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DECARBONISING ENERGY REGIMES:

METHODOLOGICAL EXPLORATIONS AND EMPIRICAL INSIGHTS FOR POLICY

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ACADEMIC DISSERTATION

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”Jag såg lite valoja där.”

Theresa Björkholm, 2019

ABSTRACT

Numerous scientific studies have called for an unprecedented effort to decarbonise global energy systems in order to limit the irreversible effects of climate. While decarbonisation presents a systemic challenge to our societies, encompassing complex and overlapping socio-technical, economic, and cultural processes, it is increasingly framed as a political challenge. Shifting towards a fossil free future is a value-laden process, prone to political contestation. It is thus critical to examine politics and policy processes that influence and condition energy system change.

This dissertation advances research on the decarbonisation policy and politics by answering methodological questions that help improve synergies between policy studies and energy transition studies. Many have already successfully initiated work on conceptual bridging to take advantage of policy-based approaches developed within the policy studies discipline. Importantly, I highlight in this dissertation that the conceptual advancement is inherently intertwined with and dependent on sound methodological practices. Nonetheless, so far the methodological questions have received little scholarly attention in the energy and transition policy circles. Limited reflection thus remains both on how to rightly apply different methods and how to combine them with existing energy transition frameworks and concepts.

Therefore, this dissertation critically explores the potential of existing and emerging textual methodologies in producing knowledge about decarbonisation processes. To do so, I explore the best practices and added value of discursive and topic modelling methods. The methodological exploration is carried out on two levels. On one hand, I examine the potential and limitations of each group of method by studying them independently on the meta-level. On the other hand, to gain additional insights from the practical research process, I also apply the methods in a decarbonisation policy context. In these cases, I study two emerging trends, namely the development of the European Energy Union project and the decline of coal-fired power generation in the UK.

The analysis of the textual methods emphasises that discursive methodologies can enhance our understanding of the role of political ideology and state orientation, publics, institutional and policy change in decarbonisation processes. In addition, discursive approaches are found to contribute to and complement the classical energy transition frameworks. The examination of topic modelling, in turn, shows that the method can be used to examine the thematic structure of policy-relevant corpora with an unprecedented scale and scope. Turning to computational approaches also offers scholars the possibility to explore decarbonisation processes and events more easily across different levels of analysis.

As a novel methodological contribution, this dissertation proposes that the topic modelling method could be used in different mixed-method designs for the purposes of qualitative textual analysis and by extension, this way could be harnessed for the analysis of policy and politics. I suggest two distinct ways of utilising topic modelling. In terms of content and classification based textual methods, researchers can potentially automate the analytical procedures, either completely or partially, depending on the method in question. I also propose ways of integrating topic modelling into discourse-based analyses through sequential mixed-method designs. Taken together, the findings encourage scholars to further experiment with the use of such computer mediated 'Textual Analysis 2.0' approaches in practice.

This study also highlights several higher level implications for research and policy. I postulate that integrating computational approaches into social scientific research endeavours necessitates further in-depth methodological dialogue among computational scientists, statistical experts and social scientists. Furthermore, I emphasise the importance of increasing reflexivity in transitions research. Put differently, it would be critical for scholars to engage in reflection on the role of the researcher as well as on how textual approaches not only inform about their empirical topic, but also construct certain realities about them.

This study contributes to the discussions in existing research in two ways. First, I expand the methodological discussions ongoing in the energy transitions research field by outlining the potential of two groups of textual methods in examining politics and policy. Second, the empirical results yield novel insights into two emerging and therefore understudied trends. The UK analysis responds to calls to examine technology decline at the national level, while the topic modelling analysis represents one of the first attempts to examine agenda shaping at the supranational level through a big data angle. Taken together, with the methodological insights provided in this work, transition scholars have an ever more refined ability to turn to approaches and methodologies from the policy studies discipline to advance the much needed research on the politics of decarbonisation.

TIIVISTELMÄ

Energiajärjestelmien muutos kohti vähähiilisyyttä on yksi tämän hetken kriittisimmistä yhteiskunnallisista kysymyksistä. Viimeisimmissä tutkimuksissa on korostettu politiikan ja poliittisen ohjauksen merkitystä energiamurrosten toteutumisessa. Politiikantutkimus onkin muodostunut tärkeäksi osaksi energiamurrostutkimusta.

Tässä väitöstutkimuksessa keskeinen huomio on energiapolitiikan tutkimuksen metodologisissa kysymyksissä. Erityisesti perehdytään ohjaamattomien koneoppimismenetelmien ja diskursiivisten metodien mahdollisuuksiin energiajärjestelmien muutosta tutkittaessa. Työn empiirinen osio tuo uutta tietoa hiilestä luopumisen diskurssista Isossa-Britanniassa ajanjaksolla 2000–2017 sekä siitä, miten Euroopan energiaunionin ilmasto- ja energiapoliittinen agenda on muotoutunut vuosina 2015–2018.

Tutkimuksessa tarkastellaan, miten energia-alan tutkimuskenttä tällä hetkellä hyödyntää olemassa olevia diskursiivisia politiikantutkimuksen menetelmiä. Tutkimus selvittää myös, mitä lisäarvoa aihemallinnus uutena ohjaamattomana koneoppimisen menetelmänä voi tuoda yhteiskunnalliseen energiatutkimukseen. Työ yhdistää näin tietoa kahdesta eri metodologisesta suuntauksesta, joita on tähän mennessä vielä vähän hyödynnetty energiatutkimuksessa.

Väitöskirjassa laajennetaan ymmärrystä diskursiivisten menetelmien mahdollisuuksista ja hyödyistä energiatutkimuksessa. Tulokset osoittavat, mitä lisäarvoa nämä menetelmät tuovat erityisesti poliittisen ideologian, yhteiskunnallisen hyväksyttävyyden ja ihmisryhmiin liittyvien ilmiöiden (’publics’) analysointiin. Diskursiiviset lähestymistavat myös mahdollistavat instituutioiden ja politiikan muutoksen syvemmän ymmärtämisen ja täydentävät olemassa olevia energiamurroksen analyyttisia tutkimuskehikkoja. Koneoppimisesta saadut tulokset tuovat esiin aihemallinnuksen mahdollisuudet politiikantutkimuksessa. Samalla tulokset osoittivat, että aihemallinnuksen käyttö vaatii syvää ymmärrystä tämän koneoppimisen menetelmän taustaoletuksista ja rajallisuuksista. Väitöskirjassa esitetään, että aihemallinnuksen arvo tutkimusmenetelmänä tulee parhaiten esiin yhdistetyissä lähestymistavoissa (mixed-method designs). Tutkimuksessa esitetään esimerkkejä tällaisista lähestymistavoista eri laadullisen tekstianalyysien menetelmille.

Kokonaisuudessaan tutkimuksen tulokset korostavat dialogin tärkeyttä tietojenkäsittely-, tilasto- ja sosiaalitieteiden tutkijoiden välillä, jotta koneoppimisen menetelmillä saadaan parhaiten vastattua yhteiskuntatieteiden tutkimuskysymyksiin. Tutkimuksen empiirinen osio puolestaan osoittaa, että Britanniassa hiilestä luopuminen on tapahtunut nopeammin ja vähemmällä vastustuksella kuin mitä

aiempi tutkimus energiamurroksista on esittänyt. Aihemallinnusanalyysi antaa vahvistusta väitteelle, jonka mukaan Euroopan energiaunioni on lähentänyt energia- ja ilmastopolitiikkaa EU-tasolla. Vähähiilisyys on muodostumassa keskeiseksi energiapolitiikkaa yhdistäväksi pilariksi.

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Karoliina Isoaho
Helsinki, January 2020

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II. **Isoaho, K** and Markard, J. The politics of technology decline: Discursive struggles over coal phase-out in the UK. *Review of Policy Research*. Accepted.

III. **Isoaho, K.,** Gritsenko, D. and Mäkelä, E. (2019) Topic modelling and qualitative text analysis for policy studies. *Policy Studies Journal*.

IV. **Isoaho, K.** Moilanen, F and Toikka, A. (2019) A big data view of the European Energy Union: Shifting from 'a floating signifier' to an active driver of decarbonisation? *Politics and Governance*, 7 (1), 28–44.

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

Author's contribution in the individual articles:
Article I was co-authored with Kamilla Karhunmaa. The idea for the article was developed by myself and Karhunmaa. We both contributed to the data collection and review of the literature. I contributed to all sections in the manuscript. *Article II* was co-authored with Jochen Markard. The original idea for analysing coal phase-out came from Markard, but the case and analytical approach for the paper was developed together by both authors. I had the main responsibility for developing the methodological approach. Both authors then equally collected and analysed the data. I was responsible for writing the sections on case background, methods and results and contributed to the introduction, theory and discussion. *Article III* was co-authored with Daria Gritsenko and Eetu Mäkelä. The core idea for the paper was developed by myself and Gritsenko. I had the main responsibility for reviewing previous research and developing the evidence base for the article. Furthermore, I was in charge of writing the introduction, results, discussion and conclusion. In the analysis, I was responsible for considering the compatibility between topic modelling and discourse analytical methods. Gritsenko covered content analytical methods. She also contributed to the paper on the whole. Mäkelä contributed to the technical work of the topic modelling method and provided insightful comments on the article throughout the writing process. *Article IV* was co-authored with Fanni Moilanen and Arho Toikka. I developed the core idea of examining the Energy Union and designed the research approach for the paper. Together with Toikka, I identified the main data sources for the paper. Moilanen was responsible for

collecting the data from these sources. Toikka was in charge of curating the corpora and running the topic modelling analysis on the data. While all authors contributed to the interpretation of topics, I had the full responsibility for analysing the results and writing all sections in the manuscript.

ABBREVIATIONS

ACF	Advocacy Coalition Framework
ADA	Argumentative Discourse Analysis
C&C	Content and Classification
CCS	Carbon Capture and Storage
CDA	Critical Discourse Analysis
CPF	Carbon Price Floor
D&R	Discourse and Representation
DG CLIMA	Directorate-General for Climate Action
DG ENER	Directorate-General for Energy
EC	European Commission
ECSC	European Coal and Steel Community
EEC	European Economic Community
EU	European Union
EU ETS	European Union Emissions Trading System
LDA	Latent Dirichlet Allocation
MLP	Multi-Level Perspective
SNM	Strategic Niche Management
TIS	Technological Innovation System
TM	Topic Modelling
UK	United Kingdom

1 INTRODUCTION

Numerous scientific studies have called for an unprecedented effort to decarbonise global energy systems in order to limit the irreversible effects of climate change (IPCC, 2018). While decarbonisation presents a systemic challenge to our societies, encompassing complex and overlapping socio-technical, economic, and cultural processes, it is increasingly framed as a political challenge (Bernstein and Hoffmann, 2018; Roberts et al., 2018). Decarbonisation, or the process of reducing carbon intensity in energy and economic systems (Rockström et al., 2017), is viewed as a 'wicked' policy problem, whereby both the problem and the solutions to the problem are complex, difficult to define and, as a result, reliant upon 'political judgement for resolution' (Rittel and Webber, 1973, p. 160). Therefore, decarbonisation is an inherently value-laden process and thus, prone to political contestation (Avelino et al., 2016; Meadowcroft, 2011, 2009). This dissertation aims to advance research on the politics of decarbonisation by answering methodological questions that help improve synergies between policy studies and energy transition studies.

Decarbonising the energy sector will involve fundamental changes to the ways in which energy is produced and consumed in our societies (Geels and Schot, 2007). The research field of 'sustainable energy transitions' has widely examined and conceptualised how such transformations to new, decarbonised energy systems can come about (Markard et al., 2012). The literature in this field has provided ample evidence of transformations towards increasing decarbonisation that are already occurring. This is for example demonstrated by large-scale diffusion and uptake of renewables in Germany, Spain, Denmark and the United Kingdom (UK) (European Environment Agency, 2018). Critically, however, at the same time, these studies also emphasise that despite the maturity and economic attractiveness of renewable energy technologies, the pace of transition has been insufficiently fast to attain the international goals for tackling climate change set by the Paris Agreement (Geels et al., 2017; Rockström et al., 2017).

As the transition from fossil fuels is occurring slowly, it is widely argued that successful decarbonisation requires purposeful steering and acceleration by public policy (Kivimaa and Kern, 2016). Scholars have therefore taken an interest in how policy can stimulate change in socio-technical environments through regulations, instruments and incentives that target the innovation and uptake of renewable energy technologies as well as weakening the conditions and structures for the use of fossil fuels (Markard, 2018). In addition, increasing attention has recently been paid to the political processes that underpin and condition policy change (Kern and Rogge, 2017; Köhler et al., 2019). By applying theories and frameworks to study, for example, advocacy and discourse coalitions, policy feedback or power relations that

underpin decarbonisation policy and politics, scholars have initiated important work on conceptual bridging between policy studies and transitions research (Edmondson et al., 2018; Hoppe et al., 2016; Markard et al., 2016).

While these contributions have yielded novel and more nuanced insights into transition dynamics, the increasing interest in politics and policy processes has also had ramifications for the research process itself. In other words, when borrowing concepts and theories developed in other disciplines, energy transition scholars have noted certain limitations to their application (Köhler et al., 2019; Sovacool, 2014a; Zolfagharian et al., 2019). Moreover, calls have been made for increasing reflection both on how to correctly apply analytical approaches with distinct ontologies and theoretical underpinnings and how to combine them with existing energy transition frameworks and concepts. For instance, Kern and Rogge (2017, pp. 1, 13) note that while there is 'much potential for cross-fertilisation of ideas across transitions and policy studies', much of the current work has been performed in 'an ad-hoc and relatively cursory way'. This arguably leaves room to leverage the full potential of policy concepts in transition research.

This dissertation starts from the premise that methodological considerations are key to improving conceptual bridging and the transfer of ideas between transitions and policy studies. At the same time, it is an area that has yet to receive in depth consideration in the current discussions. I argue that detailed reflections on the application, limitations and added value of distinct methodologies will not only illustrate best methodological practices but also produce novel insights for advancing theory and policy development. To address this need, I focus on the role of textual methodologies. In social science, textual methodologies are widely used to detect change in policy language and discourse (Fischer et al., 2007). For example, it is increasingly recognised that a more comprehensive understanding of the drivers and barriers of energy system change requires analysis of the way energy transitions are given meaning in and through discourse (Hajer and Versteeg, 2005; Scrase and Ockwell, 2010). For the purposes of this dissertation, and as will be explained more thoroughly in Chapter 3, the understanding of textual methodologies goes beyond the traditional qualitative-quantitative division. Rather, textual methodologies are taken to refer to approaches aligned on an axis that includes methods based both on human interpretation and machine quantification.

1.1 RESEARCH QUESTIONS

In this dissertation, I contribute to the line of energy transition research that examines *how adopting a policy studies perspective enriches our understandings of decarbonisation processes*. As is clear from the brief description above, this question has thus far been answered mainly by investigating the potential contribution of

different analytical approaches, such as advocacy coalitions or policy feedback theories, to the study of energy transition dynamics. The research endeavour of the dissertation is to provide this inquiry with a methodological angle. While this has been an explorative process, in this summary I operationalise my research aims with the following three research questions:

RQ1. What novel contributions do textual methodologies bring to the study of decarbonisation policy and politics, both in terms of methods and empirical insights?

The aim of this question is to understand how textual methodologies can contribute to advancing, illuminating and informing decarbonisation processes. I focus on two groups of methods, more established discursive approaches and emerging unsupervised machine learning methods. In policy studies, discursive approaches are seen as integral tools for making sense of policy processes that are highly contextual and value-laden. Unsupervised machine learning methods, in turn, are widely used in textual analysis in computational social science, and they have recently attracted heightened interest among policy studies scholars. Focusing on both discursive and unsupervised methods provides an interesting angle to the methodological exploration, as they take a sharply contrasting interpretative approach to textual analysis: all discursive approaches are supervised, because human intelligence underlies their application; conversely, unsupervised computational approaches push in the exact opposite direction in minimizing supervision. To offer a more refined understanding of how these approaches could be incorporated into the study of decarbonisation politics and policy, I both *study the methodological approaches* and *apply them respectively in an empirical context*. Accordingly, the second and third research questions read as follows:

RQ2. How do discursive approaches enrich our understanding of energy transitions policy and politics?

Through research question 2, I steer the focus towards the large family of discursive approaches which are increasingly used in transition studies. I ask which discursive approaches have been used and in what ways they have been applied in the field of sustainable energy transitions. Then, I apply a discourse analytical method in the context of decarbonisation in the UK to further examine their methodological contribution to research and policy. This part of the research raises questions about how to develop novel methodological synergies within textual analysis to attend to the complexity of energy transitions. The third research question therefore addresses this issue by asking:

RQ3. How can unsupervised computational methods be incorporated into research on energy transitions policy and politics?

Through research question 3, I explore the extent to which the topic modelling method is useful for and compatible with existing qualitative textual approaches. In addition, to gain more insights into the application of unsupervised methods in a policy studies setting, I also apply the topic modelling method to a big data corpus formed of energy policy documents by the European Commission (EC).

Taken together, the answers to these three research questions provide new knowledge on textual methods and their contribution to decarbonisation policy. Thus, this dissertation's methodological exploration will enable other scholars to better harness the arguably tremendous and underutilised potential of textual methods—both discursive and computational—for the purposes of transitions research. In addition, given that the methods examined are applied in the context of decarbonisation, there is also an underlying empirical inquiry embedded in the research questions 2 and 3. In other words, by exploring agenda setting in the European Energy Union and the coal phase-out discourse in the UK, this dissertation helps to fill two empirical research gaps identified by the prior literature: i) examining how competing policy priorities are advanced under the Energy Union and ii) focussing on the processes of incumbent technology decline at the national level instead of widely studied processes of innovation and niche development. By doing so, this dissertation also offers empirical insights that inform the conceptual literature of energy transitions and provides lessons learnt for policy and practice.

1.2 OUTLINE AND STRUCTURE

This dissertation consists of this summary and four journal articles. Of these, three articles have been published in international peer-reviewed journals and one is a submitted manuscript. The main findings of each article can be summarised as follows.

Article I: 'A critical review of discursive approaches in energy transitions'.

This article conducts a review of 77 articles that have studied energy transitions by applying discursive approaches. The findings reveal that discursive approaches have mostly been used to analyse institutional change and policy strategies and to examine energy choices through the perceptions of publics and political ideology. Empirically, nuclear energy, biomass and wind power, rather than fossil fuels, have received most discursive coverage. Moreover, the majority of studies have been conducted in

the European context and applied at a national level. The added value of discursive approaches is reported to be their assumption of complexity in policy processes and their ability to grasp notions of agency and discursive structure are reported as the added value of discursive approaches. Finally, the article provides examples of discursive research designs for studying 'political ideology and state orientation', 'publics', 'institutional and policy change' and 'transition dynamics'. The findings confirm that discursive approaches enable scholars to enrich policy discussions through accounting for transitions as complex and dynamic processes of change.

Article II: 'The politics of technology decline: Discursive struggles over coal phase-out in the UK.'

This article examines public discourse surrounding coal decline in the UK in the period of 2000–2017 by analysing discourse in The Guardian. It identifies the storylines used by actors to (de)legitimise coal use and depict the possibility of phasing out coal from power generation. The article finds that scientists and environmental NGOs criticizing coal for climate and health reasons, while government and incumbent firms tried to uphold the legitimacy of burning coal. After industry resistance collapsed, coal declined rapidly in just a few years. Essential for decline were failed promises around 'clean coal', rapid diffusion of wind energy, and pressure from various policies. Foregrounding the political contestation around decline, the study points to the interplay of discursive struggles, technology change and public policy in sustainability transitions.

Article III: 'Topic modelling and qualitative text analysis for policy studies.'

This methodological article reviews articles that have applied topic modelling in a qualitative setting and further discusses the best practices, limitations and potential of the unsupervised machine learning method. The article finds that topic modelling can, depending on the method, either completely or partially replace content analysis procedures previously performed 'by hand'. It argues that the topic model output should not be equated with discourses, frames, or narratives, as the latter concepts are highly informed by theory. Nonetheless, topic modelling can be integrated into these analyses sequentially as part of a mixed-method design. Finally, the article discusses novel methodological avenues for using topic modelling in policy research.

Article IV: 'A big data view of the European Energy Union: Shifting from 'a floating signifier' to an active driver of decarbonisation?'

This article examines the formation and agenda shaping of the European Energy Union. A topic modelling analysis of over 5000 policy documents reveals

that decarbonisation and energy efficiency dimensions are major building blocks in the Energy Union's agenda. There are also signals of policy convergence in terms of climate-security and climate-affordability policies. However, our analysis also suggests that the EC does not actively prescribe trajectories for renewable policy development. Whether the Energy Union develops from a 'floating signifier' into an active driver of decarbonisation will thus be determined by the implementation phase of the project.

The rest of this summary is structured as follows. In Chapter 2, I present the theoretical underpinnings of this dissertation. I then move on to introducing and discussing the textual methodologies used in political analysis. Next, Chapter 4 provides an overview of the research methods and data used in the articles upon which this dissertation is based. In Chapter 5, I present the main findings of the articles. Finally, Chapter 6 discusses the results and Chapter 7 summarises the main contribution of the research and offers concluding remarks.

2 THEORETICAL GROUNDING

In this chapter, I review the key literature and theoretical concepts upon which this dissertation draws. I first present the *sustainability transitions* research field, and more precisely its subfield *sustainable energy transitions*, which conceptualise and examine the ways in which current fossil-heavy systems of energy consumption and production could be shifted towards sustainability. Then, I discuss how the classical frameworks for conceptualising sustainability transitions have been criticised for their lack of interests in politics, power and agency. Finally, drawing on the work of public policy and political science scholars, I elaborate the role of policy and political processes of policymaking in the quest to decarbonise our societies.

2.1 DECARBONISATION: THE TRANSFORMATIONAL CHALLENGE ACROSS SECTORS

Decarbonisation is an urgent, global challenge now widely recognised by policymakers, researchers, businesses and citizens alike. However, it is by no means an easy task, as it requires fundamental shifts in the ways our societies are organised (Geels and Schot, 2007; Munck af Rosenschöld et al., 2014). In other words, turning away from fossil fuel use is increasingly viewed as a multi-dimensional, complex and uncertain process, which presents a systemic challenge and involves a shift of resources between industries, technologies, institutions, political cultures as well as social and cognitive practices (Antal and Hukkinen, 2010; Markard, 2018).

The field of sustainability transitions emerged in the early 2000s to conceptualise and account for such fundamental shifts in existing sectors such as agriculture, energy, food and transport (Grin et al., 2010; Loorbach et al., 2017; Van Den Bergh et al., 2011). Drawing on evolutionary economics, sociology and science and technology studies, the research field conceptualises sustainability transitions as socio-technical shifts that are guided by sustainability objectives (Geels and Schot, 2010). While historical examples exist of socio-technical transitions, such as the shift from horse-drawn carriages to automobiles (Geels, 2005), the major interest of transitions scholars has lain in examining 'how to promote and govern' transformations in contemporary societies (Markard et al., 2012, p. 954).

Socio-technical transitions contain many particularities that differentiate them from other technical transformations. First, they involve changes that are not only technical, economic and material in nature but that also simultaneously unfold at political, organisational, socio-cultural and cognitive levels. Second, and as a consequence of this multi-dimensionality, transitions involve a wide range of actors

from different backgrounds (Köhler et al., 2019). Socio-technical changes are thus influenced by multiple, and often conflicting, priorities and preferences. Third, socio-technical transitions are likely to require a long time-span in order for the envisioned systemic changes to occur. It is however often highlighted that the processes associated with any socio-technical transformation are very likely to be hindered and retarded by strong path-dependencies. These include, for example, institutional inertia, technological lock-ins and actor resistance (Unruh, 2000; Verbong and Loorback, 2012) (Unruh, 2000). Finally, given that the established socio-technical systems are deeply embedded in the workings of our societies, scholars have argued that a key overarching characteristic of all sustainability transitions is that they are normative and purposive processes, requiring facilitation and policy steering.

Socio-technical transitions have been conceptualised and explained with many theoretical approaches and frameworks. The classical conceptual frameworks include the multi-level perspective (MLP) (Geels and Schot, 2007), strategic niche management (SNM) (Kemp et al., 1998), transition management (Rotmans et al., 2001) and technological innovation systems (TIS) (Hekkert et al., 2007). The MLP is the most popular and widely used framework in the field. It explains transitions as the substitution of one dominant technology with another (Geels, 2002), and interprets the process through the dynamics of niche, regime and landscape (see e.g. Geels and Schot 2007 and 2010).

In the MLP, niches are defined as radical innovations, while regimes are conceptualised as the established practices, rules and institutions stabilising energy systems. Landscapes, in turn, refer to the exogenous conditions influencing energy systems, such as climatic conditions or global oil prices, which are under the influence of the regime and niche actors (Geels and Schot, 2010). When first introduced, the MLP promised to allow researchers analysing innovation to go beyond the investigation of single technologies to examine system change. The early transition studies conceptualised regimes as generally robust, change-resistant entities which would therefore risk only incremental developments (Berkhout et al., 2004). Nonetheless, more recent MLP scholarship argues that regimes can also be drivers of the radical change required to achieve sustainability (Bosman et al., 2014; Geels et al., 2017; Leipprand and Flachsland, 2018). This is because, as I will further explain in the next section 2.2, the recent scholarship increasingly acknowledges the relevance of regime destabilisation for system change, in other words, that changes in regime structures (for example, through the phasing out of incumbent technologies to make way for renewable and clean technology) can create momentum that drives transformation (Geels, 2014; Rosenbloom et al., 2016, p. 1276). Drawing on these conceptualisations of the recent MLP literature, this dissertation adopts this latter, more active, view on regimes.

2.2 ENERGY TRANSITIONS: FROM NICHE INNOVATION TO REGIME DESTABILISATION

As noted above, the specific transformations of different sectors can be viewed as examples of sustainability transitions. Energy system change has been widely examined by transition scholars as one such example, and it has become a subfield within transitions scholarship, referred to as 'sustainable energy transitions', or more succinctly, 'energy transitions' (Araújo, 2014; Grin et al., 2010). An energy system can be defined as one designed to provide energy and energy-services in a society (Kern and Smith 2008). It consists of energy inputs and outputs and is operationalised through the linkages between technological infrastructure, user practices, regulatory and institutional frameworks, markets and trade as well as cultural and cognitive meanings. (Araujo, 2014, p. 112; Kern and Smith, 2008, p. 4094). An energy system has many subsystems such as electricity, heat and transport. In this dissertation, I focus on the challenge of decarbonisation in electricity sectors.

Before considering how a transition to decarbonised systems is conceptualised in the literature, it is useful first to discuss the key aspects that characterise energy transitions. While delivering an energy transition represents a globally shared challenge, it consists not of one but of many parallel transition pathways that have different transformational logics (Rosenbloom, 2017a). In other words, energy transitions are likely to unfold differently depending on their context dependencies. It has been shown that the nature and speed of transitions differ between national, regional or local contexts, and that they are largely shaped by the distinct material, socio-cultural, institutional and economic dependencies inherent therein. Of course, global trends also exist, such as the trajectories of technological development that influence the dynamics in transitions. As a result, the unfolding energy transitions can be seen to be partly independent and partly overlapping (Markard, 2018). However, what energy transitions do have in common is that their association with long-term decarbonisation targets. Moreover, they often include the diffusion of renewable energy technologies or carbon neutral solutions, increased energy efficiency or the termination of incumbent technologies such as nuclear or coal.

At the same time, as is the case with sustainability transitions in general, determining the nature of these long-term targets for energy transitions is very likely to involve normative, value-laden struggles. As Meadowcroft (2009) argues, the 'selective pressures' exerted on regimes to determine the desired characteristics of change can lead societies towards very different forms of energy production and consumption. The course of electricity configurations is likely to be differently shaped if the major aim is a transformation from a fossil fuel based system towards a non-fossil system, from a non-renewable system towards a 100 per cent renewable system, or from a carbon emitting system to a carbon neutral system. Furthermore, this remains the case even if the desired change simply envisions a shift from a vulnerable to a secure or a centralised to a decentralised system (Meadowcroft,

2009, p. 327). Normative struggles over the preferred courses of action are also accentuated by the high level of complexity and uncertainty inherent in sustainability challenges: they deal with wicked, ill-defined problems, whereby policy solutions and outcomes are unprecedented in scale and scope and thus not thoroughly understood. Taken together, these characteristics make energy transitions not only uncertain and complex but also value-laden and highly contested processes.

How is change in such systems then conceptualised and examined? Traditionally, transition scholars have addressed system change through considering new, alternative innovations, technologies and business models (Bergek et al., 2008; Suurs and Hekkert, 2009). Interest was thus long focused on explaining transition dynamics through the interaction between the niche and the regime, for example, by investigating how new innovations and technologies such as solar panels, electric cars or 'smart' technologies penetrate the existing fossil fuel-based markets and regulatory systems . However, while transitions in many places have already progressed to a new phase of development whereby renewables represent a major share in the energy mix (Markard, 2018), the pace of transition has been insufficiently fast to limit the irreversible and destructive effects of climate change (Geels et al., 2017). Using MLP terminology, even if niche developments have taken off and diffused, regimes have remained rather stable as the diffusion of renewables has not significantly managed to weaken the 'reproduction of core regime elements' (Turnheim and Geels, 2012, p. 35).

This slow progress and stagnation of incumbent regime structures have forced researchers to consider how to *accelerate* transitions in order to bring them in line with sustainability targets. To achieve this end two intertwined and co-dependent phenomena have been raised to the fore; the *acceleration of renewables* and the *destabilisation of existing regimes*. In order to advance regime destabilisation, research must account for change in terms of both phenomena (Köhler et al., 2019; Roberts et al., 2018; Rosenbloom, 2017b). This line of thought expands MLP scholarship, which has not explicitly considered how we can analytically explain the processes where new technologies have already matured in order to challenge the existing regime (Geels et al., 2017; Leipprand and Flachsland, 2018). Hence, there is an increasing need to shift the interest from 'take-off' to 'breakthrough' dynamics (Rotmans et al., 2001, p. 17) and to acknowledge that regimes can also act as drivers of system change (Rosenbloom et al., 2018; Smith et al., 2005).

The decline of inclumbent technology has been highlighted as an important part of regime destabilisation processes. This stems from the understanding that rather than being a mere by-product or corollory of the large scal uptake of renewables, regime destabilisation is often a purposeful process where fossil fuel technologies must be deliberatively destroyed in order to make way for sustainable alternatives (Kivimaa and Kern, 2016; Turnheim and Geels, 2012). The role of technology decline has been found to be particularly relevant in accelerating transitions because renewables and other low carbon sources would be available on a larger scale to

substitute for the incumbent technologies if the demand were higher (Johnstone and Hielscher, 2017). Using the MLP terminology, technology decline would amount to 'the process of weakening reproduction of core regime elements' (Turnheim and Geels, 2012, p. 35).

Scholars have conceptualised the purposive termination of fossil fuel technologies as 'technology decline' (Markard, 2018), 'exnovation by creative destruction' (Heyen et al., 2017; Kivimaa and Kern, 2016) and the 'phase-out of fossil fuels' (Leipprand and Flachsland, 2018; Rosenbloom, 2017b). All these terms refer to the deliberate termination and discontinuation of 'unsustainable technologies, products and practices' (Heyen et al., 2017, p. 326). Even if technology decline is often discussed as an enacted process (see Kern and Kivimaa (2016) for a discussion on the different ways in which policies can target technology decline), it is likely also to be driven by multiple and overlapping factors, including other technologies, business model development, market influence, and changes in institutional structures (Markard, 2018).

While incumbent technology decline is still rather understudied in transitions compared to innovation, it is now widely acknowledged that these processes of decline are very likely to lead to negative, unintended consequences and adverse effects for indstries and workforce (Johnstone and Hielscher, 2017; Lehotský et al., 2019; Markard, 2018). Therefore, technology decline and destabilisation policies are defined as highly conflictual and thus likely to cause strong resistance from regime level-players (Leipprand and Flachsland, 2018). Turnheim and Geels (2012), have conceptualised different phases for incumbent industry destabilisation as denial, incremental responses, diversification, destabilization and eventual dissolution; arguing that processes of decline encompass both external pressures and internal responses from the existing regime.

To sum up, energy transitions are characterised as context dependent processes that are highly uncertain and involve normative struggles over their targets and priorities. Understanding their dynamics involves examining both the uptake and acceleration of renewables and the decline of incumbent technologies. Taken together, these processes are likely to play a productive role in regime destabilisation, eventually leading to decarbonised energy systems.

2.2.1 THE 'POLITICAL TURN' IN THE TRANSITIONS LITERATURE

In parallel to the increased attention paid to accelerating transitions, transition scholars have also sought to develop more politically-oriented accounts in their studies. This stems from a relatively recent line of critique arguing that the early transition frameworks largely neglected the role of political factors in socio-technical change (Kuzemko et al., 2016; Meadowcroft, 2011, 2009; Sovacool, 2017). This

critique highlights the insufficient focus of early transition scholarship on the role of power and issues of legitimation and agency in the dynamics of transitions (Avelino et al., 2016; Stirling, 2014).

Since the emergence of this critique, many studies have successfully demonstrated that transitions are inherently value-laden and contested processes that, therefore, do not develop outside the political realm (Bosman et al., 2014; Hess, 2014; Leipprand et al., 2016; Rosenbloom et al., 2016). These theoretical and empirical studies have investigated politics in transitions by drawing on, among others, political science, policy sciences and institutionalist theories. This trend has been framed as the 'political turn' in the sustainability transitions literature (Roberts et al., 2018).

There are many reasons why incorporating political accounts into transitions research remains critical. One major reason concerns the fact that achieving successful energy transitions is increasingly a political, rather than a socio-technical challenge. We now, by and large, possess the technologies and knowhow necessary for fossil-free energy production. Moreover, the ongoing energy transitions are uniquely political as—unlike their historical counterparts—they are, through the Paris Agreement, driven by policy-makers at the international level (Roberts et al., 2018). Despite these developments, however, governments around the world have avoided taking sufficiently ambitious steps to accelerate decarbonisation. The transitions literature explains this through the capacity of incumbent actors to resist change; they have the power and influence to shape policies to their liking (Geels, 2014) Thus, it is suggested that as long as entrenched interests remain unaligned with decarbonisation objectives, societies will lack the sufficient political will to deliver transitions.

The role of politics in accelerating energy transitions, however, involves more than increasing the 'political will' of incumbent actors. In addition to purposeful policy steering, successful sustainable energy transitions also require consideration of other 'political lock-ins' that hinder their progress. The various political lock-ins can occur, for example, as conceptualised by Rosenbloom, Berton and Meadowcroft (2016), in interactions between ideas, interests, institutions and infrastructure, or, as Roberts et al. (2018) suggest, in the coalitions shaping policy, processes of policy feedback or in the broader contexts that condition decision-making. Combined with the urgency to accelerate transitions, this creates a pivotal need to examine different facets of the politics of sustainable energy transitions.

2.2.2 EXAMINING THE POLICY PROCESSES OF TRANSITIONS

In most political science and policy literature, the analytical interest in politics cuts across three major subject areas: polity, policy and politics (Knill and Tosun, 2012, p.

4). While the study of polity concentrates on the institutional structures of a political system, policy refers to the decisions or strategies developed in a political system to address societal problems, such as objectives, rules, laws and regulations (Dermont et al., 2017). Studying politics, in turn, refers to understanding the political and policy processes that play into the dynamics of policymaking (Weible et al., 2018).

This dissertation takes an interest in the latter; the *policy processes* that underpin decision-making in energy transitions (Köhler et al., 2019; Sabatier and Weible, 2018). Such a focus requires researcher to move beyond the analysis of the content and challenges researchers to examine the policy realm and the wider political interactions that shape policy-making and change (Kern and Rogge, 2017).

Prominent policy process theories commonly view the study of policy-making as the core means of both understanding the form and output of policy and revealing how the processes leading to those outputs play out (Kern and Rogge, 2017). The latter refers to investigating the 'modes of legitimacy used by those who govern', in other words, explaining why certain policies become adopted while others are disregarded (Zittoun, 2014, p. 3). Key policy process theories explaining policy change and stability include the Advocacy Coalition Framework (ACF) (Sabatier, 1988; Weible and Ingold, 2018), multiple streams theory (Kingdon, 1984) and the punctuated equilibrium (Baumgartner et al., 2014). However, while these approaches all examine policy processes through actor coalitions, they have different views and theorisations on what draws these coalitions together (e.g. shared beliefs, interests or resources).

Another important strand of policy process theories involves investigating the role of *discourse*. Following the interpretative turn in social sciences, this approach argues for the relevance of studying the ways in which actors develop and interpret policy in different contexts (Majone, 1989). This discursive stance differs from other policy process theories in that it views discourses, not beliefs or interests, as the 'glue' used to form coalitions to support or resist policy change (Hajer, 1995; Köhler et al., 2019; Sovacool and Hess, 2017). In this approach, public policy is defined as discursive practices where actors combine a set of fragmented policy ideas into a 'coherent public policy' and power is defined as the ability to shape discourses in policy-making processes (Fischer, 2003a; Zittoun, 2009). Scrutinising discourse thus allows the researcher to elucidate the intentionality in decision-making processes, in other words, how actors use discursive practices to assign meaning, build legitimation or create relationships between policy issues.

All these above-mentioned policy process approaches are increasingly applied to the examination of energy transitions (Edberg and Tarasova, 2016; Kivimaa and Mickwitz, 2011; Markard et al., 2016; Normann, 2017; Sengers et al., 2016). In doing so, however, scholars have begun to reflect on the issues that emerge when borrowing concepts from other disciplines (Köhler et al., 2019; Loorbach et al., 2017; Sovacool, 2014b). As theories come with different ontologies and assumptions,

researchers have noted the difficulties of applying novel concepts and methods to the context of transitions, not to mention the challenge of embedding them in existing transitions frameworks (Kern and Rogge, 2017; Sovacool and Hess, 2017). To harness the full potential of these varied analytical approaches, calls have been made for greater engagement in methodological learning and knowledge bridging between public policy and energy transition scholars (Edmondson et al., 2018; Hoppe et al., 2016; Kivimaa and Kern, 2016).

In particular, more work has been demanded on the compatibility of discursive approaches with transitions research. As discursive approaches draw on a wide range of research fields, some scholars have proposed that energy transition research would benefit from a deliberative and more conceptually sound use of discursive concepts and methods (Kern and Rogge, 2017; Scrase and Ockwell, 2010; Sovacool and Hess, 2017). This dissertation echoes these sentiments by reasserting the need to direct more attention to the discursive aspects of policy processes and by opening up a wider methodological discussion on how to incorporate discursive approaches into the investigation of politics surrounding energy transitions.

2.2.3 SUMMARY: BRIDGING METHODOLOGICAL KNOWLEDGE TO ACCELERATE TRANSITIONS

Thus far, this chapter has presented the main theoretical conceptualisations developed for studying energy regime decarbonisation and explained how transitions scholarship increasingly views both accelerating the uptake of renewables and destabilising incumbent regime structures as critical conditions for successful decarbonisation. In addition, the chapter has demonstrated that while shifts towards sustainability can be conceptualised through the interaction between the niche, regime and landscape, in practice energy transitions unfold as irreducibly complex, uncertain and value laden phenomena. This underscores the critical role of the study of politics and policy processes in transitions.

Combining insights from transitions scholarship, political science and public policy, I have stressed the importance of examining the processes of policy that play into transition dynamics. However, while the role of discourse is increasingly acknowledged in these processes, I have argued that the use of the diverse discourse analytical approaches warrants more consideration. There is a need to reflect on the compatibility, role and added value of using discursive approaches in particular and textual approaches in general in transitions studies, as this will allow researchers to exploit their full potential to reveal the non-linear, political and value-oriented aspects of decarbonisation. To lay the foundations for this methodological reflection, the next chapter introduces and discusses the use of textual methodologies in the analysis of policy processes.

3 TEXTUAL METHODOLOGIES AND POLICY ANALYSIS

Textual methodologies offer researchers a way to gather information on how different actors make sense of the world and how meaning is constructed and channelled through text in various social, political and cultural settings. Here, text is taken to mean different forms of written, visual and audio(-visual) data, each with their own specific qualities in conveying meaning. While textual methodologies are popular approaches in many disciplines, they are particularly useful for studies on policy and policy processes. As Given (2008, p. 865) contends, 'textual analysis can provide rich discussion of presentational and structural specifics and subtleties that would remain unidentified if a cursory analysis was conducted'. In this summary, policy processes refer to the political action and negotiations related to policy-making and policy change (Edmondson et al., 2018; Meadowcroft, 2009). In line with most policy literature, politics and policy processes are seen as synonyms (Weible et al., 2018). By policy analysis, I refer to the analysis of policy processes and interactions that underpin policy, not to the evaluation of specific policies or instruments.

Even though, as a term, textual analysis is often associated with interpretative qualitative methodologies, it can nevertheless be used for the purposes of different research paradigms (Kuhn, 1996). Lasswell's methodological contributions to textual approaches are considered seminal in the field, as he was the first to introduce quantitative content analytical approaches to the exploration of policy phenomena. Since then, notable methodological advancements have included the 'argumentative turn', which brought to the fore an interest in discursive methodologies (Fischer, 2003; Zittoun, 2009) as well as the trend towards mixed-method research combining qualitative and quantitative textual approaches (Flyvbjerg, 2001)). Today, however, digitalisation and access to big data has precipitated yet another development, namely the 'computational turn', which enriches the methodological tool-box of social scientists with computational techniques.

For the purposes of this dissertation, I adopt a definition of textual approaches that goes beyond the traditional division between qualitative and quantitative approaches. Instead, in line with Purhonen and Toikka (2016), I consider it more apt to distinguish different textual methods according to the type of coder, i.e. human or machine, as well as to the principle of interpretation, i.e. whether the approach is open ended or follows an a priori defined schematic. Table 2 illustrates this approach on textual methodologies.

Table 1 Textual analysis techniques. Adapted from Purhonen and Toikka (2016)

		Coder	
		Human	*Machine*
Interpretative approach	*Open-ended*	Qualitative thick reading (e.g. discourse analysis)	Unsupervised machine learning (e.g. topic models)
	A priori defined	Applying a coding scheme (e.g. content analysis)	Supervised machine learning (e.g. semantic analysis)

Through this understanding of textual approaches, qualitative thick reading and unsupervised machine learning methods both emerge as examples of open-ended textual methods. At the same time, however, these open-ended interpretative methods differ sharply in their nature, as discursive approaches are supervised, because human intelligence underlies their application. By contrast, unsupervised computational approaches push in the exact opposite direction by minimizing supervision. Because of this interesting contrast, I focus on these two groups of methods in my methodological exploration. Next, I introduce the two approaches in more detail.

3.1 DISCURSIVE APPROACHES

Discursive approaches represent a family of analytical perspectives that scrutinize language, ideas, and meaning-making—or, more generally, the various aspects that condition, construct and shape discourses in society. They come in many forms, depending on disciplinary traditions and theoretical understandings (Hajer and Versteeg, 2005). Nonetheless, despite their differences, what all approaches have in common is that they seek to 'flesh out the analytical consequences' of understanding that discourse and politics matter in societal transformations (Howarth and Torfing, 2005). In this dissertation, I broadly categorise discursive approaches into three groups: discourse, frame and narrative analytical perspectives.

Discourse analytical approaches focus on the power of discourse: how language and ideas structure the way we see reality (Feindt and Oels, 2005). Again, many types of approaches exist within discourse analysis. In line with Howart and Torfing (2005), they can be distinguished by the theoretical schools of thought that underpin them. 'First generation' discourse theory views discourse in a stricter linguistic sense, focusing on the semantic and linguistic aspects of text. The analytical methodologies in this generation widely draw on socio-linguistic theories (Howarth and Torfing, 2005). In the 'second generation' approaches, discourse is understood in a broader sense since forms of social practice are also included. Critical Discourse Analysis (CDA) is an established methodology representing this generation of approaches (Fairclough, 1995; Wodak and Weiss, 2003). Drawing on Halliday, Habermas

and Foucault, among others, CDA emphasises social embeddedness, politics and ideology when analysing language. Finally, in the 'third generation' of discourse theory, discourse receives an even wider definition: it is no longer a separate aspect of the social system but covers all social phenomena. These approaches are largely considered post-structuralist and post-positivist accounts. Laclau and Mouffe (2013) and Hajer (1995), for exmaple, have developed influential discourse analytical approaches following the traditions of this third generation.

Frame analysis, or framing, has suffered from definitional ambiguity in the literature, mostly due to the large cross-disciplinary interest in the concept and the variety of research aims for which it has been used. Building largely on the works of Gregory Bateson and Erving Goffman, framing research has been an influential policy scholarship strand in political science, communication and media studies and sociology. Framing has also been widely applied in the disciplines of social psychology and behavioural economics to examine the cognitive bases for decision-making (Druckman, 2004; Lakoff and Johnson, 1999; Tversky and Kahneman, 1981). In essence, the concept of framing can be seen to refer to both templates and tools for interpretation. The former refers to the 'schemata' or 'heuristic devices' that guide actors to 'locate, perceive, identify and label' issues and events (Goffman, 1974, p. 21), while the latter is taken to mean the discursive practices 'to select some aspects of a perceived reality and make them more salient in a communicating text' (Entman, 1993, p. 52).

In policy scholarship, framing is often viewed as an interpretative approach stemming from the post-positivist literature that is used to analyse policy-making as 'a contested meaning-making enterprise' (Fischer, 2003a; Koon et al., 2016, p. 806). In frame analysis, scholars thus shift the focus to how actors express and present certain policy problems and anchor their preferred solutions to them while excluding other alternatives. In addition, frame analysis examines how framings that have entered the public sphere influence public opinion and general discourse. Frame scholars widely argue that the way an issue is framed can powerfully affect how an audience builds their understanding of it (Lakoff, 2010; Stoknes, 2014; Tversky and Kahneman, 1981). Therefore, framing can be seen to exert an influence similar to that attributed by Weber (1946 as cited in Fischer and Gottweis 2012, 15) to ideas: 'ideas have, like switchmen, determined the tracks along which action has been pushed by the dynamic of interest'.

Narrative analysis is another discursive approach popular in social and political science. It, too, is often associated with the so-called interpretative turn in the social sciences (Geertz, 1973). Narrative approaches cover different types of analysis, however, they all seek to examine narrative structure and collect, analyse, deconstruct or re-tell stories that are expressed in wider narratives. In contrast to discourse and frame analysis, however, the emphasis is more on finding sequence structure or consequential elements in stories than on examining specific wordings

or phrases (Riessman, 2005). Because policy problems often exhibit a narrative structure, containing a sequence (transformation from beginning, to middle, to end), a plot (causation stories), and characters (heroes, villains, and victims) (Stone, 2002), narrative approaches have been found useful for the purposes of political analysis. Roe's (1994) Narrative Policy Analysis is considered the seminal approach in the field. It views the policy process as a battle over the most convincing story.

Defining rigid conceptual differences between the many discursive approaches and their analytical stances is nevertheless a notoriously difficult task. The borders are indistinct as overlap can occur in both the techniques of analysis and the uses of terminology. For example, in some cases narrative analysis can be regarded as a standalone discursive approach, while in other settings it can be viewed as a subset of discourse analysis (see e.g. Hajer's Argumentative Discourse Analysis approach). Of course, one reason for this conceptual flexibility is the 'theoretically polyvalent character' of the family of discursive approaches (Howarth and Torfing, 2005). It can however also be simply explained by the nature of the research endeavour itself: with discursive approaches, scholars are attempting to conceptualise phenomena that are both necessary and impossible (Jorgensen and Phillips, 2002; Laclau and Mouffe, 2013). That is, discourses are necessary because through them societies can understand and orient themselves and consequently act upon these understandings. At the same time, distilling meaning from discourse is an impossible task due to the contingent and ever-changing nature of discourse (Howarth and Torfing, 2005). Discourses are not static but subject to continuous refining, deconstruction and reorganisation (Hajer, 1995).

3.2 TEXT-AS-DATA METHODS AND UNSUPERVISED MACHINE LEARNING

Big data and data driven approaches are increasingly heralded as novel resources with the potential to revolutionise social scientific research (Connelly et al., 2016; DiMaggio, 2015; Giest and Ng, 2018; Janasik et al., 2009). Not only is data available on an unprecedented scale and scope, these large datasets are also more rapidly 'searchable, analysable, and shareable' for research purposes (Giest, 2017; Grimmer and Stewart, 2013; Mills, 2017, p. 1). As a result, many social scientific scholars are currently applying and experimenting with these approaches. The study of social phenomena through computational approaches has been referred to as 'computational social science' (Wallach, 2018).

Before further discussing this so-called 'computational turn' in social scientific research and its influence on textual analysis, it is useful to first consider the concept of big data, which despite being a 'buzzword' in computational social science, remains a rather vague and fluid concept. In other words, there is no set definition for big

data but rather many ways of approaching and defining it for different research purposes (Connelly et al., 2016). Generally, big data refers to quantitative data of unprecedented size and coverage. Moreover, it is complex in the sense that it often includes multiple observations and variables. While big data is often associated with online activities and the use of social media, it can nonetheless originate from many sources. For example, output from commercial transactions, sensors, satellites or administrative data such as educational and tax records, can all be used as big data. Moreover, large collections of textual data deriving from policy documents, literature and newspaper material, among others, can be analysed as big data.

The most well-known definition of big data has been offered by Laney (2001), who presents the criteria of 'the three Vs': *volume* (i.e. the scale and amount of data), *variety* (i.e. the different forms of data such as text, pictures, videos and monitor data), and *velocity* (i.e. the rapid speed at which data is generated). These have later been complemented with a fourth V, *veracity*, which refers to the certainty of data. Furthermore, when defining big data, its 'found' nature is also often emphasised. By this, scholars mean the discovery and subsequent scholarly use of data resources not specifically created for research purposes (Connelly et al., 2016). Hence, big data can refer to both made and found data sets. In this dissertation, I adopt a wide definition of big data in which it is viewed as encompassing various forms of large-scale and digitally encoded quantitative data. It can either be found or made, but it contains, at least to some degree, characteristics of the 'four Vs'.

As previously discussed, the 'computational turn' and the proliferation of big data have increasingly attracted the interest of researchers conducting textual analysis. While some have been sceptical about the novelty of textual big data, arguing that large collections of text have been handled long prior to the computational era, others see the emergence of big data as a decisive development thanks not only to the variety, scale and scope of the data available but also to the speed and efficiency with which large data sets can be analysed (Giest and Ng, 2018). Computational methods indeed enable the analysis of data with less cost and resources, reducing the burden of the laborious manual activities of coding and annotation of text. However, another critical discussion concerns the possible superiority of big data over traditional qualitative data sets (or small and 'thick' data) in terms of intelligence and erudition (Mills, 2017). Nonetheless, discussions on both the epistemic assumptions of data superiority and the novelty of big data have subsided somewhat, as, in the words of DiMaggio (2015, p. 1), many consider that 'the era of two cultures' and the 'epistemological chasm' surrounding big data in textual analysis is over. Thus, rather than debating whether big data offers a superior form of intelligence compared to qualitative data or whether big data is an entirely novel phenomenon, scholars are beginning to discuss how to best harness big data to complement and augment conventional textual material and methods.

In computational social science, textual big data is analysed with so-called text-as-data methods. These refer to a large family of computational techniques that run various forms of statistical analysis on text. A well-known categorisation of the different methods has been offered by Grimmer and Stewart (2013). Briefly put, the authors divide text-as-data methods into supervised (including a-priori input) and unsupervised methods (little or no a-priori input, no use of human-curated seeds). These are not competing techniques but rather methods with different functions and aims, among which researchers can choose according to their research questions and objectives.

As is evident from the earlier part of this chapter, distilling information from text is an extremely complex cognitive task including an understanding of literal, metaphorical, contextual and inter-textual meanings. Therefore, as Grimmer and Stewart (2013, p. 4) have argued, all quantitative text-as-data methods are necessarily 'wrong' in the sense that they cannot offer 'an accurate account of the data-generating process used to produce texts'. While based on incorrect models of language, they can nonetheless be trained to perform social scientific tasks in a robust manner. This requires careful validation and evaluation of the model and case in question.

While the principles of text-as-data methods have been widely discussed and the methods themselves increasingly applied for the purposes of political analysis, the methodological compatibility of these computational methods vis-à-vis qualitative textual analysis still remains unclear within the social sciences. What the methods can offer and how they can be applied in a qualitative setting, therefore, requires further consideration. As early as 2013, Grimmer and Stewart argued 'for automated methods to become a standard tool for political scientists, methodologists must contribute new methods and new methods of validation'. In this dissertation, I extend this argument and stress that it is equally important to bridge the methodological divide in knowledge between qualitative and text-as-data scholars in order to best exploit existing designs for the purposes of policy analysis.

As will be explained in Chapter 4, this dissertation focuses on topic modelling, an unsupervised classification model in machine learning, to further the methodological discussion on using text-as-data methods in qualitative research. The reason for this choice is twofold. First, qualitative research relies on procedures that are inductive in nature, and these are, from the outset, similar to the functions of unsupervised methods. Second, topic modelling is the most widely used machine learning algorithm and is increasingly utilised in social and political science (Figure 1). Nevertheless, the method has been applied in a rather ad-hoc manner, with little methodological considerations about the best use and compatibility with qualitative textual analysis methodologies (van Atteveldt et al., 2014).

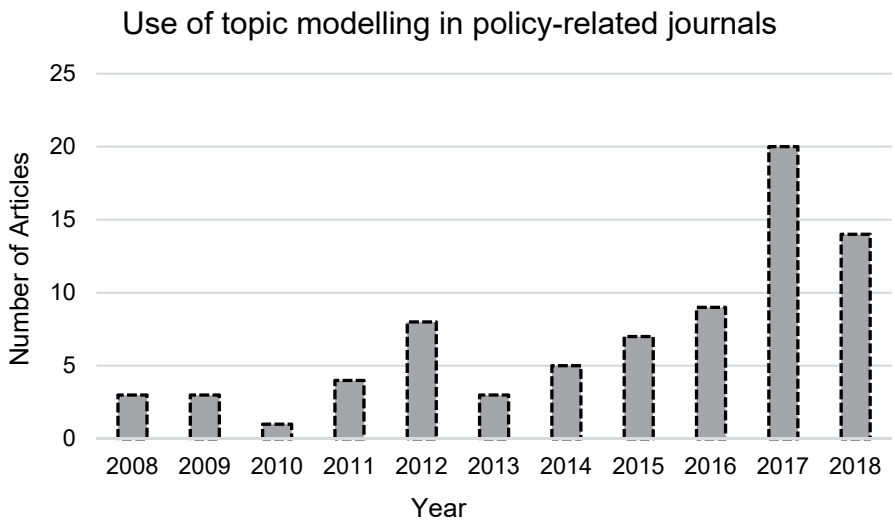

Figure 1 Use of topic modelling in policy journals in the past decade according to the Scopus data base. Source: Author.

In summary, this chapter has discussed the role of text in political analysis, introducing the more established discursive approaches as well as the emerging text-as-data methods. Their potential, applicability and role in transitions research, which itself has taken a political turn and is increasingly focusing on language and discourse, constitutes the major methodological exploration of the latter part of this dissertation.

4 DATA AND METHODS

This chapter presents the data and methods guiding this dissertation. The broad strategy that I utilise combines an 'exploratory' (testing and understanding methods) with an 'explanatory' case approach (uncovering contemporary phenomena in their context) (Yin, 2003). While the previous chapter covered the discussions that serve as the basis for the former aim, this chapter provides the background information for the empirical cases examined. Moreover, the chapter synthesises the data analysis approaches and data sets adopted in the individual articles. I conclude the chapter by considering questions on the validity and limitations of the study.

4.1 PRESENTATION OF EMPIRICAL CASES

The broad empirical interest of this research is in the decarbonisation processes that are currently occurring in Europe. I approach this topic through two specific cases: the conceptual development of the European Energy Union and processes of coal-decline in the UK.

4.1.1 THE EUROPEAN ENERGY UNION

Energy policy has played a pivotal role in European economic integration from the outset (Jegen, 2014). Two of the 'communities' upon which the European Union (EU) was founded, the European Coal and Steel Community (ECSC) and the EURATOM, dealt specifically with energy supply and production on the continent by supporting markets for coal and nuclear energy, respectively. Energy policy also occupied a major role in the third 'community', the European Economic Community (EEC), the predecessor of the European Union (Benson and Russel, 2015). However, it was not until the turn of the millennium and the adoption of the Lisbon Treaty of 2009 that a formal common energy policy was established in the EU (Szulecki and Claes, 2019).

In the Lisbon Treaty, energy policy featured for the first time as an independent issue area at the European level. The Treaty also strengthened the capacity of the EU institutions in energy matters (Council of the European Union, 2007). For example, the EC became the main executive body for European energy policy, with its Directorates-Generals for Energy (DG ENER) and Climate Action (DG CLIMA) covering energy and climate policy (Ringel and Knodt, 2018; Szulecki et al., 2016). Nonetheless, even though energy policy is listed as a shared competence between

the EU and its member states, actual energy policy-making remains for the most part under the latter's control (European Union, 2007). By contrast, the EC is often viewed as a supranational 'policy entrepreneur' shaping energy policy development in Europe (Kingdon, 1995; Maltby, 2013).

Following the Lisbon treaty, climate and energy policy objectives have been progressively integrated into European legislation. Major policy developments include introducing EU-wide clean energy and emissions reduction targets for 2020 and 2030 with the 'Energy and Climate Package' of 2007 and the '2030 Framework for Climate and Energy' of 2014; and launching a number of roadmaps such as 'Moving to a competitive low carbon economy in 2050'. In addition, many policy instruments, such as the EU Emissions Trading Scheme (ETS), have been introduced to attain the climate and energy goals set for the EU.

Many scholars have observed that, in parallel with these policy developments, the Commission has also begun to form a discourse on a common European energy policy (Jegen, 2014). It has done so by linking the three previously independent objectives of energy policy – security of supply, sustainability and competitiveness – also referred to as the 'energy policy triangle', and presenting them as interlinked pillars critical for the EU's future progress. As Maltby (2013, p. 437) contends, 'building credibility, capacity and competence in energy policy has required the construction of a narrative about why the issue is European in scope; that the problem is a European one, and by extension so is the solution'. Many scholars have noted that the EC has been very successful at promoting the idea of a European energy policy at the discursive level (Bürgin, 2018; Szulecki et al., 2016). This has also been facilitated by increasing political concern over climate change, peaking energy prices and concern over energy supply on the continent.

Even though a European energy policy became a widely-recognised policy idea in the 2010s, integrating climate and energy security agendas still remains a challenge for the EU, not least because of the lack of the Commission's actual decision-making power vis-à-vis its member states (Szulecki et al., 2016). In 2014, the European Energy Union emerged as a reform proposal to further energy policy and market integration at the supranational level (Bürgin, 2018). While first being proposed by Donald Tusk, the then President of the European Council and the Prime Minister of Poland, and framed in terms of guaranteeing energy security in Europe by relying upon member states' fossil fuel reserves, the Energy Union soon became a synonym for addressing both climate and energy objectives. The project was officially launched in February 2015 by Jean-Claude Juncker, the Commission's newly elected president, designed to comprise 'five mutually-reinforcing and closely interrelated dimensions' (European Commission, 2015, p. 4). These are illustrated in Table 2.

Table 2 The five dimensions for the European Energy Union set by the EC. Adapted from EC (2015)

	Dimensions	Description
1	Energy security, solidarity and trust	Working closely with Member States to diversify Europe's sources of energy and ensure energy security.
2	A fully integrated European energy market	Energy should flow freely across the EU – without technical or regulatory barriers. This would enable energy providers to compete freely and promote renewable energy while providing the best energy prices.
3	Energy efficiency contributing to moderation of demand	Improving energy efficiency to reduce the EU's dependence on energy imports, cut emission and drive jobs and growth.
4	Decarbonising the economy	Putting in place policies and legislation to cut emissions, moving towards a low-carbon economy and fulfilling the EU's commitments to the Paris Agreement on climate change.
5	Research, innovation and competitiveness	Supporting research and innovation in low-carbon and clean energy technologies which can boost the EU's competitiveness.

The Energy Union was chosen as a case study for this dissertation for two main reasons. First, the project deserves research interest because of its status as a major reform project with the potential to fundamentally transform the European energy regimes (Ringel and Knodt, 2018). Second, and relatedly, despite its huge potential, the Energy Union has also been the target of scholarly criticism regarding its conceptual development. Scholars caution that as the Energy Union package contains several traditionally conflicting policy goals, the project risks becoming 'an empty box in which every stakeholder tries to put whatever is on the top of their priority list' (Szulecki et al., 2016, p. 549). Given that the Commission failed to indicate a priority or emphasis for each of the five dimensions upon the project's launch, the Energy Union's transformative nature and ambition for decarbonisation remains open for interpretation and change. What is clear, however, is that for the project to deliver decarbonisation, the Commission must succeed in generating policy convergence in such a way that energy security and competitiveness are not at variance with sustainability objectives. To illuminate these discussions, this dissertation traces the conceptual development of the Energy Union project between 2015 and 2018.

4.1.2 COAL DECLINE IN THE UK

The UK has relied heavily on the use of coal since the 19th century. Coal has played an important role in the country's industrial and economic development across sectors, and has been used, for example, for heating, transport and steel production.

Furthermore, due to the UK's large coal reserves, the country also has a long history of domestic coal extraction, the mining industry having been an important contributor to the UK's economy for decades (Turnheim and Geels, 2012). The main usage of coal in the recent past has, however, been in power generation, with coal use peaking in the 1980s. Interestingly, despite this historical dependence on 'King Coal', today, the UK represents the first major industrial country to have almost completely phased-out coal in its energy mix (Johnstone and Hielscher, 2017).

This dissertation focusses on the decline of coal use in electricity generation. Two waves of decline can be identified, the first occurring in the 1990s, during market liberalisation, and the second beginning in 2013 and accelerating from 2014 onwards (Figure 2). During the first wave, also referred to as the 'dash for gas', coal was replaced by natural gas, which had become a cheap and easily scalable alternative in electricity generation (Lovell et al., 2009). In other words, the first wave represents a 'traditional' destabilisation of the socio-technical regime, whereby the incumbent energy technology was replaced by an alternative. By contrast, from the transitions perspective, the second wave is different, as it involves sustainability concerns and the important role of renewable energy technologies in the replacement of coal.

The analytical focus of this dissertation is the period from 2000 to 2017 (Figure 2). During this time, the share of coal in power generation fell from 32% to just 7%. This period was chosen because it allows the developments preceding the coal decline to be covered, that is, a time when sustainability concerns entered the public consciousness and climate change began to feature on the political agenda. This period covers major policy events by successive governments, such as the Climate Change Act of 2008, and most importantly, the government's official pledge, issued in 2015, to phase-out all unabated coal by 2025. The cut off year of 2017, in turn, allows the investigation of developments after the official announcement to end coal use.

To support the analysis, the period was divided into three phases based on significant policy events and changes in the energy mix (Figure 2). Phase 1 covers the years from 2000 to 2007. In this period, climate change began to feature in public discussions and energy technologies shifted to the centre of domestic policies (Teräväinen et al., 2011). It also saw the government's gradual introduction of climate change as a major pillar of energy policy.

Phase 2, representing the period 2008–2012, begins with the Climate Change Act, which became law in 2008 and established GHG emissions reduction targets for the UK and a framework for shifting towards a low-carbon economy. The main political debate in this period centred on the potential of carbon capture and storage (CCS) technology. The government launched many pilot projects for the technology, as it was seen as a major solution to climate mitigation. While the government continued to provided funding for CCS also after phase 2, the technology gradually vanished from the political agenda due to its lack of commercially viability.

The third and final phase, characterised by the accelerated decline of coal in the energy mix between 2013 and 2017, saw the closure of seven coal plants. During this time, coal was increasingly replaced with natural gas and renewable energies. Critical policy events in this phase include the introduction of the Carbon Price Floor tax[1] in 2013 and the official pledge to phase-out coal in 2015. Internationally, the UK signed the Paris Climate Agreement of 2016 and became part of the 'Powering Past Coal Alliance', in which 70 countries committed themselves to working towards phasing out unabated coal (Jewell et al., 2019). In terms of domestic energy policy development after the phase out pledge, the government focussed on supporting nuclear, gas and offshore wind.

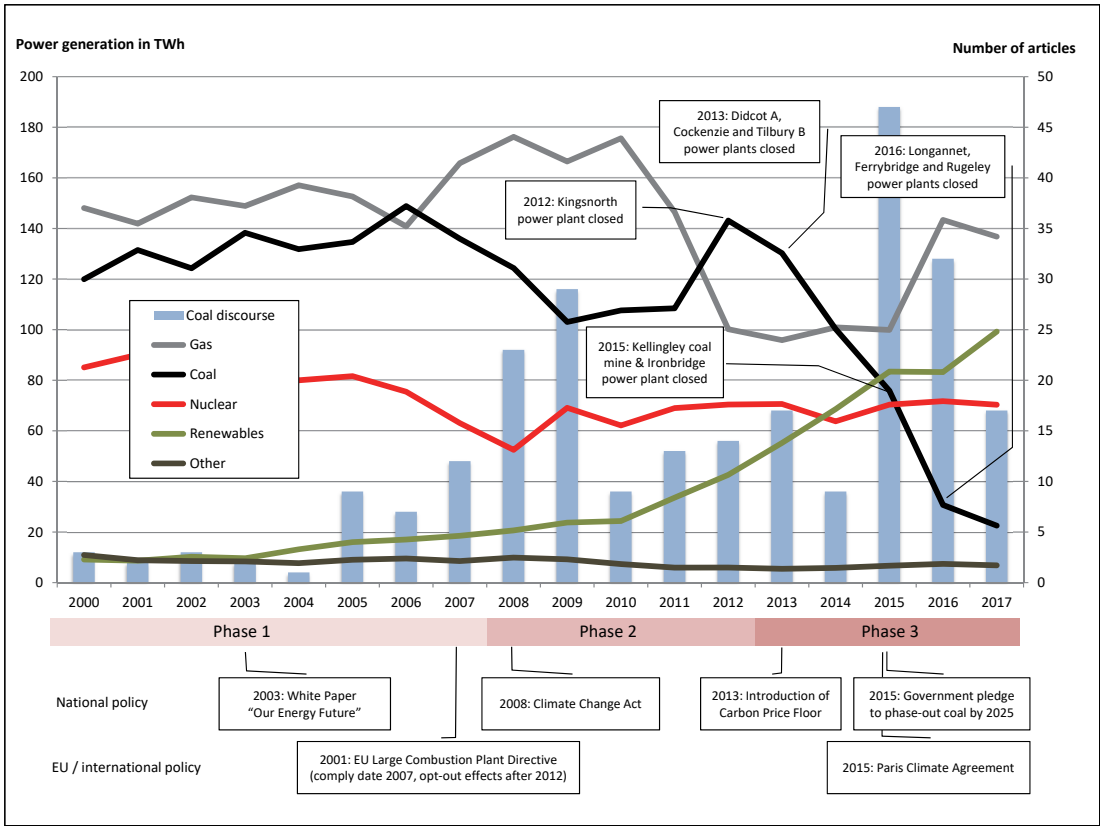

Figure 2 Three phases in the discourse on coal in the UK from 2000–2017, characterized by major policy events and shifts in the energy mix. Source: *Article II*.

1 The Carbon Price Floor (CPF) is a policy implemented to supplement the European carbon price, i.e. the EU Emissions Trading System (ETS). The aim of the policy is 'to underpin the price of carbon at a level that drives low carbon investment'(Hirst, 2018, p. 3).

In sum, this background section has demonstrated how the UK represents a unique case for studying decarbonisation as it is one of the first countries to have abandoned the use of an incumbent fossil fuel. Furthermore, it is also a politically interesting case as the UK government was the first in the world to officially commit to phasing out coal. As I have argued in this dissertation, there is a particular need to better understand and learn from developments of technology decline occurring at the national level. For this, the UK case of a near-complete decline in coal use is a prime example.

4.2 SYNTHESIS OF APPROACHES AND DATA

In this dissertation, two articles draw on literature review and evidence synthesis approaches (*Articles I, III*). By contrast, *Article II* applies the Argumentative Discourse Analytical approach to newspaper data, while *Article IV* utilises topic modelling on a big data corpus. Table 3 summarises the research designs for each individual article.

Table 3 Research designs of individual articles

Article	Data set	Data collection	Time frame	Method
I	77 peer-reviewed journal articles	Three-step search strings in the Scopus and Web of Science databases, hand picking of articles based on expert consultation.	2004–2016	Literature review
II	249 newspaper articles from *The Guardian* (UK)	Two search strings in the LexisNexis Academic database covering keywords on coal power generation and electricity as well as coal phase-out. Selecting all articles that focussed on the UK, had at least one storyline on coal, or discussed coal electricity or power (vs. mining). False positives and duplicates excluded.	2000–2017	Argumentative Discourse Analysis based on Hajer (1995), coding of storylines in Nvivo
III	25 articles that have applied topic models in a qualitative research setting, complemented with other methodology literature	Articles identified using a search string in the Scopus database and hand-picking.	Not applicable	Evidence synthesis, development of a heuristics
IV	5,055 policy documents, divided into two corpora	PDF documents collected manually from the European Commission's Directorate-General for Climate Action (DG Clima) and from the Directorate-General for Energy (DG Energy) websites. Data downloaded in April 2018.	2001–2015 (first corpus) 2015–2018 (second corpus)	Topic modelling analysis, the Latent Dirichlet Allocation method (Blei 2003)

4.2.1 JUSTIFICATION OF CHOICE OF METHOD

Articles I and *III* offer a meta-level analysis of the use, added value and limitations of the discursive and topic modelling methods, respectively. For *Article I*, reviewing the extant literature offered a useful way to illustrate the state of the art regarding the use of discursive approaches. While existing research was also reviewed for *Article III*, the approach drew more on an evidence synthesis than a review. This is because the aim was to explore the potential and usefulness of an emerging method and discuss its best practices. Moreover, due to the novelty of the topic modelling method, the number of articles applying topic modelling in a policy setting would have been too small to conduct a more systematic review.

In addition to the meta-level overviews, I also chose to apply the methods to empirical cases. *Article II* draws from Hajer's (1995) discursive methodology by applying the Argumentative Discourse Analysis (ADA) method. Building upon a social constructivist approach, ADA addresses the constitutive role of discourse in political processes. It aims to make sense of how discourse subjects produce understandings of social and physical phenomena and how this action is both enabled and constrained by the social structures and contexts in which discourses are produced (Hajer, 1995). Reflecting this position of the 'duality of structure', Hajer (1995, p. 44) defines discourse as a 'specific ensemble of ideas, concepts and categorisations that are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities'.

The underlying assumption in Hajer's approach is that environmental politics becomes a field of 'an argumentative struggle' in which actors engage in discursive practices to promote their view of a problem, while simultaneously seeking to influence the position of other actors. Ultimately, it is a struggle over gaining a 'discursive hegemony' to uphold status quo (1995, p. 59). The analytical concept of a storyline is offered to help explain how such discursive interaction play out in political processes. Here, a storyline refers to narratives that people evoke to give meaning to a phenomenon. Storylines incorporate selected discursive components and cluster knowledge to enable actors to position themselves vis-à-vis a multiplicity of alternative narratives. Consequently, storylines become instrumental for political change: new storylines can emerge to challenge and eventually re-order the status quo (1995, p. 56). Hence, political struggle resides in the moments of argumentative interaction in which some storylines are included and others omitted from discourse formation.

The concept of storyline was deemed appropriate for the analysis of coal phase-out given its capacity to explain how certain discursive constructions become prevalent and authoritative. The approach also assumes that actors' discursive positions are not constant or coherent but rather subject to change, and thus it allows the changing accounts and judgements made about coal use to be traced.

The review of discursive approaches conducted in *Article I* also contributed to the choice of drawing from the ADA method. The review found, as the following chapter explains, that ADA has emerged as a popular method within transition studies, with many examples of its useful application. At the same time, the review highlighted that fossil fuel phase-out has received relatively little discourse analytical coverage[2]. Therefore, I wished to apply a well-established methodological concepts to an understudied phenomenon to examine the practical contributions of novel discursive approaches to research on decarbonisation policy and politics.

The 'Latent Dirichlet Allocation' (LDA) method, in turn, was chosen for *Article IV* (Blei et al., 2003). Simply put, the aim of LDA is to explore the presence of word clusters in a collection of documents, thereby revealing the latent topics or thematic structure of a corpus (Boussalis and Coan, 2016, p. 92). In technical terms, LDA uses a generative approach to model text in a collection of documents, starting from the assumption that, thematically, each document arises from a mixture of topics and that these specific topics consist of a mixture of words that are closely associated with each topic (Boussalis and Coan, 2016). LDA seeks to mimic the generation of the original documents by randomly picking words from a set of topics, following word co-occurrence and probability parameters.

The LDA algorithm models both the topics and the documents as 'bags of words', or bags holding all the words from the documents. This 'bag of words' feature means that LDA does not take into account the order of words in a text. In a later step, the model then attempts to then recreate these 'bags of words'. While the modelling in LDA is initially random, proportions of words and proportions of documents are gradually changed and improved using Bayesian inference. The final 'bags of words' that the model produces are therefore expected to correspond with the original documents to a high degree (for an exhaustive technical explanation, see Blei, Ng and Jordan 2003, Boussalis and Coen 2016, *Article III*).

Prior to conforming the choice of LDA, my co-authors and I considered the benefits of other methods, for example those including meta-data from the documents. Nonetheless, as our intention was not to examine actor positions, topic prevalence or causal relations, we saw that the simple LDA model provided the best fit with our research question. By running LDA separately on two corpora, we were able to compare the thematic content and explore latent structure in the corpora. As the results of this dissertation demonstrate, had our intention been to conduct a discourse-based analysis, an extension of the LDA model might have been a more appropriate choice of method.

2 NB. Coal decline has received discourse analytical interest since the publication of *Article I*, see for example Lehotský et al. (2019) and Trencher et al. (2019).

4.2.2 DATA COLLECTION AND ANALYSIS

The empirical data used in the articles upon which this dissertation is based come from newspaper articles and policy documents. *Article II* utilised newspaper articles downloaded from the LexisNexis Academic database. *The Guardian* was chosen as the main source as it was the only available source in the database that systematically covered energy and climate issues. A two-step search string was designed after several test keyword searches. This included one search string targeting coal electricity discourse and another specifically focusing on coal phase-out. 249 newspaper articles, including news articles, editorials and opinion pieces, were included in the final data set (Table 3).

To conduct the analysis, two of the authors inductively derived a set of storylines from the data set and then compared their prevalence and content. This was achieved by first analysing a subset of the data in order to identify the main storylines. After independent analysis, the results were then compared and discussed and finally consolidated into a list of eight storylines. Next, the entire data set was coded for the storylines and the actors mobilising them. The analysis was divided equally between the two authors. Each analysed their half of the data set, while also double checking the work of the other to guarantee consistency in analysis. The final coding was performed using the NVivo software package for qualitative analysis.

For *Article IV*, 5,055 policy documents were collected (Table 3). The data set contains regulatory documents, member states' reporting materials, research publications and communication documents from the Commission's DG Clima and DG Energy webpages. These sources were chosen because they regroup the main EU-level documents for energy and climate-related matters. As the aim was to create a big data corpus, data collection included downloading all the pdf documents available in English. The data were downloaded from the websites in a systematic manner, starting from the energy-relevant main pages and following the internal links that stayed within the energy domain. The meta-data for the documents were then coded manually; this included assigning time stamps and document types. Finally, several rounds of rechecks were conducted, and articles that were not in English were excluded from the data set.

The actual analysis proceeded as follows. As the LDA model requires pre-processing of the data set, the data were formatted prior to running the analysis. All the texts were tokenised by removing overly common or rare words and omitting punctuation, numbers and non-alphabetical characters. Furthermore, specific abbreviations used regularly in EU documents, such as the 'EN' used in each document to signify an English version, were removed.

Even though LDA is an unsupervised model, researchers are required to decide certain parameters before applying the algorithm. One of these is deciding the number of topics the algorithm should generate as its output. We based this decision

on an approach that uses semantic validity as benchmark (Quinn et al., 2010). The input of researchers is also needed in the interpretation phase of topic modelling analysis. In practice, this means assigning labels to each word cluster to better grasp the thematic structure of the corpus. In our analysis, two researchers assigned labels to the topics independently by using word lists and consulting associated documents closely. These were then compared and, based on discussions among the entire research team, final labels were assigned to each topic. As the analysis showed that the majority of topics fell within Energy Union dimensions, we used these dimensions as categories to support the analytical presentation and interpretation of the results.

4.3 CONSIDERATIONS AND LIMITATIONS

Having explained the data and methods of this dissertation, I now conclude the chapter with some final methodological reflections.

Analysing policy documents and policy language is an important pillar of political and social science research. Policy texts express political purpose and, therefore, yield important information about policy-makers intentions and planned courses of action (Majone, 1989). This was one of the main reasons for choosing to collect a policy document data set for *Article IV*. Nevertheless, even with the benefits of scale and scope offered by big data, focussing on policy documents alone limits the analysis to the official and prescriptive phases of the decision-making process. For example, our data set in *Article IV* was unable to account for informal processes, such as the lobbying events and engagements between stakeholders, which constitute much of the politics surrounding agenda setting. Moreover, some of the policy documents in the data set represent prescriptive plans that may not have become concretised or implemented. On balance however, the data set enabled a novel approach to the analysis of decarbonisation policy in the EU which can be used to guide and complement further studies.

Ensuring validity is important when applying computational methods. For topic modelling, it is important to ensure the validity of the pre-processing and model parameters and confirm that the output has semantic validity, in other words, that the topics have been able to model the phenomena of interest (DiMaggio et al., 2013). LDA output has been found to represent collections of documents well when most documents mention only a small number of topics (Blei et al., 2003). As this was the case with our energy-focussed corpora, LDA output seemed likely to correspond to the phenomena of interest. In addition, as explained in Section 4.2.2, we also conducted many trial runs prior to deciding on the final model parameters. To improve semantic validity, we consulted both topic word lists and the 10 most associated documents prior to assigning labels to the topics. This was performed

by two of the authors independently, after which they compared and discussed the results.

Furthermore, the collection of the data set for Article II involved some decisions against which the results should be weighed. In line with studies that view the media as a major environmental policy-making arena alongside more formal platforms (Boykoff and Boykoff, 2007; Hansen, 2010), my co-author and I chose to conduct the discourse analysis on newspaper data. While the media is indeed not the only outlet where political discourse takes place, we argue that it is today an important arena where policy problems and trajectories regarding climate change and energy future are interpreted, defined and redefined by different actors. Media outlets can also be considered to cover views of societal actors who seek to influence environmental policymaking more through informal avenues more so than formal policy documents.

While our original intention was to collect the material from two different newspapers, ultimately we analysed data solely from *The Guardian* due to access constraints. Moreover, when we performed initial searches for *The Independent*, *The Telegraph*, *The Sunday Telegraph*, and *The Observer*; *The Guardian* was the only newspaper to have covered topics on coal electricity use in a systematic manner[3]. As the other sources failed to cover the topic to a sufficient degree, we decided to use *The Guardian* as our sole source for analysis.

In making this choice, we were aware of *The Guardian's* pro-environmental stance in its news reporting. While research has shown that *The Guardian* often emphasises climate change in its reporting, it has also been found to give voice to a broader set of actors than its right-leaning counterparts (Brüggemann and Engesser, 2017; Carvalho, 2007). Paradoxically, then, the same factor that allowed us to form a data set of sufficient coverage also became one of the study's limitations. This led us to contemplate questions of the representativeness of the data. Bearing this in mind, we were careful to explicitly discuss possible bias resulting from examining only *The Guardian* after presenting the results of each phase. In addition, we now rely more on the existing literature on UK energy and climate policy when discussing the results. We have also improved the validity of our results by discussing them with two experts on UK energy policy and disclosing the results to conference audiences.

Moreover, as explained earlier, this PhD was conducted from an exploratory angle. Working on *Article IV* was a learning process which raised many questions about using topic modelling for analysing politics and policy and which informed the methodological arguments developed in *Article III*. Similarly, although the results from review *Article I* indicated the popularity of Hajer's ADA as an approach for studying politics in transitions, I nevertheless chose to draw from it in our article

3 At the time of data collection, LexisNexis Academic did not have *The Times* as a source.

because I wished to use well-established discourse analytical concepts in order to understand their potential and limitations through practical experience. In addition, because a small number of studies had already applied discursive approaches to study technology decline in different countries and regions (Johnstone and Hielscher, 2017; Leipprand and Flachsland, 2018; Rosenbloom, 2017b), my co-author and I wished to contribute to this research by offering insights into a novel national level case study. Applying a similar discursive approach was considered useful because it eventually allows researchers to compare and contrast the independent cases. Gaining such comparative insights is pivotal for an emerging topic like coal phase-out.

Finally, as I will argue in Chapters 6 and 7, this PhD should then be built upon by further developing both the topic modelling and discursive approaches and empirically testing the novel methodological avenues indicted by the latter part of this dissertation.

5 RESULTS

This chapter summarises the main findings from the individual articles by answering the research questions posed for this dissertation. In the Introduction, I asked, what novel contributions textual methodologies bring to the study of decarbonisation policy and politics, both in terms of methods and empirical insights. To answer this question, I focus on discursive approaches on the one hand and the unsupervised method of topic modelling, on the other. Therefore, the first section in this chapter presents the results on how and for what purposes discursive methodologies have been used thus far in transitions research. Next, the chapter outlines the main results on how topic modelling could best be incorporated into qualitative textual analysis. Finally, the chapter explains the novel empirical insights on decarbonisation obtained by applying the ADA and topic modelling in this research.

5.1 APPLYING DISCURSIVE APPROACHES TO ENRICH UNDERSTANDINGS OF TRANSITIONS

In the past decade, discursive approaches have become popular in the field of energy transitions, mostly as a result of a growing trend towards more politically attentive research on energy issues. While the role of discourse in energy transitions has been widely acknowledged in the literature (Roberts et al., 2018; Scrase and Ockwell, 2010; Sovacool and Hess, 2017), many scholars have called for a more refined understanding of the different methods, their use and added value (Hoppe et al., 2016; Kern and Rogge, 2017; Rosenbloom et al., 2016). I address this gap in *Article I,* which presents a critical review of discursive approaches in the field of energy transitions and policy.

Article I finds that interpretative qualitative research designs have been most popular among energy transitions scholars using discursive approaches. However, *Article I* points to some distinct trends and patterns in the use of qualitative approaches. Discourse and frame analytical methods developed within the field of public policy and environmental social science have been by far the most popular approaches used. However, the range of framing-based methodologies varies rather widely: the review conducted in *Article I* identified the use of both quantitative and qualitative frame analysis methods, borrowed from media and communication studies (e.g. Entman 1993), policy analysis (e.g. Schön and Rein 1994) and sociology (e.g. Benford and Snow 2000; Goffman 1974). Nonetheless, the results also show limited interest in framing approaches that seek to alter research settings, for example, nudging or emphasis framing. By contrast, discourse analytical

approaches have been used more uniformly. Hajer's Argumentative Discourse Analysis (ADA) stands out as the most popular method, steering interest towards storyline identification and discourse coalitions. Other scholars referred to in the literature include Dryzek (e.g. 2001) and Rydin (e.g. 1999). While so-called 'second generation' discourse approaches, such as Critical Discourse Analysis, also feature in the results, the findings highlight the prevalence of approaches following the traditions of the 'third generation'.

Furthermore, the review identifies substantial gaps in reporting about methodological practices and justifications. Only 27 per cent of the articles included in the review reported on their method use transparently and engaged in a discussion on methodological implications. This shortcoming was visible, for example, in the few cases where narrative analysis was applied, resulting in a rather ad-hoc adoption of the method and a difficulty to trace the studies' methodological and theoretical underpinnings.

Article I also considered the ways in which discursive methods have been applied in the review sample in terms of themes, scale and geographical scope. The findings demonstrated that: 1) nuclear energy, biomass and wind power have received most coverage as opposed to fossil fuels; 2) the majority of studies have been conducted in the European context and applied at a national level, and 3) that comparative studies have been mostly designed to examine dynamics across different governance levels (local, regional, national, international), whereas country-comparisons have been less frequent.

Overall, the results indicate that the capacity of discursive approaches reveal the role of language, contestation and politics in practice has resulted in some analytical reorganisation within transitions research. The results highlight four distinct issue areas for which discursive approaches have offered novel insights: political ideology and state orientation, publics, institutional and policy change, and transition dynamics. These are summarised in Table 4.

Table 4 Issue areas analysed with discursive approaches.

Issue area	Example of contribution
Political ideology and state orientation	Understand how policy salience and legitimacy are developed in and shaped by different political contexts
Publics	Gain insights into how actors adopt, react to or influence the development of energy technologies, infrastructure and policy alternatives
Institutional and policy change	Enable the analysis of non-static institutions better than dominant approaches in institutional theory, e.g. 'policy windows', whereby policy alternatives move from the niche-level to the mainstream
Transition dynamics	Enrich existing analytical frameworks, e.g. by incorporating accounts on agency

Taken together, these points highlight the embedded role of discourse in politics and point to a pivotal role for discursive approaches in the study of decarbonisation politics and policy. Applying a small number of well-established methods, like ADA and frame analysis, can be seen as the first necessary step to exploit the full potential of discursive approaches in the context of energy transitions. However, with many examples of their use already widely available, *Article I* proposes that there is now room to exploit other methods from the diverse family of discursive approaches and further engage in methodological exploration and development. This contention then sparked my interest in the potential of using computational methods in the endeavour, which, in turn, caused me to consider the extent to which topic modelling could be incorporated into textual analysis. Next, I present the results of this exploration.

5.2 INTEGRATING TOPIC MODELLING INTO QUALITATIVE TEXTUAL ANALYSIS

As computer assisted methods are becoming more widely available to the social and political science research community, it is especially important to consider their general usefulness in supplementing conventional research methods. *Article III* offers a perspective on one important methodological question within computational social science: how unsupervised classification models can benefit scholars whose work relies on traditional qualitative text analysis methods (i.e., from classical content analysis/classification to approaches within the family of discourse analysis). *Article III* focuses on delineating the advantages and disadvantages of applying topic modelling to qualitative textual analysis.

The purpose of *Article III* was to explain the logic of topic modelling to scholars without a background in computational approaches. A detailed technical explanation of the model's probabilistic and generative functions can be found in section 2 of *Article III*. Instead of the technicalities, here I want to focus on the methodological points that determine the extent to which topic modelling is applicable to examining social scientific phenomena. The first major point identified in *Article III* is that the topic output contains two items. These are topic-word proportions (usually presented as word lists) and document-topic proportions (the documents that are associated with each topic as well as the proportions of these topics in the document). For an insightful interpretation of topic models, both items should be extracted from the model and subjected to human interpretation. Very often, document-topic proportions receive less attention, which may lead to skewed interpretation processes. While topics are often given labels based on the word lists from the topic-word output, it is also important to consult the documents most associated with the topics in order to support the interpretation process. Hence, *Article III*

highlights that the degree to which topic models are applicable to social research not only depends on validating the model's robustness and the assumptions used to define topics behaviour in the model. Critically, it also depends on how well the definition of topic in the model corresponds to the phenomenon of interest.

To facilitate a sound methodological application of topic models in social and political science, *Article III* proposes the following heuristics to guide the processes of analysis. When applying topic modelling, it is useful to ask:

1. How can the technical assumptions of topic modelling be aligned with the specifics of the phenomena of interest;
2. Which questions can be reliably answered by the corpus compiled and how do corpus size and curation affect the potential results;
3. How should both parts of the output proportion (word/topic and topic/document) be considered in assessing the phenomenon of interest;
4. How can the interpretation of the topic output be enhanced, validated, and critiqued based on the document collection?

In addition, *Article III,* illustrates how different mixed-methods research designs are appropriate for two families of qualitative textual analysis: 'content and classification' (C&C) methods (including, content, thematic or vocabulary-based analysis), and 'discourse and representation' (D&R) methods (including discourse, frame and narrative analysis). The findings in *Article III* show that topic modelling can in some cases automate C&C methods thanks to their shared positivist assumptions—both methods are grounded in data and focus on text as manifestations of explicit meaning. For example, in methodological terms, thematic analysis could be replaced with topic modelling algorithms when carefully designed.

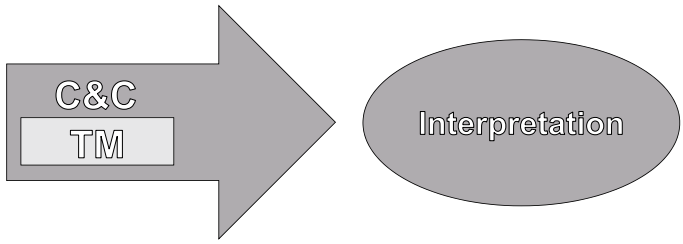

Figure 3 Content and classification methods and topic modelling in an embedded design

The results in *Article III* offer a more cautious account of combining topic modelling with D&R methods. For instance, the article emphasises that topic output is not equivalent to the theoretically informed and contextually-formed concepts of discourse, frame and narratives. The different epistemological underpinnings of

topic modelling and discursive approaches therefore hinder the substitution of analytical procedures. Indeed, while future developments of topic modelling may lead to being able to grasp the notions of discourse, in its current state, a sequential research design is the most appropriate when using topic modelling in conjunction with D&R methods (Figure 4).

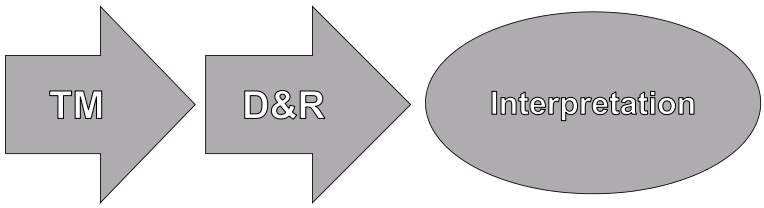

Figure 4 Discourse and representation methods and topic modelling in a sequential design

Overall, as is clear from the findings in *Article III*, topic modelling can be used together with both C&C and D&R methods; however, it should be applied with prudence regarding methodological questions.

5.3 EMPIRICAL INSIGHTS GAINED BY APPLYING TEXTUAL METHODS

The methodological exploration in this dissertation has followed a two-step logic: I wished first to examine the methods at the meta-level and then apply them in an empirical context. While the first two parts of this chapter focussed on reporting the results from the study of methods, this section draws attention to the empirical and policy-relevant results obtained by applying the methods of ADA (*Article II*) and topic modelling (*Article IV*) respectively. I first elaborate on the development of the European Energy Union's decarbonisation agenda based on the findings from *Article IV*, after which I outline the discursive dynamics that played into the discussions on coal phase-out in the UK examined in *Article II*.

Article IV contributes to a critical academic discussion on the Energy Union's transformational agenda: While framed as having the potential to actively drive decarbonisation in Europe, the Energy Union has attracted scholarly scepticism over its ambition and policy ambiguity (Szulecki et al., 2016). For example, the order of priority given to the five main dimensions shaping the Union's agenda has been unclear, which has, for example, prompted scholars to highlight the risk of the Energy Union failing to deliver sufficient policy convergence between climate and energy-issues (Bürgin, 2018). The formation of the EU's energy and climate policy agenda has traditionally been studied either at the conceptual level or with

smaller data sets. Applying topic modelling to big data allowed a novel approach to this research: the examination of topic structure in a large collection of texts representing energy policy language. In other words, by using topic modelling, it was possible to grasp the ongoing agenda-shaping dynamics at the supranational level on a scale that has largely been beyond the reach of previous studies using non-computational textual approaches. Consequently, the method was seen to offer valuable stepping stones to further research and policy.

The major overarching finding from *Article IV* is that, by introducing the Energy Union reform, the Commission has in fact restated and strengthened its focus on decarbonisation. *Article IV* finds that decarbonisation and energy efficiency are the two most predominant dimensions within the Energy Union's policy agenda, covering 66% of Energy Union topics. This represents a 16% increase from the time prior to 2015. In addition, the evidence from *Article IV* suggests that the reform project has also exerted a streamlining effect on the climate vs. security and energy efficiency vs. affordability debates, generating more policy convergence. The results also imply that there is little thematic focus on phasing-out incumbent fossils, such as coal, from European energy regimes. Below, I elaborate on these three points in more detail.

While *Article IV* finds that the Commission has maintained rather than radically changed its disposition vis-à-vis decarbonisation policy, the results do point to some interesting incremental developments. The results from *Article IV* support the argument that energy security questions are increasingly dealt with in the policy-realm of energy efficiency and decarbonisation. This is a change from the pre-Energy Union agenda where energy security often featured as an independent pillar of European energy policy. Moreover, energy efficiency is not only one of the major policy areas promoted by the Energy Union, it is also now viewed as compatible with affordability and economic competitiveness.

Moreover, *Article IV* demonstrates how decarbonisation policy is being advanced through a *techno-neutral* strategy. Thus, there are no or very shallow policy prescriptions for the promotion of specific renewable energy technologies and sources. This techno-neutrality provides member states flexibility in their approach to domestic decarbonisation strategies. At the same time, the results stress that, in the Commission's policy language, renewables are largely discussed in terms of biomass and biofuel energy generation which have more unfavourable sustainability criteria than other renewables, such as wind and solar energy.

Finally, based on the results from *Article IV*, it is also evident that the Commission's energy policy language contains little focus on discussions on phasing-out fossil fuel technologies. By contrast, there is extensive interest in revising the EU's flagship instrument for addressing climate change, the EU ETS, through pricing carbon. Nonetheless, apart from this, no other themes were identified concerning the purposeful termination of fossil fuel use. We can thus summarise that while the

ETS aims to limit emissions and promote investments in sustainable technologies, the Energy Union is not, in its current form, thematically inclined towards actively unlocking the carbon-intensive energy regimes.

How then can applying textual approaches advance and illuminate decarbonisation policy at the nation state level? *Article II* strives to explore this question by adopting a discursive approach to the study of a topical phenomenon many countries are currently beginning to address—the need to phase out coal-based power generation. The article examines the UK, which represents a unique case in that coal has almost completely disappeared from the country's energy mix. The analysis draws from the ADA method because its acknowledged value in examining the paradoxical character of environmental conflict, situations in which, for example, sustainability challenges are widely acknowledged but discrepancy remains between discourse and political action (Hajer 1995, 56; Rosenbloom, Berton, and Meadowcroft 2016, *Article I*). The challenge of phasing out coal can be seen as an example of such a paradox.

Article II examined the public discourse surrounding the decline of coal in the UK between 2000 and 2017. The article distilled eight storylines characterising discussion on coal use during this period. These consists of four delegitimising and four legitimising arguments about coal use (Table 5).

Table 5 Overview of storylines on coal in the UK.

Legitimising storylines	Coal is reliable Coal is cheap Coal important for the UK's identity CCS is a solution
Delegitimising storylines	Coal is bad for the climate Coal is a health risk CCS is not a solution Coal is not indispensable

The results over the time period investigated, which was divided into three phases, reveal that, overall, the most predominant storyline was 'coal is bad for the climate'. Moreover, while there were many legitimising accounts of coal and opposition to coal phase-out, the climate storyline was never denied by the actors examined in *Article II*. Figure 5 illustrates the weight of each storyline in the discussions over coal between 2000 and 2017.

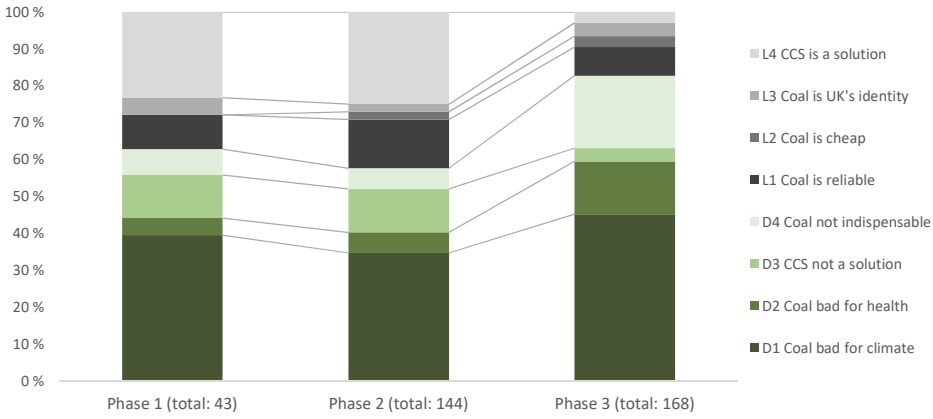

Figure 5 Share of storylines in the discourse on coal (grey-legitimising and green-delegitimising). Phase 1: 2000–2007; Phase 2: 2008–2012; Phase 3: 2013–2017.

Based on the findings of *Article II*, three main discursive shifts can be identified. The first is that the CCS technology played a major role in public discourse and largely determined the stance of government and the coal industry on mitigating climate change between 2008 and 2015. The hope that CCS technology would become widely used in the UK's coal plants generated a win-win discourse, where coal was portrayed as reliable, cheap, and, provided that emissions could be captured, also environmentally friendly. Only when it became clear that the technology would not mature rapidly enough did the government revise its position on coal use. Second, and relatedly, *Article II* demonstrates that the government's pledge to phase-out coal, while symbolically significant, was more of a late, opportunistic decision than a ground-breaking or pioneering commitment given that the share of coal in the energy mix had already significantly declined at the time the decision was made. The phase-out pledge also reflected the agenda of incumbent coal players, as many energy suppliers made significant advances in the development of new and old energy sources (often coal and gas together with biomass and wind). Third, the discourse analysis conducted in *Article II* shows that coal phase-out occurred much faster and with significantly less resistance than regime-destabilisation research would generally give cause to expect. Since 2015, a near full discursive closure on the future of coal has been evident, where it is largely understood across actor groups that the game is over for coal. Moreover, the adverse effects of phasing-out coal on jobs or regional economic development were not major issues in the material analysed for *Article II*. Simultaneously, the delegitimising storyline that coal is not an indispensable energy source' dominated the discourse across all actor groups.

6 DISCUSSION

Policies, policy processes and politics are an integral part of the energy system change. As a result, we have seen an increasing exchange of disciplinary insights between the more structurally oriented transitions scholars and politically attuned policy studies researchers. One neglected area in these processes, as I identified in the beginning of this dissertation, is the role of methodological reflection, knowledge bridging and exploration. The findings presented in the previous section contribute in filling this gap. In this chapter, my aim is to discuss the role and potential of textual methodologies in energy transitions research. I start by discussing the added value, which can be obtained from discursive and unsupervised textual methods. Furthermore, I discuss how scholars could move towards using research designs combining discursive and unsupervised approaches. I end this chapter by contemplating on the broader methodological implications, which come to the fore when incorporating computational approaches into social scientific transitions research, and by offering insights for policy.

6.1 THE ADDED VALUE OF TEXTUAL METHODOLOGIES

The findings outlined in Chapter 5 highlight that an informed take on textual methodologies can help to go beyond description and provide explanations on how and why energy systems change.

First, the findings of this dissertation suggest that a wide-spread uptake of discursive approaches has brought about novel analytical standpoints for energy transitions research. In particular, the findings reveal that discursive approaches have been useful for the study of political ideology and state orientation, publics, institutional and policy changes, and transition dynamics. Regarding institutional and policy change, discursive approaches are found to enrich decarbonisation analysis by grasping the layers of interaction, meaning creation and contestation, which have contributed to these processes. Overall, in line with Hajer and Versteeg (2005) and Sovacool and Hess (2017), the findings suggest that the added value of discursive approaches can largely be boiled down to their ability to appreciate the messiness in policy and politics.

While the use of discursive approaches allows being sensitive to the contested side of policy, they have also emerged as useful tools to study socio-technical phenomena and change. A good example of this is the changing way through which technology is understood and approached. Rather than examining technologies as mere instrumental objects, scholars have, with the help of discursive approaches, become

intrigued by understanding technology through 'publics'; for example, through the interaction between social acceptance, regulation and uptake of technologies.

Additionally, discursively constructed structures emerge as important contributors to the classical conceptual frameworks in energy transitions. One major contribution of discursive methods has been in extending and refining the MLP framework, which has received criticism over its explanatory style and lack of considerations over agency, among others (Geels, 2011). The results reveal that discursive approaches have been found to help in overcoming these limitations, for instance, by providing new insights into how discourse is used to legitimise innovations or how system framings at the landscape level favour or challenge regime structures. The biggest added value of discursive approaches is in examining the role of agency in system change. While many MLP scholars defend that agency has always been present in the framework as actors are considered to enact the conceptualised trajectories of change (Geels, 2011), discursive approaches offer a concrete way of grasping these dynamics and incorporating them into discussions on system change.

Applying ADA to the case of coal decline in the UK also shows how discursive approaches can reveal novel and complementary knowledge about decarbonisation processes. Due to the novelty of fossil fuel phase-outs as a phenomenon, researchers and policy-makers are still puzzling with understanding their complex dynamics, especially at the national level. By revealing novel insights into different discursive strategies, used for legitimation work over coal use, the discourse analysis enabled tracing normative struggles over coal's legitimacy long before the government's official coal phase-out pledge and, critically, before phase-out emerged as an established topic in the public discourse. In addition, the ADA analysis provided novel conceptual insights on technology decline and resistance, as will be further explained in section 6.3.

Second, the findings of this dissertation echo the arguments advanced in computational social science about the vast potential of computational methods in social and political sciences (Grimmer and Stewart, 2013; Wallach, 2018). The most evident added value of unsupervised methods comes through the benefits of scale and scope as it is possible to cover time- and resource-efficiently significantly more data than what researchers could qualitatively read. Then there is also the novelty obtained from digitised data sets: it is possible to form data sets to study phenomena previously out of reach of scholars. In other words, it is possible to obtain new takes on existing data such as policy documents and organisations' reports, as was the case in this dissertation. There also are entirely new outlets available for political research, for example social media platforms.

The results also suggest potential ways in which the topic modelling method specifically can bring added value to the study of policy and politics. In computational social science, topic modelling analyses have been found useful in identifying latent themes across large samples (Murakami et al., 2017). It has also previously been

argued that as topic modelling has 'high levels of substantive interpretability' (DiMaggio et al., 2013, p. 578), it comes with a good ability to 'read' texts (Mohr and Bogdanov, 2013). The findings from this dissertation similarly suggest that scholars can not only examine latent thematic structure of a corpus but also the characteristics of temporality and continuity in a given topic with topic modelling. Thus, scrutinising topic structure opens the possibility of approaching policy trends and patterns from an unsupervised angle (*Article III*).

In particular, the findings obtained by applying the LDA method show how topic modelling can reveal trends in agenda shaping at the meta-level. In the case of the Energy Union, prior studies have found, by examining smaller data sets, that the project resembles 'a floating signifier', used for advancing conflicting policy aims (Szulecki et al., 2016). An unsupervised approach to the same phenomenon thus gave an interesting vantage point: It became possible to ask, what a big data angle on policy texts reveals in this case? The main take away of the findings is that during the years leading up to the implementation of the project, the Energy Union's policy priorities have been increasingly geared towards decarbonisation objectives. Thus, the Energy Union appeared less as 'a floating signifier' and more as a project with an increasing priority towards decarbonisation objectives. This is a change from the pre-Energy Union era, which was marked by the difficulty to combine climate and energy policy agendas. Therefore, with the topic modelling method, it became possible to examine the high-level policy priorities of the EC before and after the launch of this energy sector reform project.

While the added value of both groups of methods, discursive and unsupervised topic modelling, appears significant, the findings also highlight some critical methodological limitations. In terms of the use of discursive approaches, the findings indicate that the current practices could be further improved by increasing transparency of reporting and providing more thorough considerations over the choice of method. The findings indicate that this has not been the case in a significant bulk of studies as only 27 per cent of the articles reviewed reported on their method use transparently. In terms of topic modelling, *Article III* emphasises that in much of the current work, topic modelling has been applied and interpreted in a rather ad-hoc manner. The findings thus emphasise that topic modelling offers no panacea for research on policy and politics; corpus size and curation, method validation and interpretability of output remain critical questions, which need to be considered with prudence over each case in question. The heuristic proposed in this dissertation (section 5.2) can be used to guide and help researchers in these processes.

Overall, it follows that to fulfil the entire potential of textual methods it would be beneficial to engage in more methodological considerations; both over synergies and method justification. The next section takes a step towards this direction.

6.2 TOWARDS A COMPUTER MEDIATED 'TEXTUAL ANALYSIS 2.0'

Using unsupervised computational methods in textual analysis could be an example of such a novel methodological synergy. Considering the possibilities of using topic modelling in textual analysis, therefore, emerged as an area of interest in the methodological exploration of this dissertation.

The results of the methodological work done in the articles highlight that a straightforward substitution of textual analysis methods by topic modelling would, methodologically speaking, likely end up being problematic. This is because, as a generative model grounded in data, topic modelling ultimately differs from many textual analysis methods at the level of strategy. Topic modelling was originally offered as a tool to provide a 'browsing experience' for large collections of text, or as 'an algorithmic solution for managing, organizing, and annotating large archives of texts' (Blei, Carin, and Dunson 2012, 77–79, *Article III*). To achieve this task, the topic modelling method was developed to only take into account words contained in the document corpus. As a result, because of these methodological underpinnings, topic modelling has limited possibility for grasping contextual and semantic understandings from text, at the core of many textual analysis approaches, including discursive analyses.

It is no surprise then that policy scholars with an interest in topic modelling have argued that '(t)here is no inherent reason to believe that words grouped together on the basis of co-occurrence statistics should really mean or prove anything, aside from the winkingly suggestive similarities that these word groups so often display' (Klein et al., 2015, p. 132). Indeed, the results obtained from this dissertation give ground to argue that at the method's current state of development, topic output should not be interpreted as corresponding policy concepts, such as frames, issue areas or narratives, because this risks being empirically misleading. However, results do at the same time indicate that with a more sound methodological understanding of the practices of topic modelling, it is possible to identify areas of compatibility between topic modelling and textual analysis methods. In particular, the results show that rather than seeking to gain direct qualitative or policy relevant value from the topic modelling output, the methods potential could be best fulfilled in mixed-methods designs.

Building on the findings of the methodological meta-analysis as well as the classification between Content & Classification (examining words primarily as communication units) and Discourse & Representation groups of method (focusing on the meaning of communicative acts) used in *Article III*, two distinct ways of utilising topic modelling for the purposes of textual analysis can be suggested (Table 6). Thanks to topic modelling drawing from similar positivist assumptions, being grounded in data and examining text as data that manifests explicit meaning, this

dissertation suggests that it is possible for researchers to automate the process of Content & Classification analysis with topic modelling. As Table 6 illustrates, this can be done either completely or partially, depending on the method in question.

Table 6 Potential and limitations of topic modelling for C&C and D&R methods.

	Method	Integration of TM	Considerations and limitations
High degree of convergence or substitution with TM	Content analysis	Use an embedded design. Iterative method to compare and revise coding categories.	Some content analysis methods, like grounded theory (GT), are dissimilar to TM at the level of strategy. GT aims at theory, TM is a model.
	Thematic analysis	Use an embedded design. Mining of themes in a systematic way.	Topics generated by the model can also refer to non-thematic issues. Investigating documents associated with the topic is important to validate results.
	Vocabulary analysis	Use an embedded design. Vocabulary analysis based on word co-occurrence is very close to TM in concept, although their technical implementation differs.	Methods differ at the level of strategy: Vocabulary analysis often focuses on specific vocabularies, while TM includes a wide range of words that may or may not be relevant to the research topic.
No or little potential in substitution of method with TM	Discourse analysis	Use a sequential design. Generate directions for the analysis of discourse, hidden power relations, agency and the like. TM can provide a systematic sampling method for discourse analysis.	Discourse methods have a strong theoretical basis, TM does not (in its current state) consider contextual, intertextual and semantic factors.
	Frame analysis	Use a sequential design. Provide empirical avenues for frame analysis and aid in frame discovery.	TM does not consider contextual, intertextual or semantic factors that are integral in frame analysis. Unlike frame analysis, TM does not (in its current state) consider what information is missing in the text.
	Narrative analysis	Use a sequential design. Topic output could provide a starting point in revealing meta-narratives, sequence structure in narratives or characters belonging to a narrative.	TM does not account for context, intertextuality or background knowledge. Unlike narrative analysis, TM does not (in its current state) consider what information is missing in the text.

While topic modelling output is not, as discussed above, compatible with discourses, frames or narratives, it is possible to utilise topic modelling method with the theoretically informed, context sensitive Discourse & Representation methods. Topic

modelling can add value to discursive approaches when used as a complement to these methods, in sequential mixed-method designs. For example, topic modelling could be applied to inform the first steps of discourse analysis, such as examining common collocates to certain words and then putting them into thematic categories. By informing and guiding the discourse analysis process, topic modelling can also be used to add analytical rigour to the traditionally heavily researcher-reliant analysis.

It is important to note that the application of topic modelling in mixed-method designs, especially in case of method substitution, should not be done without critical considerations over methodological questions. As *Article III* identified, the requirements for making topic models interpretable for policy is to both guarantee model robustness and validity and make the topics correspond to the phenomenon being examined. Therefore, it is crucial to consider which method – the simple LDA or its extensions – and which designs could be most beneficial in answering the research question. With this in mind, the findings challenge scholars to further experiment with topic modelling. It will be important to test the extent to which topic modelling could automate C&C procedures or be used for discursive approaches in a policy context. The potential of such 'textual analysis 2.0' synergies appears all the more significant when considering that the algorithm is constantly improving, and its contextual sensitivity is being developed.

Finally, with the results from this methodological exploration synthesised in this and the previous sections, I now wish to reflect on the choice and application of the methods the articles included in this dissertation. As often is the case in research, the work on the individual articles of this dissertation did not represent a linear process. On the contrary, the meta-level studies of discourse and topic modelling approaches were not fully completed before choosing and applying the methods to empirical cases. I thus chose each method using the best knowledge I had at the time (see section 4.2.2). My knowledge about the LDA method in particular was acquired through trial and error. In the first stages of the research, the idea was to run an LDA analysis and interpret the output as policy frames. This process raised many questions and eventually led to the methodological article being written about how topic modelling could be used in textual analysis. This gradual process explains why topic modelling was not applied in a mixed-method design to begin with. In further analyses of the Energy Union data, it would, for example, be interesting to collect the documents under the decarbonisation topic and conduct a discourse analysis to identify whether and where coal phase-out is being discussed. By investigating who is advancing this discourse and how, it would be possible to grasp the status of the discussion on coal-exit at the supranational level. It is also possible to ask why a computational approach was not applied for exploring coal phase-out in the UK. While I listed the benefits of choosing a discursive approach in section 4.2.2, I want to highlight here that the newspaper data set would not have been 'big' enough for the topic modelling algorithm to work and generate meaningful results.

6.3 IMPLICATIONS FOR RESEARCH AND POLICY

So far, I have discussed the methodological questions and possibilities arising from the findings of this dissertation. Now, I wish to contemplate on some of the higher-level implications for research that can be drawn from the results. Finally, I will conclude this section by pointing out implications for policy and transitions literature that can be drawn from the empirical cases.

First, the results highlight that integrating computational approaches into social scientific research endeavours not only requires interdisciplinary expertise but also, and critically, strides to be taken in stepping outside of the 'algorithmic black boxes' to link the powerful computational tools with real-world societal phenomena (Wallach, 2018). In policy studies, it has long been argued that a comprehensive analysis of text would require expertise from diverse and complementing domains (Sovacool and Hess, 2017). For example, Hajer (2006, 1995) has on many occasions demonstrated that a comprehensive discourse analysis of environmental policy dilemmas ultimately requires expertise across disciplines, from economics to natural and social sciences. Similarly, Fischer (1995) has pinpointed that diverse epistemological takes on the research topic are a prerequisite for thorough analysis of policy and policy processes. While the findings arising from this dissertation resonate with these notions advanced by Hajer and Fischer, they also extend them in showing that there is also a need for diverse methodological expertise in these processes. In order to advance computational social science approaches, such as the 'textual analysis 2.0' designs proposed earlier in this section, we need thorough dialogue between computational scientists, statistical experts and social scientists. In other words, to make computational models match the chosen research questions and phenomena, we need social scientists who have in-depth understandings of the phenomena in question and are interested in aspects of causality as much as we need computational scientists with solid algorithmic training (DiMaggio, 2015; Wallach, 2018). As the example of topic modelling method shows, applying a computational method without thorough methodological considerations risks ending up producing unintended false practices, even if the intensions for the analysis were methodologically ambitious. With in-depth methodological dialogue, it is also possible to avoid and overcome pitfalls that combining the traditionally very different approaches of computational science and societal research often entails.

Second, the results also contribute to the broader methodological discussions ongoing within the sustainability and energy transitions research community. In their recently published research agenda, the sustainability transitions research network outlined some persisting methodological patterns and dilemmas in the field (Köhler et al., 2019). For example, it was acknowledged that challenges remain in balancing between 'in-depth particularity' obtained from single case studies and

'generic insights', emerging from comparative work and theory building (Köhler et al., 2019). In other words, while detailed single case studies have been and are argued to remain pivotal in transitions research especially when examining new topics and contexts, it is highlighted that building general insights and lessons learnt from these cases is also critical for increasing our knowledge on transitions. The findings from this research suggest that computational social science approaches could be used in achieving more meta-level information from case studies. With computational methods, multiple single case studies on a similar topic could be examined time and resource efficiently. For instance, by applying methods drawing from Bayesian statistics, such as topic modelling, scholars could explore transition processes and events more easily along various temporal dimensions. They could also zoom in or out across different levels of analysis. In addition, when carefully applied, unsupervised methods have the potential to achieve explorative angles to a given research topic, contributing to challenge and potentially transcend, current knowledge and practices.

The third implication for research I wish to put forward here follows directly from the methodological discussion: the importance of reflexivity in transitions research. While the points above highlight that diverse methodological takes are needed to make sense of the complex and uncertain processes that underpin energy transitions, they also bring forth the need to consider the role of researchers in practising, influencing and steering these processes. In other words, in social science it is widely recognised that researchers are not separate from the phenomenon they study; rather, researchers both influence and are influenced by them (Avelino and Grin, 2017; Fazey et al., 2018). The same applies to the energy transitions research field: in addition to being a research field, the notion of energy transitions is also an influential policy concept (Voß, 2014). Therefore, in choosing the research topics, scholars also choose the ways in which transitions will be discussed and terminology through which these processes will be understood. As a result, it is pivotal to engage in open discussions on the role of the researcher as an 'intervener'. This appears especially important in the case of textual analysis, where the study of text and language can also be seen to include performative aspects. In other words, as is the case with other social science approaches, textual methods 'not only render existing objects and issues (…) describable but take part in transforming and formatting social and material realities' (Asdal and Marres, 2014, p. 2059). In this way, textual approaches can be considered to not only having analytical capacity to inform about given empirical material, but also to constructing certain realities about their research topics, while excluding others. Hence, as the way textual methodologies are applied has substantial implications for decarbonisation research and policy, researchers should be transparent and reflective about their methodological choices.

Another important point on reflexivity is concerned with the ethical considerations, relevant in efforts to take the full advantage of big data sources. Obtaining novel, large-scale, digitalised and easily searchable data sets is one of the biggest appeals of computational social science for transitions researchers. However, digitalisation and data sharing raise complicated questions of data ownership, privacy and accountability. It would be highly important, then, for transitions researchers to consider ethical questions related to data collection, sharing and storage if they were to adopt computational approaches in their research.

Finally, the empirical findings presented in the previous chapter also generate some interesting policy relevant notions and contributions to conceptual discussions in transitions literature. One interesting notion is that the policy decision to phase-out coal actually played a relatively minor role in determining the trajectory of coal use. When the discursive structures are weighed against policy events, it becomes evident that the Carbon Price Floor tax (imposed to complement the EU ETS) and the EU Large Combustion Plant policy together with the falling costs of renewables caused coal to decline well before the official phase-out pledge made by the government. Therefore, the policy decision to phase out coal was not a discontinuation policy in the strict and radical sense, as coal had already been significantly phased out in the energy mix (Kivimaa and Kern, 2016). Rather, the results point to global technology development and the shifting economic environment as mediating forces driving coal decline in the long run.

Moreover, the lessons learnt from the UK case study give insights into the conceptual literature on technology decline. Unlike what previous research on coal phase-out has suggested, the results revealed that coal phase-out in the UK happened faster and with weak resistance from incumbent actors. This is in contrast with Turnheim and Geels (2012) who, in their seminal conceptualisations of regime destabilisation, note how incumbent industry actors are likely to have created many lock-in mechanisms in the energy regimes that create inertia and increase resistance to change. Similarly, drawing from recent debates on coal phase out, Leipprand and Flachsland (2018) and Geels (2014) find that destabilisation policy is likely to be highly conflictual, especially in heavily coal-reliant countries.

Why is it, then, that this does not seem to have been the case for the UK? The results need to be considered in the specific context and history of coal use in the country. It is noteworthy that even if there was little resistance in the 2000s, the UK experienced 'fights' over the weakening of the coal regime, but these were fought in the 1990s when most coal mines had been shut down (Turnheim and Geels, 2012). Also, another possible reason for incumbents' resistance not being as strong as suggested is that most of the UK's existing coal plants were old, already reaching the end of their economic lifetime. Moreover, when renewables and natural gas became an economically viable alternatives to coal, the same incumbent firms were able to shift into developing these energy sources in their operations (Geels et al., 2016).

The UK example also highlights the need to be attentive to the dynamics and lock-ins created when transitioning and preparing for a coal exit. Literature emphasises destabilisation as a complex process, building up from a succession of cumulative events (Turnheim and Geels, 2012). Incumbent actors can adapt to increasing external pressures by only making incremental changes and only gradually abandon existing practices. In this light, it is worth noting that the UK has been reiterating its reliance on gas after the phase-out pledge and hence continues to rely on existing structures based on fossil fuels. Therefore, the UK phase-out dynamics depict transitions as more complex processes than substitution of one technology by another and importantly, indicates that even with a commitment to phase out coal, the risk of 'regime re-stabilisation' is possible (Rosenbloom, 2017b).

Furthermore, the empirical results on the Energy Union give encouraging signals of decarbonisation policy integration at the supranational level in Europe. One of the main take-aways of the findings is that during the years leading up to the implementation of the project, the Energy Union's policy priorities have been increasingly geared towards decarbonisation objectives by furthering policy convergence between climate-security and energy efficiency-affordability paradigms. In other words, some of the major contested policy areas between member state groups have now become streamlined in the policy language of the Energy Union. That the role of energy efficiency has increasing thematic weight and has extended to include aspects of affordability is important for decarbonisation, especially, in building and transport sectors. It is also a novel turn that energy security appears as an issue area directly linked to processes of decarbonisation rather than being tackled independently.

Importantly, however, this apparent policy convergence has clearly been achieved by reflecting the interests of the Western country block. It appears therefore important to pay closer attention to how policy convergence is and will be elaborated in the upcoming policy language of the Energy Union. Energy security and efficiency may still incite resistance from the Central and Eastern European member states with substantive fossil fuel reserves, and they may seek to bargain with the Western block to gain more details in energy solidarity in exchange for increasing decarbonisation.

Moreover, the findings shed light on how areas of contestation are dealt with in the EC's policy language. For example, 'techno-neutrality' is used to reduce differences and possibilities for contestation by creating stability in a policy environment. That is, flexibility in interpretation and execution of renewables policy may encourage member states to rely upon less-polluting fossil fuels or contested technologies fitting under the wide definitional umbrella of renewable energy (Harjanne and Korhonen, 2019). Hence, while increasing the share of renewable energy in the EU's energy mix is one of the main aims of the Energy Union, it also appears to be one that allows for most flexibility in its interpretation and delivery.

Finally, the findings imply that the Energy Union is not used as a device driving attention towards unlocking the carbon-intensive energy regimes in Europe with the so-called supply-side control policies. On the contrary, the weight rests largely upon the transformative potential of the EU ETS. Indeed, as a demand side policy, the ETS is putting a price on carbon and seeking to limit fossil fuel use through the 'cap and trade' of emissions. However, not considering regulation-based disruptions of fossil fuel power generation alongside market mechanisms is arguably problematic. It may be disadvantageous not only because of the urgency to take active steps to phase out coal in the majority of EU member states, but also because the EU will need to prepare for the impacts, which purposeful technology decline, enacted by its member states, may have on incumbent industries and regional development in Europe (Johnstone and Hielscher, 2017; Markard, 2018).

7 CONCLUSIONS

The aim of this dissertation was to advance the research on decarbonisation policy and politics by critically exploring the potential of existing and emerging textual methodologies in producing knowledge about energy transition processes. In doing so, I explored the best practices and added value of discursive and topic modelling methods. The methodological exploration was carried out on two levels. On one hand, I examined the potential and limitations of each group of method by studying them independently on the meta-level. On the other hand, to gain additional insights from the practical research process, I also applied the methods in a decarbonisation policy context. In these cases, I studied two emerging trends, namely the development of the European Energy Union project and the decline of coal-fired power generation in the UK. Overall, by presenting the lessons learnt from the methodological and empirical work, this dissertation contributes in further developing synergies between policy studies and energy transition scholars.

The broad motivation for this dissertation stemmed from a recent trend to more actively incorporate political factors into the socio-technical and techno-economic analyses of energy transitions. While transformations away from fossil fuels are already taking place in many areas, the struggle is real and largely dependent on political action and policy steering. Globally, we observe how many incumbent policy actors are hesitating or even slowing down action on climate change while research is consistently calling for more ambitious policy targets and strategies to limit the irreversible effects of climate change. It is no surprise, then, that the sustainable energy transitions scholarship is viewing politics and policy as central factors conditioning the envisioned shift towards a fossil-free future.

The specific gap I identified for this dissertation was the need to advance the exchange of methodological insights between energy transition and policy studies researchers. Many transition scholars have already successfully initiated work on conceptual bridging to take advantage of policy-based approaches developed within the policy studies discipline. Importantly, I highlight in this dissertation that the conceptual advancement is inherently intertwined with and dependent on sound methodological practices. Nonetheless, so far the methodological questions have received little scholarly attention in the policy circles. Limited reflection thus remains both on how to rightly apply different methods and how to combine them with existing energy transition frameworks and concepts. Therefore, I argued for the need to engage in methodological exploration, especially in terms of textual approaches, to advance the study of decarbonisation policy and politics.

The analysis of the textual methods in this dissertation emphasise that discursive methodologies can enhance our understanding of the role of political ideology

and state orientation, publics, institutional and policy change in decarbonisation processes. Put differently, the benefits of viewing decarbonisation policy through a discursive lens include more nuanced understandings of technology (de)legitimation, opening up the 'black box' of policy processes and identifying how energy systems have different, context dependent evolutionary pathways. In addition, discursive approaches are found to contribute to and complement the classical energy transition frameworks. A case in point is the MLP framework, to which discursive approaches can contribute by adding critical notions of agency to the analysis. Moreover, the methodological examination of topic modelling shows that the method can be used to examine the thematic structure of policy-relevant corpora with an unprecedented scale and scope. Turning to computational approaches also comes with the benefit of examining entirely new data sets, such as those collected from social media platforms. In addition, as the topic modelling method allows for zooming in and out of data sets, it offers scholars the possibility to explore decarbonisation processes and events more easily across different levels of analysis. That said, the findings also highlight that using unsupervised computational methods, and topic modelling in particular, to study policy processes requires a genuine understanding of the technique to draw substantially meaningful results.

As a novel methodological contribution, this dissertation proposes that the topic modelling method could be used in different mixed-method designs for the purposes of qualitative textual analysis and by extension, this way could be harnessed for the analysis of policy and politics. Building on the acquired methodological understanding, I suggest two distinct ways of utilising topic modelling. In terms of content and classification based textual methods, it appears possible for researchers to automate the analytical procedures, either completely or partially, depending on the method in question. This becomes possible due to topic modelling being grounded in data and examining text as data that manifests explicit meaning. Regarding methods examining aspects of discourse and representation, the findings emphasise that the topic modelling method should not be used to substitute the analysis. The problem lies in the fact that, in its current state, topic modelling cannot sufficiently account for semantics, contextual or intertextual factors inherent in such analyses. However, I propose ways of integrating topic modelling into discourse-based analyses through sequential mixed-method designs. Taken together, the findings encourage scholars to further experiment with the use of such computer mediated 'Textual Analysis 2.0' approaches in practice.

This study also highlights several higher level implications for research. I postulate that integrating computational approaches into social scientific research endeavours necessitates further in-depth methodological dialogue among computational scientists, statistical experts and social scientists. This is important not only because dialogue can help avoid potential pitfalls in the analysis, resulting from insufficient methodological knowledge, but also because developing computational social

science approaches critically requires that the models are designed to match the real-world societal phenomena they are applied to. Furthermore, the methodological discussion also emphasises the importance of increasing reflexivity in transitions research. In other words, when reporting from findings obtained by applying textual methods, it would be critical for scholars to engage in reflection on the role of the researcher as well as on how textual approaches not only inform about their empirical topic, but also construct certain realities about them.

The empirical cases examined in this dissertation also offer some lessons for practitioners and policymakers. The results of the Energy Union's agenda shaping highlights how the recent "Europeanisation" of energy policy has largely been advanced by pushing decarbonisation to the core of energy questions. In this process, achieving policy convergence between previously conflicting priorities of energy security and climate change as well as energy efficiency and affordability has been instrumental. However, while achieving policy convergence at the supranational level is necessary and pivotal, practitioners and policymakers should pay increasing attention to guaranteeing that decarbonisation goals become concretised despite potential opposition from fossil fuel-relying member states and regions.

Moreover, as most Western EU countries, including Finland, Denmark and Spain, have very recently declared intentions to be coal-free by 2030 (and Germany by 2038), the UK's example of a near-complete coal phase-out provides some valuable insights. The lessons from the UK case study suggests that policymakers should pay careful attention to how best to govern the disruptive processes of incumbent technology decline. One challenge is the risk of phase-out becoming an oxymoron if coal is substituted by other fossils such as natural gas. This highlights the importance of how alternatives to coal are presented and defined in policy discourse. Another challenge is taking into account resistance and the possible adverse effects the decline has on industries and regions. While our study revealed that there was little resistance in the UK case, it underscored simultaneously that these are likely to be critical aspects of decline in other contexts. Therefore, practitioners and policymakers should pay increasing attention not only to the possible adverse effects on industries (e.g. through compensation payment) but also to the social implications of incumbent technology decline, including the question of how to govern decline in a just manner so that the future prospects of affected regions and the workforce are being sufficiently accounted for.

Finally, the novelty of this dissertation research can be summarised in two contributions. First, I expand the methodological discussions ongoing in the energy transitions research field by outlining the potential of two groups of textual methods in examining politics and policy. By showing how, both independently and in synergies, these methods could contribute in improving the empirical and theoretical research on transitions, this dissertation also makes a contribution in advancing the development of the emerging computational social science research

field. Second, the empirical results yield novel insights into two emerging and therefore understudied trends; crafting a European Energy Union and enacting technology decline in countries with historical reliance on coal-fired energy. The UK analysis responded to calls to examine trends of technology decline at the national level, while the topic modelling analysis was one of the first attempts to examine agenda shaping at the supranational level through a big data angle. Overall, I hope that with the methodological insights provided in this work, transition scholars have an ever more refined ability to turn to approaches and methodologies from the policy studies discipline to advance the much needed research on the politics of decarbonisation.

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