

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

Karoliina Isoaho^a and Jochen Markard^b

^aEnvironmental Policy Research Group, University of Helsinki

^b Group for Sustainability and Technology, Department of Management, Technology and Economics, Swiss Federal Institute of Technology Zurich

Review of Policy Research (forthcoming)

Abstract

In the ongoing energy transition, the decline of carbon intensive technologies such as coal is a key element to tackle climate change. Our understanding of technology decline and of the associated policies and politics is growing but still incomplete. This paper builds on the sustainability transitions perspective, a novel approach to analyze socio-technical and political transformations. We study the decline of coal-fired power generation in the United Kingdom from 2000 to 2017 by analyzing the discourse in *The Guardian*. We find scientists and environmental NGOs criticizing coal for climate and health reasons, while governments 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, our study points to the interplay of discursive struggles, technology change and public policy in sustainability transitions.

Keywords: Sustainability transitions, industry decline, regime destabilization, actors, discourse analysis, policy change

1 Introduction

Grand sustainability challenges such as climate change, resource depletion or water pollution pose extraordinary challenges for societies (UNEP, 2016). Sustainability transitions have been suggested as a way forward to address these challenges (Geels et al., 2017; Köhler et al., 2019). Sustainability transitions are fundamental transformations of existing socio-technical systems such as energy, transport or food towards more sustainable modes of production and consumption (Markard et al., 2012). Sustainability transitions include the emergence and diffusion of more sustainable solutions such as solar or wind energy, as well as the decline of existing technologies and industries around fossil fuels. Decline is a central element in transitions: if sustainable alternatives are to diffuse widely, unsustainable technologies have to make way (Kivimaa and Kern, 2016).

Sustainability transitions are highly contested (Lauber and Jacobsson, 2016; Meadowcroft, 2011). Different groups of actors struggle over policy decisions and public discourse in order to influence the pace and direction of ongoing change processes (Hess, 2014; Rosenbloom et al., 2018). As a consequence, there is a strong connection to the public policy literature and policy process studies (Howlett et al., 2009; Sabatier, 2007). Transition scholars have recently explored different policy process theories in order to better understand the interplay of policy dynamics and changes in socio-technical systems (Kern and Rogge, 2018; Markard et al., 2016; Rosenbloom et al., 2016). This interaction of changes in policies and technologies (or industries) is central for sustainability transitions. Case studies on transitions can therefore generate important insights for public policy scholars about the role of technological change for politics (Meckling et al., 2017; Schmidt and Sewerin, 2017).

In this paper, we analyze struggles over policy and technology choices from a discourse perspective (Fischer, 2003; Hajer and Versteeg, 2005). Many recent studies on the politics of transition processes have used ideational approaches (Geels and Verhees, 2011; Kern, 2012; Rosenbloom et al., 2016; Rosenbloom, 2018). We assume that struggles over ideas and values are particularly relevant for sustainability transitions, where uncertainty is high, and problem framings are highly contested.

Our empirical setting is the ongoing transition in the electricity sector (Markard, 2018b). As renewable energies such as wind and solar are diffusing quickly and widely (Mitchell, 2016), policy attention is now turning towards the phase-out of fossil fuels, especially coal, in order to reduce CO₂ emissions. Processes of decline are highly contested and fossil fuel incumbents, utility companies and unions have been observed to resist and slow down the ongoing transition (Hess, 2014; Johnstone and Hielscher, 2017; Lauber and Jacobsson, 2016; Stefes, 2016). Decline is a rather recent phenomenon in contemporary transition studies, which

only a few scholars have addressed so far (e.g. Leipprand and Flachsland, 2018; Rosenbloom, 2018; Turnheim and Geels, 2012). It is therefore important to deepen our understanding of how the processes of decline unfold. How do struggles over the established technology unfold? How does the discourse change over time? Which arguments and storylines do different actor groups present, and how is resistance against decline enacted?

We investigate these questions with a study on the role of coal-fired power generation in the United Kingdom (UK) from 2000 to 2017.¹ We report from policy events and energy statistics, and from a discourse analysis on articles from *The Guardian*. Our study builds on the work by Rosenbloom (2018) who analyses the discursive dynamics of coal phase-out in Ontario, Canada. The UK is a unique case, in which a major industrial country that used to rely heavily on coal has phased-out this technology almost completely.

Our study contributes to the emerging literature on the politics of decline in public policy studies and transition studies. We highlight that decline can happen very quickly when technology alternatives become available and actors stop resisting but embrace the new (business) opportunities instead. Our findings also point to the key role of technology and technology change in policy processes. We argue that, for public policy scholars, the sustainability transitions perspective is a particularly promising approach to study cases that are characterized by a strong interplay of politics, policy change and technology change.

2 Theoretical background

This article builds on the sustainability transitions literature (Markard et al., 2012), which conceptualizes the ongoing transformation of the electricity sector as a socio-technical transition, i.e. a fundamental, multi-dimensional change of a socio-technical system. While technological change is a central part of transitions, they go beyond technology as they also include changes in policies, organizations, business models, infrastructures, societal norms or lifestyles (Geels et al., 2017). In fact, transition processes are multi-dimensional. Rosenbloom (2018) highlights the continuous interplay of ideas, institutions, interests and infrastructures, whereby the latter refers to the material or technological dimension. Similarly, Stefes (this issue) points to three mutually constitutive dynamics, which include economic and technological changes, changes in legitimacy and ideational support, and institutional changes in the political arena.

¹ Our empirical analysis covers the most recent years of the decline. It begins at about the time when the study by Turnheim & Geels (2012) ends.

Given this multi-dimensionality, sustainability transitions have a number of particularities (Markard, 2018b). One such particularity is that they are value-laden and highly contested. We see a broad range of actors advocating different, possibly even contrasting views on sustainability problems, transition targets, the direction and pace of a transition, policy priorities, favorable solutions, preferred instruments etc. (Hess, 2014; Markard et al., 2016; Meckling, 2011). Another particularity is that transitions are very complex and characterized by a high level of uncertainty (Markard et al., 2016). Especially in early stages of development, it is unclear whether novel technologies will actually make it into the market, or how costs and performance will develop over time. Similarly, the outcome of policies is very hard to anticipate, especially when the targeted socio-technical system, its actors and technologies are changing as policies are implemented (Hoppmann et al., 2014).

As a consequence of these characteristics, sustainability transitions are inherently political and challenging (Roberts et al., 2018). It is increasingly argued that understanding the political processes through which transitions are negotiated and contested is critical for transition studies, because these processes underpin and influence actual decision-making. In energy, incumbent actors have been observed trying to slow down the ongoing transition, or to favor technology and policy alternatives that work well with existing business models (Geels et al., 2016; Hager, 2015; Lauber and Jacobsson, 2016). Environmental NGOs, in contrast, demand quick changes and call for a rapid diffusion of renewables such as wind, solar or biomass (Hess, 2016; Rosenbloom et al., 2016).

In the following, we briefly review the existing knowledge on technology decline and the politics of policy processes in sustainability transitions, to establish where our study can make a conceptual contribution. We also connect to the issue of resistance, the core theme of this special issue.

2.1 Regime destabilization and technology decline

A classic framework on transitions, the multi-level perspective (Geels, 2002; Geels, 2011), is based on the idea that innovations emerge in protected niches and compete against so-called ‘socio-technical regimes’. These regimes are typically highly resistant to change because established infrastructures, technologies, firms, business models, standards, regulations, societal expectations and consumer practices are highly interdependent and often also well aligned in the sense of coherent institutional logics (Fuenfschilling and Truffer, 2014). Stability of socio-technical regimes is not just a matter of interrelated elements and prevailing logics, but also a result of targeted strategic action, or institutional work, of incumbent actors (Fuenfschilling and Truffer, 2016; Kungl, 2015; Sarasini, 2013; Smink et al., 2015).

Regimes can be destabilized though by exogenous shocks or escalating developments such as climate change (Kunzl and Geels, 2018). If external pressures mount and niche technologies improve at the same time, they can overthrow the existing regime and establish a new, possibly more sustainable alternative. Also, regime destabilization is strategically enacted, typically by firms that benefit from the diffusion of alternative technologies or by environmentalists or social movements that criticize the state of the art (Leipprand and Flachsland, 2018; Rosenbloom et al., 2018).

Up to now, most research in sustainability transition studies has focused on innovations in niches and the emergence of novel technologies that can destabilize existing regimes. However, as ongoing energy transitions accelerate and enter a new phase of development (Markard, 2018b), processes of technology decline call for our attention (Kivimaa and Kern, 2016; Markard, 2018a; Turnheim and Geels, 2012). Technology decline can be viewed as an important element in the broader process of regime destabilization. Without the decline of ‘unsustainable’² technologies, a large-scale diffusion of more sustainable alternatives is not possible.

There is a small but concise set of studies on technology decline and regime destabilization that have already generated some relevant insights. For example, Turnheim and Geels (2012) argue that the regime is particularly challenged when both economic and socio-political pressures align. Elsewhere, they conceptualize regime destabilization as the interplay of three processes: a reduced influx of financial resources from the external economic environment, a decrease of legitimacy and support from the socio-political environment, and an eroding commitment and trust of regime actors (Turnheim and Geels, 2013). Focusing on actors and their discourse, Rosenbloom (2018) emphasizes the relevance of strategic action in the form of framing struggles and “persistently placed pressure on decision-makers” (p. 142) for the successful phase-out of coal-fired power generation in Ontario. The author shows how opponents to coal mobilized disruptive storylines in order to achieve “discursive regime **d**estabilization”, while incumbents engaged in “discursive regime **r**estabilization” (p. 143).

2.2 Resistance and politics

Resistance is a key aspect in the dynamics of technology decline. As Turnheim and Geels (2012, p. 47) note, the enduring inertia surrounding action on climate

² Which technologies are more or less sustainable in a specific context is a matter of values and priorities and the result of a sociopolitical process rather than an objective or universal characteristic.

change suggest that “fossil-fuel related industries will not simply roll over and destabilize” (Turnheim and Geels, 2012, p. 47). Rather, incumbents that are heavily committed and invested in existing regimes are likely to initially resist change affecting their businesses or strategies (Kunzl, 2015; Smink et al., 2015). “[T]he more radical and challenging the attempted transformation, the greater this propensity [of businesses] to subversion” (Stirling, 2014; p. 84). In their study on Germany, which also struggles about the future of coal, Leipprand and Flachsland (2018) show how incumbents resist the looming decline, as they evoke threats about security of supply, suffering coal mining regions and job losses. Similar resistance against coal decline has been reported from Japan (Trencher et al., 2019).

These studies show that the processes of decline are not just struggles over economic interests but even more so a battle over ideas and societal norms, over what is considered appropriate and legitimate in the public and political discourse (Dryzek, 2001). This highlights the need to examine the politics, i.e. the processes and interactions that shape policy-making. One particular way of studying the politics is to examine how actors seek to convey certain arguments and assign meaning to decline, create legitimacy over policy and technological choices or shape the public discourse (Gillard, 2016; Hajer, 1995; Hajer and Versteeg, 2005; Kern, 2011).

In public policy studies, the role of discourse in policy processes has long been recognised (Fischer, 2003). Following the ‘argumentative turn’, many scholars have argued that, in addition to studying policy content, it is important to examine the political interactions that underpin policy-making and policy change (Fischer and Gottweis, 2012; Hajer and Versteeg, 2005). Discourse is given a constitutive role in these processes. Through their discourse, actors produce understandings of social and physical realities, and therefore influence how these are discussed and perceived in society. At the same time, the discursive action is both enabled and constrained by the contexts in which they are produced (Hajer, 1995). In line with these approaches, we view policies and discourses as mutually constitutive: Through discourse, actors constantly define and re-define their positions towards policy issues, and in this way contribute to the opening and closure of political space in which policies are formulated and debated (Yearley, 2005).

3 Recent decline of coal in the UK

The UK has been heavily reliant on coal since the 19th century. While coal has been used for a variety of purposes (heating, transport, steel production), we concentrate on the use of coal for power generation, which has been the primary area of coal consumption in the more recent past. The UK also has a long history

of domestic coal extraction, which means that the mining industry also played an important role in the country's economy. In fact, coal decline in the UK comprises both of coal extraction and the use of coal for electricity generation. In our study we focus on the latter, but also report on key events related to the former.

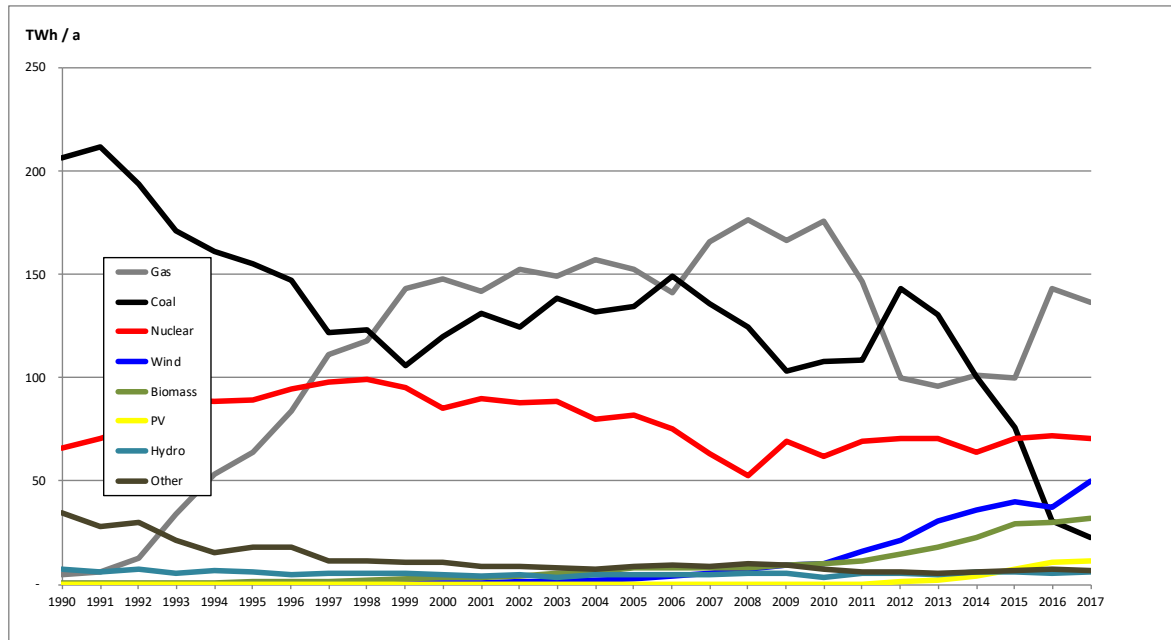


Figure 1: Sources of electricity generation in the UK (1990-2017).

In the UK, coal has been used for power generation since the beginning of the last century with a peak in consumption in the 1980s. In the 1990s, a first wave of decline happened in the context of market liberalization (Turnheim and Geels, 2012). It was triggered by political decisions by the Thatcher Government targeting privatization and market liberalization. In electricity supply, coal was replaced by natural gas, in the so-called “the dash-for-gas” (Winkel, 2002). Gas-fired power generation was not only cheaper at that time, but new power plants could also be built very quickly and were easily scalable. As a consequence, gas paved the way for new, independent power producers to enter the UK electricity market. Decline in coal-fired electricity generation in the 1990s was accompanied by many closures of domestic coalmines. In other words, coal decline affected two industries, domestic coal extraction and electricity supply.

This first wave of coal decline can be interpreted as a ‘traditional’ socio-technical regime destabilization, whereby an alternative competing energy technology (gas) displaced the incumbent one (coal). Renewable energies and sustainability issues did not play much of a role at that time (Turnheim and Geels, 2012). From 2000 to 2012, there were ups and downs in coal-fired power generation, mostly influenced by fluctuations in gas and coal prices. Also note that overall production increased from 1990 until around 2005 and then declined again by 15%. A second wave of coal decline started in 2013 and accelerated from 2014 onwards. In 2017, the

share of coal in power generation was down to 7% compared to 32% in 2000 and 65% in 1990.

Between 2012 and 2016, eight coal-fired power plants with a total generation capacity of 10.5 GW were permanently closed. In September 2018, another plant with 1.9 GW was closed with the intention to convert it to gas. This leaves the UK with seven operational coal power plants (11.4 GW) at the time of writing. Some of these are in stand-by reserve and another 1.3 GW are announced to be converted to gas as well.

Our study begins in 2000. This is because at this time concerns over climate change and sustainability ambitions started to reach the policy scene, and the energy mix started to shift towards more renewable energy use. Hence, years from the new millennium onwards offer a fruitful period to examine trends from the perspective of sustainability transitions. Moreover, the first wave of decline in the UK has been covered by previous research in historical analyses (Turnheim and Geels, 2012) and through media discourse coverage (Lovell, 2008; Lovell et al., 2009; Teräväinen et al., 2011; Teräväinen, 2014). Hence, we focus on more recent developments that warrant more scholarly attention.

4 Research design and data

We take a two-step approach to our analysis. By reporting from extant literature, energy statistics and policy events, we outline background information for the second wave of decline in more detail. In addition, we investigate the storylines on coal made by different groups of actors. This is done by conducting a discourse analysis on newspaper articles from The Guardian. Both steps were interdependent and the findings informed one another. Next, we discuss the discursive methodology, data and limitations of our approach.

4.1 Argumentative discourse analysis

We chose a discursive approach to this study. In line with recent transitions literature, we highlight the importance of examining discourse to better understand transition dynamics that are uncertain and highly contested (Bosman et al., 2014; Isoaho and Karhunmaa, 2019). We also wish to contribute to the increasing number of studies that have already applied discursive methods to examine coal phase-out in other places (Lehotský et al., 2019; Leipprand and Flachslund 2018; Rosenbloom 2017; Trencher et al., 2019). By adopting a similar approach, we want to prepare for much needed comparative insights across different settings.

We draw from the argumentative discourse analysis methodology (ADA) developed by Hajer (1995). In particular, we draw on the concept of storyline to understand discursive structure (what kind of arguments dominate in coal discourse) and how actor configurations emerge around these storylines. Storylines are defined here as “sub-discourse” that assign meaning to social or physical phenomena. They refer to selected components of the broader discourse through which actors explain, substantiate or (de)legitimizing ideas, concepts and arguments about policy issues (Hajer, 1995, p. 64-65). In other words, through storylines, actors give meaning to complex phenomena by selecting certain aspects of the discourse while excluding other alternatives.

We chose to draw from ADA specifically for two reasons. First, ADA lends itself to the study of contested environmental issues. Hajer (1995) views environmental politics as an argumentative struggle over gaining ‘discursive hegemony’. Storylines are offered as a key concept here: As new storylines emerge, they challenge the dominant discourses and eventually re-order the policy environment. This method complements our understanding of coal decline dynamics as it reveals which discursive constructions have become authoritative, and how these are challenged. Second, ADA was deemed useful as it assumes that actors’ discursive arguments are not static but rather change over time. The approach thus is well suited to trace shifts in actors’ discursive positions over time.

We chose to conduct the discourse analysis on newspaper data. While political discourse takes place in many formal and informal platforms, we argue that news media is today an important outlet where fights over defining policy-issues are fought (Boykoff, 2011 Hansen, 2010). News media can be viewed as an active arena in which policy-makers are communicating their strategies and interests to influence the framing of policy problems. Furthermore, looking into news articles is useful as it allows grasping the voices of many niche actors (Leipprand and Flachsland, 2018).

4.2 Data sources

We consulted UK energy policy literature and statistical data from the International Energy Agency (IEA) to form a picture of the policy landscape and energy mix dynamics for the second wave of decline. To collect the data for the discourse analysis, we engaged in data scoping before collecting the final data set.

For data scoping, we first ran test searches in the LexisNexis Academic database with different keyword combinations of ‘coal’, ‘decline’, ‘phase out’, ‘power’ and ‘electricity’ for different UK newspapers available in the database (The Guardian, The Independent, The Telegraph, The Sunday Telegraph, The Observer).

While our original intention was to report from two newspapers that represent different parts of the political spectrum, we chose to solely report from The Guardian. It was the only quality newspaper available at LexisNexis that widely covered energy policy, climate issues and coal use³. At the same time, relying upon just one source is not unproblematic as the results may be unbalanced. Studies have shown that right-leaning British media outlets such as Daily Telegraph or The Times give significantly more space to actors denying climate change, than left-leaning ones like The Guardian (Brüggemann and Engesser, 2017; Carvalho, 2007). Nonetheless, while The Guardian is likely to emphasise climate change in its reporting, it is also likely to give voice to a broader set of actors than its right-wing counterparts as a result.

To limit some of the potential bias of The Guardian, we excluded statements and storylines from journalists from the analysis. We only coded statements that had a societal actor attributed to it. We also discussed our main findings with two independent experts on British energy policy and made adaptations where necessary (e.g. with regard to the role of public policies). Moreover, fully aware of the remaining limitations, we will reflect our findings in the discussion against other studies on UK energy policy and also (briefly) against studies from other places on coal phase-out.

4.3 Data collection and analysis

The data set for the discourse analysis was created in two steps by using the Nexis-Lexis database. We used two search strings; one developed specifically to gather articles discussing coal phase out⁴, and the second one aimed at covering a more general discourse on coal and electricity⁵. These yielded 261 and 686 articles respectively. The final data set was compiled for the temporal scope 2000-2017 by excluding false positives (e.g. articles about domestic politics, housing, manufacturing, culture etc.) and duplicates from the sample. The articles were included if they mentioned coal phase out or decline at least once. This process resulted in 249 being included in the final data set, representing editorials, news articles and opinion pieces.

³ The Times could have also been a relevant source but it is not accessible via LexisNexisAcademic. Therefore, we could not use similar search strategy for it.

⁴ (GEOGRAPHIC(UK) AND (decline w/p coal) OR (phase-out w/p coal) AND (electricity OR power))

⁵ 1990-2017 + GEOGRAPHIC(UK) AND HLEAD(coal) AND LENGTH>500 AND (electricity OR power OR carbon OR decarbon! OR decline OR phase-out)

Table 1: Overview of storylines.

Storyline	Content-related statements	Illustrative example
D1 Coal is bad for climate	Emissions from coal contribute to climate change; to reduce GHG emissions coal plants have to be closed	“Reducing global coal consumption is a vital part of reaching our climate goals.”
D2 Coal is a health risk	Air emissions from coal fired power generation are negative for health; coal causes deaths	“If you live downstream of a coal-fired power plant your life expectancy is significantly shorter.”
D3 CCS is not a solution	CCS is a risky, costly and unproven technology	“The much-touted idea of “clean coal” has proved to be a fantasy. Carbon capture and storage is hopelessly uneconomic.”
D4 Coal is not needed	Coal not indispensable for the economy and security of supply	“Around the developed world, the age of coal is drawing to a close. Coal-fired power plants are closing down just about everywhere. They are being replaced by renewables and gas-fired plants, or rendered unnecessary by improved energy efficiency.”
L1 Coal is reliable	Coal has clear benefits vis-à-vis other energy sources, needed to keep the lights on	“We do need that coal to keep homes and businesses, our schools and hospitals, warm and powered with electricity.”
L2 Coal is cheap	Coal should be used as it is available, cheap and abundant	“It [coal] is the cheapest, easiest to get hold of, and by far the most abundant [of all the fossil fuels].”
L3 Coal is UK’s identity	Coal is part of the UK’s identity and history	“This country used to be called Great Britain and coal is part of what put ‘Great’ into that name.”
L4 CCS is a solution	CCS is a great way to avoid CO ₂ emissions; CCS also an economic opportunity for the UK	“CCS is critically important. It is the only way coal will have a long term future.”

Before the analysis of the entire data set, we explored a subset of articles to identify the main storylines. Every third article was included in this subset. Two researchers then analyzed this set of articles independently, inductively coding key issues related to coal discourse. After this coding of the data set, both researchers distilled storylines from the findings in an iterative manner. These results were then discussed and compared by the researchers. After several rounds of discussions and trials of analysis, the storylines were consolidated into eight final storylines based on their prevalence and how they related to each other (e.g. one storyline being a reply to another). Some of the earlier suggestions for storylines were dropped. For example, while we identified a storyline related to job loss, we did not include this into the final set as it was only mentioned occasionally and

mostly in relation to the decline of the mining industry (compared to electricity generation, which is the focus of this article). The eight storylines were further divided into delegitimizing (D) and legitimizing (L) storylines following Rosenbloom (2018). These are illustrated in Table 1.

A comprehensive analysis of all articles was done with the NVivo software. The two authors split the entire data set, coding storylines and the actors mobilizing them. The authors followed predefined steps for coding to assure they would apply codes in a similar manner. The codings were then double checked by one researcher.

In terms of actors, we coded all actor names and later grouped them (cf. Table). Categories for actor groups were created inductively and updated as the analysis went on. Coal power stations, energy suppliers, coal business and lobbyists were grouped under the category “coal incumbents”, while actors in coal mining, such as coal mine producers and owners and trade unions for mining, were coded into a separate “coal mining industry” category. EURACOAL, the European Association for Coal and Lignite, was categorized as a coal incumbent. This is because the association states to target activities in the whole process chain from extraction to coal use at power stations, even if most of its activities deal with coal extraction. Furthermore, we decided to separate environmental non-governmental organizations (e-NGOs) and green activists, the former consisting of green and civil society organizations, while the latter representing green social movements, climate change campaigners and individual activists. The full list of actors and actor groups is presented in Appendix 1.

The abovementioned analysis was done on news articles and opinion pieces to analyze and portrait the stances of various actors. In addition, we also conducted a media analysis on all articles (editorials, news articles and opinion pieces) to analyze the attention to coal in The Guardian and the general tone of the news. For this purpose, we coded each article on whether it conveys a positive, negative or neutral impression of coal. If the article contained an equal amount of both positive and negative statements, or no no value judgement at all, it was coded neutral. Where positive statements outweighed negative ones, the article was coded positive, and vice versa. Moreover, if the article explicitly mentioned coal phase-out as a term or discussed it as a policy trajectory, we attributed a “phase-out” code for it.

5 Results

To better illustrate the dynamics leading to coal decline, we divide our period of analysis into three phases, 2000-2007, 2008-2012 and 2013-2017. We use major changes in policies and changes in the energy mix to distinguish the phases, which we explain in more detail below. Figure 2 provides an overview of the

developments, including changes in electricity generation, ups and downs of attention in The Guardian for coal, and key events (policies and plant closures). The latter part of this section presents the results of the discourse analysis.

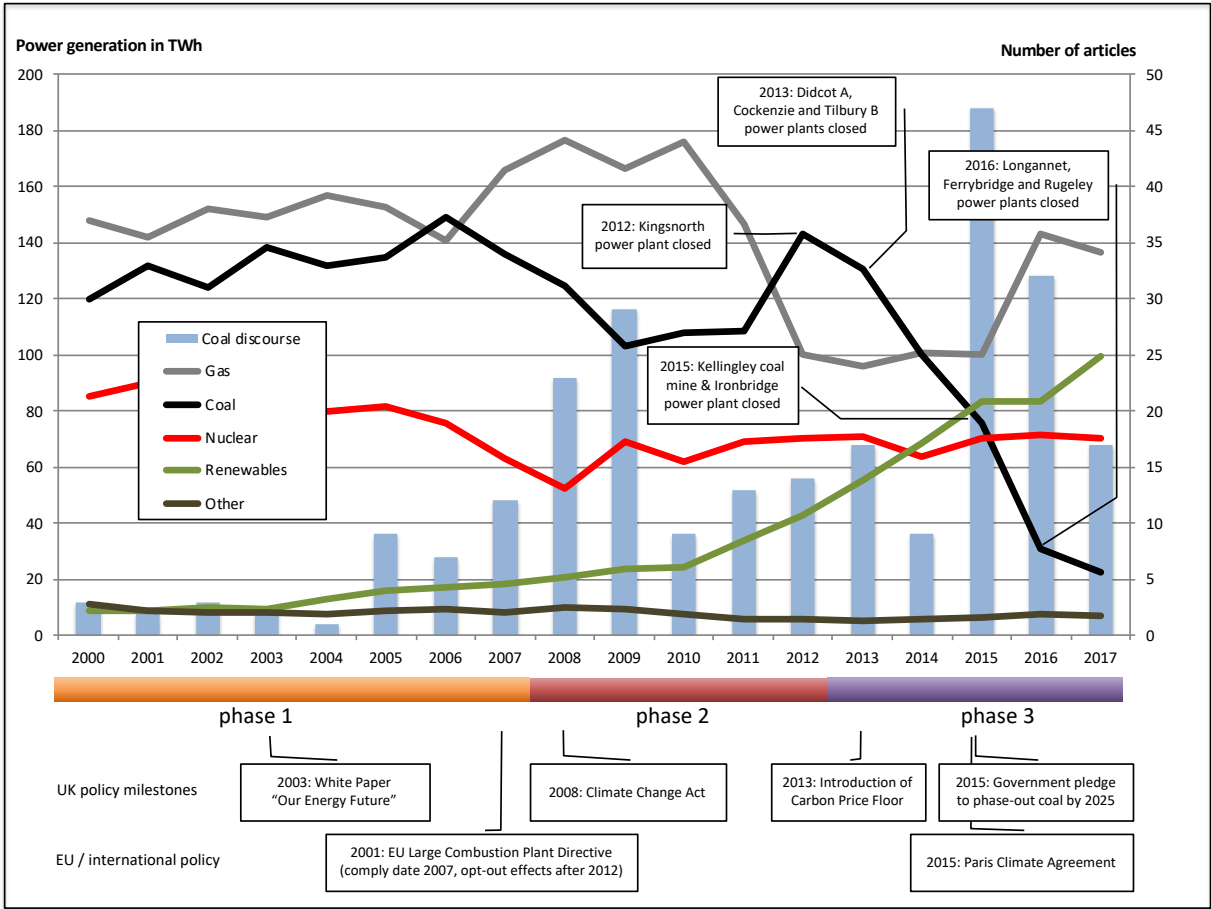


Figure 2: Three phases of coal decline in the UK from 2000-2017.

Phase 1: 2000-2007. The first phase represents a period in which energy technologies started shifting to the center of domestic policies and greater public awareness (Cass, 2016; Teräväinen et al., 2011). At the same time, a growing, albeit moderate, sense of urgency related to climate change and coal use reached the public discussion. Successive governments issued energy white papers and reviews in an attempt to make climate change a major pillar of the domestic energy policy. The UK climate change program of 2000 introduced the UK emission trading scheme, and the 2003 Energy white paper together with the 2006 Energy review outlined visions for sustainable energy use and set targets for renewable energy development (Cass, 2016; Lovell et al., 2009; Teräväinen, 2014). However, these documents and policies did not include decisions concerning the future of coal. Its share in the electricity mix was fluctuating in the first phase, as was the share of gas.

At the international level, the EU implemented the Large Combustion Plant Directive (LCPD, 2001/80/EC), which required member states to limit SO₂, NO_x

and dust emissions from large fossil fuel power stations. Existing plants either had to be upgraded or shut down eventually. The directive affected five coal plant closures from 2012 to 2015.

Attention to coal was low in the first years and only started to rise from 2005 onwards. Also, the majority of articles reported in a neutral way about coal, even though there were a few, which started to paint a negative picture (Figure 3). Coal was associated with climate change in almost every second article. Carbon-capture-and-storage (CCS) technology appeared as a potential solution towards the end of this period.

Phase 2: 2008-2012. The second phase starts with the launch of the Climate Change Act in 2008, which formulates an 80% greenhouse gas emissions reduction target for 2050 and aims to enable a ‘low-carbon economy’ (CCC, 2018). Especially at the beginning of this period, CCS technology was viewed as key for future coal use (Geels, 2014). CCS was a key pillar in “The UK Low Carbon Transition Plan”, launched in 2009. That same year, the climate secretary Ed Miliband announced that all new coal plants must be equipped with CCS.⁶ The government was to support the development of CCS technology by funding CCS R&D projects as well as by awarding funding for commercial-scale demonstration plants through a competition (Cotton et al., 2017).

In the second phase, the share of coal was still significant but fluctuating, while renewables saw a more rapid growth than before. The Kingsnorth power plant (1940 MW) closed in 2012. Attention to coal was higher throughout the entire period with a first peak in 2008 and 2009. Still, half of the articles were neutral, but the share of articles that leave the reader with a negative impression of coal doubled in comparison to the first phase (Figure 3). Also, the share of positive articles increased, so there was more of a polarization.

Phase 3: 2013-2017. The third phase is characterized by a rapid decline of coal over the entire period. Seven power plants with a capacity of 8’600 MW were permanently closed. Coal was replaced by renewable energies and natural gas (Figure 1).

The phase starts with the introduction of a Carbon Price Floor tax in 2013 (Inderberg and Wettestad, 2015). This increased the costs for coal-fired power generation and contributed to the decline. Originally intended to increase to £30 per ton of CO₂ until 2020, the tax was frozen at £18 in 2015 (Hirst, 2018).

⁶ In hindsight, this decision can be viewed as the beginning of the phase-out of traditional, i.e. unabated coal power plants. Back then, however, belief in CCS was strong and the government envisioned new clean plants instead of no new coal-fired power generation.

Internationally, the 2015 Paris Agreement was a major milestone. In this context, the UK government pledged to phase out all unabated coal from the country’s energy mix by 2025. At that time, however, coal decline was already well under way (DECC, 2016). While the government had provided funding for CCS R&D since phase 2, the CCS technology never took off – neither in the UK nor globally. The technology was thus dropped from the political agenda in 2015 when the government cancelled its plans to fund large-scale demonstration projects.

Media attention peaked in 2015 and was still high in 2016. In this final phase, coal was depicted in a distinctly more negative manner than in the previous phases. About two thirds of the articles in The Guardian painted a negative picture of coal, while one third were neutral and just three articles positive (Figure 3).

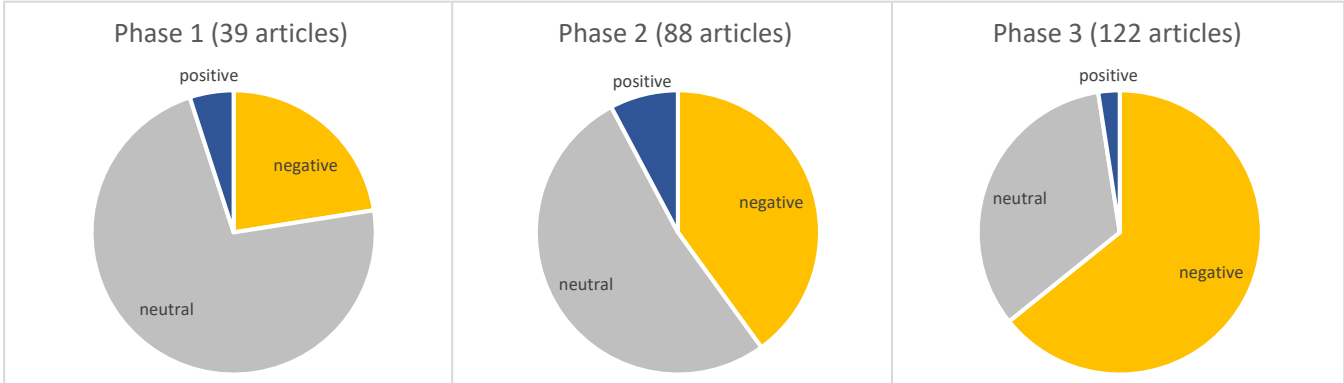


Figure 3: Tone of articles about coal-fired power generation.⁷

5.1 Discourse dynamics

Our discourse analysis shows that storylines, which delegitimize coal (green), dominate at all times with a slight dip in the second phase (Figure 4). Legitimation of coal (gray) is present in phase 1, increases in phase 2 and goes down significantly in phase 3. The five most active actor groups to engage in coal discourse are environmental non-governmental organizations (e-NGOs) mobilizing 19% of the storylines, the government (16%), researchers (15%), green activists (14%) and coal incumbents (13%). See Appendix 1 and 2 for lists of all actors engaged in the discourse on coal.

The most dominant storyline in all three phases is that coal-fired power generation is bad because it contributes to climate change (D1, Figure 5). This argument appears in more than 50% of the articles. It is most often mobilized by e-NGOs and green activists, but also other groups use this storyline. In our data set, climate

⁷ Here, the label “neutral” covers articles that presented either positive and negative values on coal in a balanced manner or no clear value judgement on coal.

change and coal contributing to it is never denied by any actor. The second most frequent storyline is that CCS (L4) is a solution. It is used in 20% of the articles.

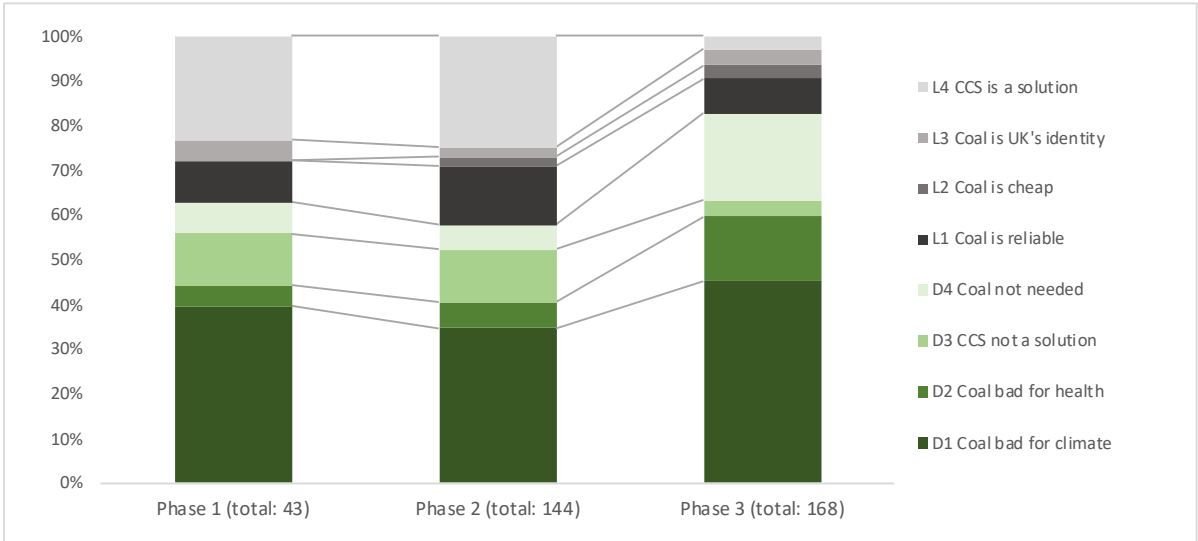


Figure 4: Share of storylines in each phase (gray - legitimizing coal, green - delegitimizing).

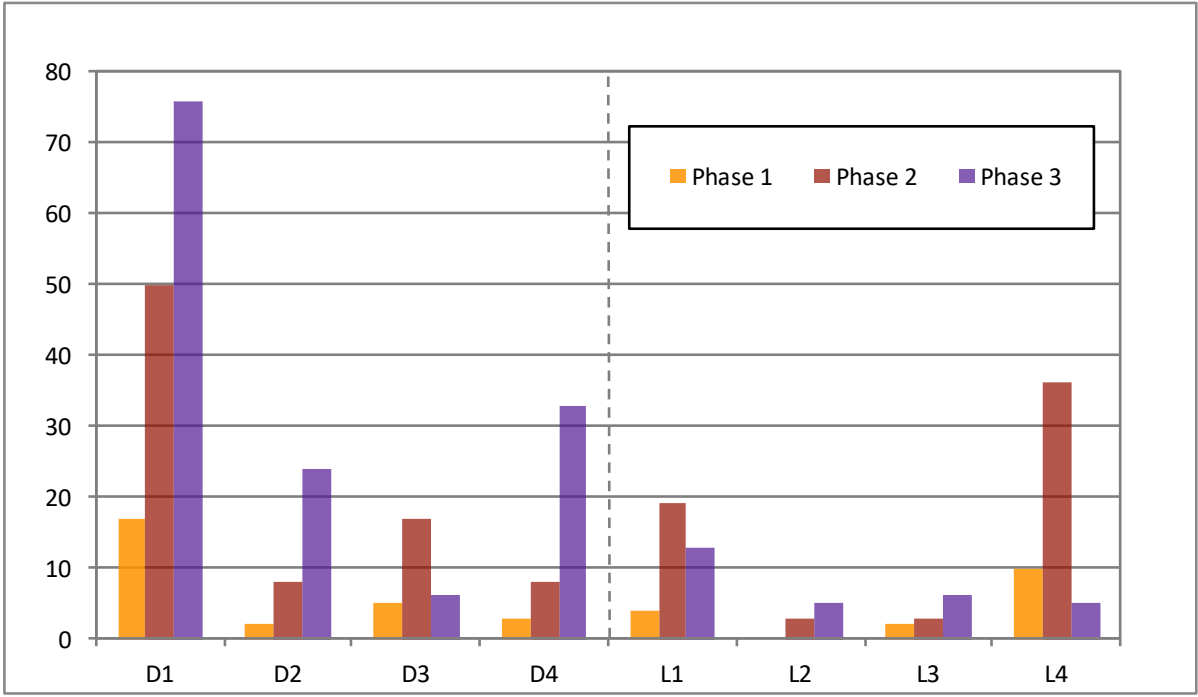


Figure 5: Absolute numbers of storylines in each phase.

When comparing the three phases, we see that after a rather quiet phase 1, phase 2 is characterized by a significant increase of legitimation work in favor of coal. It is primarily based on the ‘clean coal’ storyline around CCS (L4) but also on coal being reliable (L1). At the same time, criticism increased as well, both on the

grounds of coal being bad for the climate (D1) and CCS not working (D3). In the last phase, arguments for and against CCS (L4, D3) almost disappear completely. In addition, it is argued frequently that coal is not needed anymore but can be substituted by other sources (D4). In the following, we describe and analyze these dynamics in some more detail. All direct quotes are taken from our data set.

5.1.1 Phase 1: Climate change and the emerging promise of clean coal

In the first phase, the discourse on coal is largely influenced by e-NGOs, green activist groups and research institutes. They challenge the legitimacy of coal, highlighting the influence of coal use on climate change:

"Didcot is the second most polluting power station in Britain behind Drax in Yorkshire. Like most of Britain's power stations, two-thirds of the energy it generates is wasted, making a massive contribution to climate change."
(Greenpeace UK, 2006)

Some legitimizing work is done sporadically by political parties (mainly the Labour party) and the mining industry. Interestingly, at first, neither the government nor the coal incumbents actively engage in discussions on coal in a very frequent way or respond to the delegitimizing accounts mobilized by green groups and researchers. It almost seems as if they see no need to defend coal in the media as it is strong and established anyways.

However, some incumbent actors start acknowledging the reality of climate change in their discourse. For example, responding to climate activists' protests at their power station, the CEO of Drax acknowledges that "the carbon debate needs to be raised" due to climate change, while still positing that "among the coal stations, we're the lowest carbon emitter, per unit of electricity" (Drax, 2007). In this first phase, we also see the discussion about the prospects and role of 'clean coal' and the use of CCS technology emerging. Interestingly though, the CCS L4 storyline is mainly mentioned by e-NGOs, researchers and green activists at this stage.

In summary, we see a moderate discourse activity about coal and climate change in phase 1. CCS is viewed as a potential solution. There is not much legitimation in favor of coal going on. It seems that the status quo for the role of coal was still rather strong and incumbent actors might not have perceived much reason to engage in the discourse. The relatively low discourse activity of incumbent actors in phase 1 may also be a particularity of The Guardian being rather open to voices concerned about climate change.

5.1.2 Phase 2: Intense struggle over CCS technology

In phase 2, legitimizing accounts on coal gain ground and intensify. While negative effects on the climate is the main storyline also in this phase, we now see coal

incumbents and the government starting to actively 'fight back' to re-establish the legitimacy of coal. To do so, they harness the pro-CCS argument in their discourse and present coal use and climate mitigation as compatible (see the spike of L4 in Figure 5). Overall, the hype and debate over CCS technology (L4, D3) plays a central role in this phase.

While the relative emphasis of the pro and anti-CCS storylines does not significantly change from phase 1, both storylines are framed in a more urgent manner from 2008 onwards. It is now a heated debate between those who believe in the potential of CCS technology and those who either doubt its potential or view it as an excuse or a camouflage for the industry to continue burning coal. The mounting discussion on the prospects of clean coal is also fueled by positive statements from the government to support the development and commercialization of CCS technology through regulation and financial resources with the idea to make the UK an international leader in clean coal technologies:

"The recession and decisions of individual companies will not push us back from driving CCS forward with great urgency. There is no shortage of companies that want to come forward with projects and we are determined [to make sure] CCS happens quickly." (Energy and Climate Secretary Ed Miliband, 2009)

While the main actors in favor of CCS are the government, coal incumbents, researchers and political parties, there are also some green groups that see CCS as a useful technology due to the urgency of climate change. For instance, Friends of the Earth supports CCS in phase 1 and in the early stages of phase 2 on the grounds of clean coal being better than "going down the new nuclear road" (Friends of the Earth, 2007). Later, however, with more experiences available, they change their position on CCS.

In addition to CCS, we also see actors legitimizing coal on the grounds of reliability (L3) and costs (L2): "(c) coal generation has a significant contribution to the security of electricity supply in the UK today" (Scottish Power, 2009). The reliability storyline is questioned by green activists and NGOs, the renewables industry and researchers arguing that coal is not needed any more (D4) due to the availability of alternative energy technologies:

"[Britain has a] long standing love affair with the technologies of the 20th century, but as time goes by [the] fetish for coal and nuclear power looks increasingly naïve. All over the world jobs are being created in the renewable energy sector." (Greenpeace, 2008)

In short, phase 2 is characterized by the debate over CCS. Many actors combine climate storylines with the CCS argument in order to present coal and climate

mitigation a compatible and mutually non-exclusive solution. However, towards the end of this period, the struggle over CCS thins out as the earlier promises do not materialize. We also see actors simultaneously promoting both legitimizing and delegitimizing accounts, enabled by the CCS storylines. Note that The Guardian may have reported more extensively on actors advocating clean coal than on actors who downplay or question climate change altogether. At the same time, given that we see much discourse activity of incumbent actors and the government in this phase, it seems that we get a sufficient reflection of the different positions and arguments.

5.1.3 Phase 3: Battle is lost, no future for coal

In this phase, the delegitimizing storylines on coal are overwhelming. Akin to the two previous phases, the climate storyline (D1) is predominant. While it is advocated with similar arguments as in the latter two periods, e-NGOs also generate a variation of the D1 storyline in phase 3, arguing that financial investors such as British pension funds should withdraw from assets exposed to coal (extraction, power generation) because they harm the climate and become increasingly risky as this industry is in decline. From 2015 onwards, we also see a social movement around “divestment” that highlights the financial risk of coal investments for companies and individuals. In other words, the environmental D1 storyline is increasingly linked with economic arguments.

Another important change in this third phase is that the second most influential delegitimizing storyline is that coal is not needed any more (D4). Interestingly, this is not only visible in the increased importance of this storyline but also in terms of the actors promoting it. The RES industry, e-NGOs and green activists are now accompanied by the government and, to some extent, even by the coal industry on the use of this storyline. As Energy UK’s chief executive puts it (referring to coal):

"No one wants to be running the next Nokia. I want to drive change and move away from accepted (old-style) thinking." (Energy UK, 2016).

The arguments used to invoke the D4 storyline are also fueled by key events, such as the UK experiencing its first ever coal free day in electricity generation:

“The UK has plenty of options to cover the loss of coal-fired power through energy efficiency, renewables, interconnection with other countries and smart demand. This combination can deliver low-cost electricity reliably and quickly.”
(E3G, 2016)

Also note that in phase 3 we find a distinct and substantive storyline to delegitimize coal based on health arguments (D2). This argument is mainly mobilized by researchers and health professionals. Here, ending coal use is depicted to significantly reduce costs of the national health service. Coal is also

reflected against other societal risks as it is portrayed as “the second biggest public health threat” in the country, “killing more people than road accidents” (UK Health Alliance on Climate Change, 2016).

Finally, also in phase 3, there are still actors, mainly from the coal mining industry and local lobby groups, who hold on to a vision where coal plays a major role in the UK’s energy mix. Interestingly, they are returning to storylines around reliability and the symbolic role of coal for the UK – possibly because it is increasingly difficult to mobilize economic arguments in favor of coal at this time:

"They've knocked us down and down and down. You could understand we'd have to close if there was no market, but we're seven miles from Drax, the biggest coal-fired power station in Europe. (...) This country used to be called Great Britain and coal is part of what put 'Great' into that name." (National Union of Mineworkers, 2015)

“The most likely scenario is we’ll get to the point of 2025 and we realise we haven’t built the gas plants that we said we would, and we’re going to have to keep these coal plants operating anyway.” (World Coal Association, 2017)

To summarize, in phase 3 coal decline became a reality and only a few legitimizing voices are left in the discourse. Again, articles from The Guardian might be biased in this regard, but as the general picture of an industry moving away from coal is supported by other sources, it seems that we are not missing important voices.

5.2 *Changes in the positions of key actor groups*

In this section we take a closer look at the three most active groups of actors, the government, coal incumbents and e-NGOs, in order to track how their positions changed over time. Figure 6 provides an overview⁸.

5.2.1 UK Government: From clean coal to no coal

For most of the time covered in this study, the government viewed coal as an integral part of national power supply (L1 storyline, Figure 6). Acknowledging climate change as a challenge for coal (D1), the government took up the ‘clean coal’ narrative, strongly advocating for CCS technology (L4), especially around the beginning of phase 2.

"It would be impossible for any new coal power station to be built without being equipped with carbon capture and storage. While the details of an Emissions

⁸ While we report from the findings emerging from the Guardian, the results have been exposed to experts and conference audiences to triangulate and consolidate our findings.

Performance Standard are still being finalised, we are clear that without CCS it would be impossible to meet such a standard." (Energy and climate change secretary, 2010)

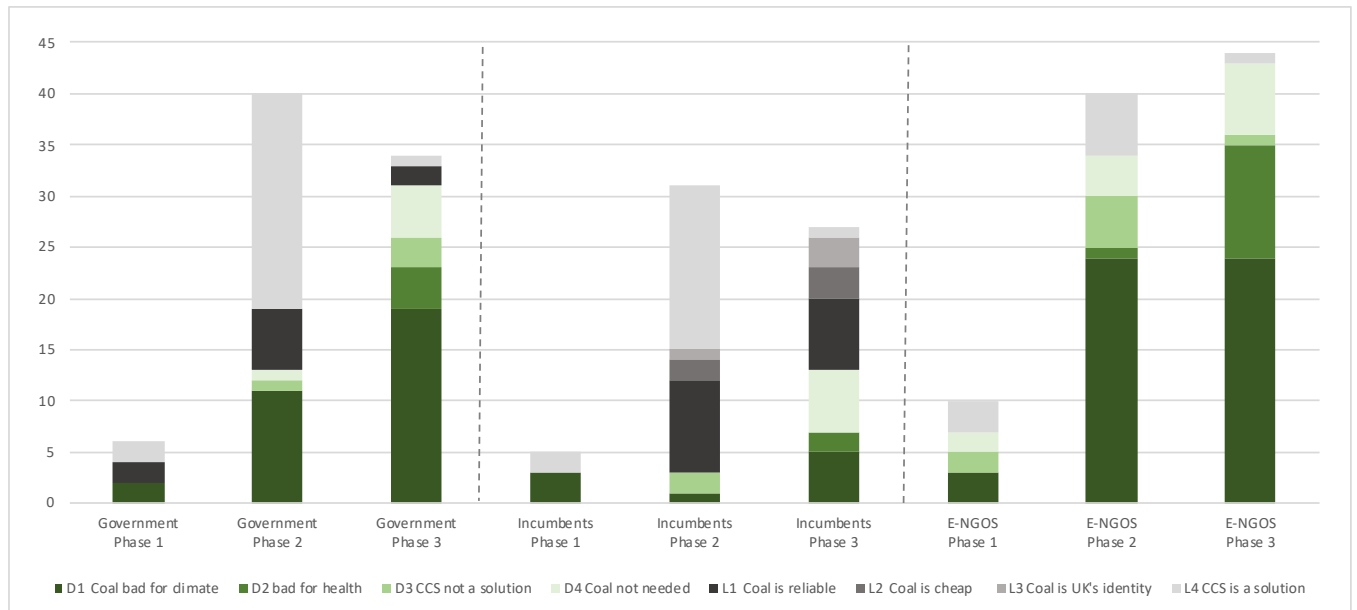


Figure 6: Changes in the storylines mobilized by the government, incumbents and environmental NGOs.

However, this rhetoric was all gone a few years later. While the government had tried to fund CCS pilots throughout phases 2 and 3, in 2015 it was clear that these would not materialize as the government cancelled a £1bn technology competition. Figure 6 shows how the CCS storyline (L4) becomes insignificant in phase 3.

The most central turning point came in November 2015, when the energy secretary Amber Rudd (Conservatives) announced to “reset” the UK’s energy policy by pledging to phase-out all coal-fired power generation by 2025. Following this pledge, the government more consistently and actively framed coal use as bad for climate and public health (D1, D2). In this period, the discourse shifted to the alternatives to coal (D4 coal is not needed). In government statements, conventional energies like gas and nuclear were mostly used to promote this storyline. In her 2015 pledge, Rudd already signaled that the coal phase-out would require investment in new gas plants. Rudd and the most recent energy ministers have also characterized gas as “a low-carbon technology”. At the same time, the government was hesitant in its discourse on renewable energies, which is a clear difference to the e-NGOs:

“At the moment renewables can’t be relied on, they are intermittent, and we need to have an absolute secure supply of electricity for homes and businesses”. (Energy and Climate Secretary Amber Rudd, 2015)

Hence, while the government’s stance on phasing out coal has been clear since late 2015, its position on the substitutes of coal plants appears less certain, with gas being favored the most.

5.2.2 Coal incumbents: Moving beyond coal faster than the government

While being rather silent in phase 1, the discourse by coal incumbents in phase 2 was similar to that of the government: there were high hopes for CCS technology. For example, in their discourse, Energy UK, the industry association that represents the business interests of electricity and gas suppliers, referred to CCS as a means to provide a future for coal and gas in the UK’s future energy mix.

The most active actors include the Scottish electricity generation companies, E.ON UK that had planned to develop a CCS power station at Kingsnorth before shelving the project in 2010, and the CCS Association group. Coal incumbents also pointed to the reliability of coal (L1, see Figure 6).

In phase 3, we see that the discourse of coal incumbents changes as more ‘green storylines’ appear. They adopted a more cautious view on coal’s hegemony. Energy UK made a U-turn in its position just one year after having argued for coal use with CCS. In 2015, the organization started to support the phase-out of coal-fired power stations, arguing that it is a vital part of the transition to a low carbon power sector. They also called for a long-term policy framework to ensure such a transition away from coal. It is important to note that this was even before the official phase-out pledge of the government.

Individual coal power stations and energy suppliers also started to move beyond coal ahead of the government. In the second phase, old and new energy sources were still viewed as complementary assets:

"Iberdrola is committed to developing the best technologies that will deliver low-carbon generation in this country. Through our existing co-firing capability of biomass with potential advances in carbon capture and storage technologies, we are ready to provide the flexible generation needed to support the UK's growth goals in renewable energy and at the same time ensure security of supply." (Iberdrola, owner of Scottish Power, 2009).

In phase 3, however, energy suppliers accept the end of coal. A good example of this is the Drax Group referring to coal phase out as a “reality” and the “writing on the wall” (D4), thus arguing that changes in their product portfolios are inevitable:

“We believe we are creating interesting options for our coal units to either be increased renewable generation or flexible gas generation to support low carbon future”. (Drax Group, 2017)

The discourse nicely shows how the positions of coal incumbents shifted over time. In the last phase, even representatives of the UK coal industry acknowledged that there is no future for their business. At the same time, they were developing alternatives for coal (e.g. gas and renewables) well before the government’s coal phase out pledge. In other words, incumbent actors were already prepared for coal phase-out when the government made the pledge, so there was little resistance in the media.

5.2.3 E-NGOs: Shifting concerns of energy policy watchdogs

The e-NGOs consistently engaged in discursive work to delegitimize coal based on the climate storyline (D1, see Figure 6). At the same time, they were advocating renewables. The e-NGOs did not go through major shifts in their position, unlike the government and the coal incumbents. A closer analysis, however, reveals two interesting discursive dilemmas.

First, there is divergence in the actors’ view on the coal versus nuclear debate, which is well illustrated with the positions of Greenpeace and Friends of the Earth during the debates over CCS (D3 vs. L4). Greenpeace clearly opposes nuclear because it is viewed as an extremely costly option for the UK:

"The publication of the draft nuclear national policy statement is a reminder of just how many hoops the industry has still to jump through. It shows that new nuclear is by no means a done deal. We don't need coal or nuclear, because proven green technologies such as wind and combined heat and power stations can secure Britain's energy needs, create green jobs and slash our emissions." (Greenpeace, 2009)

While also arguing for nuclear being expensive in recent years, Friends of the Earth was against new nuclear due to risks in nuclear security and proliferation:

“Are we really saying that every single country should have a civil nuclear system, because if we go down that route it is going to be very difficult to stop it elsewhere.” (Friends of the Earth, 2001)

Later, Friends of the Earth continued these arguments when they saw CCS as a less risky development than new nuclear. Similarly, the think tank Green Alliance also played an important role in promoting discourse in favor of CCS, arguing that industrial CCS clusters are the only way to achieve industrial decarbonization (Benton, 2015).

Second, we identify some inconsistency in the ways in which e-NGOs critique the government's energy policy decisions on coal. In phases 1 and 2, the e-NGOs mainly use climate and health storylines (D1, D2) to criticize the government on climate inaction. Interestingly, even in the first years of phase 3 when the share of coal already declined drastically, the e-NGOs continued this critique. It was not until 2016 (i.e. after the government phase-out pledge) that this critique changed its form.

Very recently, rather than focusing on coal, e-NGOs raised criticism over the technologies envisaged to substitute coal. Especially, substituting coal with gas was seen by some as yet another fossil fuel lock-in. In addition, the execution of the phase-out strategy also received criticism, especially with regard to the capacity market that assured continued income for coal:

"Amber Rudd deserves praise for deciding to phase out coal, and it's now clear that she needs to reform our outdated capacity market. Continuing to give hundreds of millions of pounds to coal is perverse and unnecessary. The UK can keep the lights on without coal if we get rid of the capacity market's bias against demand response and push ahead with new energy efficiency policy."
(Green Alliance, 2015)

In short, the e-NGOs consistently conveyed an anti-coal stance in their discourse using multiple delegitimizing storylines throughout the three phases. While e-NGOs consistently opposed nuclear, they highlighted different arguments in the coal vs. nuclear debate. In phase 3, the e-NGOs had started a new discursive battle to delegitimize natural gas.

5.3 Summary

Our analysis showed that coal and coal phase-out were contested in the UK and that e-NGOs were arguing in favor of phase-out, mobilizing primarily climate but also health arguments, while governments and incumbent actors were trying to legitimate coal – at least until 2015. A key element in the UK discourse was whether CCS (and 'clean coal') could be a solution. However, the debate around CCS pretty much disappeared after 2010, when earlier expectations around this technology did not materialize and renewables diffused more and more rapidly. Finally, power generation from coal declined from a 40% share to an almost complete phase-out in 2017. This decline happened much faster than most expected.

6 Discussion

This study explored the dynamics surrounding the rapid, and unprecedented, decline of coal in the UK, and traced storylines that different groups of actors mobilized in the struggle over the future of coal. Taken together, our results suggest a three-stage dynamic leading up to the decline. The first phase 1 (2000-2007) was characterized by low attention, ignorance and/or 'passive resistance' on the side of incumbents and policy makers. At the end of the first and beginning of the second phase 2 (2008-2012), attention increased rapidly and there was a heated debate around the future of coal with CCS as a potential 'technology fix'. Incumbents and policy makers became very active in the discourse and tried to re-establish the legitimacy of coal. Phase 3 (2013-2017), finally, was a period of rapid decline, with incumbents conceding and the policy decision to phase-out coal.

This dynamic is largely in line with the findings of earlier studies (Turnheim and Geels, 2012; Penna and Geels, 2012; Rosenbloom, 2018) that found similar patterns of ignorance or denial and incremental industry responses in early stages of 'regime destabilization', followed by increasing struggles that were eventually resolved by policy decisions, and final decline (which took longer than in our case). At the same time, there were also differences with regard to i) the intensity of contestation and resistance (which was lower than expected), ii) the role of policies (the 2015 phase-out pledge was less important than other policies) and iii) the role of technology and technological change (which was central). We will discuss these three issues in further detail below. The first speaks to the theme of this special issue, the second is key for public policy scholars and the third is a core topic of transition studies.

Resistance and contestation over energy technologies and policy, with e-NGOs and social movements criticizing existing practices and industry incumbents and governments defending them, are recurring findings in many studies (Hess, 2018; Smink et al., 2015; Trencher et al., 2019). However, we also found that resistance by incumbents in the UK was not as strong as suggested (Geels, 2014): Towards the end, industry actors acknowledged phase-out even before the government did and decline happened much faster than expected. Possible reasons for that include (i) the decline of domestic coal mining, which already happened in the 1980s and 90s and the associated weakening of the 'coal regime' (Turnheim and Geels, 2012), (ii) the age of British coal power plants (most of them were from before the 80s and at the end of their economic life time), and (iii) the fact that renewables and natural gas became or were available as alternatives (e.g. Winskel, 2002), (iv) most of which were developed and operated by the same incumbent firms (Geels et al., 2016). These issues also link to recent debates about what aspects determine the strength or stability of existing socio-technical regimes (Fuenfschilling and Truffer, 2014; Turnheim and Geels, 2012).

With regard to the role of public policies and the role of the state, we found that contrary to suggestions about the strong role of specific phase-out policies (Kivimaa and Kern, 2016; Rosenbloom, 2018; Stegmaier et al., 2014), coal decline was not a central element in the UK policy agenda until very recently. On the contrary, all British governments regardless of their political orientation framed coal as an important pillar of electricity supply. Only after coal had already declined significantly, policy finally announced a coal phase-out. This can be interpreted as a late, opportunistic decision, acknowledging ongoing developments, rather than providing long-term guidance. In fact, British politics have been typically leaning towards a 'hands off' role for government (McMeekin et al., 2019).

However, we do not claim that public policies played no role. They did. The EU directive on large power plants, British climate policy, including the climate change act and the carbon price floor, were all exerting pressure on coal-fired power generation (Wilson and Staffell, 2018). Also, earlier policy decisions in the 1980s and 90s around market liberalization and privatization very much weakened the existing socio-technical regime around coal mining and power generation (see above).

With regard to the role of technology and technological change in policy processes, we found two important developments. The first is about the expectations around CCS and the 'clean coal' framing. Echoing findings from previous studies (Chilvers et al., 2017; Geels, 2014), our analysis supports that the UK government had high hopes for this technology fix. Up to Phase 3, the government strategically privileged CCS in their discourse, arguing that it would open new business opportunities for technology export and help maintain established regime structures with large-scale, centralized power generation and incumbent actors. The weakness of this strategy was that it tied the future of coal to the success of CCS technology, which was an unproven, early stage technology at that time. When it became clear that CCS would be more expensive than anticipated and not to be realized any time soon, the legitimacy of both CCS and coal suffered and the defense line around clean coal collapsed.

In addition to that, also developments in renewable energies (which diffused rapidly and became much cheaper in recent years and) as well as natural gas played a central role as substitutes for coal. Arguments around renewables, e.g. whether they represent an economically viable and reliably energy source, were widely used to contest the role of coal in the energy mix and put pressure on decision-makers. These discursive contests mounted when technology dynamics were working very much against coal, with competing technologies (renewables and gas) getting stronger and complementary technologies (CCS) not delivering.

We highlight the role of technology development because it is central for transition studies and sometimes neglected in policy studies. Changes in technology can

affect and even facilitate policy change, and vice versa (Hoppmann et al., 2014; Markard et al., 2016; Schmidt and Sewerin, 2017). In our case, an important part of the discourse evolved around the perceived strengths and weaknesses of the various technologies with different actors seeking to legitimize (or delegitimize) their preferred options. This goes on to show that discourses of technology trajectories for public policy are continuously reproduced, negotiated and contested in the policy arena (Isoaho and Karhunmaa, 2019).

The issue of technology development also points to differences in scale: while important changes in policies often play out (and are analyzed) at national levels, technology dynamics tend to have a more global character. One, or a few countries (i.e. national public policies), may play a strong role in the early stages of technology development but international collaborations, industries and value-chains are crucial for strong positive feedbacks kicking in.

It is important to keep the interplay of contexts, material and contextual structures and discursive issues in mind when studying decline as a larger part of sustainability transitions. In Germany, for example, where domestic coal (lignite) mining is still ongoing, storylines around jobs and the future of specific regions show up as central elements in the discourse over coal phase-out (Leipprand and Flachslund, 2018). And in Ontario, where many coal power plants were located close to major cities, health arguments were the most central concern in the coal phase-out discourse (Rosenbloom, 2018). Against this background, it will certainly be interesting to analyze and compare more systematically how discourses over the future of coal unfold and affect policy making in different countries.

Before concluding, we briefly discuss the limitations of our study. As we report from articles published in *The Guardian*, we might have seen a lower number or different shares of legitimizing storylines, e.g. around security of supply, than in other newspapers (cf. section 4.3). However, as we discussed our findings with experts and at conferences audiences and also reflected them in the light of other studies on the UK energy transition, the general picture should be adequately balanced. Another limitation is that we started our analysis in 2000, while other relevant developments such as market liberalization and the associated ‘dash for gas’ (Winskel, 2002) or the decline of domestic coal mining (Winskel, 2002) happened earlier. As these dynamics have been thoroughly studied by others and were acknowledged above, we believe our observation period is justified. A third issue is whether our distinction of categories and counting of storylines is too much of a simplification of the complexity of discourse. We think that there are merits to our approach: some findings are quickly accessible and also easy to compare – across groups but, later, perhaps also across cases.

7 Conclusions and outlook

After a short, intense struggle, coal-fired power generation has declined steeply and it seems that the UK will become the first major industrialized country to phase-out coal for climate reasons. Our analysis has shown the storylines different actors groups mobilized and that the underlying ideas and interpretations played a key role in the observed policy and technology dynamics. We have also seen that the decline of fossil fuels can happen much faster and with less resistance than anticipated. As this is in part due to the particularities of the UK case, we expect that coal decline will be more difficult in Germany or the US, where e.g. domestic coal mining is still important or in fast growing countries like China (Schneider et al., 2016; Tyfield, 2014). Nonetheless, it is also a sign of hope that unsustainable technologies can be phased out quickly, if alternatives exist and are implemented at the same time.

With regard to energy transitions more broadly, our study raises the question whether we are currently witnessing a new phase of development (Markard, 2018b). The almost complete phase-out of a long-established energy source is certainly a novel phenomenon. We might see similar developments in other places in the near future. Some might also argue that rapid (coal) decline as in the UK is a sign of transitions accelerating (Roberts et al., 2018). At the same time though, transitions typically take long time (Grubler, 2012) and can be rather complex, due to the close interaction of multiple technologies (Markard and Hoffmann, 2016).

In the UK, for example, established technologies such as natural gas and nuclear still generate about 40% and 20% of the electricity, respectively. Renewables have done a great deal to replace coal but it is unclear whether they will also replace natural gas and nuclear. Moreover, in organizational and institutional terms, the UK energy transition pathway is moderate, instead of disruptive (Geels et al., 2016) and many ‘regime’ structures are still in place (e.g. large-scale power plants, subsidies for nuclear energy, supply-oriented business models, incumbent utility companies). So, instead of a complete overthrow of the existing (‘substitution’), we rather see a transformation or reconfiguration pathways with new technology providers (for wind and solar) but incumbent power suppliers.

To summarize, while coal phase-out in the UK is a promising development for the climate change challenge, there is still a long way to go for other countries to follow this lead and for other carbon-intense technologies to decline as well.

Acknowledgements

This work was supported by the Academy of Finland Grant 284972. Additional support came from the Swiss Competence Center for Energy Research (SCCER

CREST), financially supported by Innosuisse under Grant No. KTI 1155000154. We would also like to thank Julija Gergek, Kamilla Karhunmaa, Florian Kern, Julia Reinschmidt, Daniel Rosenbloom, Bruno Turnheim and Amanda Williams for their comments on earlier drafts. Special thanks go to the editors of the special issue, Carol Hager and Christoph Stefes.

References

- Benton, D., 2015. Decarbonising British industry - why industrial CCS clusters are the answer. Green Alliance, London.
- Bosman, R., Loorbach, D., Frantzeskaki, N., Pistorius, T., 2014. Discursive regime dynamics in the Dutch energy transition. *Environmental Innovation and Societal Transitions* 13, 45-59.
- Boykoff, M.T., 2011. *Who speaks for the climate?: Making sense of media reporting on climate change*. Cambridge University Press.
- Brüggemann, M., Engesser, S., 2017. Beyond false balance: how interpretive journalism shapes media coverage of climate change. *Global Environmental Change* 42, 58-67.
- Carvalho, A., 2007. Ideological cultures and media discourses on scientific knowledge: re-reading news on climate change. *Public Understanding of Science* 16, 223-243.
- Cass, L.R., 2016. Measuring the Domestic Salience of International Environmental Norms: Climate Change Norms in American, German and British Climate Policy Debates. 47-74.
- CCC, 2018. An independent assessment of the UK's Clean Growth Strategy – from ambition to action. Committee on Climate Change, www.theccc.org.uk/publications.
- Chilvers, J., Foxon, T.J., Galloway, S., Hammond, G.P., Infield, D., Leach, M., Pearson, P.J.G., Strachan, N., Strbac, G., Thomson, M., 2017. Realising transition pathways for a more electric, low-carbon energy system in the United Kingdom: Challenges, insights and opportunities. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy* 231, 440-477.
- Cotton, A., Gray, L., Maas, W., 2017. Learnings from the Shell Peterhead CCS Project Front End Engineering Design. *Energy Procedia* 114, 5663-5670.
- DECC, 2016. *New Direction for UK Energy Policy*. Department for Energy and Climate Change.
- Dryzek, J.S., 2001. Legitimacy and economy in deliberative democracy. *Political theory* 29, 651-669.
- Fischer, F., 2003. *Reframing Public Policy: Discursive Politics and Deliberative Practices*.
- Fischer, F., Gottweis, H., 2012. *The argumentative turn revisited: Public policy as communicative practice*. Duke University Press.
- Fuenfschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes - Conceptual foundations from institutional theory. *Research Policy* 43, 772-791.
- Fuenfschilling, L., Truffer, B., 2016. The interplay of institutions, actors and technologies in socio-technical systems — An analysis of transformations in the Australian urban water sector. *Technological Forecasting and Social Change* 103, 298-312.

- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* 31, 1257-1274.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions* 1, 24-40.
- Geels, F.W., 2014. Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory, Culture & Society* 31, 21-40.
- Geels, F.W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., Neukirch, M., Wassermann, S., 2016. The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990-2014). *Research Policy* 45, 896-913.
- Geels, F.W., Sovacool, B.K., Schwanen, T., Sorrell, S., 2017. Sociotechnical transitions for deep decarbonization. *Science* 357, 1242-1244.
- Geels, F.W., Verhees, B., 2011. Cultural legitimacy and framing struggles in innovation journeys: A cultural-performative perspective and a case study of Dutch nuclear energy (1945–1986). *Technological Forecasting and Social Change* 78, 910-930.
- Gillard, R., 2016. Unravelling the United Kingdom's climate policy consensus: The power of ideas, discourse and institutions. *Global Environmental Change* 40, 26-36.
- Grubler, A., 2012. Energy transitions research: Insights and cautionary tales. *Energy Policy* 50, 8-16.
- Hager, C., 2015. Germany's green energy revolution: Challenging the theory and practice of institutional change. *German Politics and Society* 33, 1-27.
- Hajer, M., Versteeg, W., 2005. A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. *Journal of Environmental Policy and Planning* 7, 175-184.
- Hajer, M.A., 1995. *The Politics of Environmental Discourse*. Oxford University Press.
- Hansen, A., 2010. *Environment, media and communication*. Routledge.
- Hess, D.J., 2014. Sustainability transitions: A political coalition perspective. *Research Policy* 43, 278-283.
- Hess, D.J., 2016. The politics of niche-regime conflicts: Distributed solar energy in the United States. *Environmental Innovation and Societal Transitions* 19, 42-50.
- Hess, D.J., 2018. Energy democracy and social movements: A multi-coalition perspective on the politics of sustainability transitions. *Energy Research and Social Science* 40, 177-189.
- Hirst, D., 2018. Carbon Price Floor (CPF) and the price support mechanism. Number 05927. House of Commons Library.
- Hoppmann, J., Huenteler, J., Girod, B., 2014. Compulsive policy-making—The evolution of the German feed-in tariff system for solar photovoltaic power. *Research Policy* 43, 1422-1441.
- Howlett, M., Ramesh, M., Perl, A., 2009. *Studying public policy: Policy cycles and policy subsystems*. Oxford University Press.
- Inderberg, T.H., Wettestad, J., 2015. Carbon capture and storage in the UK and Germany: easier task, stronger commitment? *Environmental Politics*.
- Isoaho, K., Karhunmaa, K., 2019. A critical review of discursive approaches in energy transitions. *Energy Policy* 128, 930-942.

- Johnstone, P., Hielscher, S., 2017. Phasing out coal, sustaining coal communities? Living with technological decline in sustainability pathways. *The Extractive Industries and Society* 4, 457-461.
- Kern, F., 2011. Ideas, Institutions, and Interests: Explaining Policy Divergence in Fostering 'System Innovations' towards Sustainability. *Environment and Planning C: Government and Policy* 29, 1116-1134.
- Kern, F., 2012. The discursive politics of governing transitions towards sustainability: the UK Carbon Trust. *International Journal of Sustainable Development* 15, 90-106.
- Kern, F., Rogge, K.S., 2018. Harnessing theories of the policy process for analysing the politics of sustainability transitions: A critical survey. *Environmental Innovation and Societal Transitions* 27, 102-117.
- Kivimaa, P., Kern, F., 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Research Policy* 45, 205-217.
- Köhler, J., Geels, F.W., Kern, F., Markard, J., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Onsongo, E., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions* 31, 1-32.
- Kunzl, G., 2015. Stewards or sticklers for change? Incumbent energy providers and the politics of the German energy transition. *Energy Research & Social Science* 8, 13-23.
- Kunzl, G., Geels, F.W., 2018. Sequence and alignment of external pressures in industry destabilisation: Understanding the downfall of incumbent utilities in the German energy transition (1998–2015). *Environmental Innovation and Societal Transitions* 26, 78-100.
- Lauber, V., Jacobsson, S., 2016. The politics and economics of constructing, contesting and restricting socio-political space for renewables - The German Renewable Energy Act. *Environmental Innovation and Societal Transitions* 18, 147-163.
- Lehotský, L., Černoč, F., Osička, J., Ocelík, P., 2019. When climate change is missing: Media discourse on coal mining in the Czech Republic. *Energy Policy* 129, 774-786.
- Leipprand, A., Flachsland, C., 2018. Regime destabilization in energy transitions: The German debate on the future of coal. *Energy Research and Social Science* 40, 190-204.
- Lovell, H., 2008. Discourse and innovation journeys: The case of low energy housing in the UK. *Technology Analysis and Strategic Management* 20, 613-632.
- Lovell, H., Bulkeley, H., Owens, S., 2009. Converging agendas? Energy and climate change policies in the UK. *Environment and Planning C: Government and Policy* 27, 90-109.
- Markard, J., 2018a. The life cycle of technological innovation systems. *Technological Forecasting and Social Change*.
- Markard, J., 2018b. The next phase of the energy transition and its implications for research and policy. *Nature Energy* 3, 628-633.
- Markard, J., Hoffmann, V.H., 2016. Analysis of complementarities: Framework and examples from the energy transition. *Technological Forecasting and Social Change* 111, 63-75.

- Markard, J., Raven, R., Truffer, B., 2012. Sustainability Transitions: An emerging field of research and its prospects. *Research Policy* 41, 955-967.
- Markard, J., Suter, M., Ingold, K., 2016. Socio-technical transitions and policy change – Advocacy coalitions in Swiss energy policy. *Environmental Innovation and Societal Transitions* 18, 215-237.
- McMeekin, A., Geels, F.W., Hodson, M., 2019. Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990–2016). *Research Policy*.
- Meadowcroft, J., 2011. Engaging with the politics of sustainability transitions. *Environmental Innovation and Societal Transitions* 1, 70-75.
- Meckling, J., 2011. The Globalization of Carbon Trading: Transnational Business Coalitions in Climate Politics. *Global Environmental Politics* 11, 26-50.
- Meckling, J., Sterner, T., Wagner, G., 2017. Policy sequencing toward decarbonization. *Nature Energy* 2, 918-922.
- Mitchell, C., 2016. Momentum is increasing towards a flexible electricity system based on renewables. *Nature Energy* 1, 15030.
- Penna, C.C.R., Geels, F.W., 2012. Multi-dimensional struggles in the greening of industry: A dialectic issue lifecycle model and case study. *Technological Forecasting and Social Change* 79, 999-1020.
- Roberts, C., Geels, F.W., Lockwood, M., Newell, P., Schmitz, H., Turnheim, B., Jordan, A., 2018. The politics of accelerating low-carbon transitions: Towards a new research agenda. *Energy Research and Social Science* 44, 304-311.
- Rosenbloom, D., 2018. Framing low-carbon pathways: A discursive analysis of contending storylines surrounding the phase-out of coal-fired power in Ontario. *Environmental Innovation and Societal Transitions* 27, 129-145.
- Rosenbloom, D., Berton, H., Meadowcroft, J., 2016. Framing the sun: A discursive approach to understanding multi-dimensional interactions within socio-technical transitions through the case of solar electricity in Ontario, Canada. *Research Policy* 45, 1275-1290.
- Rosenbloom, D., Haley, B., Meadowcroft, J., 2018. Critical choices and the politics of decarbonization pathways: Exploring branching points surrounding low-carbon transitions in Canadian electricity systems. *Energy Research and Social Science* 37, 22-36.
- Sabatier, P., 2007. *Theories of the policy process*. Westview Press, Boulder.
- Sarasini, S., 2013. Institutional work and climate change: Corporate political action in the Swedish electricity industry. *Energy Policy* 56, 480-489.
- Schmidt, T.S., Sewerin, S., 2017. Technology as a driver of climate and energy politics. *Nature Energy* 2, 17084.
- Schneider, J., Schwarze, S., Bsumek, P.K., Peeples, J., 2016. *Under pressure: Coal industry rhetoric and neoliberalism*. Springer.
- Smink, M.M., Hekkert, M.P., Negro, S.O., 2015. Keeping sustainable innovation on a leash? Exploring incumbents' institutional strategies. *Business Strategy and the Environment* 24, 86-101.
- Stefes, C.H., 2016. Critical junctures and the German energiewende, Germany's Energy Transition: A Comparative Perspective, pp. 63-89.

- Stegmaier, P., Kuhlmann, S., Visser, V.R., 2014. The discontinuation of socio-technical systems as a governance problem, in: Borrás, S., Edler, J. (Eds.), *The governance of socio-technical systems*. Edward Elgar, Cheltenham, pp. 111-131.
- Stirling, A., 2014. Transforming power: Social science and the politics of energy choices. *Energy Research & Social Science* 1, 83-95.
- Teräväinen, T., 2014. Representations of energy policy and technology in British and Finnish newspaper media: A comparative perspective. *Public Understanding of Science*.
- Teräväinen, T., Lehtonen, M., Martiskainen, M., 2011. Climate change, energy security, and risk-debating nuclear new build in Finland, France and the UK. *Energy Policy* 39, 3434-3442.
- Trencher, G., Healy, N., Hasegawa, K., Asuka, J., 2019. Discursive resistance to phasing out coal-fired electricity: Narratives in Japan's coal regime. *Energy Policy* 132, 782-796.
- Turnheim, B., Geels, F.W., 2012. Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913-1997). *Energy Policy* 50, 35-49.
- Turnheim, B., Geels, F.W., 2013. The destabilisation of existing regimes: Confronting a multi-dimensional framework with a case study of the British coal industry (1913-1967). *Research Policy* 42, 1749-1767.
- Tyfield, D., 2014. 'King Coal is Dead! Long Live the King!': The Paradoxes of Coal's Resurgence in the Emergence of Global Low-Carbon Societies. *Theory, Culture & Society* 31, 59-81.
- UNEP, 2016. *The Emissions Gap Report 2016*. Nairobi, p. 86.
- Wilson, I.G., Staffell, I., 2018. Rapid fuel switching from coal to natural gas through effective carbon pricing. *Nature Energy* 3, 365.
- Winkel, M., 2002. When systems are overthrown: the 'dash for gas' in the British electricity supply industry. *Social Studies of Science* 32, 563-598.
- Yearley, S., 2005. *Making sense of science: understanding the social study of science*. Sage, London.