IV), discussions amongst actors attempting to influence energy policy (Article II), and debates at the science-policy interface (Article III). In the individual articles, I analyse how different actors articulate the demand to transform energy systems. I show that a common thread in all the empirical studies is a broad commitment to a *sociotechnical imaginary of carbon neutrality*. This imaginary constitutes a collectively held and publicly performed vision of a prosperous welfare society that has addressed climate change by attaining a balance between greenhouse gas emissions and removals. I argue that this imaginary is interpretatively flexible and accommodates diverse views on carbon neutrality, which in turn enable and restrict specific practices. This leads me to the second research question of the summary:

RQ2. How is the sociotechnical imaginary of carbon neutrality co-produced with specific priorities, practices and governance arrangements?

Following the identification of a sociotechnical imaginary of carbon neutrality, I argue that it is important to examine how this imaginary is co-produced with specific desirable activities, priorities, policy practices and governance arrangements. Since interpretatively flexible sociotechnical imaginaries can accommodate various views, this question zooms in on how views on possible and desirable governance are co-produced with the imaginary of carbon

neutrality. Attending to these questions provides insights into how energy policy and transitions are constituted as sites of inquiry, action and intervention. I present some reflections on possible future trajectories for broader societal discussions on the imaginary of carbon neutrality in Chapter 6.

The rest of this summary is structured as follows. Chapter 2 presents the theoretical grounding of the dissertation and discusses the central concepts and analytical tools of the summary. To situate the dissertation into the context of Finland, I give an overview of research on energy policy and debates in Finland in Chapter 3. Chapter 4 discusses the methodological starting points of the research and outlines the collected materials and conducted analyses. The main findings of the individual articles are presented in Chapter 5. Chapter 6 discusses the findings in line with the research questions above, while Chapter 7 condenses and concludes the summary.

2 THEORETICAL GROUNDING

This chapter introduces the theoretical background of the synthesizing summary. I focus specifically on the literature that is relevant for the summary and direct the reader to the individual articles for a more thorough review of the specific strands of literature relevant to those articles. I first discuss sustainability transitions research as a rapidly growing field that has contributed to both amplifying the perceived need to change the ways we produce and consume energy as well as understanding the complexities that lie behind this process. I proceed to outline how energy transitions have been constructed in the research field of sustainable energy transitions. I place sustainability transitions research in dialogue with science and technology studies (STS) throughout the chapter and employ concepts from STS to examine transitions research. I elaborate on the contributions from STS in the third part of the chapter, where I outline research on sociotechnical imaginaries and energy transitions.

2.1 SUSTAINABILITY TRANSITIONS AS A SALIENT FIELD OF RESEARCH

The need to fundamentally alter the ways in which energy is produced and consumed has been pronounced in public and academic debates over the last few decades. Sustainability transitions research is a field that has contributed to both making analytical sense of the challenges behind altering current energy systems and has also intensified the perceived need to do so. As a field of research, sustainability transitions epitomizes, yet seldom explicitly acknowledges, what science and technology studies scholar Sheila Jasanoff calls co-production (Jasanoff, 2004, p. 2): a commitment to knowing and representing the world that is inseparable from the ways we choose to live in it. The field of science and technology studies has developed a long lineage of scholarship that examines specific moments where epistemic representations of the world are wrought together with normative and political commitments as to what it ought to be (Shapin and Schaffer, 1985; Jasanoff, 2004). Denominating a field “sustainability transitions” is such a move, as it constitutes at once both a depiction of a particular sociotechnical system as well as a portrayal of what it ought to be (i.e. sustainable).

Before discussing sustainability transitions studies, I want to briefly outline a few terms that are used throughout this summary. These are governance, policy and politics – all of which have been developed in several academic disciplines and which are used with different connotations within and across the literatures

that I review below. Therefore, my aim here is not to draw out conceptual histories or give exhaustive definitions, but rather to highlight my approach to these terms, drawing especially on the fields of science and technology studies and critical policy studies. I direct the readers to the appended articles for more specific discussions.

First, governance in all simplicity refers to the act of governing. Important questions that then arise are, of course, who governs, how, with what authority and with what outcomes. In this dissertation, I view governance as a set of regulatory, economic and voluntary practices, mechanisms and norms through which different actors attempt to influence acts of knowing, doing and organizing. Governance is thus an activity that can involve multiple actors and can refer to both official and unofficial practices. While governance has been conceptualized in environmental social science as either a normative ideal (i.e. “good governance”), a theory, or a description of empirical changes in the acts of governance (Jordan, 2008; Munck af Rosenschöld, 2017), my focus in this dissertation is on understanding governance as a set of practices and activities. This means that I am interested in how specific forms of acting and knowing are enabled and constrained in a given institutional setting through particular governance arrangements. For example, participation in policy processes is often understood rather narrowly as commenting on particular policies, taking part in working groups or responding to public consultations (discussed further in Chapter 3). This, in turn, means that diverse forms of engaging with energy transitions, such as living labs, artistic engagements, protests and community energy groups, will go unnoticed and unaccounted for in environmental governance, as Chilvers et al. (2021) demonstrate. An analysis of governance thus requires active problematization of what is being governed, how and by whom (Rose and Miller, 1992).

Second, I view policy as the more purposive activities taken by official actors to influence actions and outcomes in a given field. While policy is often directed at attaining a specific aim, this does not mean that policy does not produce unintended outcomes or cannot be interpreted disparately by various actors (Yanow, 1996; Hajer and Wagenaar, 2003). On the contrary, the implementation and uptake of policy – and the resonance with existing policies and institutional conditions – often produces unintended outcomes, which in turn may or may not result in revising policy. In this dissertation, I discuss policy as a more specific part of the wider concept of governance. Thus, it is likewise necessary to consider and problematize what is seen as (good and usable) policy, why, by whom and for which purposes (Tuinstra, Turnhout and Halffman, 2019).

Third, while a whole dissertation could be dedicated to discussing the meaning of politics, I here want to highlight two intertwined aspects of politics that are relevant to this study. In line with Palonen (2003), I view politics as both a space

as well as an activity that consists of both the performance of politics and the opening of issues as political. Politics thus constitutes both a space for negotiation as well as a performance of that negotiation. Understood like this, then, the most important questions become who gets to participate in the space of politics, and who makes issues political and with what authority? What is the role of knowledge and science in defining the space of politics and the political and vice versa, how does politics configure in delineating the role of science (Ezrahi, 1990; Latour, 1993; Jasanoff, 2004)? I discuss this aspect further particularly in the third section of this chapter.

Returning to reviewing and outlining the field of sustainability transitions research, a recent review article on the state of research in sustainability transitions acknowledges its central contribution as the conceptualization and explanation of “*how radical changes can occur in the way societal functions are fulfilled*” (Köhler *et al.*, 2019, p. 3). This aim is directed at understanding “grand societal challenges”, especially those identified as most pertinent to modern societies, such as climate change, loss of biodiversity and resource depletion. It is argued that these cannot be addressed by “*incremental improvements and technological fixes, but require radical shifts*” (Köhler *et al.*, 2019, p. 3). The purpose of stating this here is to highlight that in doing so, transitions researchers set for themselves an ambitious and salient research agenda that aims to speak directly to policy and politics and provide solutions to societal problems. At the same time, the same review calls for transitions research to seek “*societal relevance through sound science and impartial assessment*” (Köhler *et al.*, 2019, p. 19), thus obscuring the fact that doing research and making “grand societal challenges” known – to policy makers, politicians, and citizens – requires simplification and this simplification is in itself not neutral or impartial, but rather shaped by values and choices over what is included and excluded.

I want next to explore how the motivation to produce policy-relevant knowledge while remaining committed to sound science and impartial assessment plays out in the broad field of sustainability transitions research. In doing so, I acknowledge that any diverse field of research evolves through critique and response, and my contribution builds on and develops already voiced critique, especially through the lens of STS (e.g. Shove and Walker, 2007; Smith and Stirling, 2010; Smith, Voß and Grin, 2010; Stirling, 2014, 2019).

The origins of sustainability transitions research lie in the fields of evolutionary economics, innovation studies and science and technology studies. Conceptualized first through the concept of “socio-technical transition”, referring to fundamental shifts in socio-technical systems (Rip and Kemp, 1998; Geels and Schot, 2007), the term “sustainability transitions” has since become more popular. It is also codified into a research network (Sustainability Transitions Research Network) containing over 1,700 members, a yearly

conference and an explicit research agenda (Markard, Raven and Truffer, 2012; Köhler *et al.*, 2019). Sustainability transitions have been defined as “*long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption*” (Markard, Raven and Truffer, 2012, p. 956). Contrary to socio-technical transitions, sustainability transitions research proposes an explicit normative target in moving towards more sustainable systems and seeking to deliver solutions to grand societal challenges. Most often, sustainability transitions research focuses on the meso-level of sociotechnical systems’ evolution and change, thus steering away from both larger debates in the social sciences regarding the nature of capitalism, for example, or the implications of individual choices or practices (Köhler *et al.*, 2019).

Like most academic fields, sustainability transitions research is heavily loaded with conceptual frameworks, typologies and analytical tools. These include the multi-level perspective (Rip and Kemp, 1998; Geels and Schot, 2007); the technological innovation systems approach (Bergek *et al.*, 2008); strategic niche management (Kemp, Schot and Hoogma, 1998); and transitions management (Rotmans, Kemp and Van Asselt, 2001; Loorbach, 2010). These approaches have been extensively introduced, reviewed and developed in several contributions (e.g. Markard, Raven and Truffer, 2012; Köhler *et al.*, 2019) and, for the purposes of this dissertation, it is not necessary to discuss these in detail. I will limit the discussion to briefly introducing the multi-level perspective on socio-technical transitions due to its significance in the field as well as the pervasiveness of its conceptual vocabulary of niche, regime and landscape. While the empirical studies of this dissertation at times employ the conceptual vocabulary of the multi-level perspective as a shorthand to refer to different parts of energy systems, I am not methodologically or theoretically committed to this perspective.

The multi-level perspective (MLP) on transitions argues that changes occur in socio-technical systems through dynamic interaction and co-evolvement between three distinct analytical levels: 1) niches, or protected spaces for fostering innovations; 2) socio-technical regimes, or the currently stabilized ways of organizing the realization of certain societal functions; and 3) exogenous landscape developments, such as slowly changing trends or shocks (Geels, 2002; Geels and Schot, 2007). The MLP was developed to analyse historical, long-term shifts from one socio-technical configuration to another, such as from sail ships to steam ships or from cesspools to sewage systems (Geels, 2002, 2006). Since then, the MLP has faced critique for insufficient conceptualization of power, politics and agency (Meadowcroft, 2009, 2011; Smith and Stirling, 2010; Stirling, 2014) and has also responded to this critique (Geels, 2011; Avelino *et al.*, 2016; Avelino and Grin, 2017).

The MLP has strongly shaped subsequent developments in the transitions field, as both an analytical tool and a heuristic. For example, conceptualizations of power have been ordered through the analytical lens of the MLP, arguing that the type of power wielded by societal actors corresponds with the levels of the MLP (Grin, 2010; Avelino, 2017). Another example is the development of discursive methodologies that are linked to the levels of the MLP (Hermwille, 2016; Rosenbloom, Berton and Meadowcroft, 2016; see also Isoaho and Karhunmaa, 2019). The MLP has thus functioned as an important ordering device for research on transitions and the image of transitions progressing through interactions between niches, regimes and landscapes is ubiquitous (see also Stirling, 2019).

A consequence of the growth and development of sustainability transitions research has been its increased influence and uptake in different policy contexts, especially innovation-focused fields in European countries (Heiskanen *et al.*, 2009; Voß, 2014). This is not surprising, as transitions research has been policy-oriented from the beginning and approaches such as transitions management and strategic niche management have been applied to and tested in specific policy contexts already in the early 2000s, most notably in the Netherlands (Hendriks, 2009; Smith and Kern, 2009; Loorbach, 2010). The transformative capacity of these early applications remained modest, however, with researchers concluding that the use of transitions approaches to guide policy-making has not resulted in challenging dominant interests and problem frames, but rather has often led to the co-optation of radical storylines or the privileging of epistemic matters over democratic considerations (Hendriks, 2009; Smith and Kern, 2009).

Since then, the sustainability transitions field has developed and employed more applied research methodologies, such as action research (Wittmayer and Schöpke, 2014) and experimentation (Sengers, Wiczorek and Raven, 2016), for the most part with the purpose of increasing the policy relevance and impacts of research. Amidst these calls for increasing participation, self-reflection and descent from the ivory tower remains a demand to provide relevance “*through sound science and impartial assessment*” (Köhler *et al.*, 2019, p. 19). Sustainability transitions research thus seems to walk a tightrope between acknowledging the fields’ normative orientation and lacking an articulation of how this structures the production of knowledge in the field. The normative orientation of sustainability transitions appears more readily directed outwards to reflecting on the implications of research processes and results than inwards to questioning how the epistemic practices of the field constitute particular policy problems, objects of intervention, and desirable solutions and practices (see also Shove and Walker, 2007).

2.2 CONSTRUCTING ENERGY TRANSITIONS AS A POLICY PROBLEM

Within the field of sustainability transitions, energy transitions are an apt example for looking at how policy problems are constructed. Below, I discuss how the ideas of policy salience, urgency and contestation are built into current conceptualizations of energy transitions. Clark Miller and Carina Wyborn discuss such a process of co-production as an inevitable and ubiquitous feature of modern societies that “*cannot not happen*” (2020, p. 94). In the context of energy transitions, this means that whenever knowledge production about energy transitions occurs, it is accompanied by the construction of a desirable social order. While this point may be criticized as merely a descriptive statement, the aim of analysing such moments of co-production is rather to uncover dominant narratives and taken-for-granted boundaries that are described as neutral or non-political (Jasanoff, 2004). As Longhurst and Chilvers (2019, p. 974) state, “*even those visions which are seemingly descriptive or exploratory bring forward particular normativities in the form of imagined social, political and economic orders which extend beyond the exposition of future energy systems*”. In this way, analysing how energy transitions are constructed sheds light on what types of issues, practices and knowledge are included or excluded and with what consequences.

In both energy research and sustainability transitions research, energy transitions have been defined in multiple ways and there is no consensus on what energy transitions are (Laird, 2013; Sovacool, 2016). Key elements that link different definitions are energy, its use and production, and an observation of a change from some previous identified state or process. Disagreements span over where and how change occurs, what it influences, over what time and to what extent (Grubler, Wilson and Nemet, 2016; Smil, 2016; Sovacool and Geels, 2016). A difference between a more techno-economic understanding from energy research to a more socio-technical one in transitions research can be observed. For example, Sovacool (2016) outlines three distinct views where first, “energy transitions” has been used to characterize changes in the energy system, such as in the fuel source, technology or prime mover. Another definition considers how technological changes have an effect on both different energy inputs and outputs as well as wider structural changes (Araújo, 2014; Sovacool, 2016). Finally, a third line of definitions argues that energy transitions entail a radical transformation of both social and technological practices (Kern and Rogge, 2016; Sovacool and Geels, 2016).

This last definition is most in line with current conceptualizations in the sustainability transitions literature, where energy transitions are characterized not only as technological changes but as wider sociotechnical processes of change that involve a normative conceptualization of the desired end-goal. As

Miller et al. (2013) emphasize, energy transitions are not merely about changes in technologies, but about the different forms of social, political and economic arrangements that are built in combination with technologies (see also Winner, 1980). The prevalence of multiple views on what energy transitions are has led Sovacool (2016) to argue that what is counted as an energy transition depends greatly on the analyst and how energy transitions are defined. How energy transitions are constructed by different fields of research thus matters and will be reflected on in wider societal debates over whether or not we are experiencing energy transitions, how these should be valued and measured, and which aspects of energy transitions to include or exclude in debates and measurements.

The literature on sustainability transitions associates energy transitions with long-term decarbonization targets and frames sustainable energy transitions as an urgent and politically salient challenge for policy (Markard, 2018; Isoaho, 2020). For example, in a commentary in *Science*, Geels et al. (2017, p. 1242) call for “rapid and deep decarbonization”, which can be accelerated by “*increasing momentum of niche innovations; weakening of existing systems; and strengthening exogenous pressures*”. This ties the acceleration of energy transitions to reinforcing specific patterns and alignments in the previously described MLP framework, such as simultaneously promoting niche innovations and weakening the reproduction of existing regimes. Whilst the acceleration of energy transitions is an increasingly voiced demand, the temporal dimensions of energy transitions have also raised debate.

Several energy transitions scholars acknowledge the need for rapid emissions reductions. However, energy transitions are described as long-term processes that span over decades (Smil, 2016; Sovacool, 2016). In the transitions scholarship, this mismatch between historically long-term energy transitions and the need for urgent emissions reductions in response to climate change has been approached by calling for an increased role for policy to purposefully steer change (Kern and Rogge, 2018). This has resulted in, for example, deploying the conceptual vocabulary of the MLP to offer policy advice and pathways for action (e.g. Geels *et al.*, 2017). As a result, much of energy transitions research balances between offering descriptive accounts of current and past transitions while simultaneously prescribing particular policies as desirable for achieving rapid and deep decarbonization (see e.g. Roberts *et al.*, 2018). This shows how research and knowledge production have played a formative role in constructing energy transitions as an urgent and salient policy issue to which specific solutions are offered.

Already early on, sustainability transitions research on energy faced critique over its inability to account for politics. In 2009, James Meadowcroft asked “*What about the politics?*”, concluding that political processes lie at the heart of

governance for sustainable development, resulting in much messier and more complex processes of change than anticipated by contemporary transitions research frameworks (2009, p. 335). Different sociotechnical visions, such as calling for transitions towards fossil free, renewable or carbon neutral futures, will result in materializing and legitimizing different sociotechnical pathways (Meadowcroft, 2009; Lawhon and Murphy, 2012). Since this early critique, research on energy transitions has acknowledged the complexity and conflictual character of energy transitions on multiple occasions (e.g. Smith and Kern, 2009; Stirling, 2014; Rosenbloom, Berton and Meadowcroft, 2016; Rosenbloom, 2019). It is beyond the scope of this dissertation to address in detail the criticism raised towards energy transitions research or the responses that have followed. In the following, however, I show how this criticism has resulted in conceptual development in two parallel strands on the policy and politics of energy transitions.

First, scholarship that seeks to bridge energy transitions research with research on policy processes has increased in recent years (e.g. Kivimaa and Kern, 2016; Kern and Rogge, 2018). This research is interested in analysing the strategies developed by governing actors to address societal concerns and how they could be guided to shape and accelerate energy transitions. A rising trend is focusing on how to not only promote innovations but actively destabilize current unsustainable regimes, for example through policy mixes, phase-out policies or systemic disruptions (Kivimaa and Kern, 2016; Rogge and Johnstone, 2017; Johnstone *et al.*, 2020). This line of research seeks to provide explicit policy proposals and recommendations for decision-makers and thus presents energy transitions research as an area that contributes to solving “grand societal challenges”.

Second, in parallel with the focus on policy, a more explicit focus on politics and the political dimensions of energy transitions processes has emerged. In contrast to research on policy, this research is interested in examining how transitions are value-laden processes that involve conflicts and contestation between different groups and viewpoints (Hess, 2014; Betsill and Stevis, 2016; Rosenbloom, Berton and Meadowcroft, 2016). Much of the research highlights the processes through which energy transitions create distinct groups of beneficiaries and losers, resulting in support for and resistance against proposed policies (Geels, 2014; Leipprand and Flachslund, 2018; Roberts *et al.*, 2018). One specific area where conflict plays out is through discursive struggles, where different groups compete over framing policy processes and attempting to legitimize particular practices (Rosenbloom, Berton and Meadowcroft, 2016). This involves both constructing meaning for observed changes as well as creating links between specific issues and actors, such as coal phase-out and blue-collar workers in underprivileged regions (Leipprand and Flachslund, 2018; Isoaho and Markard, 2020). The focus on politics has alerted transitions scholars

to examine the political arena as one that can significantly impede the development of rapid energy transitions, but also as one where potential coalitions can be formed to accelerate transitions (e.g. Haukkala, 2018). This line of research seeks to provide policy recommendations, but addresses these often to a broader range of actors than policy-makers.

Energy transitions research has thus taken on board several of the early criticisms regarding power, politics and agency raised against it. Nonetheless, I want to raise a few points for further reflection. First, the acknowledgement of energy transitions as inherently political processes has resulted in developing and calling for methodological and theoretical crossovers with different fields, such as policy studies (Kern and Rogge, 2018), political science (Roberts *et al.*, 2018) and science and technology studies (Hess and Sovacool, 2020; Sovacool *et al.*, 2020). At the same time, there remains a tension regarding how to account for the different ontologies and epistemologies, and the plethora of methodological approaches, that have been developed within and across these fields (Sovacool and Hess, 2017; Isoaho, 2020). Second, and related, energy transitions research teeters between being a reflexive field that is interested in how transitions towards sustainability are governed, yet at times struggling to account for social science and transitions research itself as a powerful means of ordering the world. While the turn to policy and politics in energy transitions research shows promising avenues, there still remains conceptual work to be done in acknowledging how visions of the future shape politics and governance. I turn to this question in the next section, where I discuss energy transitions as a sociotechnical imaginary and present research on energy and imaginaries.

2.3 ENERGY TRANSITIONS AS A SOCIOTECHNICAL IMAGINARY

As described above, sustainability transitions research frames energy transitions as urgent and politically salient policy problems that require public intervention. This has led to a sustained and persistently voiced claim to transform current modes of producing and consuming energy. As such, transitions research is co-producing visions of a desirable future with views on desirable social order. The purpose of stating this here is to acknowledge that the social sciences, too, are world-making practices that construct objects of analysis and intervention, and deserve to be studied as such (Asdal and Marres, 2014). As stated in the introduction, science and technology studies is the field of research that is interested in analysing such processes, i.e. both the processes through which scientific knowledge and technological objects are constructed and how science and social order are mutually shaped. Much research in the genealogy of STS has focused specifically on the production of *scientific* knowledge in rather traditional settings, such as the laboratory (e.g. Latour and Woolgar, 1979;

Knorr-Cetina, 1995) and on the formation of *technological* artefacts (e.g. Bijker, Hughes and Pinch, 1987). Within the diverse field of STS, I draw upon an intersecting analytical lineage, namely that of co-production (Jasanoff 2004). While I have already referred to co-production in several parts of the dissertation, I want to briefly outline the type of analysis that co-production³ allows for.

Co-production seeks to analyse the mutual production and shaping of knowledge and social order. Jasanoff (2004, pp. 2–3) explains co-production as follows: “*The ways in which we know and represent the world (both nature and society) are inseparable from the ways we choose to live in it. Knowledge and its material embodiments are at once products of social work and constitutive of forms of social life; society cannot function without knowledge any more than knowledge can exist without appropriate social supports.*” Co-production is thus a way of talking about the mutual dependency of the epistemic and the normative, or how stating what *is* is always entangled with what *ought to be*. A co-productionist perspective views science and technology as sites that are imbued with norms and values. Simultaneously, society’s governing institutions both borrow from scientific reason as well as regulate the space and scope for science.

I situate this dissertation in this analytical lineage since, firstly, I view energy transitions as processes of both social and material change as well as meaning-making that aims to make sense of those changes. This means that material, technical and social changes are intertwined with the social and discursive processes that vie to construct meaning for those changes. Second, co-productionist analysis is particularly suited to analysing how knowledge and social order are constituted in the social sciences and policy, which still tend to receive less analytical attention in STS than the natural sciences (Asdal and Marres, 2014). As previous research has attended especially to how technological or innovation pathways feature in energy transitions (e.g. Levidow and Papaioannou, 2013), the role of desirable policy and governance has received less attention. However, I will demonstrate that policy is also a site where imaginative capacities are exercised to label specific issues as (un)controllable, (un)certain or (un)desirable. In sum, co-productionist analysis enables analysing energy transitions as both an epistemic and normative undertaking.

I now turn to the concept of sociotechnical imaginaries to elaborate on the role of future visions in shaping social order. The concept of sociotechnical imaginaries, as developed by Sheila Jasanoff and San-Hyun Kim (2009, 2015), builds on previous work that views imagination as a profoundly important attribute of human societies (e.g. Anderson, 1983; Taylor, 2004). The capacity

³ I approach co-production as it has been developed in science and technology studies. Co-production has also been developed in public and business administration and sustainability science. For a thorough review on the different disciplinary approaches, see Miller and Wyborn (2020).

to imagine distinct futures allows for painting both fanciful dreams of better times as well as chilling views of a future to avoid. Imagining the future can thus create abstract, yet coherent and durable, entities that order social and political life. In previous scholarship, Benedict Anderson challenged the prevalent idea of nations as distinct political entities. Instead, he showed how the idea of a nation is built upon imagined political communities, or shared and collectively distributed understandings of who we are, which are repeatedly rehearsed and recollected through different media, such as the print media and museums (Anderson, 1983). Charles Taylor (2004), in turn, argued that imagination is not merely a set of ideas but rather the enabling condition that holds modernity together through distilling a tacit sense of how one ought to live and what can be viewed as correct and legitimate with regard to the state of 'modernity' we are in. However, as Jasanoff (2015a) shows in the introductory chapter to *Dreamscapes of Modernity*, these previous studies on the role of imagination fail to account for the profound role that science and technology have, not only in shaping our societies, but also in performing and being called upon to produce collective visions of the future.

Extending from previous scholarship, Jasanoff (2015a, p. 4) defines sociotechnical imaginaries as “*collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology*”. This places importance on viewing imaginaries as shared resources that touch upon tacit understandings of what may “feel right” in a given time or place. Through being collectively held and performed, imaginaries can account for how rather abstract ideas, such as the autonomy of science, come to persist over time (Jasanoff and Kim, 2015). Imaginaries, thus, are not only imagined but also collectively performed, pointing to the importance that displays of statehood, power or accountability have on legitimizing and enabling certain views on desirable futures (see also Ezrahi, 1990). At the same time, imaginaries of desirable futures build upon and gain ground through attachment to rather tangible things, such as material resources and infrastructures, which in turn are constituted and reinterpreted through imaginaries (Kuchler and Bridge, 2018). In sum, the concept of imaginaries highlights how all visions of the future, even those that claim to be merely descriptive, are performative as they mould and formulate present realities (Longhurst and Chilvers, 2019).

Next, I turn to the literature that discusses sociotechnical imaginaries with regard to energy. As sociotechnical imaginaries were first coined with a comparison on the governance of nuclear energy in the US and South Korea (Jasanoff and Kim, 2009), it is not surprising that there are plenty of studies that examine sociotechnical imaginaries in the context of energy (e.g. Eaton, Gasteyer and Busch, 2014; Kuchler, 2014; Ballo, 2015; Korsnes, 2016; Smith and

Tidwell, 2016; Kuchler and Bridge, 2018; Tozer and Klenk, 2018). In a recent review on the integration of STS with energy research, Hess and Sovacool (2020) state that sociotechnical imaginaries was the most frequently used term to discuss collectively held views on the future, in contrast to visions, anticipation or expectations. Within energy research, analysis on sociotechnical imaginaries has been paired and combined with different theoretical and methodological takes, such as pathways (Levidow and Papaioannou, 2013), frames (Eaton, Gasteyer and Busch, 2014), storylines (Tozer and Klenk, 2018), prefigurative activism (Marquardt and Delina, 2019) and resource materialities (Kuchler and Bridge, 2018). This shows that the intersection of energy and sociotechnical imaginaries is a rapidly growing and developing field of study that is branching into different theoretical and methodological directions, all of which cannot be reviewed here. In the following, I focus on three themes that are somewhat understudied and important for understanding this dissertation: the scale, heterogeneity and mobility of imaginaries. I argue that, collectively, all of these themes point to the importance of analysing the interpretative flexibility of sociotechnical imaginaries and how imaginaries are co-produced across space and time.

Sociotechnical imaginaries were first conceptualized as collectively imagined forms of social order that are reflected in nation-specific scientific and/or technological projects (Jasanoff and Kim, 2009, p. 120). Jasanoff and Kim (2009) showed how the development of nuclear power in the US and South Korea has both relied on and contributed to nation-specific ideas on the governance of technology and the distribution of risks and benefits. In South Korea, the risks of developing nuclear power were contrasted against the risks of failing to develop as a nation, whereas in the US, the discussion on the risks of nuclear power was tightly contained and risks were referred to as limited and manageable (Jasanoff and Kim, 2009). This initial focus elevated nation-states to function as both explanatory resources for divergent sociotechnical pathways as well as to act as the key analytical units through which imaginaries research was conducted. However, researchers began to quickly suggest that sociotechnical imaginaries are relevant also at other scales than the nation-state.

Smith and Tidwell (2016) argued that imaginaries research focused too strongly on the nation-state, failing to account for how ordinary citizens both produce imaginaries of their own or criticize, transform or take up broader imaginaries. They introduced the term “bounded imaginaries” to refer to imaginaries that are limited to the local scale and fail to gain ground in national discussions of a good future. As can be seen from the definition of sociotechnical imaginaries given above, the issue of scale has been revisited and sociotechnical imaginaries are now discussed as belonging to collectives that can vary across space and time and are not necessarily bound to the nation-state (Jasanoff, 2015a). In the context of energy, research has examined imaginaries beyond the nation-state

through analysis of transnational organizations (Kuchler, 2014), networked cities (Tozer and Klenk, 2018), and regional innovation policies (Levenda *et al.*, 2019). At the same time, scale remains a relevant issue in the analysis of sociotechnical imaginaries. A question that has not been comprehensively addressed in the literature is the extent to which an imaginary can be shared – rather than distinct – across geographical scales, yet exhibit specific elements that vary according to location or scale. This brings me to the second theme on imaginaries and heterogeneity.

As sociotechnical imaginaries are defined as “collectively held, institutionally stabilized and publicly performed”, they contain a degree of stability, tenacity and comprehensiveness. This can lead to asking whether imaginaries can come to function as strongholds of the imagination or as stubborn structures resistant to change. Giving imaginaries an ontologically fixed status, however, would “*rob them of their analytical value*”, Jasanoff (2015b, p. 339) argues. This means that analysts must stay attuned to both how dominant imaginaries are performed but also to what impedes or facilitates alternative imaginaries to arise and gain foothold. An adjacent question regarding alternative imaginations is that of how much heterogeneity an imaginary can allow for. That is, how much plurality can an imaginary afford without transforming into a completely different imaginary? This is a topical issue for research on sociotechnical imaginaries, which has recently highlighted conflict and contestation across different imaginaries (e.g. Levidow and Papaioannou, 2013; Burnham *et al.*, 2017) instead of the possible divergence that can exist within an imaginary.

In this thesis, I will argue that plurality in the form of interpretative flexibility can come to function as the glue that holds an imaginary together. Interpretative flexibility thus provides one answer to the question of how practices of collective imagination can resolve conflict and produce consensus (Jasanoff, 2015a, p. 27). That is, through remaining interpretatively flexible, imaginaries can speak to and unite broad collectives without causing conflict.⁴ At the same time, the heterogeneity underwritten in interpretative flexibility means that while speaking of the same imaginary, it is possible to see and analyse different co-productions. While sociotechnical imaginaries contain a degree of cohesion even under broad and flexible ideas, how these imaginaries play out across time and space is a question of how the imaginary is co-produced with contingent priorities and practices. This brings me to my third point concerning the mobility and capacity of sociotechnical imaginaries to travel across distinct contexts.

Research in STS has shown how political and technological changes never lead to identical responses in different cultures, but rather that changes are always

⁴ I further qualify this discussion with regard to boundary objects (Star and Griesemer, 1989; Star, 2010) in Chapter 6.

filtered into pre-existing imaginations, institutional structures and practices of sense-making (Jasanoff, 2007; Felt, 2015). This explains how shocks, such as the Fukushima accident, led to officials stressing the safety of nuclear power in Finland, while German politicians decided to push through plans of nuclear phase-out (Hermwille, 2016; Ylönen *et al.*, 2017). Likewise, when sociotechnical imaginaries travel from one context to another, they are transformed. Pfotenhauer and Jasanoff (2017) discuss the MIT model of innovation as a “traveling imaginary” to highlight how seemingly universal ideas about innovation are modified to respond to particular diagnoses of social problems in different contexts. With this analysis, they show how models of “best practice” – whether in innovation, environmental governance or development policy – are never transferred unchanged, but will always be tailored according to local views on the problem at hand.

In a similar move, Forsyth and Levidow (2015) warn of the dangers of assuming that the subjects of comparison (such as policy frameworks) are mobile and detachable from their origins and that comparison of such subjects could shed light on desirable best practices. Instead, they argue that the act of detaching a subject from its place of origin is in itself a site of ontological politics – one where decisions are made on what is worthy and possible of comparing. Thus, when we speak of imaginaries as moving from one context to another, it is important to be specific about what is assumed to be mobile, by whom and how that mobility plays out. This is pertinent in the context of energy transitions, which saddle at the same time the rather universalizing idea of requiring “deep and rapid decarbonization” while simultaneously paying heed to how hugely context-dependent and variable this process is likely to be in different geographical and political spaces.

The issues of scale, heterogeneity and mobility all point to the importance of analysing how sociotechnical imaginaries are co-produced in distinct places over time. From early on, imaginaries have been described as analytical resources that do not abide by strict dichotomies such as those of agency and structure. The focus on the institutional stability of imaginaries, however, draws attention to how imaginaries allow for specific types of action while restricting others. Imaginaries in this sense condition that which is seen and acted upon (Jasanoff, 2015a). This emphasizes the more structural element of imaginaries, or how imaginaries contribute to constituting the conditions of what is seen as potential and prehensible (see also Stirling, 2019). Focusing on scale, heterogeneity and mobility, in turn, can orient the analysis of imaginaries towards questions regarding agency and the scope of agency in the context of a sociotechnical imaginary. I do not state this in order to advocate a return to problematic dichotomies of structure and agency. Rather, my aim is to highlight some possibilities for exercising agency that the themes discussed above allow. First, focusing on the scale at which desirable futures are imagined allows for

seeing and knowing alternative futures and asking to what extent they are seen and acted upon by those in power (Smith and Tidwell, 2016). Second, looking for heterogeneity in imaginaries allows for examining the subtle distinctions in the ways that actors propose to attain desirable futures. Third, examining how imaginaries transform as they are transported from one place to another allows for appreciating the capacity of different actors to shape and mould imaginaries. In sum, these three themes highlight some of the avenues that actors can pursue to exercise agency in both imagining and acting otherwise.

This chapter has presented an overview of three distinct fields of study: sustainability transitions research, energy transitions research, and STS studies on sociotechnical imaginaries. I have presented sustainability transitions research as a growing research field that is aimed at addressing grand societal challenges and that is engaged in producing policy-relevant research. Within this field, energy transitions are framed as a particularly urgent, salient and contested policy problem. Both sustainability transitions research and energy transitions research reflect a broader trend in energy policy to govern futures, change and transition. They do so through intertwining descriptive accounts of energy transitions with prescriptive calls to shape and accelerate transitions (e.g. Sovacool, 2016; Geels *et al.*, 2017). Acts of knowledge production are thus co-produced with views on desirable social order. In the third section of this chapter, I have argued that it is necessary to analyse such moments of co-production and I have presented research on sociotechnical imaginaries as a means of doing so. In contrast to transitions research, the analytical focus of STS shifts the gaze from the study of past and future energy transitions to asking how and for whom such pasts and futures work in the present.

3 GOVERNING ENERGY IN FINLAND

This chapter introduces the Finnish energy sector and discusses previous research on the governance of energy in Finland. While the empirical studies presented in Chapter 5 focus on the 2010s, the aim of this chapter is to contextualize these studies with a discussion on earlier developments. The first part of the chapter discusses the role of different energy sources in the Finnish energy system, whereas the second part focuses on policy processes and governance.

3.1 CHARACTERIZING THE FINNISH ENERGY MIX

“In compiling the National Energy and Climate Strategy, it is essential to take into consideration our national special features, such as the cold climate, long transport distances, our extensive energy-intensive industry as well as our own raw materials resources, particularly forest biomass.” (Huttunen, 2017, p. 14)

The Government report on the National Energy and Climate Strategy for 2030 starts by declaring that Finland’s long-term aim is a carbon neutral society (Huttunen, 2017). The above quote, which lays out the national characteristics or “special features” of Finland that structure and motivate the governance of the energy system, is situated towards the end of the brief introduction. While this can be read as a description of “the ways things are”, the short statement says a lot about both the historical development of the Finnish energy sector as well as current motivations to shape and transform it towards carbon neutrality.

Finland is one of the European countries with the highest per capita energy consumption. In both policy and academic text, this is often attributed to the reasons identified in the above quote: the cold climate and the extensive heating this necessitates, the long distances within the country and the needs of energy-intensive industry. Heating takes up 26% of final energy consumption and transport around 17% (Statistics Finland, 2020b). Both the heating and transport sectors have been discussed as key challenges for policy, due to their reliance on fossil fuels. While heating and transport are important challenges for the energy sector as a whole, this dissertation does not zoom in on these two sectors. Instead, I focus on energy policy as an area of governance, and particularly on changes in the electricity sector. This choice stems largely from the research design and collected empirical materials, outlined in more detail in Chapter 4. I have approached energy policy with a broad orientation and interest in questions related to governance, policy processes and their negotiation. This, in turn, was discussed in the collected materials either on a

broad level or, if specified, often with regard to changes in the electricity sector. This is likely due to the electricity sector being in the limelight of policy attention, academic interest, media discussions and future expectations, especially regarding the electrification and digitalization of services. In the following overview of the Finnish energy mix, I highlight the share of different energy sources both in final energy consumption and in electricity provision.

The Finnish energy sector has historically developed around three main groups of energy sources: fossil fuels, nuclear energy and renewable energy. Fossil fuels are especially important in the transport and heating sectors, including combined heat and power (CHP) plants. In 2019, imported oil, coal and natural gas accounted for 34% of final energy consumption and 13% of electricity production (Statistics Finland, 2020a; Energiatieto, 2021). From the 1970s oil crises onwards, diversification of the energy mix has been a stated governmental aim. As a result, the first nuclear power reactors began operating in Loviisa in 1977 and 1981. Meanwhile, the high share of renewable energy in the Finnish energy mix, which has grown gradually from the 1970s onwards, is due to the large use of forest residues as energy, developed as a by-product of the pulp and paper industry. The development of nuclear energy and bioenergy has been systematically supported by energy-intensive industry, particularly the forestry industry, in close cooperation with politicians and civil servants (Sunell, 2004). The long history and development of nuclear energy and bioenergy in Finland shows how “carbon neutral” energy sources were systematically promoted prior to being labelled as carbon neutral. Indeed, Kivimaa and Mickwitz (2011) discuss how the adoption of new climate mitigation goals in the 1990s did not lead to the promotion of new technological options in energy policy. Instead, bioenergy was reframed as a renewable resource and existing commitments to bioenergy were reinforced. Likewise, Kojo and Litmanen (2009) document how nuclear energy has repeatedly been reframed as a carbon neutral option from the 1990s onwards in response to tightened climate mitigation targets.

Up until today, Finnish energy policy remains largely committed to advancing both nuclear energy and bioenergy. Finland is one of the few European countries (along with the UK and Hungary) that has opted to move ahead with nuclear new build projects. In 2019, nuclear energy accounted for 18.3% of final energy consumption and 34.7% of electricity production (Statistics Finland, 2020a; Energiatieto, 2021). In 2010, the Finnish Parliament made a Decision-in-Principle⁵ that allowed two new nuclear reactors to be built: a new nuclear reactor in the Olkiluoto site by Teollisuuden Voima and the development of a

⁵ (*periaatepäätös*, in Finnish). This is a government decision to permit the construction of new nuclear units. The Parliament ratifies such a decision by voting. Unlike most voting in Parliament, voting on nuclear new build is considered a “question of conscience”, where representatives do not have to vote in line with the official position of their Parliamentary group. For a more detailed discussion on this, see Laihonen (2016).

completely new nuclear site by Fennovoima. Finnish nuclear politics has been described as a “peculiarity” in the international context (Laihonen, 2016).

Firstly, because Finland was the first Western nation to start constructing a new nuclear power plant in 2002, after a 15-year impasse in nuclear new build projects. Since then, the Olkiluoto3 nuclear power plant has been delayed by over a decade while expenses have added up to 85 billion euros, dubbing it one of the world’s most expensive buildings (Karlsson, 2018; Laakso, 2019). The Fennovoima nuclear power project has likewise been delayed over the course of years, as ownership structures in the project have altered and the involvement of the Russian state-owned Rosatom has raised questions. The second distinctive feature of Finnish nuclear energy is the commitment to nuclear safety and the extensive development of nuclear know-how, which are both considered benchmarks for other nations developing nuclear energy (Laihonen, 2016). Lastly, Finland is one of the few countries that has a policy for the final disposal of spent nuclear fuel as well as a disposal site in construction (Ialenti, 2017; Litmanen et al., 2017). Due to these issues, nuclear energy and nuclear politics have been extensively studied in the Finnish context. Numerous studies confirm that nuclear energy, and particularly recent nuclear new build, has been repeatedly framed as a necessary societal project that ensures the advancement of carbon neutrality, economic growth and societal welfare (Kojo and Litmanen, 2009; Litmanen and Kojo, 2011; Laihonen, 2016).

Meanwhile, the high share of renewable energy in Finland is explained by the extensive use of bioenergy, which accounts for over a quarter (28% in 2019) of Finnish final energy consumption (Statistics Finland, 2020a). In electricity production, biomass accounted for 18.9% in 2019 (Energiatoteellisuus, 2021). In policy debates, there are both high ambitions for the increased use of bioenergy as well as serious anxieties over its sustainability. The 2017 National Climate and Energy Strategy focused heavily on increasing bioenergy use. However, Finnish researchers and environmental organizations have repeatedly raised concerns over the detrimental impacts of increased wood use on biodiversity as well as the negative climate impacts of burning wood for energy. While bioenergy is often promoted as a carbon neutral energy source due to the assumption that the carbon released by burning wood will be bound again as forests regrow, recent openings have emphasized the need to maintain carbon sinks to ensure rapid emissions reductions (Seppälä *et al.*, 2017). This, in turn, has led to questioning the ability to utilize forest resources extensively to meet carbon neutrality targets. Finnish researchers have participated actively in public debates over the sustainability of bioenergy in both national and international discussions and have signed petitions that caution against increased wood use for energy (Berglund *et al.*, 2017; Saarela, 2019). Meanwhile, bioenergy continues to form the largest share of renewable energy in Finland and some researchers have proposed that the new law to ban the use of coal in heating and electricity

generation from 2029 onwards is likely to increase the use of wood for energy provision (Vadén *et al.*, 2019).

As for other energy sources, hydropower accounts for around 3% of total energy consumption and 18.5% of electricity production in 2019, but is prone to yearly fluctuations (Statistics Finland, 2020a; Energiateollisuus, 2021). While at times significant especially in electricity production, hydropower has very limited expansion potential in Finland at the moment and the share of hydropower is unlikely to increase in the future. Finland has substantial peat resources and peat provides 4% of final energy consumption and 4.3% of electricity production (Statistics Finland, 2020a; Energiateollisuus, 2021). The use of peat for energy production is a significant source of contention due to its high global warming potential and harmful impacts on mire ecosystems (Albrecht, 2018). Since 2013, however, the discontinuation of peat usage has increasingly been on the agenda (Albrecht, 2018).

While Finland has significant renewable energy consumption and has thus been labelled a forerunner in the development of renewable and low-carbon energy production (e.g. Lyytimäki, 2018), the development of decentralized renewable energy has been slow and researchers have identified significant barriers for the diffusion of decentralized energy (Haukkala, 2015; Ruggiero, Varho and Rikkonen, 2015; Varho, Rikkonen and Rasi, 2016). For example, wind power developed slowly in Finland in comparison to other Nordic countries. However, wind power has increased substantially in the last few years and accounted for 1.6% of total energy consumption and 9.1% of electricity production in 2019 (Statistics Finland, 2020a; Energiateollisuus, 2021). The share of wind energy in electricity production has increased rapidly in the last few years, which is often attributed to the significant financial subsidies created by a feed-in tariff system, which was approved in 2011. The 2011 feed-in tariff was limited to commercial actors working with large-scale wind power. As the feed-in tariff system created financial incentives vis-à-vis the decreasing market price for wind energy, a new system for supporting wind power was approved in 2015. This resulted in a scramble for wind power permits, as companies vied to benefit from the withdrawing feed-in tariff system (Berninger *et al.*, 2017). The first project without subsidies was announced in 2018 and at the moment the majority of current wind energy projects are proceeding without subsidies (Alakoski and Frantti, 2020).

The large-scale uptake of solar energy has likewise progressed slowly and was considered ludicrous by a majority of industrial actors even in the early 2010s, as Haukkala (2015, 2019) documents. However, solar installations have increased in recent years and solar energy now accounts for 0.05% of final energy consumption and 0.3% of electricity production in 2019 (Statistics Finland, 2020a; Energiateollisuus, 2021). This is partially a result of the persistent

lobbying and information campaigns of small-scale renewable energy associations, but also due to incumbent energy companies attempting to shape the emerging field of solar energy in Finland (Apajalahti, Temmes and Lempiälä, 2018; Haukkala, 2019). An outlier in the development of decentralized renewable energy are heat pumps, which have often been considered a success story (e.g. Berninger *et al.*, 2017). The large-scale uptake of heat pumps has developed without significant policy support and approximately over 1 million units have been sold since 1996 (SULPU, 2019). The uptake of heat pumps has benefitted from the efficient organization of the industry, the increase of quality control and monitoring as well as an active internet community that has spread information and contributed to peer learning (Heiskanen, Lovio and Jalas, 2011; Hyysalo, Juntunen and Freeman, 2013). Finally, regarding decentralized energy technologies, the small-scale combustion of wood is used as a heating form for detached houses while biogas has formed a marginal share in energy production. In conclusion, this section shows that the Finnish energy mix consists of diverse energy sources combined with centralized production practices and an emerging field of decentralized energy production.

3.2 GOVERNANCE AND PARTICIPATION IN THE ENERGY SECTOR

The previous section has illustrated the status of different energy sources in Finland. I will now provide an overview on the governance of the energy sector in Finland. As discussed in Chapter 2, I view governance as the activities and processes by which the energy sector is shaped, overseen and controlled. These consist of both official and administrative governing, which happens through laws and regulations as well as unofficial governing through self-organization, norms and different public-private partnerships and market tools. In addition to governance, I am interested in the wider space where energy issues are discussed, including the Parliament, the media and various interventions made by different actors aiming to influence policy and politics.

Finland is often characterized as an open, consensual and corporatist democracy (Arter, 2013). These traits are attributed to the multi-party political system, the prevalence of stable majority governments and the convention of forming collective political agreements between trade unions, employers' organizations and the state (Arter, 2013). In line with other Nordic countries, Finland has a long history of tightly integrating interest groups into policy-making to enhance political consensus. This has been labelled "routine corporatism" or the institutionalized tendency to involve different interest groups at various stages of the decision-making process through working groups, Parliamentary

committees and stakeholder hearings⁶ (Vesa, Kantola and Binderkrantz, 2018). Vesa et al. (2018) argue that routine corporatism remains strong in Finland as majority governments typically agree upon reforms in government programmes, thus placing the emphasis of lobbying on the ministries and civil servants that are responsible for negotiating the execution and implementation of policies.

In Finland, the main actors that officially negotiate and coordinate energy policy are located in the Cabinet, the Parliament, and the Energy Department of the Ministry of Employment and Economy (MEE). Under each new government, the MEE's Energy Department is responsible for preparing a National Climate and Energy Strategy,⁷ which is then passed on to the Parliament for debate and voting. The MEE's Energy Department commissions analyses and reports for the Strategy, organizes the working groups and collects statements from stakeholders. The MEE's Energy Department thus holds a significant position in making strategic choices over policy formulations, the inclusion of different stakeholders and the commissioning of reports in the process of drafting Climate and Energy Strategies (Ratinen, 2019).

There are several possibilities for official and unofficial participation in policy-making during the process of drafting these strategies. Ratinen (2019) describes the options for participation as follows. The principal arena for participation are the working groups organized by the Energy Department, which define policy alternatives and form the basis of policy formulations. Working groups often comprise ministry representatives, trade unions, employer's organizations and non-governmental organizations (NGOs). According to recent research, different interest groups view ministerial working groups as important sites of advocacy while civil servants consider working groups as the most commonly used form of consultation in policy-making (Vesa, Kantola and Binderkrantz, 2018). This places significant weight on working groups as an area of policy preparation. A second area of participation is hearings, where the Energy Department seeks views and statements from stakeholders and other interested groups. In the 2016 Climate and Energy Strategy, an open online consultation to elicit stakeholder and citizen views was trialled for the first time in response to demands to increase possibilities for participation. In the Government Report on the 2016 Strategy, public participation (such as online consultation) is discussed as increasing the breadth and quality of policy-making and thus contributing to the acceptability of decisions concerning climate policy (Huttunen, 2017, p. 17). Finally, Parliamentary committees organize expert hearings where they invite different actors to comment on policy propositions.

⁶ Routine corporatism is contrasted to "peak corporatism", which refers to the Nordic tradition of tripartite income policy bargaining (Arter, 2006).

⁷ The latest Climate and Energy Strategies that are discussed in the empirical studies that form this dissertation are from 2013 and 2017. A new National Climate and Energy Strategy is due mid-way in 2021.

Ratinen (2019) notes that unions, governmental research organizations and ministries were amongst the main participants in the 2001, 2005 and 2008 National Climate and Energy Strategies. She concludes that few actors are explicitly excluded from policy processes, which are designed to be open to comments from all interested parties. At the same time, actors expressing different viewpoints describe decision-making as evolving around a few policy alternatives, resulting in frustration over being formally included, yet not having an impact on policy debates (Ratinen, 2019). Likewise, the extensive research of Ilkka Ruostetsaari on participation in energy policy concludes that the official processes of decision-making have been led by an “energy elite” that has been rather stable from the 1980s onwards (Ruostetsaari, 2010). In energy policy, this elite includes interest groups from the energy industry and energy-intensive industry, relevant ministries, and large individual firms in the energy sector. Ruostetsaari argues that new actors, such as energy users, citizen groups and environmental non-governmental organizations (ENGOS), have had difficulties in reaching the arenas of influence and participation. While these groups may be consulted during policy-making, their influence on policy outcomes has remained small (Ruostetsaari, 2010)

These findings on participation in energy policy are supported by recent research in the adjacent field of climate change policy in Finland. In climate policy, Vesa et al. (2020) show how a pro-economy lobby that prioritizes economic competitiveness has been influential and occupied a central position in the policy network. Contrary to other countries, such as the US and UK, Vesa et al. (2020) highlight that this pro-economy lobby has not actively voiced their views in the media, but has instead influenced policy through inside lobbying and informal policy networks. In summary, previous research highlights that an open policy culture has resulted in all interested actors being able to participate at some stage in the policy process, while a corporatist tradition has contributed to favouring informal networks and valuing the expertise of industry actors (Teräväinen, 2010; Huttunen, 2014; Vesa, Gronow and Ylä-Anttila, 2020). This paints a picture of governance in energy policy as concentrated within the hands of a small group of actors that share similar aims, ambitions and educational backgrounds (Ruostetsaari, 2010; Salo, 2014).

What, then, are the central aims of energy policy that have been identified by previous researchers studying Finnish energy policy? One of my interviewees, a civil servant, aptly summarized these when asked about their views on an ideal energy system: “*Reliable. Low-emissions. Competitive in cost. Market-driven.*” (Ministry, March 2017). This brief statement encapsulates what energy social scientists have documented over the last decades, namely that Finnish energy policy is driven by the aim to produce secure and affordable energy through economies of scale, resulting in the favouring of centralized energy production (Teräväinen, 2010; Kivimaa and Mickwitz, 2011; Huttunen, 2014; Salo, 2014). As

discussed in the previous section, the imperative to address climate change has been added to these aims, expressed by the interviewee as “low-emissions”. The motivation to provide affordable energy for industry has been summarized by Kivimaa and Mickwitz (2011, p. 1819) as follows: *“the goal [was] phrased as securing ‘a low price’ in the 1970s, ‘inexpensive energy’ in the 1980s, ‘competitive’ pricing in the 1990s, and ‘reasonable’ pricing in the new millennium”*. This aim has resulted in specific policy measures that are justified as enhancing the competitiveness of Finnish industry (Teräväinen, 2010; Tamminen, Ollikka and Laukkanen, 2016). For example, the manufacturing industry benefits from a lower tax rate for electricity tax than that paid by consumers, the service industry and public administration. In addition, around 140 companies in energy-intensive industries receive substantial tax returns,⁸ leading some economists to label this as a tax aid for energy intensive production (Tamminen, Ollikka and Laukkanen, 2016).

Teräväinen (2010) discusses how in the 2000s a competition discourse has become the *“only credible discourse in Finnish energy policy debate, leaving no other valid options available”*. A competition discourse stresses the importance of economic growth and market governance in policy, while leaving a role for selective state intervention in securing the market for new technologies and promoting innovation-led growth (Teräväinen, 2010). In the context of nuclear new build, Laihonen (2016) shows how an economized political discourse equates economic good with broader societal good and welfare. The development of a competition discourse is often tied to general neoliberal developments emphasizing innovation and economic growth in Finnish politics (Heiskala and Luhtakallio, 2006; Patomäki, 2007) as well as the more specific process of liberalizing electricity markets. Up until the 1990s, energy companies had functioned as public utilities aimed at providing affordable energy for both citizens and industry. The Electricity Market Act liberalized energy markets for businesses in 1995 and for households in 1998, changing energy companies’ role from acting as public utilities to acting as competitive business organizations (Apajalahti, 2018). For consumers, this meant that electricity bills were unbundled and consumers could compare and choose between different electricity production modes, while continuing to pay a fixed price for electricity transfer. For large energy companies, market liberalization resulted in vast organizational changes and attempts by large companies to provide new products for consumers.

Salo (2014) argues that in policy processes, a focus on competition has been paired with the previously discussed focus on consensus. This is demonstrated in the case of negotiating a feed-in tariff system for wind energy, where Salo (2014) documents how the previously identified “energy elite” actors strongly

⁸ These have been estimated to amount to over 200 million euros annually in 2014 (Tamminen et al., 2016).

shaped the final tariff system. The potentially radical effects of a feed-in tariff system, such as diversifying actors and allowing new entrants into the market, were watered down by demands to create a “competitive” and “market-driven system” through setting a minimum plant size for wind power plants and giving a bonus for projects that could be rapidly operationalized. This, in turn, favoured already existing large actors who could quickly develop projects, and can be seen as an attempt to create the least harm for the existing energy industry and energy intensive industries (Salo, 2014).

Several researchers have discussed the prevalence of a “technoeconomic rationality” in Finnish energy policy since the early 1990s (e.g. Paldanius and Sairinen, 1989; Vehmas, 1995). Broadly speaking, this refers to viewing questions on desirable energy policy and energy production primarily through technological and economic terms. A technoeconomic rationality sits within the discourse of ecological modernization, which was discussed in Finland and elsewhere in Europe especially in the mid-1990s (e.g. Hajer, 1995; Massa and Rahkonen, 1995; Feindt and Oels, 2005). Since then, however, ecological modernization is rather rarely discussed explicitly, most likely since it is continuously reinterpreted through concepts such as the green or circular economy (Leipold *et al.*, 2019). This does not mean that ecological modernization has disappeared; rather, it seems that ecological modernization has become pervasive to the extent that more elaborate conceptual terms are required to discuss its different facets. In more recent research, Laihonen (2016) shows how a technoeconomic rationality plays out in debates on nuclear new build, where the question of societal good is interpreted narrowly as a question of economic good, thus leaving little space to raise other concerns.

Drawing on earlier and more recent research, I have painted a rather bleak picture on the governance of energy policy in Finland, where decision-making is concentrated and governed by a shared logic. Of course, alternative viewpoints and demands to diversify the governance of energy policy have always existed. Earlier social movements attempting to influence energy policy have focused on opposing nuclear power, large-scale logging, peat production as well as the development of hydropower in the 1960s and 1970s. These have consisted of a range of different actors, from environmental activists and political groups to place-based social movements (Lehtinen, 2014). As is demonstrated in the empirical studies that comprise this dissertation, the 2010s feature a heightened attention to criticizing the governance of energy policy, or the practices, politics and transparency of governing energy in Finland. This is different to protesting against specific energy sources or power plants. It is rather a critique that focuses on who is able to participate in decision-making, how, and with what types of knowledge and expertise. Haukkala (2018) discusses the 2010s as the time when a “green advocacy coalition” that attempted to influence energy policy arose. This advocacy coalition consisted of a broad range

of actors from environmental organizations, the renewable energy industry and academics, who together sought to diversify participation in energy policy discussions and promote decentralized renewable energy in Finland. The 2015 Parliamentary elections became a central target for several different groups who attempted to raise energy policy as a topic of interest. These processes, and how my results offer another interpretation, are further discussed in Articles II and III and in Chapters 5 and 6 of the summary.

In addition to heightened civil society activity, the 2010s have witnessed several research projects and large research consortiums that work on energy policy and transitions in Finland. These have addressed, for example: energy security,⁹ the transition of the electricity system,¹⁰ futures of different energy technologies,¹¹ and how Finland could benefit from global energy transitions.¹² Several of the research projects have taken sociotechnical transitions research as their basis. For example, the Smart Energy Transitions project hosted and developed transitions arenas that engaged with policy makers, energy producers, users and large corporations (Hyysalo *et al.*, 2019). Such engagement activities and policy relevance are a requirement of strategic research funding, a new funding instrument launched by the Academy of Finland in 2014 with the aim to provide “*research that seeks solutions to the challenges facing Finnish society*” (Academy of Finland, 2020). While strategic research, or specific research projects, are not discussed explicitly in this dissertation, the prevalence of transitions research and the demands of strategic research speak to a broader societal trend of viewing climate change and energy transitions as grand societal challenges, where research is expected to deliver policy-relevant information and solutions to problems, as discussed in Chapter 2 (Kaldewey, 2018). Longhurst and Chilvers (2019) indicate that the intertwinement of research with the wider energy assemblage has shaped the types of knowledge produced, resulting in the production of future visions that align more closely with dominant, government-led sociotechnical imaginaries than, for example, alternative civil society perspectives. As is further discussed in Chapter 6, this raises the question of whose imaginaries are we talking about when examining sociotechnical imaginaries.

In conclusion, energy forms a widely studied area of research in Finland and the links between research and policy have become more explicit in the 2010s with the development of strategic research. My overview on the development of different energy sources and on previous research in the governance of energy policy has sought to situate the governance of energy policy in a wider societal and historical context. While previous research has focused especially on specific

⁹ From Failand to Winland: <https://winlandtutkimus.fi/english/>

¹⁰ EL-TRAN: <https://el-tran.fi/in-english/>

¹¹ FutWend: <https://www.utu.fi/fi/yliopisto/turun-kauppakorkeakoulu/tulevaisuuden-tutkimuskeskus/tutkimus/futwend>

¹² Smart Energy Transition: <http://smartenergytransition.fi/en/front-page/>

technologies and energy sources, this research takes a distinctly broad perspective by examining how the idea of energy transitions is debated and what meanings are attached to it by different actors in various public arenas.

4 METHODOLOGY, MATERIALS AND ANALYSIS

“How do you know?” Paul Edwards (2010, p. 3) describes asking his students. In order to understand something, it is necessary to interrogate and open up each part of this question, ranging from the collection of evidence to how it becomes authorized and trusted as valid knowledge. This, in my view, is what methodology – or the approaches we develop to study topics – is about. In this chapter, I first describe my methodological orientation and explain why I have chosen an interpretative and constructivist approach to addressing the research questions of this dissertation. My aim is to give a reflexive and practice-oriented account of the research process and to expand on some methodological questions I have not been able to discuss in the separate articles. In the second part, I describe the collected research materials and discuss the possibilities and limitations offered by the empirical material. I proceed to explain how the materials have been analysed and what limitations arose while conducting the research. Finally, I discuss the ethical issues I have faced when conducting the research.

4.1 ORIENTATION

“The way we describe and understand the world is so entangled with our own values and assumptions that the two can never be fully separated. What we mean when we use the word ‘nature’ says as much about ourselves as about the things we label with that word.” (Cronon, 1996, p. 25)

A constructivist approach questions the idea that truth or nature are distinct entities in an outside world that can be found by scientific inquiry processes. Instead, the ideas of truth or nature just like those of falsity or unnaturalness are interpreted and enacted by social processes, research practices and different actors. A constructivist approach is thus interested in the *making of worlds*, both materially and imaginatively (Jasanoff, 2004, 2015a). This calls for situating the researcher into the process of producing knowledge and acknowledging the researcher’s partial and situated vision in contrast to a universal and “*conquering gaze from nowhere*” (Haraway, 1988, p. 581). To do so, I adopt a co-productionist methodological orientation that seeks to understand and query contingent, historical and locally situated processes through which specific objects are designated as natural, scientific, political or epistemological. This requires symmetrical analysis that does not privilege either scientific or political explanations, but rather seeks to demonstrate how the two are mutually constituted (Shapin and Schaffer, 1985; Jasanoff, 2004). In doing so, my aim is

to show the stakes of conceiving of and rendering the world in particular ways, thus offering a possibility to both imagine and act otherwise.

I employ an interpretative and comparative methodology to put a constructivist orientation to work. An interpretative approach focuses on processes of meaning-making and acknowledges that multiple realities are possible (see also Mol, 2002). Analysis centres on how specific objects and issues are relationally constructed as meaningful or insignificant, as sites of intervention and contestation, and how this in turn enables or restricts action. Interpretative analysis relies on a constant interplay between theory and methodology, where neither theoretical assumptions nor methodological opportunities are taken for granted, but instead both are constantly questioned and problematized. This places importance on the interpretative work of the researcher in constructing and analysing the research materials, which I discuss further in the next two sections.

Since the “linguistic turn” of the 1980s, interpretative analysis in environmental policy has often focused on how reality is constituted through language and discourse (Hajer, 1995). This, in turn, has been met with critique from new materialist accounts, which claim that “*language has been granted too much power*” and “*the only thing that does not seem to matter anymore is matter*” (Barad, 2003, p. 801). However, I think this criticism needs to be contextualized in response to representational views that separate reality from its representation as discourse, fact or object and thus continue to produce dichotomous distinctions, such as those between language and reality. In contrast, a symmetrical, constructivist and co-productionist approach does not seek to place material or discursive accounts into confrontation or privilege one over the other. Instead, the aim is to show how both material and discursive practices, and their mutual entanglements, contribute to and allow for different meaning-making processes. Just as a constructivist approach is critical of calls to “nature” as explanation, so too it is critical of seeking to use “discourse” as a mere explanatory factor. Discourse is not an external structure that influences actors from the outside, but is instead a specific, situated and contingent way of imposing order on the world that relies on interaction and interpretation (Foucault, 1972; Behagel, Arts and Turnhout, 2019). Such a reading of discourse and language places it into much closer dialogue with new materialist accounts (Asdal, 2015). An interpretative approach thus focuses on tracing how something is constituted as an issue or object of intervention.

While an interpretative approach calls for closeness to the research process, comparison often works in the opposite direction. A comparative approach calls for and allows analysts to distance themselves and see things differently, as one object is placed next to another one. At the same time, a comparative approach requires responsibility and flexibility towards the things that are being

compared. Which aspects are we actually comparing? Moreover, and equally importantly, which aspects are we excluding from comparison or assuming to be the same? While the purpose of comparative analysis is to elucidate differences and identify similarities, it can also precariously advance ideas about the existence of common metrics of progress towards or away from universal goals. As discussed in Chapter 2, to avoid this, Forsyth and Levidow (2015) argue that comparative research needs to be explicit about the assumptions it is making on the mobility and representation of objects. To what extent do analysts assume that the objects of analysis exist separately from their contexts and can be detached and circulated to other contexts? Too often comparative research looks for the same objects in different places without taking into account how local contexts destabilize and change the objects in question. The aim of a comparative approach in this dissertation is not to take distinct entities from separate places and ask how well they have been taken up in other contexts (see also Pfotenhauer and Jasanoff, 2017). Instead, my aim is to problematize the concepts themselves and ask what happens to them in the process of moving from one context to another (c.f. Latour, 1990).

I employ these insights from interpretative and constructivist methodology to analyse an ongoing process of sociotechnical change. Doing so, however, poses some methodological difficulties. Understanding sociotechnical change as a *process* requires a different standpoint from viewing sociotechnical change as a stable, discrete and singular entity that can be observed from above (Stirling, 2019). It requires taking a relational and constructivist view that does not assume certain entities, power relations or structures into being but rather challenges and problematizes them. At the same time, research on ongoing processes must admit to the practical challenge of analysing objects that are moving and transforming during analysis. In practice, the collection of research materials at least ends at some point, even if research, knowing and acting does not. In each of the articles of the dissertation, I have stopped collecting research material at a specific time, yet stayed attuned to recent developments and updated materials where possible.

In summary, I want to highlight a methodological commitment to epistemic charity together with methodological flexibility and pluralism. Reading and thinking with epistemic charity means seeking to understand where arguments come from, analysing what motivates them and what makes them rational in that specific context.¹³ For me, epistemic charity is a way to include more voices in societal debates and to take seriously the concerns and motivations of others, rather than to dismiss different opinions as unsound, irrational or unscientific.

¹³ This concept was introduced to me in the Harvard STS program during 2017-2018 and struck a chord with how I have viewed the process of research and analysis. Jasanoff has not written on the concept, but does summarize it in a brief recorded interview, available here: <https://soundcloud.com/euroscientist/sheilajasanoff-part-2> [Accessed 12 April 2021]

Likewise, methodological flexibility and pluralism call for appreciating different views and seeking to situate these. In contrast to the grand frameworks that convey so little of the complex mess that we are in, methodological flexibility appreciates that a diversity of approaches is required, can be appreciated, and should be critiqued and challenged. I have taken this up in the research process through employing different, at times contentious, methodological starting points and linking these to a variety of theoretical notions.

4.2 MATERIALS

The empirical materials collected in this dissertation constitute a variety of forms of text, talk and activity, including Parliamentary transcripts, policy documents, media articles, interviews and participant observations. Using a variety of sources is central for understanding the meaning-making processes in energy transitions. I outline the process of collecting the research materials below, while Table 2. summarizes the materials.

Article I is based on national parliamentary discussions, City Council debates and policy documents from the years 2011-2015 and participant observation during 2015-2016. Parliaments and city councils are key sites of political debate and day-to-day political practice. However, they have been overlooked in STS research in contrast to the sites of making science, such as laboratories and research centres. Parliaments and city councils need to be analysed as ordered sites that attend to particular procedures, time frames and genres of speech (Asdal and Hobæk, 2020). Article I examines how energy futures and desirable governance is debated in two political sites at different levels.

For the Parliamentary debates, I first searched the online database on Parliamentary debates¹⁴ for discussions on energy policy. This produced over 700 documents covering energy policy in different types of Parliamentary meetings. To limit the material, I focused on plenary meetings that had been covered in either of the two major news outlets in Finland (*Helsingin Sanomat* – the widest reaching newspaper in Finland and *Yle* – the national broadcasting company) during 2011-2015. This selection produced five plenary debates for analysis (two during 2013 and three during 2014), totalling 234 pages of text for analysis.

The other set of materials used for the article consists of debates in the Helsinki City Council¹⁵ and supporting background documents prepared for the City Council, totalling 65 pages of text for analysis. The City Council debate

¹⁴ www.eduskunta.fi

¹⁵ These are available through the City Council's webpages: <https://www.hel.fi/helsinki/fi/kaupunki-ja-hallinto/paatoksenteke/kaupunginvaltuusto/Keskustelupoytakirjat/>

concerns the decision over the future of a centrally-located coal-fired heat and electricity power plant in Helsinki (Hanasaari power plant). The particular debate was selected to represent an instance where City Councillors debate energy futures in deciding on the future of a specific power plant.

In addition, the study has employed materials collected as a participant in energy policy events. These include public and invited events, such as a public breakfast meeting organized by the Parliament on renewable energy and the launch of work on the 2016 Climate and Energy Strategy. Participant observation meant attending the events, listening to different presenters and keeping notes.

Articles II and III are based on expert interviews, documents, media materials and participant observation. The conducted interviews have been used in both articles, whereas the secondary material (documents, media, observation) somewhat differs. I first outline the joint interview material.

Qualitative interviews are a prevalent method for collecting research materials in constructivist and interpretative research. Interviews are conducted to gain insights into specific phenomena and different actors' meaning-making processes. A common feature of interviewing is an attempt to gain an in-depth understanding of the phenomenon at hand through engagement with the interviewee. An interview situation forms an interactional space for the researcher and the interviewee to communicate, which is not free of power relations.

The interviewees for Articles II and III were selected based on a review of relevant actors in Finnish energy policy. Our aim was to interview different actors with expertise on Finnish energy policy to ensure that diverse views were represented (see Table 1). Altogether 24 interviews were conducted. I refer to the interviewees broadly as "energy policy actors", as all of them were either involved in policy-making or were attempting to influence policy. The majority of the interviews were conducted together with Sanni Eloneva, a research colleague from the Academy of Finland DEFEND¹⁶ project. I conducted six interviews alone and Sanni conducted one interview alone.

¹⁶ Decentralizing Finland's energy regime: The triggers and dynamics of transition (DEFEND), Academy of Finland funded research project, 2015-2018.

Table 1. *Summary of conducted interviews*

Interview category	Number of interviewees
Environmental non-governmental organizations and citizen activists	4
Industry groups	6
Ministry representatives	3
Politicians	3
Academics	4
Other (multiple affiliations)	6

The interviews relied on a semi-structured interview guide that focused on the past, present and future of energy policy in Finland. The interview guide was slightly modified for each interview, depending on the respondents' role. Expert interviews contain their own set of challenges such as gaining access to the interviewees and ensuring their confidence (Bogner, Littig and Menz, 2018). The experts we contacted were keen to participate in the research, make time for us and share their own views and critical comments on their own organizations and other actors.

In addition to the interviews, Articles II and III employed a collection of documents, media materials and participant observation. For both articles, this material complemented the interviews, provided contextual information and was used to validate specific points that were brought up in the interviews. For example, when an interviewee discussed participation in a specific policy process, we used the relevant policy documents to check who had participated in the policy process and in which form. The reliance on multiple sources of information enhances the rigour and validity of the research, as specific points can be cross-checked from different sources.

For Article II, a co-author (Laura Kainiemi) collected a set of documentary materials during January-April 2017, using search words such as (in Finnish): “decentralized energy”, “wind power”, “professor group”, “peat”, “bioeconomy”, “solar power”, “energy strategy”, “energy transition”, “energy renovation 2015”, and “clean energy association”. This selection aimed to capture key trends in the Finnish energy policy over a brief period of time. The search produced 87 documents, consisting of policy documents, press releases and newspaper articles.

For Article III, I collected a series of materials on the professor group¹⁷ on energy policy for the years 2015-2018. I collected all materials produced by the group itself (reports and a book) and also media materials that covered the professor group. In addition, I attended a few events where the professor group was present.

Article IV is based on news articles published in five different news outlets: *Helsingin Sanomat* (Finland), *Index and Origo* (Hungary) and *The Times* and *The Guardian* (the United Kingdom). News articles and media materials are often used to analyse how specific environmental issues, such as climate change (Boykoff and Boykoff, 2004; Carvalho, 2007) or energy technologies (Teräväinen, 2014) are constituted in and through the media. Media analysis often takes a comparative perspective, where media sources in different countries are compared and contrasted to one another. However, this practice faces several caveats that should be acknowledged. First, media ecologies differ according to national and local contexts to the extent that assumptions of sameness do not hold. Second, analysts need to be careful in stating what the media represents. The selection of news articles as empirical material aims to capture how a specific energy policy phenomena is problematized and contextualized in national news media and we do not claim to present public debates.

The above five news sources were selected as representing the most read news outlets in each of the countries. Originally, we intended to include two news outlets from each country but had significant problems with the online search functions of *Yle*, the Finnish broadcasting company, due to their lacking and problematic use of Boolean operators.¹⁸ We considered replacing *Yle* with a regional newspaper (e.g. *Aamulehti*), but decided this would limit the comparison to other countries, where national news outlets were selected.

We used five different search strings (in the respective languages) in the online databases of the news outlets. The search strings included key words on energy policy and the German energy transition. The combinations were chosen to capture central elements of the German Energiewende and limit the empirical material to a manageable size. We included all articles that referred explicitly to German energy policy and the Energiewende, totalling 549 news articles. In the articles, we selected the sections that discussed Germany, as well as contextualizing sentences before and after, for analysis. It should be noted that the replicability of the study faces severe constraints due to changes in one of

¹⁷ The “professor group on energy policy” was a bottom-up and voluntary science-policy initiative that consisted of ten professors from different academic fields working to influence Finnish energy policy through public interventions and private meetings. The group is presented in greater detail in Article III.

¹⁸ Boolean operators are the words used as conjunctions (e.g. AND, OR, NOT) to combine or exclude keywords in a search string.

the news outlet's online databases. The searches for *Helsingin Sanomat* were done in January 2016. Since then, the *Helsingin Sanomat* online portal was modified so that it no longer allows one to set Boolean operators or timeframes to delimit the search. This greatly restricts the potential for others to replicate the conducted searches, although with careful manual searches it could be possible to go through all the newspaper articles.

Table 2. *Summary of collected empirical materials and analysis methodologies*

Article	Collected material	Amount	Process of collecting materials	Time period covered by the empirical materials ¹⁹	Method of analysis
I	Parliamentary and City Council debate transcripts, supporting policy documents, participant observation.	Five Parliamentary plenary debates (2 in 2013, 3 in 2014). Total of 234 pages of text. City Council debate and supporting background documents. Total of 65 pages of text.	Search in Parliament's online database. Selecting discussions that received media attention. Search in City Council's online database.	Parliamentary debates in 2013 and 2014 City Council debates in 2015	Inductive and interpretative comparative analysis of the two sets of material, drawing on sociotechnical imaginaries (Jasanoff 2015). Iterative coding in Atlas.ti.
II	Interviews, documents, press releases, media materials	Interviews (n=24), documents and news sources (n=87)	Selection of diverse experts working in and with energy policy (e.g. ENGOs, industry, ministry, politicians, academics). Collection of documents (policy documents, press releases, media materials) based on keyword searches	Interviews conducted during 2016 – 2017 Documents collected between January-April 2017	Interpretative and iterative reading of materials. Identification of key themes, narrowing research focus on institutional work, iteration amongst co-authors. Use of Atlas.ti and Excel to assist analysis.

¹⁹ For the collected documentary materials, I present the time period these have been published in. For the interviews, I present the time period these were conducted in. As specified in Articles II and III, the interviewees focused on the 2010s but could also reflect on longer time periods, depending on their own experience working with energy policy.

Article	Collected material	Amount	Process of collecting materials	Time period covered by the empirical materials ²⁰	Method of analysis
III	Interviews, reports, media materials, participant observation	Interviews (n=24), reports (n=3), media materials, participant observation	Selection of diverse experts working in and with energy policy (e.g. ENGOs, industry, ministry, politicians, academics). Following work of the professor group during 2015-2018, collecting materials at the same time.	Interviews conducted during 2016 – 2017 Documents cover the time period 2014 – 2018 Observations during 2015 – 2018	Interpretative reading of materials. Focus on linearity of science, policy and politics. Focus on use of expressions and terms regarding science-policy relations. Assisted by coding in Atlas.ti and ordering in Excel.
IV	Newspaper articles from The Guardian (UK), The Times (UK, Helsingin Sanomat (FIN), Index and Origo (HUN)	The Guardian (G) = 300 The Times (T) = 102 Helsingin Sanomat (HS) = 91 Index (I) and Origo (O) = 56 Total = 549 articles	Search string (in respective languages) in online databases of the newspapers (HS, I, O) and LexisNexis database (G, T). Selection of all articles that discuss German energy policy.	News articles cover the time period 2011 – 2015	Inductively developed coding scheme for newspaper articles. Verification of intercoder reliability with 10% of UK material with Krippendorff's alpha test. Interpretative comparative analysis of codes and empirical material.

²⁰ For the collected documentary materials, I present the time period these have been published in. For the interviews, I present the time period these were conducted in. As specified in Articles II and III, the interviewees focused on the 2010s but could also reflect on longer time periods, depending on their own experience working with energy policy.

4.3 ANALYSIS

As described in the first part of this chapter, the analysis in this dissertation draws upon a constructivist and interpretative approach, while employing specific methodologies in the empirical studies and contributing to different theoretical discussions. The individual methodological and analytical choices are discussed in greater depth in the articles. My commitment to methodological plurality and flexibility assist in overcoming the restrictions placed by adherence to a single methodological framework or theoretical approach. While research is often afterwards summarized into a coherent and linear trajectory, the analysis process for the articles in this dissertation has been much more ad-hoc, messy and open to surprise. I have attempted to avoid pre-empting results through maintaining an open-ended approach to both theoretical conceptualizations and empirical findings. Likewise, I think it is important to acknowledge that research is a constant process of negotiation: with yourself, with theoretical concepts and empirical materials, with co-authors, supervisors, reviewers and editors. This necessarily results in compromise, as you respond and adapt to the demands around you, while at the same time learning to both question and defend your own assumptions.

All of the articles contain a focus on language, discourse and meaning-making that has been inspired by a Foucauldian approach to discourse (Foucault, 1972, 1980). As I have outlined in Section 4.1, this attention to discourse does not aim to exclude material, or sociotechnical, aspects from the analysis. Words and discourses are thus not viewed as mere symbols or representations, but rather as “*systematically form[ing] the objects of which they speak*” (Foucault, 1972, p. 49; Asdal, 2015). Thus, I view language and discourse as not only processes of meaning-making that are relationally constructed, but also as practices that modify and order the objects and issues in question (Asdal, 2015). In environmental policy, a Foucauldian approach has been developed especially by Maarten Hajer (1995) and more broadly in the field of political ecology by, amongst others, Fairhead and Leach (2003) and Forsyth (2003). While I have been greatly inspired by these works, I do not employ, for example, the concepts that Hajer has developed (such as discourse coalitions or storylines) in my analysis. Therefore, I have chosen to refer to a broader “discursive approach” in this summary, while giving a detailed and practical account of the analysis process itself.

Methodologically, this means that while analysing the empirical material I have been attuned more to *how things are portrayed* rather than *what is said*. While there is of course overlap between the two and it is impossible to do qualitative research without focusing on what is said, this distinction means that I have focused on the relational construction of different objects and phenomena, according to distinct terms and values, rather than claiming to present a neutral

description of a phenomenon. Focusing on *how things are portrayed* means analysing how certain issues are framed and problematized and consequently, how these framings and problematizations enable certain forms of acting and knowing while excluding others. My aim has thus been to show that constructing knowledge and objects of intervention always involves choices and simplifications.

The analysis for Article I relies on an interpretative and comparative analysis of two different sets of empirical materials. I proceeded by reading and coding the empirical material several times in Atlas.ti. First, I coded the materials with a general focus on temporalities and how the future is made present in political speech. Later, I came to focus on the expectations addressed towards governance and policy required for making those futures possible. The analysis thus relied on several rounds of reading the empirical material to arrive at the relevant research questions and extracting parts of the material to compare the two levels of governance (Parliament and City Council) with one another. The concept of sociotechnical imaginary and related methodological pointers²¹ (Jasanoff, 2015a, 2015b) guided the analysis.

The analysis for Article II was done together with the co-authors Laura Kainiemi and Sanni Eloneva. Hence, it contained several rounds of iteration and negotiation as we discussed the relevant topics and themes for the analysis as well as how to best proceed with analysing the materials. First, the interview materials were read by all authors and coded by Laura Kainiemi and myself. The aim of this was to gain a general picture of the material and find out what topics could be interesting for further analysis. We wrote the first versions of the article together at the same time and thus engaged with different possible theoretical concepts for the research. In order to condense the empirical material, we organized it into Excel to summarize actors' viewpoints on different issues. It took a while for us to arrive at the concept of institutional work, even though we had been interested in different actors' attempts to influence energy policy from the beginning. We revisited the empirical material with the concept of institutional work and reordered the material in the process of rewriting the article. The analysis was subject to constant iteration amongst the authors, as we sought to find common understanding and theoretical concepts to convey this.

The analysis for Article III developed over a lengthy time period as I followed the work of the professor group during 2015-2018. Since the interview materials were the same as for Article II, I analysed the materials at the same time and

²¹ Jasanoff (2015a; 2015b) outlines several methodological pointers for analysing sociotechnical imaginaries, including a focus on comparison, language and framing and analysing how different social actors and institutions respond to disruptive events. Further, she highlights moments of origin, embedding, resistance and extension as particularly fruitful for assessing how imaginaries are expressed and performed.

coded the interviews with both Articles II and III in mind. For analysis on the professor group, I focused on how the linearity of science, policy and politics is articulated in the interviews. I proceeded to organize the interview materials in Excel, in order to examine the differences between actors' views on desirable science-society interaction. The analysis of the interviews was complemented with reading and viewing the collected documentary and media materials. Furthermore, I attended a few events, at which I took notes. All of the materials were read several times in order to refine the analytical concepts and approach along the way.

The analysis for Article IV consisted of several iterative stages together with my co-author, Miklós Antal. We began by individually reading and coding the sections of the news articles selected for the analysis. We assigned codes to the material inductively while simultaneously developing a mutual coding scheme, where the assigned codes were defined. We discussed the codes several times, using examples from the materials, to make sure that we understood them in the same way. Following this, we conducted an intercoder reliability test (Krippendorff's alpha) on 10% of the UK material. With this, we wanted to ensure that we were coding the material in a similar way. The process, once again, sparked discussion on our interpretations of the codes and led to further refinement of the coding scheme. We then re-coded the material once more. At the same time, we evaluated the normative standpoint of the news articles we were analysing; i.e. whether it contained a positive, negative, descriptive or ambiguous (presenting both positive and negative views) description of the *Energiewende*. While this is bound to have ambiguities, we nevertheless saw it as offering a valuable overview of the general ways in which the *Energiewende* is depicted over time and in the different news sources.

The coding process resulted in a table that outlined the number of codes assigned to different topics. We used the codes, their frequency and distribution over topics, as starting points to query into the empirical material with questions such as: which aspects of the *Energiewende* are highlighted or not discussed in the different sources? What type of an example is the *Energiewende* presented as? What connections are made between German energy policy and national energy policy? The analysis then proceeded to compare the different sources to one another in the process of writing the article. In the article, we stress that we use quantitative figures to characterize the empirical material but that they form only the starting point for analysis rather than functioning as the end results.

4.4 ETHICS

Lastly, thinking about how one knows requires attending to the ethics of making something knowable. Here I want to reflect on the specific ethical issues that arose during the research process. At the same time, I want to highlight that research ethics requires constant attuning to research design, assessing the impacts of the research and being open to the unexpected during the research process. For this study, key ethical considerations include the confidentiality of interviewees and the role of the thesis supervisor.

For the interviews conducted for Articles II and III, potential interviewees were conducted directly by myself or my co-author to ask for their participation in the study, offering them the ability to decline at any time. In the invitation letter, the theme of the project and research interview was described to the interviewees as well as how the data from the study would be analysed and stored. The interviewees were informed that the interviews were confidential and we would refer to them at the level of their organization. This was an important factor in gaining the confidence of the interviewees, since energy policy is a contentious topic in Finland. Policy circles are small and actors are familiar with one another. Our approach was confirmed in the interviews, where two participants were concerned about being identified in voicing their views. When conducting the interviews, we were careful not to name other interviewees or make reference to comments from other interviewees that could be identifiable. We did ask for recommendations for further interviewees, but refrained from commenting on whether these would be conducted. During the interview, we restated the terms of participation and confirmed the interviewees' willingness to contribute to the study via oral consent.

The interview material has been stored by myself and the co-authors of Article II. The interviewees are referred to at the level of their organization in Articles II and III (e.g. ministry actor, industry actor, environmental NGO). We decided not to name the specific organizations, since this could assist in identifying the individual. We also decided not to include numeric tags to the quotes (e.g. industry representative1), as this would have allowed the readers to connect several quotes to one person and thus have a better chance of guessing who the interviewee is. Both articles II and III use publicly available materials (websites, documents, newspaper articles, etc.) to complement the analysis. We do not claim that the publicly available material is from the same actors that have been interviewed for the study. Rather, the publicly available material forms another data set for the analysis and is described in Section 4.2.

Despite these careful considerations, it may be possible to identify some of the interviewees from the research as the field of energy policy is rather small and actors know one another. The interviewees were made aware of this during the

interviews. We also sent the interviewees a draft version of the manuscript of Article II to revise the used quotes prior to submitting the article. We received three responses of which none commented on specific quotes from the interview material. None of the interviewees wanted to receive such versions to revise in the future and therefore the same procedure was not applied in the case of Article III. The aim of this was to minimize potential negative consequences to the interviewees. After finishing the dissertation, the interview material will be stored indefinitely by myself and the co-authors of Article II. We have agreed that the material can be used for further articles jointly or by the individual authors, but the co-authors have to be informed about the use of the materials and consent to it.

Article III raises ethical questions regarding my own position and the role of my PhD supervisor, Professor Janne Hukkinen. In Article III, I examine the work of the professor group on energy policy that my supervisor has been a member of. Further, I have assisted the professor group in compiling a research funding application in May 2015, prior to commencing my thesis. This raises questions about my own involvement with the group and about the supervisor's power to influence the analysis process and the results. As described in Article III, I coordinated a funding proposal for the professor group in May 2015 while I was working at another Finnish university, prior to commencing my PhD. At the time, I was working on other research projects (e.g. Karhunmaa, Pitkänen and Tuominen, 2015; Karhunmaa, 2016) and coordinating the funding proposal for the group was an ad-hoc one-month administrative job. I was not involved in any of the professor group's substantive activities or public appearances.

Working on the funding application sparked my interest in the group as a potential case study for examining expertise and science-policy initiatives in Finnish energy policy. I had the possibility to do so as I commenced my PhD studies as part of the DEFEND project at the University of Helsinki in September 2015. The first three years of my PhD were funded by a research project that included two professors from the professor group. Within the research project, I had the freedom to pursue my own interests and design my own research. I was not expected to take part in any working packages or produce any collaborative research. My research had to fit broadly under the banner of the project's title (Decentralizing Finland's energy regime: the triggers and dynamics of transition), but I faced no other expectations or restrictions on the substance of the research.

My prior experience with the professor group members aided me in reaching them for interviews. However, as I was never publicly associated with the group nor took part in making any substantive decisions, I could easily interview other actors in energy policy, including those that were critical of the Professor Group. I have not interviewed my thesis supervisor for Article III. While I have

discussed various parts of the research with him, I have not breached the confidentiality of the interviewees or shared any confidential interview material with him. In discussing Article III, Professor Hukkinen has performed the duties of an academic supervisor: he has given advice on where to submit the article, commented on my manuscript drafts and discussed possible theoretical anchorings with me. I have designed, conducted and analysed the results independently and presented the results of the research to various peers and advisors in numerous seminars and conferences.

Being in such a position already heightened my awareness of ethical considerations at the early stages of the research process. My own role and the role of my supervisor have been discussed in several different academic settings, including seminars, conferences and meetings with my other thesis advisors and colleagues. I consider situating myself in the research process important, as it allows the reader to develop a more nuanced understanding of how the research process has progressed. These considerations are also highlighted in Article III. Further, the process shows the contingency of research – it is unlikely I would have pursued these particular questions without my involvement with the professor group. Finally, as discussed in several sections of this dissertation, research ethics calls for a humble and reflexive view on research that both situates the researcher and acknowledges limitations. I return to these questions in the discussion in Chapter 6.

5 SUMMARY OF THE FINDINGS

This chapter provides a summary of the four original research articles that form this dissertation. All of the studies shed light on different arenas where energy policy and energy futures are discussed. The articles draw on somewhat different theoretical traditions and contribute to specific discussions in those traditions, which are further elaborated on in the articles themselves. This chapter focuses on presenting the research setting, empirical materials, methodology and key results of each study in a concise manner. The broader findings are elaborated on collectively in Chapter 6.

5.1 ARTICLE I: DESIRABLE GOVERNANCE FOR CARBON NEUTRALITY IN CITY COUNCIL AND PARLIAMENTARY DEBATES

This article examines how politicians at two distinct levels of governance – the national Parliament and the City Council – debate energy futures and the desirable means of attaining those futures. Previous research on sociotechnical imaginaries has focused on the competition between different imaginaries (e.g. Levidow and Papaioannou, 2013). In contrast, I argue that it is necessary to examine the differences accommodated within a specific sociotechnical imaginary. To do so, I ask how do politicians in the Finnish Parliament and the City Council of Helsinki present desirable energy futures and propose policy pathways to attain these futures?

Previous analysis of scale and local imaginaries have assessed how distinct scales produce different sociotechnical imaginaries and visions on the role of energy in a good society (Smith and Tidwell, 2016). At the same time, parallel research on multilevel governance has highlighted the role of cities and regions as important actors responding to climate change (e.g. Späth and Rohrer, 2010, 2012; Marsden *et al.*, 2014; Hodson, Marvin and Späth, 2015). The policy expectations related to the agency and capacities of cities to take effective action on climate change are, however, ambiguous. On the one hand, cities are subsumed in national and international policies and assumed to respond to higher orders. On the other hand, cities are expected to act as innovative test-beds from which sustainability solutions can either be scaled-up or transferred to other localities (Bulkeley *et al.*, 2018). This calls for analysing cities as situated sites, where agency is both enabled and constrained through national and international networks, policies and governance systems.

In the study, I am interested in how a particular way of attending to the future is framed as good or bad policy, rather than the specific proposed policy measures themselves. This means that the comparison across scales does not seek to establish a particular way of responding to current and future uncertainty as better or worse, but rather to make explicit different assumptions about agency and control with regards to policy and governance. Empirically, I assess political speech in the City Council of Helsinki and the national Parliament of Finland during 2013-2015 through an analysis of transcripts, documents and participant observation. I show that politicians at both levels express a commitment to a sociotechnical imaginary of future carbon neutrality. A central component of this imaginary is the commitment to clean technology development, economic growth and promoting employment.

In the national Parliament, politicians stress that the way to attain carbon neutrality is through predictable and stable energy policies. While the surrounding context is viewed as unstable and unpredictable, politicians highlight that energy policy must remain static in the sense that it should provide a stable environment for investments and companies' profitability calculations. Technological development, for example the development of renewable energy, is described as variable and beyond the control of politicians, whereas policy development is regarded as an area where politicians can exercise control. The linkages between technological development and policy are not made explicit. Uncertainty is framed as something that can be managed and controlled through appropriate policy measures.

In the City Council of Helsinki, politicians describe the rapidly changing energy policy environment as an impetus to revise policy orientations. Politicians promote the adoption of policy pathways that are adaptable and flexible to change as they identify the field of energy policy as uncertain and rapidly developing. Politicians shy away from committing to large, single projects in heat and electricity provision and prefer more loosely defined options that leave space for adopting a variety of technology and policy measures.

While the distinctions between the two levels of governance are clear, I argue that these do not constitute separate sociotechnical imaginaries. The commitment to a carbon neutral society is the same, and politicians at both levels promote clean technology, growth and employment. In other words, the sociotechnical imaginary of carbon neutrality is linked to a technologically driven and economically prosperous state. The differences between national level Parliamentary and City Council debates lie in the ways that desirable policy and the agency of the responsible actors – the politicians in Parliament and City Council – are described. Parliamentarians describe themselves as capable of creating a specific policy environment and minimizing uncertainty, yet are incapable of influencing technological development. City Council members

regard their role as one of responding to exogenous change and being aware of, yet incapable of decreasing, uncertainty.

The study demonstrates how sociotechnical imaginaries are co-produced with particular ways to attain them. While sociotechnical imaginaries form rather coherent visions of desirable futures, they can nonetheless accommodate different desirable means to attain the imaginary. As further discussed in Chapter 6, I argue that analysis of sociotechnical imaginaries will benefit from being attuned to the different ways in which imaginaries are co-produced in specific sites and times with desirable pathways to realise the imaginary. This not only adds granularity to the analysis of sociotechnical imaginaries, but also helps to explain how contestation can occur within a seemingly shared and uniting vision.

5.2 ARTICLE II: ACTORS' INSTITUTIONAL WORK TO CHANGE ENERGY POLICY

This article examines the types of institutional work that energy policy actors undertake in Finland, how these contribute to energy transitions, and how they are discursively justified. As discussed in Chapter 2, the literature on sociotechnical transitions has emphasized the importance of destabilizing current unsustainable ways of producing and consuming energy. Since a majority of industrialized countries are discursively committed to acting on climate change, we argue that it is also necessary to examine the different ways in which actors seek to influence their institutional context. To do so, we highlight the concept of institutional work as a promising way to bring more nuance, context and complexity to destabilization debates.

Institutional work is particularly suited for analysing processes of change when these are understood as discrete, fragmented and contextual, as is the case in destabilization processes. Destabilization is defined as a process where specific parts of current energy regimes are replaced with novel ones (Leipprand and Flachslund, 2018). While previous literature has discussed transitions processes as struggles between incumbents and challengers, the picture of incumbents is diversifying (Galeano Galvan, Cuppen and Taanman, 2020; Sovacool *et al.*, 2020). Incumbents, or actors that enjoy an established role and wield significant power, do not only maintain existing structures but also take part in establishing and modifying novel ones (Apajalahti, Temmes and Lempiälä, 2018). Similarly, actors that challenge current practices respond to changes in the surrounding institutional context and tailor their activities accordingly. Institutional work examines how actors aim to influence their surrounding environment while at the same time being constrained by those same institutional structures (Lawrence and Suddaby, 2006). Actors' activities aimed at creating, disrupting,

maintaining and defending institutions form the basis of the approach. We argue that the concept of institutional work allows for a subtle analysis of how institutional structures condition actors' activities and how actors attempt to change institutional environments.

The analysis is particularly suited to the context of Finland, which exhibits a strong commitment to acting on carbon neutrality and transforming energy systems, yet a relatively stable institutional context. Empirically, our analysis is based on 24 semi-structured interviews with experts representing different interests and backgrounds in energy policy. We complement the interviews with documents and literature. The analysis focused on actors' accounts of institutional work, their discursive justifications and links to current and potential changes in energy policy.

Our findings confirm that Finnish energy policy experts have a broad commitment to carbon neutrality. However, actors' stances differ on the inclusion of bioenergy and nuclear energy in definitions of carbon neutrality. To discuss our findings, we categorize the actors into three groups based on their views on carbon neutrality and their position in energy policy. First, traditional actors have an established position in energy policy and are willing to include bioenergy and nuclear energy in their conception of carbon neutrality. Second, carbon neutral actors have similar views on the inclusion of bioenergy and nuclear energy in carbon neutrality, but belong to more marginal or recently established groups. Third, renewable supporters pursue a 100% renewable energy system for Finland and likewise belong to more marginal or recently established groups.

In terms of institutional work, our analysis shows that all actors performed creative institutional work, disruptive work was scarce, and maintaining and defending current institutions was downplayed by traditional actors. Creative institutional work focused on advocating for new regulations, promoting participation in energy policy and forming new alliances between different actors. While creative institutional work was essential for new actors to gain standing in energy policy, traditional actors focused on the importance of including all actors in accordance to existing practices related to consensus politics. Disruptive activities were scarce and limited to individual actors or groups of actors. Disruptive activities focused on challenging current practices of negotiation and inclusion in energy policy. Traditional actors took part in maintaining existing institutional structures by embedding current policy orientations, such as the commitment to market-based regulation, and policy networks, such as their own role as policy experts. Defending institutional structures took place as traditional actors questioned the legitimacy of new alliances and networks based on their lack of adherence to established structures.

The results show how actors take part in different forms of institutional work and how their choice of doing so is conditioned by the existing institutional environment. Renewable supporters deliberately focused on creative institutional work and avoided disruptive activities in order to create new alliances and distance themselves from old conflicts in energy policy. This has resulted in increased inclusion in policy processes, but it has occurred at the expense of renewable supporters' limiting their institutional work to positive narratives of creative change and the potentials offered by renewable energy. Despite novel practices of inclusion, traditional actors continue to hold significant power over who gets to participate in policy processes and in which role. At the same time, the interpretative flexibility of carbon neutrality allows for various interpretations over what it is that actors are agreeing to. This commitment to a shared goal can assist in discrediting any disruptive work as unnecessary. The analysis points to the importance of analysing how sociotechnical imaginaries such as carbon neutrality legitimize specific policy practices and institutional arrangements.

5.3 ARTICLE III: PERFORMING DESIRABLE SCIENCE-POLICY RELATIONS IN ENERGY POLICY

This article assesses why and in which form does a linear model persist in science-policy interaction through the analysis of an empirical case study on an ad-hoc and voluntary science-policy initiative in Finland. The practice and literature on science policy has consistently called for moving away from a linear model towards more participatory and inclusive means of producing and communicating knowledge (e.g. Etzkowitz and Leydesdorff, 2000; Lemos *et al.*, 2018). In contrast, a linear model calls for maintaining science and policy as two separate spheres of action, where results from science form a necessary input for rational decision-making. The linear model has been critiqued as a simplistic representation of both scientific practices and policy-making (Turnhout and Gieryn, 2019). Yet, the linear model continues to be evoked in both the literature and practices of science policy. In order to explain this persistency, I present a novel theoretical categorization of three different ways in which the linear model endures.

First, the linear model is used as a mirror image to reflect upon calls for more participatory approaches in science-policy interaction. That is, claims to increase inclusiveness in science-policy are justified by contrasting them to a linear model. Second, STS research has observed the linear model as an ongoing practice in science-policy interaction, where academics structure their activities in accordance with a linear model. Third, academics use the linear model as a repertoire to describe and justify specific activities, such as refraining from taking part in participatory knowledge production. The novel categorization

demonstrates how the linear model persists in different forms. It is analytically useful to distinguish between instances when the linear model structures activities and practices in science-policy interaction, and instances when the linear model is employed as a repertoire to justify activities. I claim that both are performative activities that enact a particular way of acting and justifying action at the science-policy interface.

Empirically, I focus on following the work of a bottom-up science-policy initiative in Finland through interviews, documents, media materials and participation observation. The self-named “professor group on energy policy” was initiated in the summer of 2013 as the group’s coordinator and founding professor gathered a group of ten professors from different fields to discuss the current status of Finnish energy policy and possibilities to act on it. The professor group published reports, had several media appearances, and private meetings with politicians, policy-makers and business representatives. Throughout its activities, the professor group fluctuated between linear engagement and more participatory practices. On the one hand, the group produced knowledge in a close circle and sought to deliver this in a linear manner to decision-makers. On the other hand, the group structured its activities to have an impact on public discussion and sought to create space for other actors to participate in energy policy.

At the same time, the group employed a linear repertoire to justify its science-policy interaction. In its reports, the group demarcated scientific activities from value-driven political ones and sought to establish the group as a central source of authoritative knowledge on energy policy in Finland. Likewise, other energy policy actors employed a linear repertoire to evaluate the group. Actors that welcomed the contributions of the professor group, such as environmental non-governmental organizations and activists, maintained that the group had acted as a neutral expert body in the tumultuous terrain of energy policy. Actors that were critical of the professor group, such as the energy industry, claimed that the professors had stepped beyond the limits of academic involvement into the political arena. Thus, both supporters and opponents evaluated the professor group’s activities based on their view of the group’s adherence to a linear model.

The case study shows the persistence of a linear model as a repertoire used to justify and evaluate activities in science-policy interaction. The analysis shows how the persistence of the linear model in science-policy interaction is both pragmatic and normative. Knowledge producers and knowledge users demand linear interaction as they expect this to have an impact on policy and to enact a correct ordering of science and society. This shows a tacit pragmatic adaptation to expectations regarding the appropriate role of academics in the public sphere. This, in turn, makes the use of a linear repertoire normative as it contributes to solidifying the maintenance of science and policy as separate,

that being considered the correct way of ordering science-society relations. I argue that research on science-society relations will benefit from empirical analysis on the contingent politics of science-policy interaction and querying into the expectations that different actors have for science-policy interaction.

5.4 ARTICLE IV: A COMPARATIVE ANALYSIS OF CONTEXTUALIZING ENERGY TRANSITIONS IN NATIONAL NEWS MEDIA

This article examines how the German *Energiewende* has been constructed in the news media of three countries – the UK, Finland and Hungary – that are following alternative nuclear pathways during 2011-2015. Germany's pioneering energy policy has been thoroughly observed around the world, yet how the example shapes national energy policy discussions has not been examined. We argue that energy transitions are not definitive and universal policy objects, but rather that the *Energiewende* is distinctively constructed in the news media of each country.

The *Energiewende* refers to Germany's decision to shape its energy policy through nuclear phase-out, increasing renewable energy and promoting energy efficiency. To assess which issues of the *Energiewende* are highlighted, we selected the only European countries that have committed themselves to building new nuclear power plants in the 2010s (the UK, Finland and Hungary) in contrast to Germany's nuclear phase-out decision, providing fruitful ground for comparative analysis.

For the comparative analysis, we selected leading national news media from each country and focused on the years 2011-2015 as indicative of the first five years of energy policy debates following Fukushima and the German decision to recommit to nuclear phase-out. We noted three trends that were in common in the three countries' news media. First, all constructed the sociotechnical process of change as technoeconomic. That is, news media coverage focused on the economic and technological causes and implications of change in Germany and linked these to national concerns. Second, and related, the focus was on supply-side technologies and how these contribute to sociotechnical change. This is seen in the high coverage of the nuclear phase-out and increase in renewable energy, with little discussion on demand-side politics. Third, as nuclear and renewable energy received attention, bioenergy was almost completely missing from news media coverage.

In the UK, *The Guardian* and *The Times* paint two contrasting pictures of the *Energiewende*, where *The Guardian* highlights the benefits of collective ownership and local participation, whereas *The Times* presents the *Energiewende*

as a costly project and threat to UK manufacturing. However, both sources stress a competitive tension between Germany and the UK and justify the pursuit of specific policies through their impacts on the UK's global competitiveness.

In Finland, a connection is drawn between Finland and Germany as two industrial and manufacturing countries that are each committed to climate change mitigation. Media coverage in *Helsingin Sanomat* focuses on how German energy policy is aligned with the goal of carbon neutrality. Proponents of the *Energiewende* stress that the German focus on renewable energy creates green jobs and space for technological development. Critics of the *Energiewende* highlight the reliability and low price of nuclear energy in contrast to renewable energy.

In Hungary, news media coverage on the *Energiewende* is largely descriptive and does not connect policy changes in Germany to current or possible energy pathways in Hungary. Germany thus appears as a distant country from which there is little to learn or compare to in Hungary.

The analysis shows how policy concepts, such as the *Energiewende*, change as they travel from one context to another. The *Energiewende* is both a process of material sociotechnical change and a process of interpreting and giving meaning to change. The article shows how the *Energiewende* is co-produced with national concerns in three different political settings: in the UK as a rivalrous threat to national competitiveness, in Finland as an alternative vision of carbon neutrality, and in Hungary as a distant process of material transformation. As the news media in all three countries exhibit a technoeconomic focus with limited attention to energy demand, the various constructions of the *Energiewende* place the agency for change in technologies, prices, policies, and elite actors. This sidelines both the historical roots of the *Energiewende* as a collective grassroots movement and current calls to increase democratic participation in energy governance. This in turn narrows the question of what is at stake in energy transitions and who gets to participate in making such calls.

6 DISCUSSION

Energy transitions research has elaborated on the need to transform energy systems towards sustainability, highlighting both the urgency and salience of required transitions as well as the contested character of transition processes. In the Introduction, I have asked how do these calls to transform energy systems shape the imagination, governance, politics and practices of energy policy in Finland. I situate such calls to transform energy systems amongst a wider shift towards governing futures in the present. The aim of this thesis has been to uncover how visions of the future enable, legitimize and restrain actions in the present. To do so, I have turned to the concept of sociotechnical imaginaries. While the empirical studies draw on several research traditions and form independent pieces, this chapter elaborates on these findings in conjunction in order to present more general arguments related to the imaginary of carbon neutrality in Finland. To do this, I first discuss how the sociotechnical imaginary of carbon neutrality is contextualized and argued for in Finland (Section 6.1, responding to research question 1). I proceed to argue that differences arise when the imaginary of carbon neutrality is co-produced with specific views on desirable governance and the ordering of policy, science and technology (Section 6.2, responding to research question 2). I end the chapter with a discussion on the limitations and societal implications of the study and the future research needs that arise.

6.1 THE SOCIOTECHNICAL IMAGINARY OF CARBON NEUTRALITY IN FINLAND

In the Introduction, I have asked how is the need to transform energy systems debated and contextualized in Finnish energy policy discussions (RQ1). Taken together, the empirical studies of this dissertation describe a sociotechnical imaginary of carbon neutrality in Finland. While previous studies have shown a wide expert consensus in Finland for a carbon neutral energy system (e.g. Toivanen *et al.*, 2017), I extend such discussions by showing that carbon neutrality is an interpretatively flexible sociotechnical imaginary that is widely shared by energy policy actors in Finland, visible in national news media and present at different scales of political decision-making. In this sense, the imaginary has formed a collectively held reference point and anchor for both current debates and future projects (Jasanoff, 2015a, p. 28). During the writing of this dissertation, the Finnish Government elected in 2019 declared the goal of aiming for carbon neutrality by 2035 and carbon negativity soon after (Government of Finland, 2019). As both the empirical materials and analysis for this dissertation predate this declaration, they shed light on the undertones

present prior to the Government's declaration, while also offering suggestions as to future trajectories.

The dissertation fills a research gap by providing an extensive analysis of the imaginary of carbon neutrality in the early phases of its expression and solidification in Finland. This contributes to research at the intersection of science and technology studies and social scientific studies on energy (Hess and Sovacool, 2020; Sovacool *et al.*, 2020) that focuses on the embedding of sociotechnical imaginaries (Jasanoff, 2015b) and assesses institutional stabilization as a process that raises its own set of questions and possibilities for negotiation (e.g. Hilgartner, 2015; Flegal and Gupta, 2018). The analysis further contextualizes and offers nuance to more recent discussions on the concepts of net-zero, carbon negativity and carbon neutrality (see e.g. Carton, Lund and Dooley, 2021; Dyke, Watson and Knorr, 2021).

The materials analysed in the studies paint an imaginary of Finland as a prosperous, technology-driven, industrial welfare society that is carbon neutral. In the empirical material, carbon neutrality is discussed as a static state located in the future. When carbon neutrality is evoked as a desirable future goal, distinctions are rarely made regarding the inclusion and exclusion of specific technologies as carbon neutral or on the role of transboundary carbon flows, offsetting, carbon capture and storage or other negative emissions technologies. The empirical analysis demonstrates that there is no overarching consensus in Finnish energy policy over what carbon neutrality means and what practices it allows for. Instead, carbon neutrality forms a broad societal commitment through which different actors show a willingness to address climate change and respond to the need to transform energy systems.

The findings in Chapter 5 highlight how the topics of economic growth, employment, clean technology and a linear relation between science and policy are linked to carbon neutrality. This demonstrates how the imaginary of carbon neutrality is a continuation of previous tendencies and motivations in Finnish energy policy (Teräväinen, 2010; Laihonen, 2016; see also Chapter 3). Under the rubric of carbon neutrality, energy policy continues to be framed as an enabler of societal welfare through economic growth, employment and contributions from industry. Responding to climate change has required that these broad societal goals, which have been the cornerstones of Finnish social and welfare policy since the 1960s (Kuusi, 1961; Hirvilammi, 2015), are recast to fit within the confines of carbon neutrality. Through comparative analysis of Finnish, British and Hungarian news media, Article IV illustrates how the commitment to carbon neutrality is distinct in Finland. While UK newspapers present the German *Energiewende* as a potential threat to the UK's economic competitiveness in both renewable energy and traditional industry, Finnish newspapers discuss the *Energiewende* in terms of its potential to contribute to

carbon neutrality. This shows how a potentially destabilizing example of energy transitions (i.e. the *Energiewende*) is reframed through the concept of carbon neutrality to enable promoting specific practices while contesting others.

The imaginary of carbon neutrality in Finland is broad and interpretatively flexible. With interpretative flexibility, I refer to the idea that there is significant space for interpretation of what counts as carbon neutral, with what data, measurements, calculative apparatuses and assumptions (Star, 2010). In the context of Finland, a basic definition that has been put forward by the Climate Panel, an advisory scientific body for policy-making, explains carbon neutrality as “*a state where net emissions caused by human activities, measured in carbon dioxide equivalents, are zero during a given time period*” (Seppälä *et al.*, 2014, p. 5). However, there is significant ongoing negotiation and overflowing of these categories in terms of what are deemed appropriate and relevant baselines, time-frames, geographical scopes, included greenhouse gases, and calculative practices (see also Callon, 1984; MacKenzie, 2009; Åkerman and Peltola, 2012; Carton, Lund and Dooley, 2021). A pertinent example of this are the continuing discussions on LULUCF²² accounting in the European Union as well as in Finland, where a fierce debate is taking place over the carbon neutrality of forest bioenergy and how to account for it (e.g. Berglund *et al.*, 2017; De Wever *et al.*, 2017). In this dissertation, I do not delve into the intricate and political practices of how carbon neutrality is calculated and constructed in different fields and with what assumptions. Rather, in identifying carbon neutrality as an interpretatively flexible imaginary, my aim is to show what the broad scope for negotiation and interpretation enables in terms of promoting or contesting change in energy policy. I argue that this is not merely social negotiation concerning a scientific question (i.e. whether or not certain activities lead to net changes in atmospheric carbon dioxide contents) but rather political negotiation over *what is made to count in creating a desirable future*.

This distinguishes carbon neutrality as a sociotechnical imaginary from carbon neutrality as a boundary object. Boundary objects are interpretatively flexible objects that sit between different social worlds (Star and Griesemer, 1989). They allow different individuals and social groups to come together to cooperate and discuss the same object without reaching a consensus on what that object is. This, in turn, facilitates the maintenance of different groups’ identity and autonomy (Star and Griesemer, 1989; Star, 2010). I agree that the interpretative flexibility of carbon neutrality allows different groups to talk about the same object, i.e. a carbon neutral future, without establishing agreement on what types of practices and policies that allows for. However, boundary objects do not capture the future-oriented dynamic nor the performative power that

²² LULUCF refers to emissions and removals of greenhouse gases resulting from direct human-induced land-use, land-use change and forestry. How to account for changes in this sector has been a source of tension in both UN and EU negotiations.

resides in sociotechnical imaginaries. I argue that the performed promise of a desirable future can bring different groups together and allows for communication, while leaving space to negotiate over how to attain that future.

This is seen in Article II, where the interviewed energy policy actors have a broad consensus on carbon neutrality but distinguish it with seemingly similar terms, such as zero emissions, emissions-free, low-carbon and truly carbon neutral. In doing so, actors are taking at times implicit and at times explicit stances on the inclusion and exclusion of different energy sources, technologies and calculative practices. For these actors, carbon neutrality refers to different realities, where distinct energy sources and technologies are promoted and embedded into governance practices, infrastructures and sociotechnical systems. As seen in Article II, policy actors use these diverse interpretations of carbon neutrality to garner support for their views on both established and novel policy choices and institutions. This calls for further analysing how the deployment of a carbon neutral imaginary can legitimize and materialize not only vastly distinct sociotechnical futures but also present practices and preferences (see also Tozer and Klenk, 2018).

Lastly, I want to further contextualize the imaginary of carbon neutrality as a politically salient imaginary. I have shown in Chapter 2 that energy transitions are constructed in both literature and policy as urgent and salient policy problems that require action. However, I want to highlight that the empirical materials gathered for this dissertation present an elite view of desirable futures, one that is institutionally stabilized and publicly performed by politicians, policy makers, industrial organizations and other actors that have at least partial access to decision-making and seek to influence it. This is an important observation, as recent research on sociotechnical imaginaries increasingly focuses on acknowledging and questioning whose imaginaries we are talking about (Smith and Tidwell, 2016; Kuchler and Bridge, 2018; Longhurst and Chilvers, 2019; Smallman, 2019). As such, my approach does not diversify the analysis of imaginaries to alternative visions and underrepresented groups, which I further reflect upon in the last part of this chapter. At the same time, my aim is not to present elite imaginaries as static structures that inhibit the voicing of alternative views or acting on those views. Rather, I want to stress that the imaginary of carbon neutrality was not questioned in the current set of empirical

materials²³ but continually performed by various elite actors and in different fora, such as the Parliament, City Council and national news media. Meanwhile, disagreement arose over *how* carbon neutrality is co-produced with particular practices and priorities, which is discussed in the next section.

6.2 CO-PRODUCING CARBON NEUTRALITY

The previous section has identified carbon neutrality as an interpretatively flexible sociotechnical imaginary. In this section, I discuss how this imaginary is co-produced with specific priorities, practices and governance arrangements (in response to RQ2). As discussed in Chapter 2, the work on sociotechnical imaginaries arose from a desire to push the analysis of co-production further; to seek to not only *understand* how science and social order are co-produced but to *explain* how a particular ordering of science and social order came to be (Jasanoff, 2015a, p. 3). In doing so, differences in sociotechnical imaginaries have been offered as explanatory resources for diverging sociotechnical pathways, such as the regulation of nuclear energy (Jasanoff and Kim, 2009). As discussed in Chapter 2, little analytical work has been done on the differences that can reside *within* a sociotechnical imaginary (although see e.g. Tozer and Klenk, 2018; Skjølvold, Ryghaug and Throndsen, 2020), and recent work has rather developed in the opposite direction of examining conflict and contestation *across* diverging imaginaries (e.g. Levidow and Papaioannou, 2013; Eaton, Gasteyer and Busch, 2014; Smith and Tidwell, 2016; Burnham *et al.*, 2017). At the risk of sounding tautological, I argue that understanding differences in policy debates and political negotiation that can occur *within* a sociotechnical imaginary requires a turn back to the concept of co-production.

The contribution of this dissertation builds on the appended articles, which show that there is significant variation in how the imaginary of carbon neutrality is co-produced within the rather confined context of Finnish energy policy. In doing so, this dissertation contributes to understanding how divergent notions of governance, appropriate policy measures and the scope for political negotiation can be accommodated within a single sociotechnical imaginary. This aims to respond to Clark Miller's call for STS to "*upgrade the field's capacity to theorize the governance of sociotechnical systems change*" (Sovacool *et al.*, 2020, p.

²³ A significant blind spot of this dissertation is the lack of attention given to right-wing, nationalist and populist political movements and their visions of desirable energy futures. The nationalist and populist Finns Party, which since 2011 has risen to be one of the four largest political parties (alongside the Social Democrats, the Centre Party and the National Coalition Party), has taken a pronouncedly differing stance on climate change than the rest of Finnish political parties. Previously, the party focused on questioning climate change, but in the 2019 elections the political rhetoric turned to emphasizing the insignificance and high cost of mitigation activities in Finland when compared to global emissions, especially those of China, India and other large industrializing nations. This shows that the Finns Party does not share the elite imaginary of carbon neutrality as desirable, which concurs with the anti-elite stance of populist movements more generally.

14) by analysing how different forms of governance are constructed as desirable and possible. I argue that governance and policy are sites where significant imaginative capacity is exercised to deem some avenues of acting and organizing as more desirable and possible than others. Such a treatment of sociotechnical imaginaries brings more nuance to their analysis, as it appreciates that a common understanding of “what is” does not necessarily result in common practices and consequently a widely shared sense of legitimacy, as proposed by Taylor (2003; 106). Instead, various actors’ assumptions and expectations related to structure, agency and control shape how views on desirable governance are co-produced within the imaginary of carbon neutrality. In the next paragraphs, I discuss each of these in turn.

The analysis highlights how actors are not free to pursue a sociotechnical imaginary of carbon neutrality through any means, but instead will co-produce desirable and possible means of governance within the existing institutional context. In Chapters 3 and 5, I have described the Finnish institutional context surrounding energy policy and climate change as ambiguous. On the one hand, there is a commitment to action on climate change and a broad consensus on future goals. On the other hand, the institutional context of energy policy is stable and has been criticized for consolidating the position of powerful actors and leaving little room for new entrants. In this context, actors are equipped with discursive resources to promote change, yet face institutional structures that uphold stability. This places actors calling for change in current institutional structures in a difficult position as they are using the same discursive resources as the actors working to maintain current networks, policies and practices.

Previous research has shown how a shared vision or sociotechnical imaginary can assist in building broad and diverse coalitions and creating a sense of contributing to the same goal (Haukkala, 2018; Tozer and Klenk, 2018). The contribution of this dissertation is to offer another possible dynamic. Article II shows how a shared imaginary can result in the ability to discredit challenging demands and actors, by arguing that the future vision and direction is shared by all. In Finland, incumbent actors and elite policy institutions have significantly shaped the imaginary of carbon neutrality from early on, thus establishing a firm hold on visions of the future (see also Kivimaa and Mickwitz, 2011). The process appears to have unfolded rather differently in Finland (Apajalahti, Temmes and Lempiälä, 2018) than elsewhere, where incumbent actors have encountered more conflict and resistance (see e.g. Kungl and Geels, 2018; Lee and Hess, 2019).

This finding contributes to research on sociotechnical imaginaries by showing how the idea of a shared imaginary is both inserted into existing institutional structures and reasserted to question contestation on the different elements of

that imaginary and how to attain it. I show that the institutional conditions for reasserting an imaginary must exist prior to potentially disruptive developments for them to resonate with that imaginary (see also Felt, 2015). Thereby, for example, the disruptive *Energiewende* can be assessed in Finland primarily through its impact on Germany's status as a potentially carbon neutral industrial nation, rather than through its implications for energy democracy, local communities or demand-side policies, as discussed in Article IV. Similar tendencies are likely to exist in other policy-relevant fields, such as innovation or health policy, where broad future imaginaries of universal progress can be reiterated by elite policy institutions to quell dissenting voices regarding, for example, whether that progress actually reaches those most in need of it (see also Parthasarathy, 2017).

Likewise, the analysis of science-policy interaction (Article III) shows how expectations regarding the institutional context structure the ways in which actors justify their activities. I show that a linear repertoire, which calls for science to “speak truth to power” in decision-making (Wildavsky, 1979; Ezrahi, 1990), is a dominant way to describe, evaluate and justify desirable governance for carbon neutrality. In this context, academics are not free to choose any form of science-policy engagement based solely on the type of policy problem and its setting, as is at times promoted in the literature on knowledge brokerage (e.g. Michaels, 2009; McNie, Parris and Sarewitz, 2016). Instead, academics adapt their activities to rather tacit assumptions and expectations regarding their public role. This shows how different energy policy actors restrict the scope of possible and desirable governance for carbon neutrality by publicly performing and maintaining a linear conception of science-society interaction. This type of performative utilization of the linear model illustrates how academics engaged in policy-making want to be seen as separate from policymakers to maintain credibility and thus need to constantly balance between negotiation and boundary work (Jasanoff, 1990). At the same time, such performative work contributes to further cementing the linear model as the correct way of ordering science and policy.

While the previous paragraphs shed light on how current institutional conditions and expectations structure the scope of possible and desirable governance, I want to highlight that there nonetheless remains scope for agency. As seen above, agency is relational, as actors flexibly take into consideration the surrounding institutional environment. In his work on modern social imaginaries, Charles Taylor describes how actors draw upon a “repertory of collective actions” at their disposal, referring to a rather implicit and tacit understanding of what is seen as correct and legitimate (Taylor, 2003; 107). This dissertation asserts that such activities are often missed if agency is not appreciated as situated and relational. In Article II, we have shown how actors seeking to challenge current practices in energy policy have pre-empted and

thus sought to avoid potential sources of conflict by focusing on positive storylines of technological change brought about by renewable energy, avoiding negative critique on undesirable energy sources and distancing themselves from previously contested issues in energy policy. Similarly, the professor group exercised agency in acting both collaboratively and linearly, albeit justifying their activities through a linear model. These examples show how energy policy actors are aware of and sensitive to expectations regarding desired modes of governance, yet can flexibly orient their activities to work around them.

Finally, the empirical studies shed light on different actors' assumptions related to control. For example, in Article I, Parliamentarians demand that the governance of energy policy remains predictable and anticipatory despite uncertainty over technological and political developments. Uncertainty is thus framed as something that can and should be controlled. Similarly, I have shown how both academics and potential knowledge users demand linear science-policy interaction in Article III. Such demands are rarely a realistic description of engagement in a policy-relevant field, where being involved requires at a bare minimum accepting and endorsing given normative policy formulations of problems (Turnhout, 2019). More often, however, being involved in science-policy interaction requires a complex negotiation of different values in delineating what are deemed of as relevant policy problems, how to address and analyse them and what types of solutions to bring forward. The demands voiced in Articles I and III for predictable governance and linear-science policy interaction can thus be described as unrealistic descriptions of the practices of policy and governance, while at the same time being real demands to order science, policy and governance in a particular way. In doing so, they foster and perform restricted views of governance that do not only sustain prevailing patterns of privilege but also delimit the space for presenting alternative views. They are thus performative world-making practices that limit the scope of possible and desirable action.

In summary, this dissertation contributes new knowledge to research on sociotechnical imaginaries. First, the empirical case studies collectively show the prevalence of a sociotechnical imaginary of carbon neutrality in Finland and qualify the key characteristics of this imaginary. Second, I argue that this imaginary is interpretatively flexible in allowing for different interpretations of what carbon neutrality entails. Through remaining interpretatively flexible, the imaginary of carbon neutrality speaks to a broad collective and can assist in creating a consensus. This brings me to the third contribution, the importance of analysing how imaginaries are co-produced across space and time. I have shown that the imaginary of carbon neutrality is brought to the present through the co-production of the imaginary with different visions of desirable governance, policy and politics. I illustrate how these are produced within a specific institutional context that delineates the scope of agency. To further

qualify the analysis, I next turn to the limitations and societal implications of the research.

6.3 SOCIETAL IMPLICATIONS, LIMITATIONS AND FURTHER RESEARCH

I have shown that sociotechnical imaginaries need to be understood as future resources that motivate and justify action. At the same time, sociotechnical imaginaries are constantly made real and tied to the present through co-production and linking imaginaries to different possible, desired and envisioned forms of governance. In this process, the context where an imaginary is co-produced and made real becomes all the more important. I have shown that this context both enables and constrains the scope of possible political debate and action by requiring actors to formulate their views through interpretations of desirable pathways towards carbon neutrality. At the same time, Jasanoff (2015b) highlights that while imaginaries shape the agency of actors, there is always a possibility to imagine otherwise. The empirical studies in this dissertation, however, point to limited alternative imaginaries amidst the prevalent imaginary of carbon neutrality. I want to first raise some preliminary points as to why this is so, before outlining some methodological limitations of the current study that also explain the lack of alternative imaginaries. Lastly, I offer some reflections on the societal implications of a carbon neutral imaginary.

I offer two exploratory explanations for the prevalence of a carbon neutral imaginary. First, carbon neutrality speaks to the technocratic and expert-driven nature of Finnish energy policy that has been discussed in Chapter 3. That is, it reduces the complexity of emissions reductions and wide societal transformations to a question of attaining “zero net emissions” in a given time frame, an issue that can be quantified and progress towards which can be measured. This, in turn, sidelines how political the questions are of what is made to count as “zero net emissions”, over which time-frame, and with which calculative assumptions (see also Carton, Lund and Dooley, 2021). Second, I suggest that different energy policy actors have hung on to the imaginary of carbon neutrality due to the political potential the imaginary affords. As demonstrated in the previous section, the imaginary of carbon neutrality leaves plenty of space for advocating different sociotechnical pathways and solutions. This, in turn, facilitates political work in a consensus-driven society and hence motivates different actors to reproduce the imaginary.

At the same time, I want to acknowledge that the current study has its own limitations, which also explain the lack of alternative imaginaries. First, as I have described above, the sociotechnical imaginary of carbon neutrality needs to be qualified as an elite imaginary. It is performed and reproduced by actors that

have access to rather traditional sites of power, such as political decision-making, policy and the media. This is due to the methodological choices I have made. Had the research examined other sites, such as rural communities, children and youth, technology start-ups, alternative ecological communities and social movements, it is likely that imagined energy futures would have looked different. The recent popularity and publicity around new ecological social movements, such as Fridays for Future and Extinction Rebellion, shows that alternative imaginaries do exist. The debates put forward by Fridays for Future activists in Germany, for example, oscillate between proposing alternative and radical visions of future societies versus promoting doable, science and technology-driven solutions to the climate crisis (Marquardt, 2020). Thus, whether they offer alternatives to an imaginary of carbon neutrality remains to be seen.

While this dissertation has focused on rather dominant and central imaginaries, future research needs to examine imaginaries that are more marginal, distributed and decentred (Longhurst and Chilvers, 2019). In the context of Finland, future research could examine the extent to which the imaginary of carbon neutrality speaks to more marginal and decentred communities and is present in the daily lives of citizens. Is the imaginary “bound” (Smith and Tidwell, 2016) as an elite one at the national level that manifests itself in the arenas of politics, science, policy-making and media or is it more widely shared, and if so, by whom? How is the imaginary of carbon neutrality contested and what types of alternative imaginaries exist? Or, as suggested by this dissertation, do alternative imaginations also operate through the broader imaginary of carbon neutrality?

A second methodological caveat relates to how I have arrived at the imaginary of carbon neutrality. The analysis conducted in this dissertation has constructed carbon neutrality as a broad and shared imaginary based on the collected empirical materials. This is a different analytical process than starting with the concept of carbon neutrality and examining its genealogy over time or looking at the various, potentially conflicting, articulations and practices of carbon neutrality in Finnish climate and energy policies and practices. That said, I think such an analysis would be extremely interesting. It could shed light on questions that have remained unanswered by this dissertation. In this context, I offer two broad areas for further research. First, future research could examine the different calculative and accounting practices surrounding carbon neutrality in Finland and how difficult questions, such as baselines, time-frames and the role of transboundary carbon flows and offsetting, are negotiated by different actors. For example, carbon offsetting through the voluntary carbon markets is increasingly becoming an everyday practice of individuals, organizations and companies in Finland, without wider debate on the assumptions inscribed into the practice. Second, a genealogy of carbon neutrality could trace how the term

has been inserted into governance practices at distinct scales, especially given the extensive development of carbon neutral practices, policies and accounting systems in municipalities across Finland (Heiskanen *et al.*, 2015). Such an analysis could benefit from a comparative approach, where the genealogy of carbon neutrality in Finland would be compared to other contexts.

Finally, this dissertation raises some questions for wider societal debates on energy futures in Finland and more widely. I raise four possible, nonexclusive trajectories for societal debates on carbon neutrality that I suggest are all currently unfolding in some form or another. First, as carbon neutrality is a widely shared imaginary, it holds political potential for producing a consensus around future visions. In 2019, the Finnish Government codified the aim to reach carbon neutrality by 2035 and strive towards carbon negativity shortly thereafter (Government of Finland, 2019). Globally as of spring 2021, more than 100 nations have made pledges towards carbon neutrality, albeit all with rather different timelines and notions of the concept (Darby and Gerretsen, 2021). In Finland, at the time of writing this summary, various ministries and the government are in the process of concretizing the 2035 aim with roadmaps, legislation and policy initiatives. While I have shown that there is a broad expert and policy consensus behind carbon neutrality, the interpretative flexibility of the term means that such processes where aims are narrowed into specific policy measures are likely to result in intense debates over what counts as carbon neutral and based on what assumptions. This, in turn, can be viewed either positively as a possibility for political debate over what counts in creating a desirable future or more cynically as an opportunity for currently powerful groups to reframe existing technologies and institutional structures as “carbon neutral” without a more thorough rethink of their social, environmental and justice implications.

Second, I see a parallel course of action that calls for more precise societal and academic debate over different energy sources, technologies and practices. For example, Harjanne and Korhonen (2019) have called for “*abandoning the concept of renewable energy*” due to its conceptual ambiguity, negative policy impacts and problems regarding sustainability. Similarly, Vadén *et al.* (2019) discuss how framing wood biomass as a renewable energy resource obscures the fact that it is not a carbon-free fuel. Both end by calling for diversifying the conceptual vocabulary related to energy, especially regarding the carbon emissions produced by different energy sources. As such, they advocate using terms such as “*carbon-intensive, low-carbon and carbon-free*” (Vadén *et al.*, 2019, p. 8). However, this is likely to run into similar problems of defining and overflowing that I have identified with regard to carbon neutrality in terms of what counts as carbon-intensive, low-carbon or carbon-free, with which time-frames, and with which calculative assumptions. It also contains the danger of

rendering a fundamentally political issue even more technical and possibly less accessible to many.

A third path that appears to be emerging vis-à-vis the concept of carbon neutrality are the increasing calls for abandoning goals such as carbon neutrality altogether and instead declaring a state of climate emergency or climate crisis. This has been prevalent amongst recent social and ecological movements, such as Extinction Rebellion and Fridays for Future, but also different professional associations (such as doctors) and universities. In response, various national governments, such as the UK, France, Ireland and Canada, have declared states of climate emergency within the last few years. This can be seen as a culmination of the politics of urgency or a reaction to years of declaring that we “*only have n more years to act*” and we must “*do what it takes*” (Hulme, 2019, p. 23). However, narrowing the complex phenomena and process that climate change constitutes into a question of climate emergency faces its own problems, too.

My greatest concern with such declarations is that they tend to reduce the space for discussing other equally pertinent issues, of which a long list exists. This has been particularly visible in the case of biodiversity loss, which is now facing its own politics of urgency as different actors aim to increase its political salience in comparison to climate change. Second, when zooming in on climate emergency, declarations tend to focus on universal understandings of the complex phenomenon, curtailing climate change to “*reductive and seductive*” metrics, such as achieving net-zero emissions (see also Miller, Iles and Jones, 2013; Hulme, 2019, p. 24). As I have already outlined, such understandings and metrics encompass a wide range of political choices and assumptions that are often left opaque. As Mike Hulme elaborates, metrics such as net-zero emissions “*are only a proxy for global temperature, which is only a proxy for regional weather, which is only a proxy for human well-being, which depends on innumerable other factors for its achievement and maintenance*” (Hulme, 2019, p. 24). Hulme is thus criticizing the tendency of an emergency discourse to reduce complex issues to simple metrics and of emergency responses to focus on promoting mere survival, instead of envisioning a just and desirable present as well as a future, amidst climate change. As Sheila Jasanoff (2010, p. 239) eloquently explains, there is a stark difference between “*‘living’ and ‘survival’: the former rich, grounded, particular to the experiences of specific peoples in identifiable places...; the latter impersonal, detached from community, indifferent to life itself*”.²⁴ This, in turn,

²⁴ Jasanoff reflects here on a quote by Brazilian stakeholder that is incorporated in the classic Brundtland Commission report *Our Common Future* from 1987. The quote, in full, captures much of what is at stake when climate change is framed as a question of emergency and survival. The commentator states: “You talk very little about life, you talk too much about survival. It is very important to remember that when the possibilities for life are over, the possibilities for survival start. And there are peoples here in Brazil, especially in the Amazon region, who still live, and these people that still live don’t want to reach down to the level of survival” (World Commission on Environment and Development (WCED), 1987, p. 40).

calls for a much more elaborate discussion on living with climate change, not only in the future but also in the present, than that afforded by the themes of emergency and survival.

Fourth, then, I suggest that this dissertation offers another pathway for research and societal debate that focuses on both critically examining whose imaginaries we are talking about and further acting to include previously unheard voices and their imaginative potential. The first part of my suggestion thus concentrates on questioning the origins of sociotechnical imaginaries whereas the second part directs attention not only to including marginalized voices but also to listening and acting on voiced concerns (Longhurst and Chilvers, 2019; Smallman, 2019). This dissertation has shown that the capacity to imagine the future cannot be detached from its context, but that it is rather shaped by nuanced and often tacit norms, codes and adaptations to that context. While this dissertation has shown the limits of imagination in terms of the broad and consensual imaginary of carbon neutrality, I urge both researchers and other societal actors to delve deeper for alternatives. This, in turn, requires not only imagining otherwise but also thinking about how alternative imaginations can be economically, institutionally and societally supported and embedded into political and administrative cultures (Smallman, 2019; Levidow and Raman, 2020).

To sum up, I think all four of the broader societal trajectories identified above are ongoing developments in how the politics of climate change is taking shape through debates about when, how, where and by whom to act. They are parallel and nonexclusive discussions forming in different societal arenas where energy policy, transitions and the politics of climate change are deliberated upon. While I have pinpointed issues of concern, as well as possible problematic dynamics and avenues for further research, I nonetheless see all of these as necessary societal discussions. It is important to have broad societal goals and envisionings of desirable futures, it is important to call for distinctions and specifications, and it is likewise important to be able to imagine otherwise, challenge dominant narratives and present alternatives. At the same time, I hope this dissertation can contribute to understanding the power and responsibility that comes with doing so and raising that in itself as an issue of reflection. That is, realizing and making explicit that when the future is called upon in the present, the visions that are produced are always partial, political and performative.

7 CONCLUSIONS

This dissertation has examined societal debates on energy policy and transitions in Finland. The need to change the ways in which we produce and consume energy has become a key driver of discussions on energy policy and transitions. Debates on energy issues have shifted from debating the necessity of an energy transition to debating how, when, why and by whom action should be taken to create sustainable energy futures. In this move, energy transitions are constructed as urgent and salient policy problems that require action from different societal actors. At the same time, the necessity of energy transitions is justified through sociotechnical imaginaries, or visions of a desirable future in which the transformation of energy systems has been successful. What types of energy futures are imagined matters, as imagined futures are configured into extant practices, policies and sociotechnical systems.

The broad motivation for this research has been to step back from the ubiquitous calls to shift and transform energy systems. Instead, I have sought to analyse how such calls are perceived and contextualized by different actors in Finland. This means keeping the demands to transform energy systems in sight, yet placing the analytical focus on how such demands are understood and with what implications. To do this, I have engaged with a wide range of literature from several strands of research: sociotechnical transitions studies, social scientific studies on energy, institutional theory and science and technology studies. Each of these fields deals with energy transitions in a different way. The aim of this synthesis has been to present collective insights from the different empirical studies through an analysis of the sociotechnical imaginary of carbon neutrality in Finland and its co-production with different priorities and practices. As such, this synthesis contributes particularly to the emerging intersection of science and technology studies with social scientific studies on energy (Hess and Sovacool, 2020; Sovacool *et al.*, 2020).

Together, the empirical studies have contributed to the field of science and technology studies through elaborating on the concept of sociotechnical imaginaries and showing how interpretative flexibility can function as the glue that holds an imaginary together. I have demonstrated the prevalence of a sociotechnical imaginary of carbon neutrality in Finnish energy policy discussions. Through this imaginary, different energy policy actors show a collective willingness to address climate change and to transform energy systems. However, as the imaginary of carbon neutrality is interpretatively flexible it allows for various views on the inclusion and exclusion of specific technologies and energy sources and on desirable governance and policy practices. The empirical studies show how the imaginary is performed by various

actors in different sites, such as the media and arenas of political decision-making. While I demonstrate a broad commitment to the imaginary of carbon neutrality, I also show divergences in how the imaginary is co-produced with specific practices and priorities. This finding is developed especially in Article I, which addresses how political actors in the national Parliament of Finland and the Helsinki City Council co-produce different understandings of what desirable governance for carbon neutrality means.

Individually, the rest of the empirical studies have contributed to more specific fields of research, such as sociotechnical transitions (Articles II and IV) and the literature on science-society relations (Article III). Articles II and IV are both examples of situating transitions research in dialogue with other fields of inquiry, namely institutional theory (Article II) and media studies (Article IV). Article II highlights how current institutional structures condition the types of institutional work energy policy actors are willing and able to perform, thus tempering the idea that it is possible to easily destabilize and disrupt energy systems. Instead, the findings demonstrate how energy policy actors tailor their attempts to influence energy policy in line with institutional practices that are assumed to be effective. Article IV shows how global policy concepts and examples, such as the German *Energiewende*, are interpreted and contextualized through national news media. The analysis shows how distinct national concerns are linked to the *Energiewende* in media discussions in the UK, Finland and Hungary in order to promote change or enhance the stability of current national energy policies and practices. Article III, in turn, takes discussions on energy policy and transitions as the site through which I analyse the performance and justification of science-policy relations. The Article contributes new knowledge to the literature on science-policy interaction by developing a theoretical categorization of the linear model of expertise and further qualifying the categorization through an empirical case study. As this recollection of the findings evinces, the empirical studies extend the observations I have elaborated on in this synthesis through more specific results that speak to different fields of inquiry.

Finally, through engaging with different strands of research and policy-relevant concepts, I would like to extend a call to develop and nurture an STS sensibility beyond the field of science and technology studies to other fields of inquiry and action. Such a sensibility calls for being constantly attuned to and reflexive of the processes through which we both come to know and shape the world that we inhabit. This involves asking how the things of this world are constructed and what are the stakes in doing so. I see this as an opening move that invites us to be cognizant of our limitations, tolerant to diversity and open to imagining and acting otherwise.

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