# The destabilisation of existing regimes in socio-technical transitions:

*Theoretical explorations and in-depth case studies of the British coal industry (1880-2011)*

**Bruno Turnheim**

A thesis submitted in March 2012 in partial fulfilment of the requirements for the degree of

*Doctor of Philosophy*

**SPRU - Science and Technology Policy Research**
**University of Sussex**

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

**Signature**: ............................................

Bruno Turnheim

**Le mépris (II/IV), Bernard Frize, February 1982**

**Watercolor and collage on paper, private collection**

UNIVERSITY OF SUSSEX

Bruno Turnheim, DPhil in Science and Technology Policy Studies

**The destabilisation of existing regimes in socio-technical transitions: Theoretical explorations and in-depth case studies of the British coal industry (1880-2011)**

## Summary

This thesis, which addresses an innovation studies audience, deals with a neglected topic in the study of socio-technical transitions: the destabilisation and decline of established industries. While most of the transitions literature focuses on the emergence of novelty, this thesis investigates the productive role of destabilisation and processes of *un*locking of existing regimes.

The research question is:

*How can we understand the unfolding of industry destabilisation processes?*

To answer this question, this thesis aims to make theoretical contributions by developing an integrative framework that overcomes shortcomings in existing views of destabilisation. Insights from a number of different approaches are mobilised as 'building blocks' for theoretical elaboration. Destabilisation is understood as a process involving: 1) multiple interacting pressures, 2) industry strategies and responses to (economic and legitimacy) challenges, and 3) decreasing commitment to industry regime rules. The theoretical perspective addresses: a) destabilisation as a long-term unfolding process, b) the multi-dimensional and co-evolutionary nature of destabilisation, and c) the role of normative problems in destabilisation.

To assess the robustness of the conceptual perspective, the thesis studies three cases of destabilisation:

- The destabilisation of the British coal industry in the transition from the omnipresence of coal to a four-fuel economy (1880-1967)
- The destabilisation and decline of British deep coal mining in the electricity sector (1967-1997)
- The destabilisation of coal use in the transition towards low-carbon electricity (1990-2011). Possible revival?

The case studies show the usefulness of the conceptual framework. The analysis of patterns and causal mechanisms further identifies similarities and differences of destabilisation pathways in the cases. Specificities in the kinds, rates, interaction and timing of these dynamics produce different destabilisation patterns.

# *Table of Contents*

# *List of Figures*

# *List of Tables*

# *List of Abbreviations*

| | |
|---|---|
| ARA | Amsterdam-Rotterdam-Antwerp |
| ATM | Advanced Technology Mining |
| BC | British Coal |
| BCURA | British Coal Utilisation Research Association |
| CAA | Clean Air Act |
| CBI | Confederation of British Industry |
| CC | Climate Change |
| CCC | Coalfield Communities Campaign |
| CCL | Climate Change Levy |
| CCGT | Combined Cycle Gas Turbine |
| CCS | Carbon Capture and Storage |
| CCSA | Carbon Capture and Storage Association |
| CEE | Central Engineering Establishment |
| CEGB | Central Electricity Generating Board |
| CLRTAP | Convention on Long-Range Transboundary Air Pollution |
| $CO_2$ | Carbon Dioxide |
| CPS | Centre for Policy Studies |
| CRE | Coal Research Establishment |
| CSAS | Coal Smoke Abatement Society |
| CUC | Coal Utilisation Council |
| DBERR | Department for Business, Enterprise and Regulatory Reform |
| DECC | Department of Energy and Climate Change |
| DoE | Department of the Environment |
| DTI | Department of Trade and Industry |
| EC | European Community |

| | |
|---|---|
| EdF | Electricité de France |
| EMR | Electricity Market Reform |
| ESI | Electricity Supply Industry |
| ETS | Emission Trading Scheme |
| EU | European Union |
| FBC | Fluidised Bed Combustion |
| FBI | Federation of British Industries |
| FGD | Flue Gas Desulphurisation |
| FoE | Friends of the Earth |
| GHG | Greenhouse Gas |
| GJ | Gigajoules |
| HDFE | Heavy Duty Face Equipment |
| HQTD | Headquarters Technical Department |
| HMSO | Her Majesty's Stationery Office |
| HoC | House of Commons |
| HoL | House of Lords |
| IEA | International Energy Agency |
| IGCC | Integrated Gasification Combined Cycle |
| IPCC | Intergovernmental Panel on Climate Change |
| JU | Joint Understanding |
| LCPD | Large Combustion Plant Directive |
| LME | Liberal Market Economy |
| CME | Coordinated Market Economy |
| MAGB | Mineowners Association of Great Britain |
| MFGB | Miners' Federation of Great Britain |
| MINOS | Mine Operating System |

| | |
|---|---|
| MMC | Monopolies and Mergers Commission |
| MRDE | Mining Research and Development Establishment |
| MRE | Mining Research Establishment |
| MW | Megawatt |
| NCB | National Coal Board |
| NGO | Non-Governmental Organisation |
| NP | National Power |
| NUM | National Union of Mineworkers |
| OCCS | Office of Carbon Capture and Storage |
| OE | Opencast Executive |
| OECD | Organisation for Economic Cooperation and Development |
| OFFER | Office of Electricity Regulation |
| OMS | Output per Manshift |
| ONR | Office for Nuclear Regulation |
| NFFO | Non Fossil Fuel Obligation |
| PFBC | Pressurised Fluidised Bed Combustion |
| PG | PowerGen |
| PM | Prime Minister |
| RCEP | Royal Commission on Environmental Pollution |
| R&D | Research and Development |
| RD&D | Research, Development and Demonstration |
| RO | Renewables Obligation |
| SALGB | Smoke Abatement League of Great Britain |
| SWAP | Surface Waters Acidification Programme |
| TSO | The Stationery Office |
| UDM | Union of Democratic Mineworkers |

| | |
|---|---|
| UK | United Kingdom |
| US | United States of America |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WOCOL | World Coal Study |
| WP | White Paper |
| WWF | World Wildlife Fund |

# *Acknowledgements*

The research reported in this thesis has been carried out and written at SPRU, University of Sussex. It was supported by an ERC grant (No. 204246), for which I am very grateful, in the context of the DESTABLE project.

I wish to thank my supervisors, Professors Frank W. Geels and Andrew Stirling for their intellectual stimulation, ongoing support and warm encouragements. Their established academic excellence and international reputations preceding them, they have become role models, and have set high academic standards for me to live up to. Professor Frank Geels – in his qualities of project leader, principal supervisor and co-author – has been in a position to interact most closely with me. I am grateful for his generous transmission of knowledge – formal and tacit –, patience, dedication and eagerness to see me engage with academic communities from the very beginning of the doctoral process. Like any relationship, it has not always been an easy one, but together we have been able to build up trust, understanding and, I hope, a true sense of mutual esteem. Surprisingly, it is his forthrightness and ability to critique my work frankly that I have cherished the most.
Professor Andy Stirling has provided me a no less valuable, more hands-off kind of guidance, challenging my ideas and intellectual production from a somewhat greater distance, as justified by his lesser formal supervision duties, but also by his inclination to question the more philosophical and normative implications of my line of thought. I am grateful for his input, which certainly has contributed to deepen my analysis. On a more personal level, sharing an office space with him over these years has been a most enjoyable experience, which has also provided me first-hand access to the workings of academia and its responsibilities.
Essential to the completion of my thesis, of course, were Caetano Penna and Bram Verhees, whom I wish to thank for their moral and intellectual support throughout this journey that we shared as peers and the friendship that has resulted.
I am indebted to SPRU alumni, Professor Staffan Jacobsson, who supervised my MSc. at Chalmers University, for comforting my intuitions and encouraging me to go down the academic path in the exciting field of science and technology studies.
I also wish to thank colleagues at SPRU more generally, who together make up SPRU's truly interdisciplinary research environment. I have benefitted from abundant opportunities for open intellectual exchange, ranging from organised seminars and discussions to corridor chat at the Freeman Centre and its surroundings. Such discussions were carried well beyond the University's boundaries, in the wonderful pubs of Brighton and Hove. I would like to personally thank Rob Byrne, Florian Kern, Roberto Camerani, Kai Ilchmann, Adrian Smith, Markku Lehtonen, Ruud Kempener, Christophe Rynikiewicz, Erik Millstone, and the entirety of the Sussex Energy Group for contributing to an intellectually stimulating environment.
I would like to thank my interviewees and informants for their availability and insights. I am grateful to Peter Pearson, Ed Steinmüller, Mike Parker, Roger Fouquet, Nick von Tunzelmann, Nathan Rosenberg, Arnulf Grübler, Johan Schot, Geert Verbong and Jonathan Köhler for their constructive engagement at various stages of the work presented in this thesis.

I would like to thank my friends in Brighton, London and Paris, for their enduring support. In Brighton, Javier for hosting me endless number of times in exchange for cheese and wine, and Jari James for keeping me in high spirits. In London, Alex and David for their generous presence. In Paris, my thoughts go particularly to the Barbès community, where anything is possible – including delivering a dissertation roughly according to schedule. Special thanks to Emiland, Victor and Marine for the winter and summer sunshine. I am grateful to École for providing me office space in Paris. Finally, to my family. I would like to express a thought for my father, the late Michael Turnheim, for passing on to me the taste for intellectual matters. Our struggle against his cancer taught me that some battles cannot be won, irrespective of hope and technological sophistication. I would also like to thank my mother, without whom none of this would have been possible, as well as Max, Gala and Alix for sharing their love and laughter, and Stefan and Lucy for being their counterpart in London.

# 1 Introduction: the destabilisation of socio-technical systems

This thesis is about the destabilisation of established industries. Industry destabilisation is related to technological transitions and often parallels the emergence of novel technological systems. As such, destabilisation can be seen as the ‘flipside’ of the emergence of novelty in transitions.

This topic is relevant to the societal debate on transitions to sustainability. Focussing on destabilisation may lead to new insights on how to accelerate and provide direction to transition processes.

Furthermore, this topic is relevant to academic debates in the transitions literature. Destabilisation remains a neglected topic in transitions research. Addressing it thus promises to open up a new research agenda.

## *1.1 Background motivations*

Contemporary societies face unprecedented environmental and sustainability challenges. Environmental problems have been worsening in the past decades, with issues such as climate change, resource depletion, biodiversity loss, etc. coming to the fore of public and political debates. Avoiding dangerous climate change has emerged as a substantial challenge of the 21$^{st}$ century (UNFCCC 2011). With continued global energy demand growth, global CO2 concentrations are still rising (IPCC 2007) and are expected to keep on rising in the coming decades under current assumptions, business practices and policies (IEA 2011). Stabilising CO2 and other GHG concentration to 450ppm in order to increase our chances of limiting global temperature increase to 2ºC “is likely to be very difficult and costly” (Stern 2007:338) and unlikely to be achieved without strong policy commitments and a “far-reaching transformation of the global energy system” (IEA 2010).

The scale and importance of the climate problem have been increasingly recognised by governments, organisations and individuals throughout the world, leading to calls for rapid transitions to low-carbon economies (Stern 2007, DTI 2007, DECC 2011b, IEA 2011). Addressing such *societal challenges* calls for the deep structural transformation of socio-economic systems in more sustainable directions (Unruh 2002). This means fundamentally changing the structure of existing societal domains such as energy, transport, agri-food, housing, and water supply. However, because environmental problems in general, and climate change in particular, relate to public goods (Stern 2007), there are no clear short-term economic incentives to address them:

> "The climate is a public good: those who fail to pay for it cannot be excluded from enjoying its benefits and one person's enjoyment of the climate does not diminish the capacity of others to enjoy it too. Markets do not automatically provide the right type and quantity of public goods, because in the absence of public policy there are limited or no returns to private investors for doing so: in this case, markets for relevant goods and services (energy, land use, innovation, etc.) do not reflect the consequences of different consumption and investment choices for the climate. Thus, climate change is an example of market failure involving externalities and public goods." (Stern 2007:25)

Solving the climate problem is thus likely to require public intervention, as industry alone will not enact the required structural transformation. This means that transitions to sustainability and low-carbon societies require the public expression of normative goals, societal aspirations, and political determination if substantial change is to be delivered:

> "Climate Change is an issue requiring urgent and extensive action on the part of governments, business and citizens if the risk of serious damage to global prosperity, sustainable development and security is to be avoided." (UN Global Compact 2010)

Two broad views can be distinguished in the policy discussions on transitions to low-carbon societies. The first view emphasises the need to stimulate the emergence of new, low-carbon alternatives to current systems. The second view emphasises our reliance on high-carbon, unsustainable technologies, and seeks ways to reduce our dependence on fossil fuels and avoid *lock-in* to a high-carbon energy trajectory.

So far, policy and entrepreneurial efforts have primarily focussed on the first view: fostering innovation and investment in more sustainable alternatives such as wind turbines and solar PV (Scrase and MacKerron 2009), often with very limited success (Mitchell and Connor 2004). Within this approach, new technological systems are expected to replace existing ones. For instance, low-carbon energy technologies are nurtured in protective technological niches (in specialised and/or subsidised small-scale applications) until they are able to scale up and compete with existing technologies (Kemp *et al.* 1998, Kemp and Soete 1992, Schot *et al.* 1994, Sandén and Jonasson 2005).

However, this approach is unlikely to be sufficient, as the strong resistance and inertia of established systems make it very difficult for alternative technologies to displace them:

> "Historically driven by economies of scale, the electricity system becomes easily locked into a technological trajectory that demonstrates momentum and is thereby resistant to the technical change that will be necessary in a shift to a low-carbon economy" (Stern 2007:355)

Heavy reliance on fossil fuels is showing no strong signs of change, but rather persistence, as fossil fuels use continues to increase at greater rates than renewable energy worldwide (Fisher *et al*. 2007). The urgency and scale of the challenges faced means that the prospective transition away from fossil fuels needs not only to be directed, but also to be accelerated (Jefferson 2008).

The limited deployment of renewable energy so far, and the stable patterns of fossil fuel use, suggest the usefulness of the second view. Proponents of transitions to sustainability, or to low-carbon energy systems should not only focus on the nurturing and diffusion of more environmentally benign technologies, but also on the displacement or restructuring of established industries and energy systems.

> "Some of the reasons cleaner technology is not diffusing rapidly through firms, for example, relate to overarching structures of markets, patterns of final consumer demand, institutional and regulatory systems and inadequate infrastructures for change." (Smith *et al.* 2005:1491)

It is thus highly relevant to the debate on sustainability transitions to focus on the productive role of the destabilisation of established systems. By focussing on the destabilisation of established industries in relation to pressing environmental problems, this thesis thus contributes to the exploration of pathways to sustainability, a topic directly relevant to contemporary societal and policy challenges.

## *1.2 Academic relevance and audience*

The destabilisation of socio-technical systems is also an important academic topic, which relates to several academic debates. This thesis engages primarily with the growing research community of transitions scholars interested in long-term structural change in socio-technical systems. In this section, I relate my research topic to debates within this academic community, and highlight my contributions to these debates.

The literature on socio-technical transitions has attracted the interest of a growing community of researchers. So far, contributions have mainly focussed on:

- the successful deployment and development of new technological systems (Kemp *et al.* 1998, Sandén and Jonasson 2005),
- understanding transition patterns and dynamics of sociotechnical systems and regimes (Elzen *et al.* 2004, Rip and Kemp 1998, Geels 2005a, Geels 2005b, Smith *et al.* 2005), and

- developing policy-relevant strategies to nurture the emergence of innovations, e.g. via visions, learning, networks, etc. (Loorbach 2007, Rotmans *et al.* 2001).

Such contributions have deepened our understanding of the emergence of new systems, themes that generally bear a positive connotation.[1] Comparatively, only little has yet been done in exploring the flipside of transitions: the destabilisation and decline of incumbent systems. I aim to avoid what might be called the ‘winner bias’ by shifting the analytical focus to the erosion/loss of stability of established systems.

This thesis contributes to the transition debate, and the debate on path dependence and lock-in.

**Relevance to the transitions debate**

The debate on socio-technical transitions, and innovation studies more broadly, have so far had a tendency to focus on the emergence of novelty – often assuming the destabilisation of incumbents along the way. More than thirty years ago, Rosenberg already warned that the focus on 'new' rather than 'old' technologies may lead to incorrect conclusions:

> “It is a general practice among historians to fix their attention upon the story of the new technology and to terminate all interest in the old. The result, again, is to sharpen the belief in abrupt and dramatic discontinuities in the historical record” (1976:203)

Shove and Walker’s criticism of transition management is therefore pertinent, and suggests that destabilisation and emergence are two parallel processes:

> “A more comprehensively systemic approach (...) would also offer an equally detailed analysis of processes that parallel those of innovation, these being trajectories of erosion, decay, and fossilisation. (…) transitions of any description routinely involve and require the loss or abandonment of previously important sociotechnical systems. (…) the transitions management literature says little about how the ‘death’ of undesirable systems might be engineered” (2007:767).

Within the neo-Schumpeterian literature on ‘technological discontinuities’, the breakthrough of novelty is assumed to *precede* or *cause* the decline of old industries (Tushman and Anderson 1986, Christensen 1997), as radical competence-destroying innovations make previous technologies obsolete. This focus on the emergence of novelty is dominant in transitions studies. It has been translated in its theoretical

[1] New technologies inherently relate to birth, expansion, growth, and other positive connotations. Successful innovations entail consequences that are perceived as benefiting the society as a whole: new jobs, new research, growth, and *progress* in general.

developments, in the choice of empirical focus, and in the types of policy and governance implications that have been devised.

This relative neglect does not mean that the productive role of destabilisation in transitions has not been acknowledged. The multi-level perspective (MLP), for instance, emphasises the nesting of processes at various levels (Geels 2002a, Geels 2004, Geels and Schot 2007). It provides a widely used model for transitions where broad societal transformations (new problems, socio-cultural change, political cultures and ideologies, etc.) and emerging technological alternatives ('niche-innovations') exert pressure on incumbents. Problems originating in the wider landscape of socio-technical regimes are a source of unlocking, which can put established configurations in flux and thus increase their vulnerability to technological challenges. Alternative technologies may take advantage of periods of flux in which broad societal change and the emergence of problems cast opportunities for change.

So, while transition scholars have devoted most of their attention to the process of technological breakthrough, they have so far provided mere hints about the 'downward' process of destabilisation. Destabilisation remains an under-investigated topic. This thesis is motivated by an attempt to address this neglect.

**Relevance to the debate on path dependence and lock-in**

The debate on path dependence in innovation studies and evolutionary economics has emphasised the stability of existing technologies and industries. Technological systems get locked in (sub-optimal) configurations (David 1985, Arthur 1989, Nelson and Winter 1982). Authors interested in these questions have investigated the influence of processes of selection, path creation, and historical contingencies in the trajectories leading to lock-in. This literature suggests that socio-technical configurations, once established, are highly persistent through time. This thesis, instead, is concerned with understanding the reverse mechanisms of 'unlocking' of deeply embedded industry activities. I suggest that such mechanisms may open up windows of opportunity and eventually lead to the decline or re-configuration of industries entailing important negative externalities.

So, established socio-technical systems have an in-built tendency to resist change, which makes the breakthrough of new technologies difficult. Socio-technical systems are dynamically stable, evolving along established socio-technical trajectories (Geels 2002a). The co-evolution of technology, industries, markets and institutions in socio-technical systems can lead to various forms of lock-in (David 1985, Arthur 1989, Unruh 2000, Walker 2000, Kemp *et al.* 2012) that decrease the likelihood of introducing substantial change. For instance, the present structure of electricity supply (large-scale supply, highly centralised distribution, dominance of fossil fuels and imported fuel sources, lasting commitments to nuclear, few powerful suppliers in liberalised markets, remoteness from user concerns) is a typical lock-in situation – related to constraints at play during its build-up and consolidation –from which it is proving difficult to depart today (Unruh 2000, Nye 1999).

The destabilisation of established industries is thus a difficult process because of inherent mechanisms of inertia. A variety of forms of industry lock-in has been identified in the literature, including:

a) *in technology and infrastructure*: existing technical capacity, infrastructure and related competences prevent adaptation to disruptive innovations (Tushman and Anderson 1986);
b) *routines* (skills, knowhow and tacit knowledge) which prevent industry actors from initiating radical new search processes (Nelson and Winter 1982, Dosi and Nelson 1994);
c) *market-related*: commitment to specific trade partners, customers, and supply chains through established resource flows (Christensen 1997) that result from the search for increasing returns (Arthur 1989);
d) *institutional lock-in*: prevailing rules and norms in industries (Greenwood and Hinings 1996), further amplified by widespread adoption by industry actors (DiMaggio and Powell 1983);
e) *cognitive lock-in*: deeply engrained cognitive beliefs and which prevent industry actors from interpreting environmental signals clearly (Barr *et al.* 1992) and recognising disruptive change (Tripsas and Gavetti 2000).

Such lock-in mechanisms thus raise barriers to unlocking. Destabilisation is unlikely to be driven solely by endogenous dynamics, and external pressures for change can be expected to be important for unlocking. The build-up of pressure in destabilisation is likely to involve processes of accumulation, articulation and alignment across multiple dimensions.

Furthermore, lock-in is not solely a structural mechanism, but is also *enacted*. This means that various forms of lock-in are actively reproduced by actors defending established regimes[2] through resistive strategies.

## *1.3 Specific goals and contributions*

Destabilisation has attracted academic interest in various disciplines. In this thesis, I will argue that existing views on destabilisation are insufficient to address my research questions and related research criteria. In chapter 2, I will distinguish five existing views on destabilisation and will suggest three aspects that I wish to address jointly. Rather than making specific contributions to these existing views, the conceptual elaboration in chapter 3 will build on and combine them in order to address my research goals.

Aspects of destabilisation have attracted the attention of researchers in a broad range of disciplinary traditions, including economic and political history, studies of industrial change, corporate change and organisation studies, innovation studies, and business and management communities. There has been interest in decline at the level of nations and national economies (Thompson 1998, Elbaum and Lazonick 1986, Wiener 1982, Edgerton 1996), industries (Dintenfass 1992, Lorenz 1991, Lazonick 1983, Zammuto 1985) and organisations (Mone *et al.* 1998, Nystrom and Starbuck 1984, Huff *et al.* 1992, Weitzel and Jonnson 1989). Such contributions tend to focus on the adverse contextual conditions and factors that may lead to decline (Porter 1980, Ansoff 1987, McCarthy *et al.* 2010) and on the types of response strategies devised to cope with such conditions (Pettigrew 1987, Barr 1998, Tripsas and Gavetti 2000, Kaplan *et al.* 2003, Miles and Cameron 1982, Meyer 1982, Weitzel and Jonnson 1989).

In chapter 2, I review the existing theoretical contributions of relevance to industry destabilisation. Five non-exclusive views can be analytically distinguished and related to specific disciplinary backgrounds:

1. The literature on technological change and the role of technological discontinuities
2. The literature on economic change and the role of wider market dynamics
3. The literature on industry legitimacy and the role of socio-political challenges

---

[2] In this thesis, I will adopt the notion of 'industry regime' as a set of field-specific institutions enabling and constraining the behaviour and action of industry actors (see 3.2.3 and 3.3.1.3).

4. The literature on organisational change and managerial responses to challenges
5. The literature on institutional change and the role of changing rules

Some authors combine elements from these views – which I distinguish analytically. I will suggest a specific way to combine them that is tailored to addressing my research questions.

Indeed, I aim to put particular emphasis on three aspects of industry destabilisation:

1. My interest in processes of *long-term unfolding* leads me to put a particular emphasis on the temporal articulation of change at multiple levels.
2. My interest in *multi-dimensional co-evolution* leads me to consider multiple interacting sources of change in destabilisation processes.
3. My interest in current *sustainability challenges* leads me to consider the role of a particular kind of societal challenges in destabilisation processes: environmental issues.

These three aspects of destabilisation processes provide the location for specific theoretical contributions developed in this thesis. The following sub-sections give an overview of the related challenges and introduce the scope of contributions to be elaborated in chapter 3.

### 1.3.1 Destabilisation as long-term unfolding process

Although concerned with change, most authors addressing industry destabilisation and decline tend to look for (sets of) *dependent variables* influencing the performance of a given industry, instead of considering destabilisation as an *unfolding process*. Destabilisation has been related to external sources of change that are detrimental to industries (Abernathy and Clark 1985, McCarthy *et al.* 2010, Porter 1980), the degree of fit between organisations and their environments (McCarthy *et al.* 2010, Zammuto 1985), or the influence of firm characteristics on the type of decline experienced (D'Aveni 1989, Hambrick and D'Aveni 1988, McKinley 1993, Mone *et al.* 1998). In exploring destabilisation, these authors tend to take a 'variance approach', in which change in the value of an independent variable is described as the result of fixed relationships to its dependent variables (Poole *et al.* 2000) that often takes the form of universal and testable laws. These authors investigate the *whys* of change, with little consideration for crucial characteristics of long-term change: changing entities and contexts, temporal contingency, multiple and mutable causalities, changing meanings and attributes, etc. (Haydu 2010). There has been relatively little conceptualisation of the actual *process of change*, and the underlying generative mechanisms that explain the *hows* of change. This observation – related to different epistemological choices – appears to have more general relevance for the study of organisational change:

> "much research on organization change is ahistorical, aprocessual, and acontextual in character (...) There are remarkably few studies of change that actually allow the change process to reveal itself in any kind of substantially temporal or contextual manner." (Pettigrew 1987:655).

This thesis, by taking a *process approach* to destabilisation (Poole *et al.* 2000, Van de Ven and Poole 2005), sets particular emphasis on *unfolding* over long periods of time.[3] In this way, sequences of action and events can thus be seen as located within enabling and constraining structures and contexts (that themselves undergo change), rather than the outcome of 'atemporal' laws and variables (Abbott 1992). Furthermore, I will mobilise insights from historical approaches to develop the notion of *multiple levels of unfolding* in destabilisation processes as a core organising principle for theoretical elaboration and analysis that will allow me to distinguish different mechanisms playing on and across different levels: industry, environments, and landscape.

### 1.3.2 Destabilisation as multi-dimensional co-evolutionary process

Within the literature on destabilisation and decline, most scholars tend to restrict their analysis to a narrow set of sources of change likely to disrupt industry stability. Among the kinds of pressures considered, they have emphasised the role of technological change (Tushman and Anderson 1986, Christensen 1997), competitive and market pressures (Porter 1980, Ansoff 1987), sometimes adding a regulatory dimensions (McCarthy *et al.* 2010, Abernathy and Clark 1985). Other scholars have been attentive to the role of institutional change and legitimacy (Leblebici *et al.* 1991, Lounsbury 2001, Scott 2001), and social movements in destabilisation (Den Hond and De Bakker 2007, Davis *et al.* 1994). The problem is that few contributions have explicitly focussed on the *co-evolutionary* nature of changes on multiple dimensions in destabilisation processes, and thereby they may understate the role of the interplay between economic, political, socio-cultural, technological and institutional change.[4] My contribution therefore is to

---

[3] The epistemological assumptions of this thesis are further elaborated in chapter 4.

[4] Economic historians (Freeman and Louça 2001, Lazonick 1983, etc.) and socio-technical scholars (Geels 2004, Geels and Schot 2007, Smith *et al*. 2005, etc.) provide illustrations of how such a task may be addressed.

elaborate a conceptual perspective that attends to the interaction of pressures for change between multiple dimensions.

Some authors have recognised the co-evolutionary nature of destabilisation (Oliver 1992, Tushman and Romanelli 1985, Scott 2000, Meyer *et al.* 1990). However, their analyses are oriented towards the search for fixed causal relationships and factors affecting destabilisation,

> "The purpose of this paper is to identify the *factors* that are likely to predict deinstitutionalization" (Oliver 1992:564, my emphasis)

or forces for fundamental change (Tushman and Romanelli 1985) that can explain 'mode shifts' between continuous and discontinuous change (Meyer *et al.* 1990, Tushman and Romanelli 1985), rather than towards uncovering the *unfolding* of *co-evolutionary processes* in destabilisation, which I intend to address.

This thesis makes the case for a co-evolutionary approach to destabilisation that addresses the multi-dimensional nature of the challenges faced by industry actors in socio-technical configurations across economic, technological, regulatory and socio-cultural domains.

### 1.3.3 The role of societal challenges in destabilisation

The bulk of the literature on decline focuses on economic factors, and tends to downplay socio-political pressures and particular normativities involved in addressing societal challenges. However, such pressures are crucial for a better understanding of transitions to sustainability, because of the public goods characteristics discussed in section 1.1. I am interested in understanding the emergence and articulation of societal problems, insofar as they influence the destabilisation of existing regimes.

Within the debate on socio-technical transitions, Smith *et al.* (2005:1502) have referred to 'purposive transitions' as those "which have been deliberately intended and pursued from the outset to reflect an explicit set of societal expectations or interests". Most transitions analysed in the literature have however followed more decentered and emergent patterns (Smith *et al.* 2005). So far, only a limited number of historical transitions cases where societal issues and central coordination have been important have been analysed. Such cases can however provide valuable insights to the real world challenges of sustainability and transitions to low-carbon societies, and promise to allow for valuable theoretical contributions (Fouquet 2010, Smith *et al.* 2005).

Societal problems and related normative contests are not only important for transition studies, but also growing concerns in the innovation literature at large, particularly through its engagement with policy communities. However, societal problems remain an underdeveloped topic in innovation studies. In a critical assessment of the field of science, technology and innovation policy research, Morlacchi and Martin (2009:575) conclude that:

> "we still don't have a very satisfactory theory of social change. Our ability to improve social problems remains rather limited, and we do not know why we appear to have only modest gains in relation to many societal problems"

This thesis contributes to these debates by investigating the role of societal challenges in destabilisation processes, focussing on environmental problems.[5] This interest further highlights the importance of taking a co-evolutionary view on long-term processes, as environmental problems emerge in socio-political spheres (normative contestation, policy, etc.) but may penetrate economic and market spheres and significantly affect the trajectories of socio-technical regimes.

## *1.4 Focus and research questions*

Within the general topic of the destabilisation of socio-technical regimes, this thesis adopts a specific focus on industries.[6] Industry actors in a particular technological system do not operate autonomously, but in the context of socio-technical regimes (Rip and Kemp 1998). I will thus take industry actors as the main focal group in socio-technical configurations, and consider their embeddedness in multi-dimensional co-evolving environments.

The main research question of this thesis is oriented towards a better understanding of the process of destabilisation. The thesis aims at answering the following question:

---

[5] I take environmental problems as a particular kind of societal challenge. Throughout the thesis, I refer to 'environmental problems' as societal problems related to the natural environment. However, because I conceptualise industries as facing pressure in their environments (economic and socio-political), I have strived to avoid confusion throughout the text by distinguishing 'environmental *problems*' from 'pressure in industry environments' or 'environmental change' (also referred to as 'external problems' – not to be confused with 'externalities').

[6] Industries are understood as populations of industry actors (firms) producing similar products or services. Industry boundaries are defined for each case study according to geographical scope, products, markets and main technologies.

1. *How can we understand the unfolding of industry destabilisation processes?*

Taking into account my aforementioned interests and research goals, this question can be further declined in three sub-questions:

a. *How can we attend to destabilisation as a (long-term) unfolding process?*
b. *How can we attend to multi-dimensional co-evolutionary nature of destabilisation?*
c. *How can we attend to the role of societal challenges in destabilisation?*

Considering the substantial amount of relevant literature contributing to address one or more aspects of destabilisation (see chapter 2) and my crosscutting research goals, a related challenge concerns combinatorial forms of theoretical elaboration.

In order to address my background motivations, and delve into policy-relevant elaborations, a further question is oriented towards the application of research findings to current challenges:

2. *What lessons for current sustainability transition challenges can be derived from a theory of destabilisation elaborated and refined on the basis of historical cases?*

## *1.5 Research criteria*

A number of epistemological assumptions underpin the understanding of destabilisation put forward in this thesis. I seek to explain destabilisation as an *unfolding process* – that is, by explaining how things change over time (Van de Ven 1992, Pettigrew 1997) and appreciating the effect of time and timing (Van de Ven and Poole 2005). Adopting this standpoint, my research is inscribed within a *process* research tradition (see chapter 4), in which explanation relies on the identification of developmental event sequences, rather than the influence of a set of dependent variables (Van de Ven and Poole 2005, Van de Ven 2007, Langley 1999, Sminia 2009). This epistemological positioning is particularly suited for the study of substantial change unfolding over extended periods of time.

Studying long-term change processes (e.g. transitions and industry destabilisation) can be done by mobilising forms of explanation attentive to history (Geels and Schot 2010). A number of authors have highlighted the mutual benefits of a dialogue between historians and social scientists in this respect (Burke 2005, Sewell 2005, Braudel 1958, Van de Ven and Poole 2005).

This thesis is receptive to such historical approaches. Historically-minded social scientists have highlighted a number of characteristics of unfolding processes. These are here mobilised as search heuristics that will guide theoretical elaboration and empirical research.

These heuristics are:

1. the unfolding of change processes

> "To understand a change process, it is critical to understand how it unfolds over time and how time and timing affects it." (Van de Ven and Poole 2005:1394)

One way of dealing with unfolding is to mobilise ideal-typical developmental sequences. Interest in the longitudinal unfolding of change has led some scholars to develop models that outline an ideal progression pattern:

> "the central focus of developmental process models is on progressions (i.e. the nature, sequence, and order) of activities or events that an (…) entity undergoes as it changes over time. (...) a linear sequence of stages or phases of development is a common form of progression in these process models" (Van de Ven 2007:199)

I suggest using such stylised models as a general frame of reference from which to elaborate refined interpretations to take account of more nuances:

2. the co-evolution of multiple sequences of events within multiple temporalities and multiple patterns of causality

> "One significant characteristic of historical events, is that they always combine social processes with very different temporalities – relatively gradual or long-run social trends, more volatile swings of public opinion, punctual accidental happenings, medium-run political strategies, sudden individual decisions, oscillating economic or climate rhythms – which are brought together in specific ways, at specific places and times, in a particular sequence." (Sewell 2005:9)

> "Most historical sociologists reject the notion of a single master process, acknowledging multiple processes that overlap and intersect one another. Explaining a particular outcome or pattern of development thus involves a particular logic of explanation: situating events or outcomes in terms of their location in intersecting trajectories with independent temporalities" (Aminzade 1992:466)

3. changing patterns of causality

"A fully eventful conception of temporality must also deny the assumption that causal structures are uniform through time. Events must be assumed to be capable of changing not only the balance of causal forces operating but the very logic by which consequences follow from occurrences or circumstances." (Sewell 1996:263)

4. unpredictable and contingent patterns of change

"As against the implicit assumption of most social scientists, that social change takes place according to smooth, gradual, predictable, and linear processes, historians assume that historical temporality is lumpy, uneven, unpredictable, and discontinuous." (Sewell 2005:9)

5. durable path dependence and sudden shifts

"Contingent, unexpected, and inherently unpredictable events (…) can undo or alter the most apparently durable trends of history (…) History displays both stubborn durabilities and sudden breaks, and even the most radical historical ruptures are interlaced with remarkable continuities." (Sewell 1996:264)

Further considerations on process and historical approaches will be developed in chapter 4, when presenting the epistemological assumptions underlying this thesis in detail: *process theory* and the search for *patterns*.

## *1.6 Research strategy*

### 1.6.1 Case studies

In order to assess the *plausibility*, the *usefulness* and further explore the explanatory power of the conceptual perspective, I mobilise two historical cases of fully realised destabilisation processes. The resulting theory of destabilisation is then applied to a contemporary challenge of societal relevance (forming a third case).

Case studies are suitable methods for the tracing of destabilisation patterns and mechanisms. Indeed, case studies are regarded as a suitable strategy for research attentive to rich context and complex developmental processes (Yin 1994).

Because destabilisation is a long-term co-evolutionary process, its investigation justifies the mobilisation of longitudinal case studies (Siggelkow 2007), and a research design that is attentive to the *unfolding* of processes (Van de Ven and Poole 2005, Langley 1999, Sminia 2009). Indeed, case studies are rich in context, and allow for the tracing of unfolding processes in search for generative mechanisms (Ragin 1997, George and Bennett 2004, Eisenhardt and Graebner 2007). Methodological choices are further elaborated in chapter 3.

### 1.6.2 Empirical focus: destabilisation in the British coal industry

**Case study design.**

The cases chosen for the empirical investigation of destabilisation patterns cover three periods of the British coal industry, ranging from 1880 to the present. I have chosen the coal industry for its historical relevance as an energy source, its deep societal embedding, and multiple decline paths throughout the twentieth century.

While most comparative studies tend to cover a single period in multiple geographic settings, I have taken a different approach. I cover multiple periods in the same context. The UK context has been chosen for its historical importance in developing and maintaining coal as a fuel source, but also for pragmatic reasons such as the accessibility of data sources. Furthermore, comparing juxtaposed cases presents difficulties but also opportunities for the investigation of destabilisation processes. Indeed, specific causal relations are unlikely to hold from one period to another (Haydu 2010). However, by comparing cases across time periods, the researcher can gain to access a deeper understanding of causal mechanisms to generate generalisable findings that transcend specific historical contexts. This kind of explanation is especially relevant when one goal is to generate findings from historical cases and to apply them to contemporary challenges.

Methodological choices related to case study design are further developed in chapter 3.

**Case selection.**

Within the period covered (1880-present), three case studies are developed:

- Case 1: The destabilisation of the British coal industry (1880-1967)
- Case 2: The destabilisation and decline of the British deep coal mining (1967-1997)
- Case 3: Climate change and the destabilisation of coal-fired generation in the UK (1990-2011). Possible revival?

The selection and temporal bounding of cases is based on theoretical criteria.

The historical cases display a high degree of phenomenon: a destabilisation process can be clearly identified. In each case, the focal industry actors have experienced serious pressures across multiple dimensions. In the two historical cases, this has led to major decrease in industry size, and fundamental change in structure and the scope of activities. The first case ends in 1967 with the transition to the four-fuel economy, while the second case ends with the completion of the dash for gas in 1997. Figure 1.1 provides an overview of the two historical cases, reflecting various stages of economic decline. The cases selected here fall into the *extreme* and *paradigmatic* types (Flyvbjerg 2006). They are *extreme* because they are particularly rich and complex, involving many different sources of change, with strong degrees of interaction. They are *paradigmatic* because of the central role of coal in economic, political and social considerations in Britain, which put the industry in the frontline of the radical changes affecting British society throughout the period of study.

All three cases have also been selected in relation to environmental problems, as the industry was confronted with different problems with the natural environment: coal smoke, acid rain and climate change, respectively. The third case is of a more prospective kind: coal-fired electricity generation, under substantial pressure, still faces an uncertain future, which can however be understood with the conceptual approach developed.

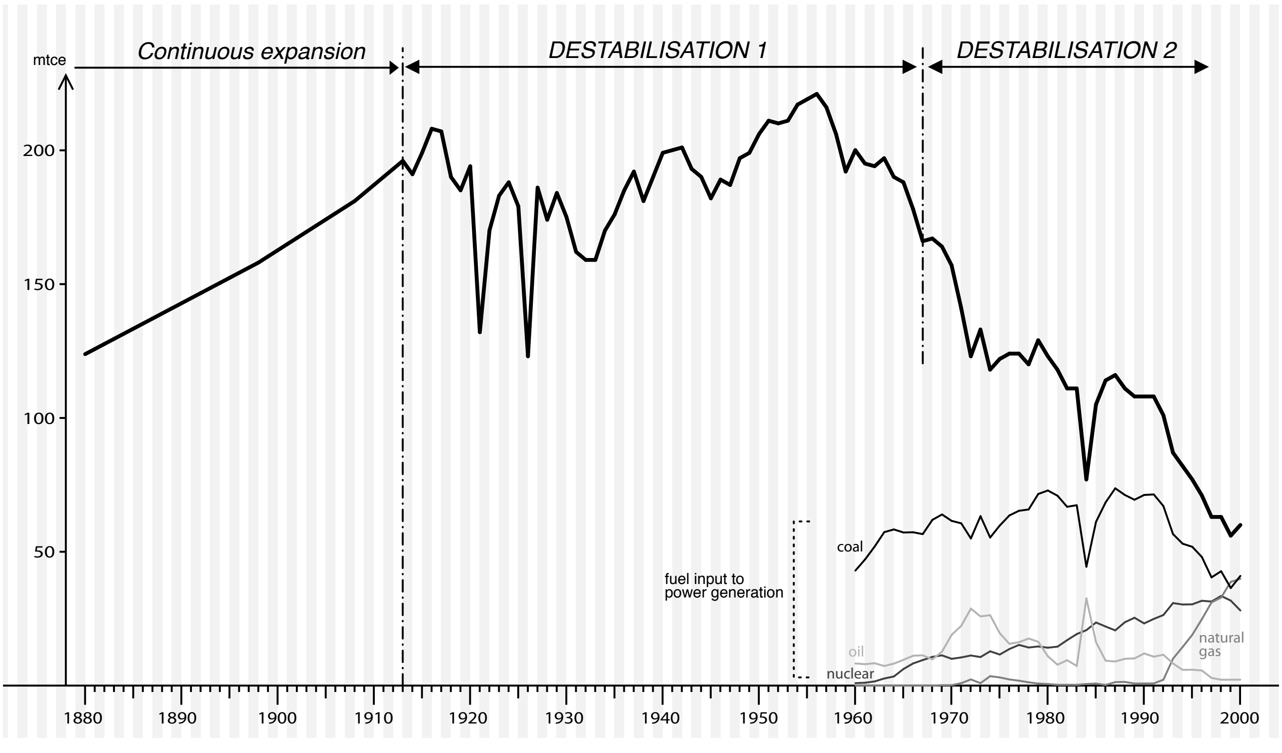


**Figure 1.1: Coal consumption in Britain (1880-2000), outline of destabilisation pattern for historical cases.**

## *1.7 Thesis overview*

Chapter 2 looks at existing contributions to destabilisation, analytically identifying five views in various literatures. It then introduces contributions that provide insights related to the three research challenges. The last section of the chapter collects 'building blocks' from the theoretical perspectives covered, and suggests guidelines for theoretical elaboration.

Chapter 3 presents the conceptual perspective developed to investigate industry destabilisation. Building on the existing literature on destabilisation, this chapter formulates the conceptual perspective mobilised for the study of industry destabilisation. Taking a 'building blocks' approach to conceptual elaboration, it mobilise insights from the different views on destabilisation covered in chapter 2 to formulate a synthetic perspective tailored to address my three research aims. It addresses 1) dynamic unfolding at multiple levels, 2) multi-dimensional co-evolution, and 3) the role of environmental problems.

Chapter 4 spells out the methodology used in this thesis. It discusses epistemological assumptions, explains the research design, the rationale for choosing a case study approach, justifies the choice of case, and outlines the analytical strategy.

Chapters 5 to 7 make up the empirical sections. They each contain an analytical narrative and an analysis of the destabilisation pattern.

Chapter 8 compares the cases in search of generalisable findings in order to answer the research questions. It formulates conclusions concerning the three research challenges and generates lessons for sustainability challenges. The chapter ends with a discussion of the contributions, the nature of the research, the qualification of the conclusion and outlines potential avenues for further research.

# 2 Theoretical review of destabilisation

This chapter discusses existing perspectives on destabilisation in various academic literatures. It is argued that most existing views have some blind spots in relation to the research criteria elaborated in the introduction. The different views introduced here will be mobilised selectively as 'building blocks' from which to elaborate the conceptual perspective in the next chapter.

## *2.1 Destabilisation in the literature: five views*

A number of explanations for destabilisation can be found in the literature. I organise the existing literature in five broad views, according to their privileged focus and explanation for the phenomenon. This partitioning results from analytical choices and is somewhat artificial. Some authors do not fall clearly into one view. Because I am interested in building a synthetic understanding of destabilisation, I will first focus on their distinctive features, before discussing complementarities (theoretical and practised) in order to integrate elements from each view in chapter 3.

In each view specific mechanisms are seen to affect stability and change in established systems, linking industry destabilisation and decline to:

1) the breakthrough of radical technological innovations which overthrow established industries,
2) selection pressures on economic dimensions (markets, technology, competition, etc.),
3) selection pressures on socio-political dimensions affecting political and cultural legitimacy,
4) the development of managerial responses to challenges, and
5) patterns of institutional change.

I discuss these views with the aim of generating building blocks for further integration in my conceptual perspective.

### 2.1.1 The role of technological discontinuities in destabilisation (view 1)

The literature on technological discontinuities explains destabilisation by focussing on the role of competence destruction arising from innovation. Competence-destroying innovations are radical innovations that disrupt established technological trajectories, overthrowing existing technological systems and the industries supporting them

(Tushman and Anderson 1986, Christensen 1997). In this view, influenced by Schumpeter's (1939) metaphor of creative destruction, the introduction of novelty is seen as the *cause* of industry destabilisation, as "radical technological innovations create new market opportunities while simultaneously damaging, destroying, or transforming demand in many existing product markets" (Hill and Rothaermel 2003:259).

Such innovations introduce a new type of technology, leading to greatly improved price/performance, or new or fundamentally improved specifications to markets. Competence-destroying innovations are:

> "so fundamentally different from previously dominant technologies that the skills and knowledge base required to operate the core technology shift. Such major changes in skills, distinctive competence, and production processes are associated with major changes in the distribution of power and control within firms and industries". (Tushman and Anderson 1986:442)

Often emerging outside industries (Cooper and Schendel 1976), competence-destroying innovations are disruptive for established firms and lower barriers to entry for new firms (Tushman and Anderson 1986). They imply substantial challenges to established industries, and may eventually lead to their downfall:

> "The effect [of radical innovations] is thus to reduce the value of existing competence, and in the extreme case, to render it obsolete." (Abernathy and Clark 1985:6)

The successful introduction of radical innovations can thus have serious destabilisation consequences on established industries (Freeman and Soete 1997), because they rely on resources and infrastructure that incumbents do not possess or master. In most cases, strong inertia in established routines and technological trajectories increase incumbent vulnerability to such challenges.

Thus, technological change may be an important source of industry destabilisation.

### 2.1.2 The role of market forces in destabilisation (view 2)

A broad corpus of literature, including economic history, industrial economics, business and management studies, relates industry destabilisation to a range of market selection pressures. Industry actors are seen to evolve in market environments in which they face competitive pressures (Porter 1980). These pressures affect the performance and survival of individual firms (Hannan and Freeman 1977), as well as entire industries (Lorenz 1994). Increasing pressure in economic environments creates economic and competitive problems for industry actors. Long periods of low economic performance may lead industry actors to question established practices and prevailing regime rules (Tushman and Romanelli 1985, Geels 2011, Turnheim and Geels 2011).

Economic approaches to industry environments consider the influence of markets, products and technologies, and governments on the evolution of industries (Ansoff 1987, Porter 1980, Abernathy and Clark 1985, Bourgeois and Eisenhardt 1988, McCarthy *et al.* 2010). These elements affect stability and change in organisational environments. Porter (1980, 1991) sees industries as embedded in an economic environment where competitive forces are at play (see Figure 2.1). According to this view, industry actors thus face 1) the intensity of rivalry between existing firms, 2) the bargaining power of suppliers, 3) the bargaining power of buyers, 4) the threat of new entrants, and 5) the threat of technological substitutes (see view 1). Organisations are seen as seeking competitive advantage by adapting to these forces. Other sets of factors affecting competition in industries include new technology, changing customer demands, government policy and regulation (Abernathy and Clark 1985), technological, products, demand, regulatory, and competitive change (McCarthy *et al.* 2010).

So, this view explains both stability and change in relation to industry embeddedness in market environments, and exposure to multiple forces of changes therein. While this type of research tends to focus on the individuation of exogenous factors, and often takes a variance approach to the industry-environment relationship, the sources of change identified provide a useful starting point for the identification of dimensions of change likely to co-evolve in the destabilisation of industries.

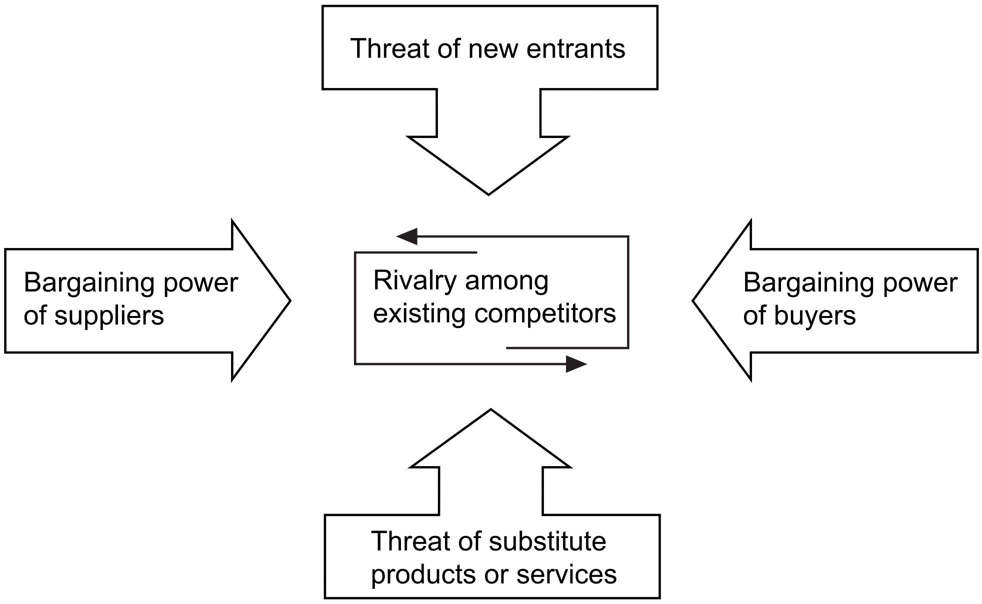


**Figure 2.1: Porter's five forces, summary of key drivers (based on Porter 1980)**

Economic historians have also contributed to the understanding of decline, related to market forces, but tend to take a more process-oriented approach. The theme of destabilisation and decline is not new to students of economic history, who have made a *genre* of histories of 'the rise and fall of…' in which an entire developmental process, from emergence through golden age and decline, are captured. Historians have covered the decline of different forms of social organisations: the decline of civilisations, the decline of empires and nations (Edgerton 1996, Elbaum and Lazonick 1986, Wiener 1982), and the decline of industries (Dintenfass 1992, Church 1995, Lorenz 1991, Lazonick 1983, etc.).

The long-term analysis of decline in political and economic entities points to three main factors (Thompson 1998): 1) the inflexibility of institutionalised practices (Elbaum and Lazonick 1986, Kirby 1992), 2) the search for continuity in the face of external threats of various kinds (economic, political, military, etc.), and 3) the inability to innovate and exploit the opportunities arising from changing. Such historical approaches thus provide the additional benefit – in line with my epistemological choices (see chapter 4) – of attending to long-term processes, explicitly articulating exogenous factors and endogenous enactment, and also capturing institutional dynamics.

### 2.1.3 The role of socio-political challenges to legitimacy in destabilisation (view 3)

Contributions labelled under this view share a focus on non-economic forces of change in industry environments, which may challenge industry *legitimacy*. Indeed, industry actors can be seen as also embedded in socio-political environments in which non-economic forces and actors interact and may exert pressures on the legitimacy of industries:

> "The success or failure of a new industry and firms within [the political context] depends on their abilities to achieve institutional isomorphism (DiMaggio and Powell, 1983). To achieve this, firms may either adapt to institutional requirements or attempt to build their goals and procedures directly into society as institutional rules (Meyer and Rowan, 1977). Thus, *firms compete not only in the marketplace, but also in this political institutional context*. Rival firms often cooperate by collectively manipulating their institutional environment to legitimize and gain access to resources necessary for collective survival" (Van de Ven 1993:30, my emphasis)

The nature of change in industries is thus not only influenced by economic and technological determinants, but also by socio-political forces. With respect to destabilisation, forces in the socio-political environment of industries can exert substantial legitimacy pressure on existing regimes (Pettigrew 1987). According to Suchman (1995:574), legitimacy can be defined as:

> "a generalized perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions."

Industry actors thus also compete for the legitimacy of their activities (Leblebici *et al.* 1991). The socio-political legitimation process can be defined as follows:

> "Sociopolitical legitimation refers to the process by which key stakeholders, the general public, key opinion leaders, or government officials accept a venture as appropriate and right, given existing norms and laws. One can measure sociopolitical legitimation by assessing public acceptance of an industry, government subsidies to the industry, or the public prestige of its leaders." (Aldrich and Fiol 1994:648)

Aldrich and Fiol (1994) have been primarily concerned with the central role of legitimacy for the stabilisation of new industries. But legitimacy also has to be maintained throughout industry evolution (Suchman 1995). Legitimacy is thus equally important for established industry actors.

Because industry actors are embedded in socio-political environments, non-economic actors bear influence on industry patterns and strategies. Destabilisation can be conceived as a *de-legitimation process*, involving normative contestation, changing regulations, political ideologies, and changing public beliefs affecting industry legitimacy. In 2.2.3, I will further expand on the role of environmental problems (as a specific kind of socio-political challenge), by mobilising the issue lifecycle and social movement literatures.

### 2.1.4 Organisational change and managerial responses to destabilisation (view 4)

I now turn to an approach to industry destabilisation that focuses on processes of organisational change. Organisational theory and managerial studies provide insights on industry responses to adverse conditions and challenges. I here review such contributions that are relevant to destabilisation processes. Starting from an overview of the organisational decline literature (Weitzel and Jonsson 1989, Zammuto and Cameron 1985, Whetten 1987, Grinyer and Spender 1979, Mintzberg *et al.* 1998) as a dynamic process, I then focus in on three sub-processes influencing organisational change in challenging environments.

**Organisational decline as a dynamic process**

Increasing pressure in industry environments does not always lead to immediate action and change by industry actors committed to deep-seated regimes. The enactment of destabilisation implies matching industry strategies with changes in industry environments, and may thus lead to various outcomes ranging from smooth adaptation to radical transformation or organisational collapse.

The organisational decline literature has developed various typologies and stage models receptive to the dynamic interplay between external challenges and endogenous enactment of change (Weitzel and Jonsson 1989, Zammuto and Cameron 1985). Keeping in mind their ideal-typical nature, such models can be used as initial guides to endogenous enactment in destabilisation processes.[7]

Ideally, organisations have the ability to avoid decline. But when responses are delayed, strategic changes tend to require deeper transformations. Avoiding decline thus involves the implementation of increasingly radical organisational change as problems increase

[7] Indeed, these stage models tend to simplify the decline process by assuming a linear sequence of stages. We will see that such a progression may be challenged in practice (interruption, overlaps, skipping stages, etc.), as acknowledged by the authors. Nevertheless, such analytical simplifications are useful to distinguish ideal patterns and deviations therefrom.

and performance gaps deepen (Weitzel and Jonsson 1989), and may eventually lead to a point of no return (see Figure 2.2). The decline of organisations is not inevitable, but seen as the result of inappropriate actions in various stages (Table 2.1). Each decline stage comes with opportunities for corrective action. Organisational inaction (arising from a failure to perceive, interpret or act upon pressures) increases the likelihood of progress through later stages, eventually leading to terminal decline in the absence of timely action and adaptive strategy.

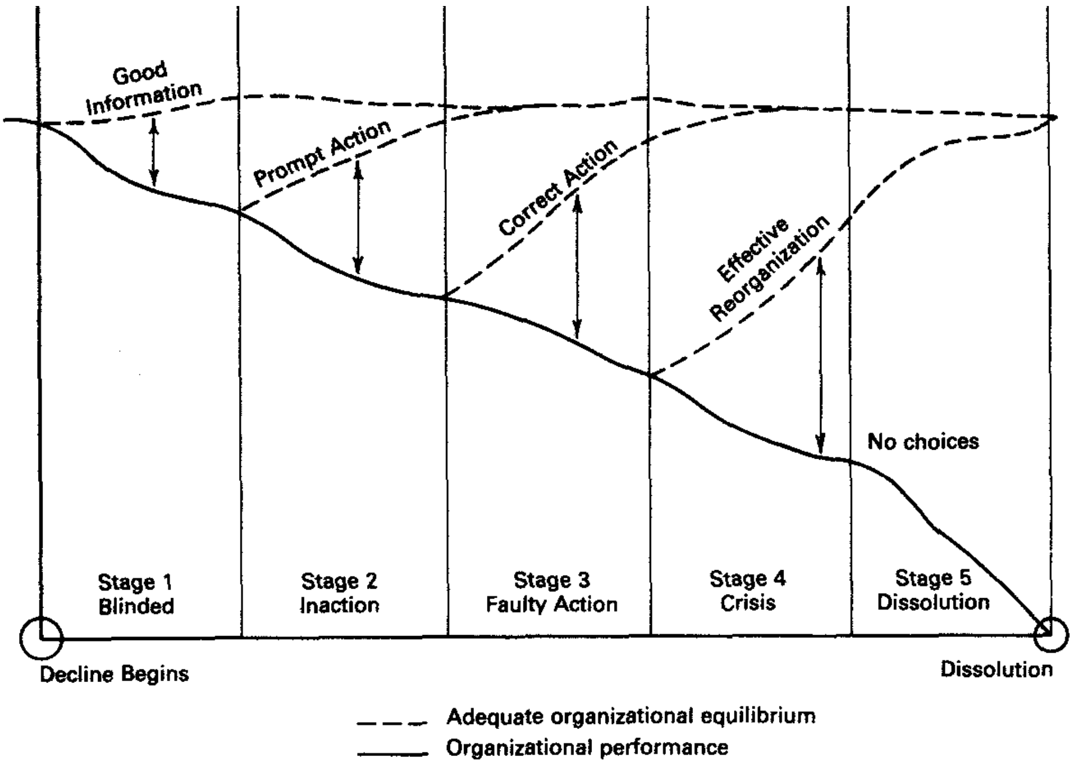


**Figure 2.2: Widening performance gap as decline deepens (source: Weitzel and Jonsson 1989)**

**Table 2.1: Stages of organizational decline and corresponding organizational action (Weitzel and Jonsson, 1989:97)**

| Stages | Organizational action |
|---|---|
| 1. Blinded | Failure to anticipate or detect pressure toward entropy; decline begins |
| 2. Inaction | Failure to decide on corrective action; decline becomes noticeable |
| 3. Faulty action | Faulty decisions; faulty implementation of decisions |
| 4. Crisis | Given faulty-action stage and unforgiving environment, last chance for survival. Given forgiving environment, slow erosion. |
| 5. Dissolution | Given crisis stage and unforgiving environment, rapid demise. Given forgiving environment, slow demise. |

As destabilisation progresses, and industries are threatened, it becomes increasingly difficult for industry actors to get away with minor changes to their activities and strategies. Accordingly, they must operate changes of a more transformative kind (Tushman and Romanelli 1985). Grinyer and Spender (1979) have focussed on nested levels of structure guiding organisation strategy (see Figure 2.3), and how industry responses move from incremental to more radical kinds of questioning: 1) tighter controls, 2) new strategy, and 3) new 'industry recipe'. According to Grinyer and Spender (1979), problems need to worsen before regime rules are questioned. However, when corrective action and learning are delayed, there is a risk for industry strategy to be 'too little, too late'. Indeed, delayed response to destabilisation pressures can lead to deteriorating performance, and an acceleration of destabilisation pressures (Hambrick and d'Aveni 1988).

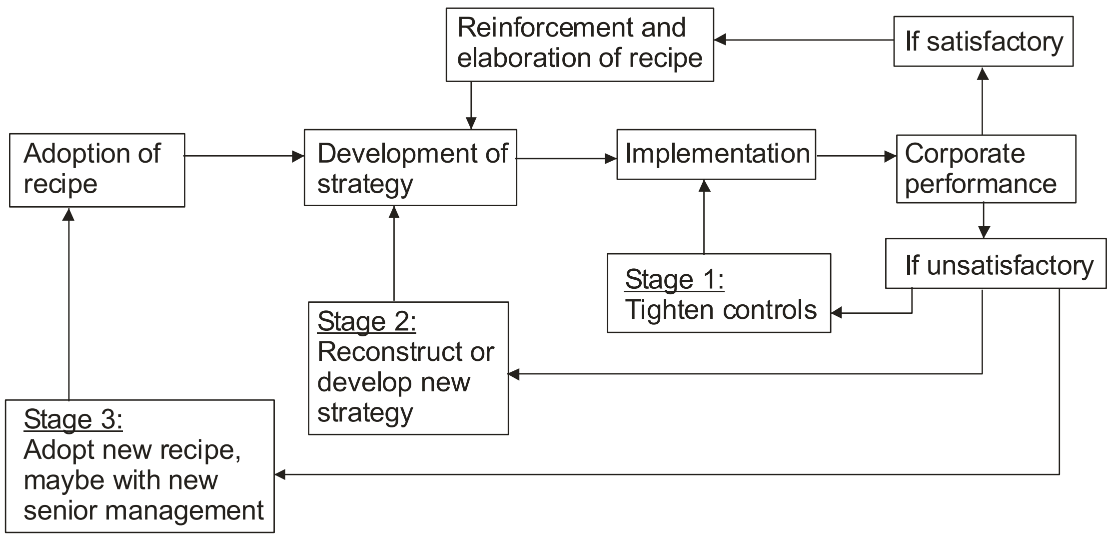


**Figure 2.3: Dynamics of reorientation (Grinyer and Spender, 1979:122)**

Tushman and Romanelli (1985) provide a similar formulation of destabilisation stages, when problems become more pressing. In these stages, the ability of organisations to survive without introducing major change is increasingly reduced. Three main trajectories may then be pursued: 1) organisational *re-orientation*, 2) organisational *re-creation*, and 3) organisational *dissolution*. Organisational re-orientation implies significant changes to the main activities and strategies, without questioning core assumptions such as mission, identity, norms and beliefs. Organisational re-creation implies fundamental changes in core values and beliefs within organisations (Tushman and Romanelli 1985). Decline implies the inability of an organisation to survive in any form. According to Weitzel and Jonsson (1989:94):

> "Organizations enter the state of decline when they fail to anticipate, recognize, avoid, neutralize, or adapt to external or internal pressures that threaten the organization's long-term survival."

So, industry actors have the ability to develop strategies and implement radical transformations to avoid destabilisation conditions at various points in the unfolding of the process. With respect to internal capacity to respond, the literature suggests that:

- in early stages, good information about problems is crucial (Weitzel and Jonsson 1989, Pettigrew 1987),
- as problems become serious, effective strategies are required (Weitzel and Jonsson 1989, Grinyer and Spender 1979, Pettigrew 1987), and
- when problems become crises, only substantial transformative change may avoid decline (Tushman and Romanelli 1985, Wetizel and Jonsson 1989).

I now turn to these three sub-processes influencing organisational change in challenging environments.

**1) Perceiving and interpreting problems**

Destabilisation involves the emergence of new problems or the worsening of existing problems, which have to be addressed by appropriate strategies. However, industry actors do not always adequately perceive problems, especially when these involve new situations.

Strategic choices and action thus require industry actors to interpret new situations as challenging (Daft and Weick 1984), recognising the types and rates of change they are facing (Judge and Miller 1991), adjusting the sense of urgency respectively, and avoiding denial. Sense-making and interpretation of industry environments are essential. However, prevailing cognitive structures may blind actors from understanding novel situations. Industry actors tend to simplify their environments, mobilising mental maps in order to better navigate them (Mintzberg *et al.* 1998:159).

Information and signals that are not consistent with prevailing schemas tend to be left out (Mintzberg *et al.* 1998:161). The resulting myopia or blindness means that external signals are not always seen with clarity (Barr *et al.* 1992). Blindness to challenges delays response strategies and contributes to inertial response patterns (Barr 1998, Tripsas and Gavetti 2000, Kaplan *et al.* 2003).

> "Organizations (…) might not be able to respond adequately to a change in the environment because an outmoded but institutionalized frame continues to predominate." (Kaplan 2008:747)

So, while industry actors need to recognise problems with existing strategies and activities (Barr 1998), this might require changes to prevailing rules and interpretive frames. The ability to change industry-specific rules is referred to as second-order learning (Argyris 1976, Mintzberg *et al.* 1998, Nystrom and Starbuck 1984), a crucial skill of adaptive organisations in adverse environments. The early questioning of dominant positions and ideology is particularly important to deflect destabilisation processes in pre-crisis periods (Pettigrew 1987).

**2) Formulating and implementing response strategies**

In stable environments, industry actors tend to follow well-established strategies and ways of doing things that have proved successful in the past:

> "organizations spend most of their time pursuing given strategic orientations" (Mintzberg *et al.* 1998:313)

Furthermore, established routines and capabilities are highly valuable as they facilitate basic organisational search processes in conditions of regular and predictable change (Robertson and Langlois 1994, Dosi and Nelson 1994). Overall strategic orientation provides a coherent frame for action in stable times, which can be differentiated into more specific strategies linked to various dimensions of industry environments (Geels 2011). Typical strategic changes include new marketing strategies, R&D, product development, lobbying, public relations and information campaigns. However, because industry actors are involved in multiple games in their environments (Porter 1980), there are cognitive limitations as to how many problems can be perceived and addressed simultaneously without stretching the coherence of industry positioning and prevailing strategies.

Thus, early responses to problems tend to remain within the boundaries of established strategic regimes and may be successful at alleviating moderate degrees of pressure (Ansoff 1987). Most response strategies remain incremental or related to a given dimension of industry environments, and thus don't require the fundamental questioning of the industry's identity, core values and beliefs, but rather doing things differently.

**3) Implementing transformative change**

Incremental change to established strategies, supported by prevailing routines, may be ineffective in the face of novel situations:

> "Then [when situations change] all that is constructive and effective about an established strategy becomes a liability." (Mintzberg *et al.* 1998:18).

Formulating and implementing transformational change can be problematic, as it requires breaking out of the existing strategic mould. Existing strategies draw on substantial material resources, skills and capabilities, and routines. Such commitments hinder swift adaptation to external change (Child 1997, Leonard-Barton 1992, Miller 1990, Robertson and Langlois 1994).

Organisational inertia and resistance to all but incremental change impede on "a firm's ability: (1) to reassess environmental opportunities and constraints, and thus to initiate a strategic reorientation; and (2) even given such reassessment, to substantially disrupt the networks of interdependent resource relationships and value commitments toward implementation of a new strategic orientation." (Tushman and Romanelli 1985).

Thus, in addition to cognitive and interpretive problems discussed above, various forms of lock-in limit industry responses to destabilisation conditions:

- commitment to existing material stocks and resources flows, which limit the availability of resources for forward-looking or responsive initiatives (Judge and Miller 1991),
- commitment to established routines (established ways of doing things that guide strategic action), which may become core rigidities that prevent adaptation in changing environments characteristic of destabilisation contexts (Leonard-Barton 1992, Miller 1990)
- commitment to prevailing beliefs and values that constrain what is seen as acceptable and feasible:

> "the basic beliefs, or mindset, of the strategic actor tend towards stability, and this inhibits the making of strategic choices which are adaptive to new circumstances." (Child 1997:50).

So, while industry actors have the ability to develop creative response strategies, they often find it difficult to abandon existing templates or archetypes, because mechanisms of inertia create resistance to major change (Huff *et al.* 1992).

However, in destabilisation processes, when industry actors experience a widening performance gap with external conditions, overcoming organisational lock-in and inertia requires deep transformations in the ways things are done. Strategic renewal and organisational reorientation call for the ability to learn to change rules (second-order learning) (Barr 1998, Argyris 1976, Nystrom and Starbuck 1984).

However difficult they are, organisational reorientations happen. They are seen to punctuate longer convergent periods of incremental change (Abernathy and Utterback 1978, Tushman and Anderson 1986). They imply a radical reformulation of organisational strategies and processes, involving changes in products, markets, and normative positioning (Tushman and Romanelli 1985).

### 2.1.5 Institutional change and destabilisation (view 5)

Institutional theory provides another kind of explanation of stability and change, as related to rule structures. While the organisational processes discussed under view 4 are closely tied to industry activities and strategies in dynamics of economic decline, institutional theory and sociology provide valuable complementary insights into the non-material aspects of change. In such views, industry actors can be seen as *structurated* by institutional rule-sets, commonly referred to as industry mindsets or cultures (Phillips 1994), recipes (Grinyer and Spender 1979), templates (Huff *et al.* 1992), regimes (Geels 2011), within organisational fields (DiMaggio and Powell 1983). Institutional theorists attend to the non-material structuring elements of social life. They have dedicated their attention to the relationships between institutions and action, conceived of as a dynamic process. Institutions are a key sociological concept to explain the non-material structure of social action at multiple levels of organisation. Institutions are the set of formal and informal rules (norms, values, and beliefs) that guide (enable and constrain) social action (Giddens 1984). Within organisational sociology, organisations are seen as embedded in co-constructed institutional structures:

> "organizations, and the individuals who populate them, are suspended in a web of values, norms, rules, beliefs, and taken-for-granted assumptions, that are at least partially of their own making" (Barley and Tolbert 1997:93)

The growing body of literature on institutional *change* has so far mainly addressed the emergence of institutions; research on what might be labelled 'de-institutionalisation' is comparatively scarce:

> "Empirical studies of deinstitutionalization are relatively rare" (Scott 2001:183)

Prevailing institutions within organisational fields can be challenged, as some industry actors within them abandon them (Davis *et al.* 1994, Lounsbury 2001). Institutional structures lead to strong inertia and institutional lock-in, which means that de-institutionalisation is difficult. Institutions are powerful frames for action. However, these frames are not static; they are regularly changed and modified:

> "The concept of institution clearly connotes stability and order, but that does not mean that institutions do not undergo change. Institutional systems undergo change for both external and internal reasons. Exogenous change may be occasioned by disruptions occurring in wider or neighboring systems—whether for political, economic, or social reasons—that destabilize existing rules and understandings." (Scott 2008:437)

Lounsbury *et al.* (2003) suggest that the establishment of new strategies and practices within industries requires the previous de-institutionalisation of existing industry frames. It is, however, difficult to question taken-for-granted rules and routines. This is especially true for core regime rules (mission, identity, core beliefs) in highly institutionalised settings:

> "the lack of flexibility that comes with increasing institutionalization of an organization's mission will inhibit the organization's ability to innovate in response to organizational decline." (Mone *et al.* 1998: 121)

A few studies of *de-institutionalisation* (Oliver 1992, Scott 2000) provide essential background to the understanding of destabilisation. De-institutionalisation can be defined as:

> "the de-legitimation of an established organizational practice or procedure as a result of organizational challenges to or the failure of organizations to reproduce previously legitimated or taken-for-granted organizational actions" (Oliver 1992:565)

Mahoney (2000) suggests four different kinds of explanations for the reversal of self-reinforcing institutional processes in various strands of economic history. De-institutionalisation has thus been explained as a process arising 1) "when it is no longer in the self-interest of actors to reproduce a given institution", 2) when "an exogenous shock (…) puts pressure on the overall system, making a given institution's function obsolete and demanding its transformation to preserve the system in the new environmental setting", 3) through conflict, when subordinate groups "successfully challenge the prevailing arrangements", or 4) "when events bring about its forceful juxtaposition with an alternative, mutually incompatible conceptualization" leading to the "breakdown in consensual beliefs regarding the reproduction of an institution" (Mahoney 2000).

Having noted that institutions change over time, involving institutional decline and institutional emergence, my interest in process leads me to question how the relationship between actors and institutions play out over time. Structuration theory provides an entry point to a more processual approach to de-institutionalisation. Within structuration theory, institutional structures are portrayed as constraining and enabling the behaviour of actors (Giddens 1984). Actors actively draw on such existing structures to guide their action, interpreting them in new contexts. Through their agency, actors are seen to produce and reproduce structures – structures are constantly *enacted*. These structures make action possible but also limit future possibilities. The notion of structuration provides a useful way to consider the duality of structural regularities and individual action; structures are both the medium and outcome of social interaction (Giddens 1984).

With respect to destabilisation, structuration theory suggests that structural regularities (e.g. patterns of change and stability) must be conceived of with attention to the actions of individual agents: destabilisation patterns are visible at the macro-level and enacted at the micro-level. This recursive relationship is schematised in Figure 2.4: actors draw on existing structures for action, and structures are (re)produced in local practices, in ongoing processes (thus the time axis). It follows that destabilisation must be analysed with attention to structural patterns *and* enactment by industry actors. This can be done sequentially, by 'analytical bracketing' (Giddens 1984, Archer 1982) – that is, by analysing structure and agency separately.

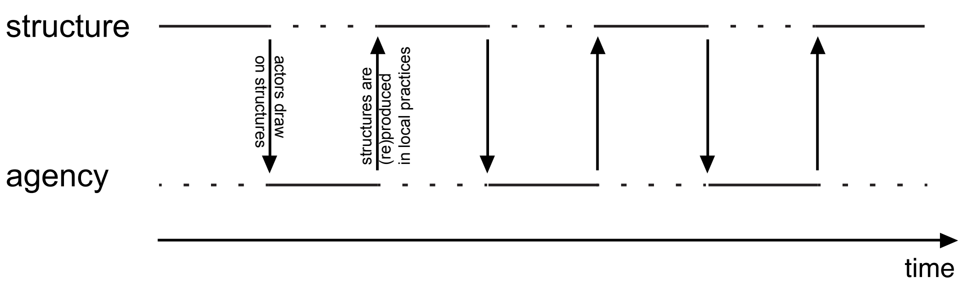


**Figure 2.4: Ongoing recursive relationship between structure and agency in structuration**

However, de-institutionalisation processes are "likely to be associated with the arrival of new beliefs and practices" (Scott 2001:184). Scott (2001) stressed the need for 'destructuration and restructuration' processes to be investigated. Figure 2.5 schematically represents how, *in destabilisation processes, institutional re-production processes are interrupted* as industry actors 'break away' from established structural patterns by questioning inherited institutional frames (de-institutionalisation) at the same time as producing new ones (re-institutionalisation). According to this view, destabilisation involves the erosion and breakdown of existing institutional structures as they lose their meaning and relevance and are abandoned by actors mobilising new frames to make sense of the world.

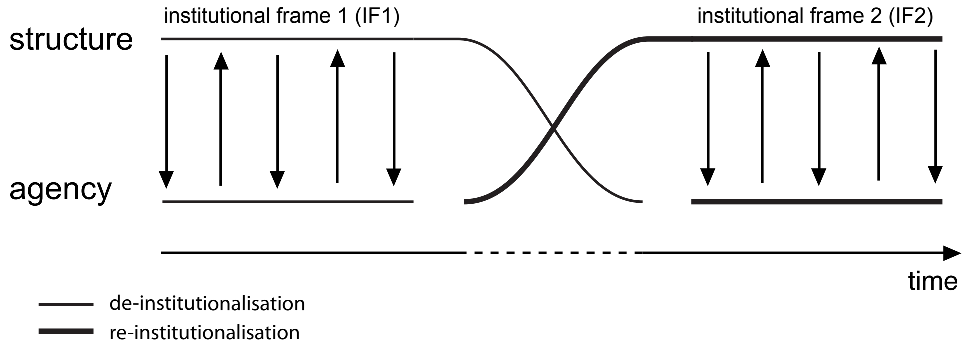


**Figure 2.5: De-institutionalisation and re-institutionalisation in destabilisation processes, dotted line represents expansion of time (drawing on and combining Den Hond and De Bakker 2007, Giddens, 1984, Archer 1982)**

## *2.2 Underdeveloped aspects and relevant insights from different literatures: three aspects*

The first part of this theoretical review was organised around the analytical – and arguably artificial – partitioning of five views, which provide a variety of explanations for destabilisation processes that can be mobilised and combined for theoretical elaboration to address my research questions.

I now turn to three emerging aspects of destabilisation to which this thesis seeks to contribute:

- destabilisation as multi-level unfolding process
- destabilisation as multi-dimensional co-evolutionary process
- the role of societal problems in destabilisation processes

I argue that these aspects have not been the main focus within the existing literature on destabilisation, although some authors have provided useful contributions in these directions. In order to complement and connect the explanations provided by the views covered so far, I mobilise insights from different literatures. This discussion allows me to suggest additional insights that cut across the building blocks in view of theoretical elaboration in chapter 3.

### 2.2.1 Destabilisation as long-term unfolding process

When approaching destabilisation or long-term structural change, the approaches reviewed in 2.1 have tended to take a variance approach to multi-dimensional contexts (McCarthy *et al.* 2010, D'Aunno *et al.* 2000), with little attention to processes of unfolding. The destabilisation of industries is a long-term process. I have suggested in the introduction that a process epistemology can enhance our understanding of destabilisation. Taking the longitudinal aspect of destabilisation as a central objective of explanation calls for a processual view of change that accommodates the unfolding over time of mechanisms across multiple levels.

I here examine the contributions of authors that investigate temporal dimensions of destabilisation and provide potential bridges towards an understanding of the unfolding of destabilisation dynamics across different levels.

#### 2.2.1.1 Historical views and multiple temporalities

Historians have provided fruitful approaches to the study of long-term processes. A fundamental assumption is the existence of multiple time scales and temporalities (Braudel 1958, Sewell 2005, Burke 2005 Geels and Schot 2010). Gaddis (2002) suggests that historians provide a meaningful way of linking together multiple levels of change across different temporal dimensions. They mobilise layered explanations that incorporate immediate causes (e.g. actions, decisions, trigger events), intermediate causes (e.g. social contexts, specific discourses, actors dependencies) and distant causes (broader contexts such as macro-ideologies, wars, economic cycles) (Figure 2.6).

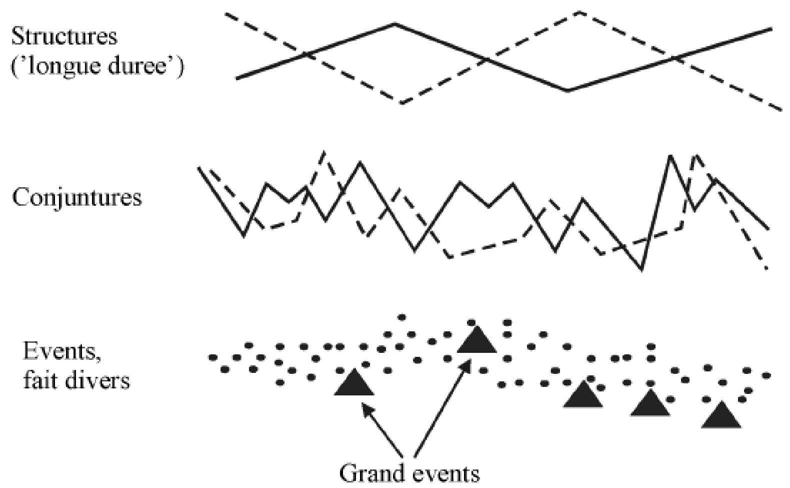


**Figure 2.6: Different levels of unfolding (Bertels 1973:123)**

Interaction between multiple levels of change is likely to be important in destabilisation processes. This means that destabilisation involves the conjunction of processes at different structural levels, with different temporal characteristics and causal mechanisms. Analysing such kind of change is challenging.

Multi-level approaches allow for the nesting of various levels of causalities and related temporal patterns, but require the ability to define relations between different units of analysis. Industry actors can be seen as being inscribed in industries, themselves inscribed in industry environments, themselves inscribed in their broader societal context. Agents interact within and across these levels. Similarly, institutional structures can be seen as operating at these multiple levels (individuals, organisations, industries, organisational fields, etc.).

I thus distinguish three levels of unfolding that I will further unpack in chapter 3: 1) industry moves and games towards its environments, 2) pressures and interaction in environments, and 3) broader landscape changes. Changes on these different levels have to be linked to each other. Specific dynamics are at play at each one of these levels. In specific instances, which need to be better understood, these different dynamics may be coupled together, providing momentum to emerging patterns of change. I here review contributions that attend to the mechanisms of unfolding across different levels of organisation.

#### 2.2.1.2 Characterising the types of environments faced by industries

Within the management and organisational change literatures, authors concerned with the types of environments facing industries (Ansoff 1987, Bourgeois and Eisenhardt 1988, McCarthy *et al.* 2010, Damanpour and Gopalakrishnan 1998) have focused on the types of change in industry environments. While these contributions do not really attend to the processual nature of change, they do provide insights for the study of patterns and regularity at the interface between industry actors and their environments.

These authors consider *timing*, *rates*, *direction* and *predictability* of change across multiple dimensions. Ansoff (1987) characterises organisational environments in terms of their rate and predictability, yielding 5 types of environmental conditions: 1) placid and non-turbulent, 2) expanding environment, 3) changing environment, 4) discontinuous change (change in multiple dimensions), and 5) highly turbulent change. Destabilisation is more likely under the two latter types of environments, in which surprises are more frequent, inherited strengths can become weaknesses, and past strategies are unlikely to remain relevant. Damanpour and Gopalakrishnan (1998), drawing on Mintzberg (1979), suggest that in unstable and unpredictable environments, organisations are substantially threatened and “must innovate consistently to compete, or even survive” (1998:15).

In a similar vein, McCarthy *et al.* (2010) have built on the notion of high velocity environments (Bourgeois and Eisenhardt 1988), as those presenting “rapid and discontinuous change in demand, competitors, technology and/or regulation" (1988:816), and destabilising existing knowledge. They provide a useful conceptualisation of environmental change, and dynamic relationships between various dimensions of change. Industry destabilisation is more likely in conditions where degrees of change are experienced across multiple dimensions which are tightly coupled – i.e. "the degree to which the velocities of different dimensions in an organizational environment are causally connected – the degree to which a change in the velocity of one dimension causes a change in the velocity of another" (McCarthy *et al.* 2010:612-4). Under such conditions, anticipating causal connections between different forms of change in industry environments may crucially determine the success of individual firms within industries under adverse conditions. McCarthy *et al.* (2010) recognise the role of timing and sequencing of change across environmental dimensions:

> "The impacts of changes in the velocity of one dimension on the velocities of other dimensions are unlikely to occur instantaneously but, rather, over time, as the social and technological mechanisms that connect the dimensions are sequentially triggered and exert their impact." (McCarthy 2010:620)

This focus on characterising particular industry environments leads to the identification of regularities, predictability and cyclical nature of environmental variables (velocity), issues of synchronism, dynamic fit between organisations and the pace of change in their environments. Such a broad view on change has to be enhanced by an approach receptive to the unfolding of processes.

#### 2.2.1.3 Macro-patterns of environmental unfolding

Taking the path-dependent nature of change (and destabilisation in particular) seriously stresses the importance of developing a long-term view of change that is receptive to the unfolding of processes and patterns over time. Suarez and Oliva (2005) have made an important step in this direction. They characterise what they refer to as 'environmental change' across four basic attributes: frequency, amplitude, speed and scope (Table 2.2), and are thus mainly interested in meso- and macro-level process, i.e. environmental change and broader landscape transformations. They then suggest a typology based on combination of these attributes, selecting five 'interesting' types of environmental change: 1) regular change, 2) hyperturbulence, 3) specific shock, 4) disruptive change, and 5) avalanche change (Figure 2.7).

**Table 2.2: Attributes of environmental change and resulting typology (Suarez and Oliva 2005)**

| Frequency | Amplitude | Speed | Scope | Type of environmental change |
|---|---|---|---|---|
| Low | Low | Low | Low | Regular |
| High | Low | High | Low | Hyperturbulence |
| Low | High | High | Low | Specific shock |
| Low | High | Low | Low | Disruptive |
| Low | High | High | High | Avalanche |

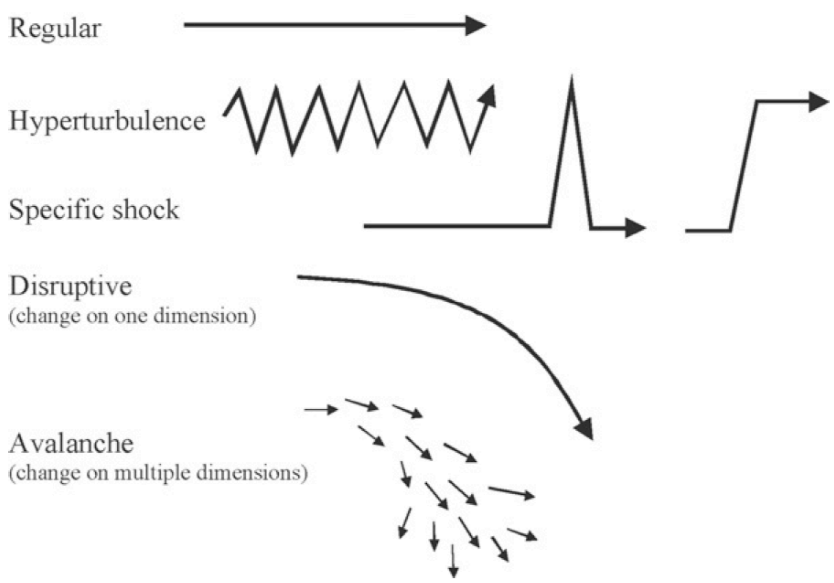


**Figure 2.7: Types of environmental change (Geels and Schot 2007, adapted from Suarez and Oliva 2005)**

While an understanding of the three first types of environmental change has been discussed in the literature (see discussion on environmental velocity above, and the role of shocks below), disruptive and avalanche change remain underdeveloped in studies of destabilisation.

Geels and Schot (2007) have further demonstrated the usefulness of such a typology. Building on Suarez and Oliva (2005), they combine the types of change with multi-level mechanisms in order to develop a typology of transition pathways. In this way, they effectively link environmental change to multi-level system dynamics and provide a generalisable account of unfolding processes within socio-technical transitions. The formulation of different ideal transition pathways as “combinations of dynamic mechanisms” (Geels and Schot 2007:416) allows for an analysis of individual cases in search for patterns in sequences of events.

The approach to destabilisation put forward in this thesis aims at formulating ideal patterns in order to make sense of a variety of possible event-sequences that might be observable in real-world cases.

#### 2.2.1.4 The role of shocks and extreme events

So, destabilisation can be seen as resulting from long-term unfolding processes at multiple levels, which may play out to form specific patterns. However, substantial change is often associated to significant events, which are seen as critical turning points. Historically-minded social scientists have been attentive to developmental trajectories, and the role of turning points in re-directing established trajectories.

> "In studying the temporal intersection of different trajectories, sociologists have often emphasized the way in which this intersection produces key moments, or conjunctures that mark the coming together of relatively autonomous processes. At these points, the choices and intentions of actors become highly consequential and the possibility of substantial change arises. Thus the future-oriented subjectivities of social actors in a crisis situation, produced by the temporal intersection of political and socioeconomic trajectories, may lead to institutional restructuring by revolutionaries who 'seize the time'" (Aminzade:1992:467)

Tensions between interlinked processes of change are thus likely to arise at critical points in time in which event-sequences are brought together in path-dependent processes (Mahoney 2000, Sewell 2005). At such turning points, the synchronicity and timing of change in co-evolving processes appear to be critical.

Shocks and extreme events are significant discrete occurrences with important contingent consequences (Suarez and Oliva 2005). They can trigger disruptive event sequences (Meyer *et al.* 1990, Frantzeskaki *et al.* 2008, Sewell 2005), and thus disturb existing contexts in favour of change in new directions. They "are likely to shake the system, thereby causing the organization to break away from the path" (Sydow *et al.* 2009:701). Shocks may also open up windows of opportunity for the coupling of new ideas, agendas and solutions (Kingdon 1984, True *et al.* 1999).

Shocks may play a substantial role in relation to the salience societal problems:

> "Highly publicized events are critical triggers of institutional transformation (…). Such public occurrences, here called critical events, are contextually dramatic happenings that focus sustained public attention and invite the collective definition or redefinition of social problems" (Hoffman and Ocasio 2001:414)

> "Major shocks or accidents, for instance, can push an issue higher on the agenda and strengthen the empirical credibility of particular discourses" (Elzen *et al.* 2011:265)

However, unless they are actively mobilised, the influence of shocks remains limited. Indeed, "[a] specific shock may dissipate and disappear after a while, returning to base line, or it may lead to a structural stepwise change" (Schot and Geels 2007:404). This means that in order for an extreme event to influence destabilisation processes, it must be interpreted in relation to problems with existing systems.

### 2.2.2 Destabilisation as multi-dimensional and co-evolutionary process

When considering industry-environment relationships, most scholars tend to focus on a specific aspect of environments (e.g. economic change, or socio-political change), or specific sources of change within them (e.g. technology, demand, regulation, etc.). Various dimensions of environmental change are usually considered separately, with little interest in interactions. Destabilisation has thus mostly been conceived of as resulting from technological competition, adverse market conditions, *or* socio-political change – as represented in Figure 2.8.

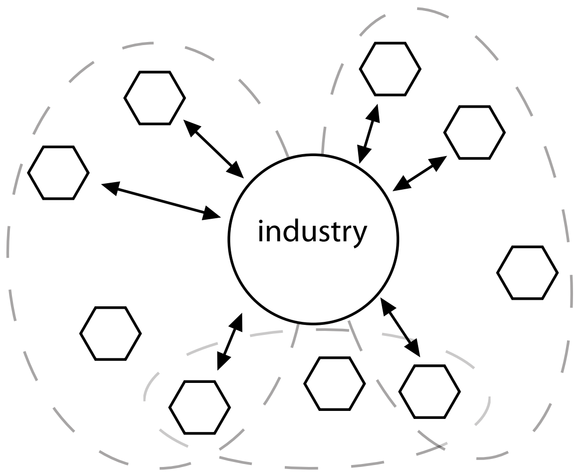


**Figure 2.8: Bidirectional relationships between industry and external actors (hexagons) in various environmental dimensions (dotted zones)**

Even when taking into account a wide array of potential sources of radical change (D'Aunno *et al.* 2000, McCarthy *et al.* 2010, Oliver 1992, Meyer *et al.* 1990, Scott 2000), scholars tend to give only limited attention to processes of interaction between interdependent elements of industry environments. The interaction between environmental dimensions is particularly relevant when studying industrial change as a process involving change along multiple dimensions. Indeed, changes in markets, technology, policies, and socio-cultural dimensions – although they come with their own features and relative autonomy – are likely to influence each other (Freeman and

Louça 2001), thus increasing their respective destabilisation potential. Thus, not only do industries co-evolve with actors and dimensions in their environments, but environmental dimensions also co-evolve with each other in destabilisation processes (bold arrows in Figure 2.9).

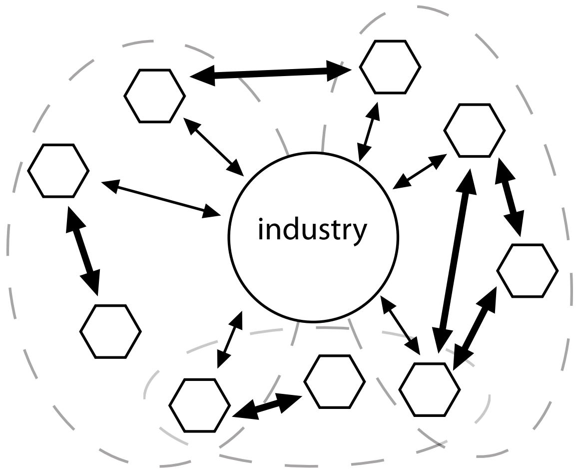


**Figure 2.9: The co-evolution of environmental dimensions in socio-technical configurations**

So, established regimes face multiple pressures that can display varying degrees of alignment over time:

> "There is typically no shortage of pressures acting on any given regime, often pushing in opposing directions. In practice, it is therefore not simply the existence of such pressures that is decisive. Instead, it is what we term the *articulation* of pressures for any given regime transformation." (Smith *et al.* 2005:1495)

Furthermore, because of the multi-dimensionality of industry environments, industry actors can be seen as constantly engaged in multiple changing games:

> The choice of strategy [in rapidly changing or heterogeneous contexts] is a series of ever-changing games in which the position in one game can influence but does not determine the position in the next one. (Porter 1991:110)

Industry actors thus face the challenge of balancing coherent action and strategy with divergent environmental conditions (McCarthy *et al.* 2010). Industrial change is thus likely to reflect the complexity and degree of alignment between pressures in environments.

Building on the socio-technical literature (Geels 2002a, Geels and Schot 2007, Smith *et al.* 2005), and other contributions that consider the multi-dimensionality of industry environments (e.g. McCarthy 2010, D'Aunno *et al.* 2000), this thesis aims to develop a conceptual framework that allows understanding how pressures in industry environments co-evolve to form destabilisation contexts, as well as how industry actors enact destabilisation. Such an approach requires attention to mechanisms of change, and a conceptualisation that is receptive to changing patterns of interaction across multiple forms of 'embeddedness' (Dacin *et al.* 1999). Furthermore, such an approach should be compatible with an understanding of industry actors as engaged in multiple games, which themselves interact with and influence each other (Porter 1980). The conceptual perspective will thus formalise such interaction processes, notably through the notions of 'pressure interaction' and 'enactment patterns'.

### 2.2.3 Societal problems in destabilisation

Because of my interest in sustainability and low-carbon transitions, I here pay extra attention to the role of *societal issues* in destabilisation processes. This interest has been motivated in the introduction in relation to contemporary challenges facing energy systems, such as aspirations to direct change towards low-carbon energy systems. While such issues may reach the status of 'societal challenges' when they achieve high levels of attention and mobilisation, they tend to originate outside of prevailing societal regimes. I am thus interested in the evolution of *societal challenges* – defined as problems that come to the attention of industry actors not through their own normativities as constituted by industry regimes, but through contrasting normativities of non-regime actors as constituted by wider social movements and civil society – and their influence on established industries.

The role of societal problems in destabilisation processes and in theories of social change in general remains an underinvestigated topic:

> "we still don't have a very satisfactory theory of social change. Our ability to improve social problems remains rather limited, and we do not know why we appear to have only modest gains in relation to many societal problems" (Morlacchi and Martin, 2009:575)

In destabilisation processes, challenges to the image, reputation and identity of industry actors may be substantial sources of external pressure (Hoffman and Ocasio 2001), especially with the increase of public attention to specific problems associated with industry practices (Hilgartner and Bosk 1988).

I mobilise two literatures that address the role of societal problems in destabilisation processes: 1) the issue lifecycle literature and 2) the literature on social movements.

**2.2.3.1 Issue lifecycles**

The issue lifecycle literature seeks to identify the determinants of issue evolution in society, as they rise to public attention, and eventually lead to policy or industry response. Such contributions are relevant to an understanding of destabilisation processes insofar as they attend to the gradual build-up of momentum around new societal concerns, and relate this emergence process to challenges to existing industry practices and strategies.

The literature on issue lifecycles suggests that public awareness and concern about new issues varies through time (Rivoli and Waddock 2011). New issues may rise to (and fall from) public and political attention, resulting in varying degrees of pressure on businesses and governments to address these problems. Furthermore, the temporal evolution of specific issues can be analysed as sequences of ideal stages, from the emergence to a resolution of problems (Downs 1972, Mahon and Waddock 1992, Bigelow *et al.* 1993, Lamertz *et al.* 2003, Rivoli and Waddock 2011). Crucial determinants of issue evolution include refinements in the framing of problems and controversies (Wartick and Mahon 1994, Lamertz *et al.* 2003), the involvement of multiple environmental actors, media attention and public concern (Hilgartner and Bosk 1988, Newig 2004), and industry and policy responses to new societal claims (Mahon and Waddock 1992, Rivoli and Waddock 2011).

In early stages of issue emergence, framing and the diffusion of a shared understanding of the problem at stake are important. When societal issues reach mass public attention, they increase the sense of urgency that drives perceived responsible actors (policymakers and/or industry actors) to search for adequate solutions (Mahon and Waddock 1992). Public opinion and its attention to specific problems is however difficult to measure. Common proxies include media coverage (Carvalho and Burgess 2005) – a common shorthand indicator for managers (Hoffman and Ocasio 2001) – and opinion polls (Newig 2004). Issue lifecycle theorists also highlight that public attention is limited, which means that societal problems “must compete both to enter and to remain on the public agenda” (Hilgartner and Bosk 1988:58). Issues may thus remain unaddressed if attention is not sustained (Bigelow *et al.* 1993).

Policy formulation and intervention is often portrayed as the resolution stage of societal issues (Bigelow *et al.* 1993, Newig 2004) – that is, new issues emerge in the public sphere, may acquire salience through public attention, leading to political activity and eventual policy outcome with the intention of positively addressing the issue. Such approaches thus emphasise regulatory pressure as the process by which externalities can be 'internalised' by industry actors. New government regulations are crucial for the de-institutionalisation of social practices:

> "Among the external pressures identified, changing government regulations are most likely to deinstitutionalize past practices, given the strength of coercion that underpins the legal enforcement of government mandates." (Oliver 1992:584).

This means that the translation of societal problems into a policy concern with substantial traction marks a turning point in the articulation of socio-political pressure on industries. For instance, strong environmental regulation is seen as a driver of environmental innovation (Porter and von der Linde 1995).

But issues may gain societal salience and still not move towards resolution or responsive industry action. The literature on stakeholder and issue management has been more concerned with understanding what kind of, and whose claims really matter from the perspective of corporate actors (Mitchell *et al.* 1997, Wartick and Heugens 2003). The ability of external actors and their claims to affect industry legitimacy and reputation raises an issue's salience and its likelihood to be addressed (Zyglidopoulos 2003, Mahon 2002).

#### 2.2.3.2 <u>Social movements</u>

The literature on social movements provides keys about the societal mechanisms by which new issues such as sustainability may gain momentum in society (Dryzek *et al.* 2003). It is interested in the mobilisation of public support around new (often far-ranging) societal problems. These typically concern side effects, externalities or recurring problems related to public goods associated with technological systems. Societal issues may include health and safety concerns, social and labour problems and environmental problems (Mahon and Waddock 1992). Via the expression of such problems, new values, normative positioning and cultural preferences and ideologies may challenge established practices. As mainstream beliefs and normative orientations change within society, conventional assumptions, such as the legitimacy of technological and industrial systems can be questioned and challenged. Such mechanisms can play a significant role in industry destabilisation.

Different relevant social agents and stakeholders "may become involved with an issue at different times" (Mahon and Waddock 1992:19). These different actors or groups are central to the framing (Hilgartner and Bosk 1988, Benford and Snow 2000) and evolution of issues (Wartick and Heugens 2003), thus affecting the kind of pressure they exert on industries. Social movement theory suggests that activists actively seek to increase momentum and mobilisation around new issues. Social movements are built around the motivation of diffusing new field frames (Benford and Snow 2000) and exposing public opinion, policymakers, economic entities and/or industry actors to societal issues.

Social movements interact with the general public and public opinion in two significant ways: a) through education and awareness raising on new or underrepresented issues that contribute to the framing of problems (Mahon and Waddock 1992, Rivoli and Waddock 2011), and b) through the mobilisation of public support for policy change via democratic processes (protest, vote, etc.).

Societal issues and problems tend to be initially raised and formulated by activists, as they call for change in prevailing practices and raise controversies. An important activity concerns the framing of problems and potential solutions:

> "Collective action frames are constructed in part as movement adherents negotiate a shared understanding of some problematic condition or situation they define as in need of change, make attributions regarding who or what is to blame, articulate an alternative set of arrangements, and urge others to act in concert to affect change" (Benford and Snow 2000:615)

Social movements actively participate in cultural framing via the articulation and diffusion of knowledge around societal issues (Rivoli and Waddock 2011), e.g. through scientific research and awareness raising campaigns.

Social movements and activists are thus crucial for new issues to be raised in public and political arenas – they act as agenda builders (Wartick and Heugens 2003). They are the driving force behind societal pressures. They use "extra-institutional tactics, or tactics not commonly embraced by institutional elites and that, in some way, are subversive to the target institution" (King 2008:396). Social movements seek policy change and reform by mobilising and sustaining public attention to specific issues. They try to influence policy formation processes by raising new issues, framing them as substantial problems, and eventually offering potential solutions. The literature suggests that three main strategies are available to overcome the difficulties of access to policy formation: 1) to capitalise on public mobilisation (Giugni and Passy 1998), 2) to form strategic political alliances (Tarrow 1994, Dryzek *et al.* 2003), and 3) to develop uncontested expertise. These processes are interlinked:

> "When they benefit from the support of public opinion, social movements increase their legitimacy as political actors in front of the political authorities." (Giugni and Passy 1998:3).

Activists can also exert highly localised contestation pressure on a given public or private organisation (Den Hond and De Bakker 2007). Indeed, “effective NGOs engage not only the corporations that they target but also attempt to influence government and public opinion” (Etzion 2007:653). Activists and contestation groups can also lead, foster or associate themselves with niche-level initiatives (technological alternatives, policy proposals, alternative cultural preferences, etc.) (Smith 2005, Hess 2005). Because of their simultaneous involvement on multiple fronts, social movements and normative contestation groups are thus crucial for problem interaction in socio-political and economic environments.

## *2.3 Taking stock of the literatures and the way forward*

In this chapter, I have introduced a number of literatures relevant to destabilisation. I have highlighted a number of blind spots with these existing views, focussing on three ‘transverse’ challenges that this thesis seeks to address. I provided complementary insights from a range of literatures that can inform a more integrative approach around these ‘transverse’ challenges. These challenges will structure theoretical elaboration in chapter 3. I now take stock of the literatures introduced, focussing on ‘building blocks’ and their further combination.

### 2.3.1 Building blocks

For each view, I list a number of insights that will be mobilised as ‘building blocks’ in chapter 3:

View 1:

1. Technological competition is an important source of industry destabilisation.
2. Technological alternatives can exert substantial destabilisation pressure, through the introduction of market opportunities based on new functionalities, improved performance, and the integration of problems with existing technologies.
3. ‘Disruptive’ technologies pose challenges to existing industries that are unlikely to be addressed within established regimes.

View 2:

4. Economic problems are important sources of destabilisation. A multiplicity of economic pressures can be identified, including: 1) the intensity of rivalry between

existing firms, 2) the bargaining power of suppliers, 3) the bargaining power of buyers, 4) the threat of new entrants, and 5) the threat of technological substitutes.

5. Economics pressures affect the financial and economic performance of established industry actors.
6. Long periods of low economic performance may lead industry actors to question established practices and prevailing regime rules.

View 3:

7. Industry actors are also exposed to non-economic pressures.
8. Socio-political pressures on established industries challenge their legitimacy.
9. Closely-knit organisational fields contribute to the resistance to change at a collective level.
10. Firms are expected to comply with changing norms and rules in order to survive within an organisational field.
11. The institutional rule-sets structurating industry activities are stable over long periods of time, but also regularly undergo substantial change (see view 5).

View 4:

12. Organisational decline can be seen as a dynamic process, involving numerous stages from blindness to dissolution, through crisis.
13. Each stage of decline comes with opportunities to avoid progression in the later stages.
14. As performance gaps widen, reverting decline requires increasingly radical transformation.
15. When destabilisation contexts become more pressing, three main trajectories are possible: 1) organisational *reorientation*, 2) organisational *re-creation*, and 3) organisational *dissolution.*
16. Avoiding organisational decline is related to a sequential set of challenges: 1) the perception and interpretation of problems, 2) the formulation of response strategies within existing regimes, and 3) the implementation of transformative change outside the boundaries of existing regimes.
17. In pre-crisis stages, good information about problems, sense-making and interpretation are crucial to deflect destabilisation processes

18. While early responses to problems tend to remain within the boundaries of established strategic regimes, as problems become serious, more daring strategies are required.
19. When problems become crises, only substantial transformative change (that question established routines) may avoid decline.
20. The implementation of transformational change is risky as it requires breaking out of the strategic mould and abandoning commitment to valuable skills and resources.
21. Various forms of lock-in (commitment to existing material resource flows, established routines, prevailing beliefs and values) limit industry responses to destabilisation conditions.

View 5:

22. The actions and strategies of industry actors are structurated (enabled and constrained) by non-material, institutional, rule-sets (i.e. industry regimes).
23. Industry regime rules are relatively stable over time, but can also be challenged in de-institutionalisation processes.
24. In destabilisation processes, institutional re-production processes are interrupted as industry actors 'break away' from established structural patterns by questioning inherited institutional frames (de-institutionalisation) and the same time as producing new ones (re-institutionalisation).

### 2.3.2 Mobilising research challenges as guidelines for theoretical elaboration

Based on blind spots identified in the literatures discussed, I derive a set of guidelines that will allow me to address three main 'transverse' theoretical challenges:

- Unfolding process
    - Destabilisation is a long-term process, in which the sequencing and timing of events and processes is crucial.
    - Destabilisation involves the conjunction of processes at different structural levels, involving different temporalities and causal mechanisms.
    - Three levels of unfolding can be proposed: 1) industry moves and games towards its environments, 2) environmental pressures and interaction, and 3) broader landscape changes.

    - The intensity, frequency, amplitude and scope of external change are likely to influence the unfolding of destabilisation processes.
    - The interaction, alignment and coupling of change at multiple levels are likely to accelerate and intensify destabilisation processes.
    - A theory of destabilisation should address the role of external shocks as triggers of far-ranging change processes (in conjunction with other dynamics).
- Multi-dimensional co-evolution
    - Destabilisation involves external pressures in multiple domains in the economic and socio-political environments of industries.
    - Consequently, industry actors can be seen as involved in multiple games towards various dimensions in their environments.
    - In terms of process, destabilisation results from economic decline and de-institutionalisation processes.
    - Destabilisation theory must address 1) the breakthrough of radical technological innovations which overthrow established industries, 2) selection pressures on economic dimensions, and 3) selection pressures on socio-political and institutional dimensions.
    - Destabilisation involves the interaction and mutual influences between pressures across environments.
    - The interaction of multiple sources of change is likely to determine the play-out of destabilisation trajectories.
- Societal problems
    - Societal problems are an underdeveloped topic in theories of social change that should be attended to in destabilisation processes.
    - New issues may rise and fall on the agenda of public, political and economic entities.
    - The emergence of new societal issues is a dynamic process of gradual build-up involving a variety of actors in industry environments (normative contestation groups, policymakers, public opinion, industry actors).
    - Societal issues may become serious challenges for industry actors who develop strategies to deal with threats to their legitimacy.

- Because of their simultaneous involvement on multiple fronts, social movements and normative contestation groups are crucial for problem interaction in socio-political and economic environments.
- Social movements are built around the motivation of diffusing new field frames (Benford and Snow 2000) and bringing societal issues to the attention of the public, policymakers, economic entities and/or industry actors.
- The translation of societal problems into a policy concern with substantial traction marks a turning point in the articulation of socio-political pressure.
- A theory of destabilisation should be receptive to the role of societal problems in conjunction with other determinants of socio-economic change.

These guidelines for theoretical elaboration, related to broad ‘transverse’ research challenges, will provide the epistemological ‘glue’ to mobilise and combine the identified ‘building blocks’.

# 3 Conceptual perspective

## *3.1 Overview*

This chapter presents the conceptual perspective mobilised to investigate destabilisation processes. Building on the various views on destabilisation discussed in the previous chapter, theoretical elaborations are guided by three research challenges. The aim is to develop an understanding of destabilisation that attends to multi-level unfolding, multi-dimensional co-evolution, and environmental problems.

### 3.1.1 Contributions and positioning

This chapter formulates the conceptual perspective mobilised for the study of industry destabilisation. Taking a 'building blocks' approach to conceptual elaboration, I mobilise insights from the different views on destabilisation covered in chapter 2 to formulate a integrative perspective tailored to address my three research challenges. It addresses 1) dynamic unfolding at multiple levels, 2) multi-dimensional co-evolution, and 3) the role of environmental problems (as a particular kind of societal problem).
The contributions of my conceptual perspective combine and complement existing perspectives reviewed in chapter 2 by attending to the long-term unfolding of destabilisation processes at multiple levels (from industry actors to broader landscapes) and to the co-evolutionary nature of change on multiple dimensions in industry environments. My interest in environmental problems provides a further justification for a multi-dimensional perspective that attends not only to developments in the economic environment, but also in the socio-political environment of industries.

### 3.1.2 Structure of the conceptual perspective

The conceptual perspective builds on the Triple Embeddedness Framework (TEF) of industrial change (Geels 2011), which provides a synthetic conceptualisation of industry as embedded in multiple environments and institutional structures. Furthermore, the TEF, drawing on notions of industry embeddedness (Geels 2011, Granovetter 1985, Dacin *et al.* 1999, Krippner 2001), accommodates a multi-dimensional understanding of industry stability, and is thus a useful starting point for conceptual elaboration on destabilisation processes.
Using this framework as a 'stepping stone', I can then formulate an original synthetic perspective on destabilisation, consisting of three interrelated processes: 1) the

evolution of external pressures, 2) industry responses to perceived challenges, and 3) mediation by industry regimes (inertia *and* change). I address the three 'transverse' research challenges to elaborate an integrative perspective on destabilisation that satisfies my research criteria.

## *3.2 Triple Embeddedness Framework (TEF)*

The TEF (Geels 2011) provides a synthetic and useful (Turnheim and Geels 2011) conceptualisation of industry actors as embedded in two selection environments (economic and socio-political), and structurated by field-specific (enabling and constraining) institutions: *industry regimes* (see Figure 3.1). This framework is here mobilised as a 'stepping stone' to provide an initial conceptualisation of industry embeddedness that allows for the investigation of destabilisation processes.
Destabilisation results from challenges to prevailing forms of stability. It is thus relevant to explore the elements that contribute to industry stability. The TEF suggests two broad forms of explanation for the long-term stability of industries: 1) stable relationships with external environments (external fit), and 2) inertia provided by industry-specific institutions (regime commitment).

### 3.2.1 Multi-dimensional external pressures

I have already pointed to my (theoretical) motivations for dealing with multi-dimensional industry environments that include both economic and socio-political elements. While some efforts towards integration have been noted in the literature (d'Aunno *et al.* 2000, Mone *et al.* 1998, McCarthy *et al.* 2010, Oliver 1992, Meyer *et al.* 1990, Scott 2000, etc.), they have tended to neglect dynamic interactions between environmental dimensions. The TEF conceptualisation of industry environments is compatible with my coevolutionary motivation, and thus provides a useful starting point for theoretical elaboration. I first discuss two broad environments (economic and socio-political), and then address their interactions.
The *economic* environment encompasses supply-chains and markets. Relevant social groups include suppliers, customers, new entrants and competitors, and technological alternatives (Porter 1980). The main resource flow concerns goods and services, which are exchanged in transactions assessed principally according to economic and material criteria: price, cost, technical performance, efficiency, etc.

The *socio-political* environment contains non-commercial relationships between industry and non-market actors. Relevant social groups include policy makers, civil society, and social movements. The main selection criteria are social fitness and legitimacy, which determine industry actors' 'license to operate'. Legitimacy has been defined as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995:574). Firms in industries are expected to adhere to institutions expressed formally, such as in policies and regulations, or more tacitly, such as in normative prescriptions, public values and expectations (Fligstein 1996, Leblebici *et al.* 1991, D'Aunno *et al.* 2000).

Environmental boundaries and their respective institutional singularities are not hermetic; they interpenetrate each other through two main processes: 1) mutual shaping, and 2) the active engagement of actors across environmental dimensions.

1) The economic and socio-political dimensions overlap. Economic sociologists have argued that economic activities are partly determined by prevailing institutional rule-sets and policies (Barber 1995, Davis *et al.* 1994, Dacin *et al.* 1999), e.g. economic policies set framework conditions for market transactions. Similarly, the criteria at play on markets exert their influence beyond market transactions, such as when policies are evaluated on the basis of their cost-effectiveness for instance.

2) Furthermore, social actors engage with each other between environments. Socio-political actors actively engage in activities with an aim to alter the conditions of economic transactions. Economic actors also engage in activities with the intention to shape norms, regulations and legitimacy criteria.

In stable conditions, environmental dimensions and actors follow relatively predictable interaction patterns that contribute to the stability of established trajectories through alignment. But when environments are in flux, *interactions between forces and actors across environmental dimensions are crucial to the build up of dynamics of change that guide the direction of industry trajectories*. Environmental interactions are further considered below in the context of multi-level unfolding (3.3.2) and multi-dimensional interactions at environmental level (3.3.3).

### 3.2.2 Industry strategies

Building on insights from evolutionary economics and institutionalist perspectives, the TEF suggests that industry actors develop bi-directional relationships with their environments, which are mediated by institutional structures.

Industry actors actively engage with their environments (Child 1997, Miles and Cameron 1982, Geels 2011, Mintzberg, *et al.* 1998). Oliver (1991), for instance, suggests that organisations may adopt 'defiant' or 'manipulative' strategies towards change in external institutions, while Miles and Cameron (1982) see firms as capable of a variety of positioning strategies on markets, including domain defence, domain offence and domain creation. Child (1997:45) considers firms as actively selecting the kind of environment in which they operate.

The relationships between industries and their environments are also enacted. The literature on corporate strategy offers clues as to various strategies available to organisations to respond to or shape pressures in their environments. Geels (2011) provides a summary of the strategies employed by industry actors towards their environments.

> "The main strategies towards various environments are the following:
>
> a) *Economic positioning strategies* focus on the position of industries in the (economic) task environment. They include supply chain management, operations management, marketing and sales.
>
> b) *Innovation/technology strategies* include R&D, knowledge management, and product development alliances.
>
> c) *Political strategies* relate to government policies, and include lobbying, financial contributions to political parties, litigation, organized pressure strategies, and information strategies (Hillman and Hitt, 1999);
>
> d) *Socio-cultural strategies* relate to social debates and public opinion, and include framing strategies, public relations, advertising and information campaigns (Lounsbury and Glynn, 2001)."
>
> (Turnheim and Geels 2011:6)

### 3.2.3 Mediation by industry regimes

Building on institutional theories (Giddens 1984, Scott 2001, Haveman and Rao 1997), the TEF supplements the embeddedness of industry actors in environments by a structuration process (see view 5). The 'industry regime' (Geels 2011, Turnheim and Geels 2011) is a set of industry-specific institutions (Haveman and Rao 1997) that enable and constrain the behaviour and action of industry actors. Industry regimes differ from broader institutions, at play in industry environments (such as societal discourse and beliefs, economy-wide regulations, customer prescriptive values, etc.), which structure whole economies, societies, etc. Regime commitment and capacity for action are tightly linked (Greenwood and Hinings 1996).

Building on Scott's (2001) conceptualisation of institutions, and adding a technical dimension, industry regimes include:

1) cultural-cognitive elements (beliefs and cognitive frames),
2) normative elements (mission, identity and values),
3) technical elements (competences, knowledge, capabilities), and
4) regulatory elements (specific regulations).

These institutional structures of industries provide a frame for action. They are mobilised on a routine basis to make sense of external reality. They provide the rule-set for firms in industries to formulate strategies, but also set limits to the creativity of responses to environmental conditions. Indeed, as frames for action, institutions provide limits to what is seen as possible, and are powerful sources of conformity and *lock-in*. The different elements of industry regimes have here been ordered according to their structural importance, cognitive elements having precedence over action elements in a continuum between abstraction and physicality (Gavetti and Rivkin 2007). Cultural-cognitive and normative elements constitute the core rules as they relate to 'ways of being and interpreting'. They are thus more fundamental than technical and regulatory elements, which relate to 'ways of doing' or the 'world of action' (Gavetti and Rivkin 2007). Consequentially, when core rules are changed, they are likely to lead to changes throughout established sets of rules. The contrary is not necessarily true.

Commitment to industry regimes may lead to various forms of lock-in, which provide industry inertia and raise barriers for change. At industry levels, four broad types of lock-in can be specified in relation to regime elements:

1) Commitment to cultural-cognitive institutions (routine rigidity) narrows down the scope and focus of industry search and sense-making (Gilbert 2005). Managers and engineers become blind to developments outside their search area (Nelson and Winter 1982), underestimating threats and opportunities. Cognitive inertia leads to difficulties in processing external change and may delay the matching perceived problems with solutions or strategies (Barr 1998, Tripsas and Gavetti 2000, Kaplan *et al.* 2003).

2) Commitment to predefined mission and identity refrain industry actors from changing their normative positioning in society (Dutton and Dukerich 1991).
3) Commitment to the existing technological and competence base creates resistance against technological discontinuities (Tushman and Anderson 1986), which by definition tend to disrupt past investments in skills and technologies. New capabilities are difficult to develop in exploitation phases (March 1991).
4) Industry actors are committed to industry-specific regulatory institutions through compliance mechanisms (Scott 2001). These institutions constrain the behavior of industries with incentives and disincentives.

Institutional logics are relatively stable, but can change and be disrupted. Institutional change has been receiving increasing attention from scholars (Scott 2008, Dacin *et al.* 2002, Oliver 1992, Mahoney 2000, Den Hond and De Bakker 2007). Drawing on such contributions, industry regimes are not seen as permanent structures. Instead, they are stable over extended periods of time, *as long as industry actors are willing to reproduce them*. They are generated by the cumulative action of organisations during industry formation (emergent enactment), are actively reproduced by on-going mobilisation of its categories by organisations (routine enactment), and may be modified through second-order learning processes (enactment of change).

### 3.2.4 A synthetic understanding of industry stability

Industry actors are thus embedded in environments and in sets of rules. The former type of embeddedness in environments relates to interaction between mutually dependent actors), while the latter type is oriented towards rules and structures. The related forms of explanation are thus complementary.

Industry actors are subject to external selection pressures in their environments, and tend to conform to prevailing institutions (see Figure 3.1). The TEF discussed above suggests essential sources of industry stability (Geels 2011).

1) Industry actors seek fit with their environments: a) stable or growing resource flows in the economic environment, and b) acceptable levels of legitimacy in the socio-political environment.
2) Internal industry stability is maintained by the reproduction of industry-specific institutions. Industry actors are committed to regime rules and tend to reproduce them as long as they are perceived as viable.

The external and internal dimensions of stability are interlinked, such that stable industries ascribe to strongly institutionalised rule-sets and strategies, and benefit from a stable relationship with external conditions. The resulting stability is enacted on an on-going basis. In conditions of regular change, rules and resource flows are reproduced by actors. Destabilisation thus requires actors to question the regime rules when experiencing problems with resources and legitimacy.

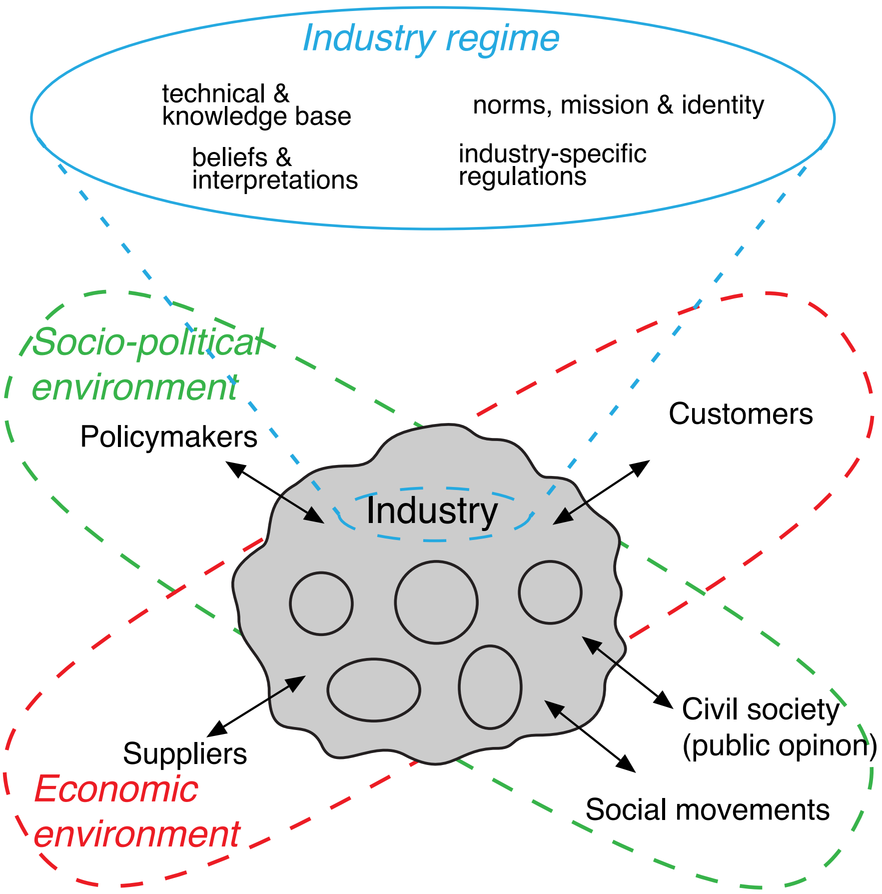


**Figure 3.1: Triple embeddedness representation of industries (adapted from Geels 2011)**

## *3.3 Industry destabilisation*

I now mobilise the TEF to integrate the 'building blocks' covered in the literature review, and position my conceptual contributions in relation to the research challenges introduced in chapter 2.

### 3.3.1 Towards a synthetic understanding of industry destabilisation

Building on the TEF (see 3.2), which formalises bi-directional relationships between industry actors and external actors in industry environments, and institutional rules structures enabling and constraining the agency of industry actors, I can now elaborate a perspective that attends to destabilisation in relation to these forms of industry embeddedness.

Destabilisation can be understood as resulting from the weakening of external sources of stability *and* actor commitment to established regime rules. These processes are interlinked and mutually influence each other. I first conceptualise external pressures and industry responses separately, before specifying their dynamic interaction.

#### 3.3.1.1 External sources of change

I here integrate insights on forms of change in industry environments presented in chapter 2 (views 1 to 3). Various scholars have considered different sets of sources of change in industry environments (Porter 1980, Ansoff 1987, Abernathy and Clark 1985, McCarthy *et al.* 2010). Building on such insights and on the TEF, I identify ten distinct types of forces in industry environments from which substantial pressure can originate (see Figure 3.2).

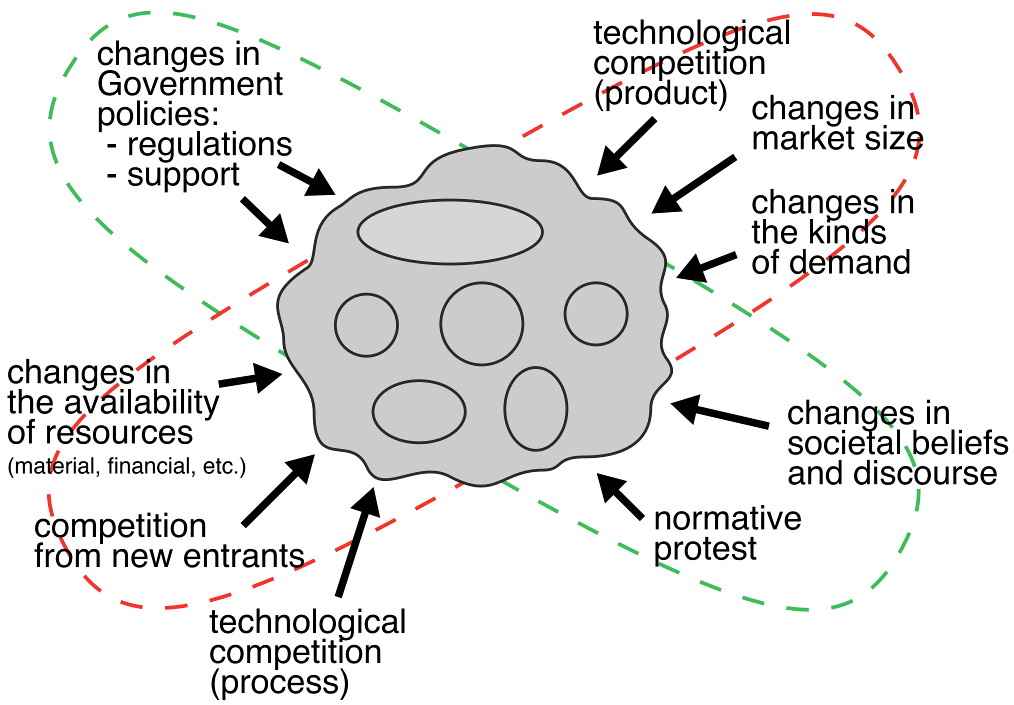


**Figure 3.2: Sources of change in industry environments**

In the economic environment, industry actors face pressures on markets and on the supply side. These pressures overlap partly with Porter's 5 competitive forces (1980). The market position of industry actors is affected by changes in:

1. the *size of demand* (market size),

2. the *kinds of demand* (qualitative attributes)
3. the degree of *technological competition in products*.

These sources of change are mainly enacted by customers and competing industries. On the supply side, industry actors face:

4. on-going challenges concerning the *availability of essential resources* (financial capital, raw materials, equipment and machinery, labour and capabilities, etc.)[8],
5. the introduction of substantial *process innovation*, and
6. *competition from new entrants*.

These pressures are enacted by suppliers and industrial competitors.

In the socio-political environment, industry actors face

7. *changes in societal beliefs and discourse* expressed by the general public,
8. *normative protests* expressed by specialised activist organisations concerned with undesirable industry practices in relation to societal challenges (Den Hond and De Bakker 2007),
9. changes in *policies that regulate*, and
10. changes in *policies that provide support* to industry activities.

These latter types of selection pressures are articulated by actors that fall beyond the realm of the market, but nevertheless exert significant influence on regimes.

#### 3.3.1.2 Industry responses

Thus, industry actors simultaneously face multiple pressures in their environments, which affect their market position, financial performance, and political and cultural legitimacy. They develop specific response strategies to attend to pressures in multiple domains. These responses have to be balanced with each other for overall strategic consistency, and are enabled and constrained by regime rules.

In chapter 2, I have highlighted three processes relevant to industry enactment of pressures and destabilisation contexts (view 4), namely 1) the perception and interpretation of problems, 2) the formulation of response strategies, and 3) the implementation of transformative change. I here integrate these insights to the TEF and the notion of regime rules.

---

[8] See for instance, discussion of munificence in the organisational literature, as the availability of organisational environments to provide sufficient resources for the population they host. Such conceptions are different from resource-based views, which emphasise that firms and organisations actively develop resources for themselves (e.g. capabilities and core competences).

The three processes are sequentially linked, and each involves a particular kind of relationship with environmental signals that is mediated by internal structures:

1) the perception and interpretation of problems is the first mode of interaction between industry actors and their environments in destabilisation processes. Internal controls and sense-making devices assess the existence of gaps between external expectations and actual performance. Problems and performance gaps may be missed, downplayed, or denied, in which case they can get worse. However, if recognised, problems are met by adjustments to existing strategies, or the development of new strategies.
2) According to the TEF, four types of industry strategies can be distinguished: a) economic positioning strategies, b) innovation/technology strategies, c) political strategies, and d) socio-cultural strategies. Each type of strategy addresses specific environmental dimensions. The strategic response process involves the initial search for and selection of new strategies, followed by increasing resource dedication, and later the abandonment of previous strategies. The successful implementation of response strategies can alleviate problems altogether. However, because industry strategies are constrained by prevailing industry regime rules that limit the field of possible action, they might not be enough to cope with serious threats, or multi-dimensional combinations of pressures.
3) When pressures are intense, multiple, and/or highly aligned, environments might become so challenging to industry actors that they can no longer be addressed without reformulating existing regimes rules. Implementing transformative change to industry rules is a difficult task that requires the ability to question taken-for-granted assumptions, the ability to substantially re-direct committed resources, and the creativity to define a new fruitful trajectory to guide future strategies. Depending on the depth and scope of regime rule change, industry transformation can be a re-orientation or a re-creation trajectory (see below).

#### 3.3.1.3 The articulation of external problems and endogenous responses

Increasing pressures in the environment of industries (changing external rules and resource flows) can lead to weakening economic performance and/or decreased levels of legitimacy. Sustained weak performance may lead to doubts in the adaptive potential of existing regimes, and may trigger the initial search for solutions outside the bounds of the existing regime (early diversification). If problems continue unresolved and turn into serious challenges, industry actors may have to implement major regime change in order to survive. This implies the re-evaluation of peripheral regime rules (re-orientation), or the fundamental re-evaluation of core beliefs (re-creation) (Tushman and Romanelli 1985).

However, radical changes to strategies and regime rules (i.e. changes in mission, identity, and industry structure) are risky for industry actors, because they involve the development of new activities in unchartered and uncertain territory. In destabilisation contexts, undertaking such risky renewal activities may, however, be the only way to alleviate external pressures. Because destabilisation involves the temporal articulation of external and internal dimensions, the timing of responses strategies and structural transformation is crucial. Navigating destabilisation contexts involves the risks of adapting too soon, or too late.

The understanding of destabilisation processes could thus be improved by attending to their unfolding, including variations in the nature, timing and interaction of sources of change at multiple levels. In the next section, I further conceptualise these aspects of destabilisation processes.

### 3.3.2 Destabilisation as a multi-level unfolding process

In this section, I attend to destabilisation as a multi-level unfolding process. Building on historical approaches to long-term change, I first distinguish three levels of unfolding, cover mechanisms at play in each of them, and suggest their articulation in destabilisation processes.

I have already distinguished several organisational levels in which industry actors are inscribed. These organisational levels are implicit in the TEF, but are worthwhile rendering explicit and developing further. The TEF *maps* industry actors within industries, and within environments. Figure 3.3 represents industry actors as inscribed in multiple organisational levels: 1) industries, 2) industry environments (organisational fields), and 3) broader environments (landscape).

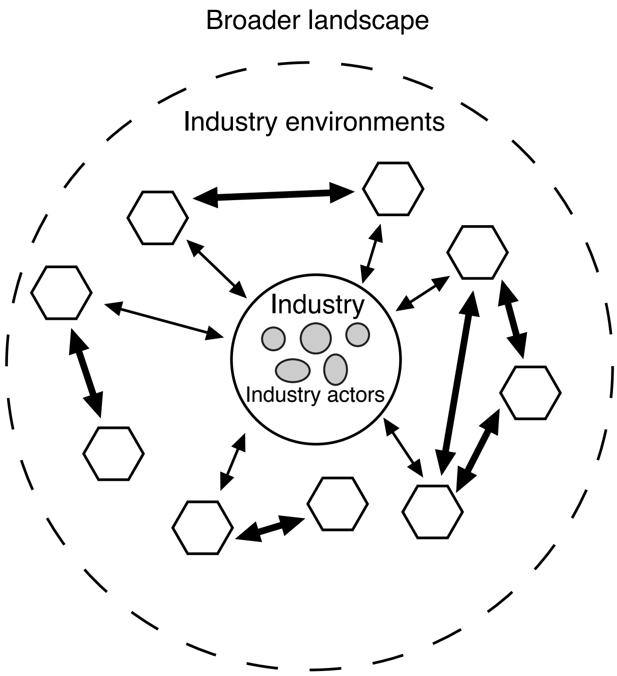


**Figure 3.3: Industry actors inscribed in multiple organisational levels**

This conceptualisation of multi-level embeddedness remains fairly static. Building on multi-level perspectives inspired by historical approaches (2.2.1.1), when considering destabilisation as an unfolding process, specific dynamics and temporalities can be seen as operating at each level. The unfolding of processes at each level is further specified below. Because of my focus on industries and industry actors, I first conceptualise the unfolding of destabilisation processes at this level, before conceptualising 'higher-order' dynamics. Furthermore, these levels are interrelated, and thus require the specification of multi-level interaction mechanisms.

#### 3.3.2.1 Industry enactment of destabilisation

Here I build mostly on managerial and institutional approaches (views 4 and 5), which link destabilisation to decreasing regime commitment and processes of strategic change. Understanding destabilisation as an unfolding process requires a conceptualisation of the process of change at organisational and industry levels as it is implemented in the face of serious external challenges. Destabilisation involves increasing external challenges and decreasing commitment to established strategies and regime rules.

The destabilisation of industries can be represented as progressing through a number of phases. Such phase models are ideal-types that can be mobilised as search heuristics to guide empirical analysis (O'Rand and Krecker 1990). They are necessary simplifications of real-world processes.

Isolating industry response requires to 'analytically freeze' other dimensions and organisational levels, in order to take an 'inward' look. Therefore, I for now assume that problems increase gradually, and focus solely on industry responses and enactment of transformational regime change. Building on existing conceptualisations of organisational decline (Collins 2009, Weitzel and Jonsson 1989, Tushman and Romanelli 1985) and issue evolution (Bigelow *et al.* 1993, Rivoli and Waddock 2011), the internal enactment of destabilisation by industry actors can be conceptualised as following five phases, from denial to dissolution (see Table 3.1):[9]

1) Blindness and denial. In the early stages of destabilisation, when pressures have emerged but remain weakly articulated, industry actors tend to pay very little

---

[9] This kind of developmental model is shares some attributes with of life-cycle theories of organisational change. In such models, "the typical progression of change events (…) is a unitary sequence, [for which the progression] to the final end state is prefigured and requires a specific sequence of events" (Van de Ven and Poole 1995:515). Ideal progression sequences are conceptualised as linear, although some departures can be considered as deviations. Such models tend to view the influence of environmental forces of change (e.g. selection pressures at environmental level) as limited. Here, for instance, problems are assumed to increase gradually in the ideal enactment model. However, the stage model is not here taken as a determined programme following an endogenous logic towards an end state, but rather as an ideal pattern against which to compare more sophisticated real-world developments. The inherent logic is evolutionary, as the focal entity (industry) is conceptualized as adjusting to changes in a selection environment.

Evolutionary theories of change base their explanation on "a continuous cycle of variation, selection, and retention" (Van de Ven and Poole 1995:518), operating at a higher organisational level – that of populations. The notion of 'fitness' can be mobilised to appreciate the relationship between industry strategies and environmental selection pressures (see 0).

What is the relationship between the five-stage enactment model of destabilisation enactment and the overall evolutionary perspective suggested by the TEF? The overall evolutionary logic provides the backdrop of the conceptual perspective, allowing for the consideration of multiple environmental selection pressures, and variational changes (incremental and more radical) in industry action and strategies. This multi-faceted explanation of change is located at the boundary between industries and their environments. The stage model provides a nested form of explanation (at the level of industry actors) that is here used as a heuristic device against which to evaluate industry development trajectories, and variations thereof. The two forms of explanation are thus complementary and operate at different levels. Working out the relationship between these two models of change thus "requires specifying macro-micro links" (Van de Ven and Poole 1995:534), which is done throughout this section.

attention to problems, downplaying them or even denying them. Industry strategies follow a 'business as usual' mode, with strong regime commitment.

2) Early small changes. As problems are better articulated, they can no longer be denied and are increasingly recognized by industry actors (Rivoli and Waddock 2011). Industry strategies remain defensive, with the implementation of tighter controls, but also some early diversification and incremental innovation strategies. Regime commitment is still strong in this phase.
3) Doubts and diversification. When problems increase, they create substantial pressure for change. The widening of performance gaps and the accumulation of negative feedback point to the ineffectiveness of old strategies. Industry actors thus devote an increasing amount of resources into diversification and exploration activities (Miles and Cameron 1982), as increasing doubts about regime viability lead to weakening commitment.
4) Full destabilisation and decline. As problems become more pressing, the level of urgency is raised, so that industry actors face serious threats to their activity and a possible crisis. Industry actors lose faith in the existing regime. In such cases, depending on the severity of the problems in relation to the industry's core competence and the ability of industry actors to enact radical change, industry actors will develop drastic turn around strategies in order to have a chance to survive. Two main options then become available to industry actors (Tushman and Romanelli 1985, Geels 2011, Turnheim and Geels 2011):
   a) *Re-orientation*: substantial change in peripheral rules (technical and knowledge base, regulations) with core principles untouched. Loss of faith thus leads to the development of *new means* for survival.
   b) *Re-creation*: deeper changes to core regime rules (mission, identity, core beliefs). Loss of faith thus leads to the development of a *new hope* for survival around a fundamentally changed industry.
5) Dissolution: failure or inability to address mounting problems. Loss of faith leads to the abandonment of prospects for survival. Industry strategies focus on making the most of decline, or avoiding the eventuality of collapse, by downsizing and 'milking' assets.

**Table 3.1: A stage-model of industry destabilisation**

| | Problem recognition | Regime commitment | Industry strategies |
|---|---|---|---|
| **1. Blindness or denial** | Denied and downplayed | Strong | Business as usual |
| **2. Early small changes** | Recognised | Strong | Tighter controls, domain defence, incremental innovations and early diversification |
| **3. Doubts and diversification** | Increasing problems | Early doubts in regime viability, weakening commitment | Exploration and diversification |
| **4a. Re-orientation** | Urgent, threatening, crisis | Loss of faith – new means | Substantial change of *peripheral* rules (ways of doing) |
| **4b. Re-creation** | Urgent, threatening, crisis | Loss of faith – new hope | Radical change of *core rules* (ways of being) |
| **5. Dissolution** | Urgent, threatening, crisis | Loss of faith – no prospects | Downsizing, 'milking', collapse, etc. |

This form of stage model is a useful simplification that can be mobilised as a heuristic device against which to evaluate more complex cases, for which developments as specified in each column (Table 3.1) may be less linear. The resulting understanding of industry destabilisation enactment thus goes beyond life-cycle models, as it is based on a process of industry adjustment (rather than development toward an end state), and includes a dynamic understanding of industry-environment interactions. In evolutionary terms, industry destabilisation may be linked to increasing selection pressure, the questioning of regime rules issued from previous retention phases, and strong variation in the search for new adaptive industry forms and attributes.

### 3.3.2.2 Unfolding at environmental level: alignment and spillovers

Building on approaches attending to sources of change in industry environments (views 1 to 3), and other multi-dimensional perspectives, I now unpack processes of unfolding at the level of industry environments, in which pressures are articulated.

I here build on Freeman and Louça's (2001) approach to the explanation of historical economic change. They suggest that the co-evolution of five semi-autonomous subsystems (science, technology, economics, politics and culture) provides insights to historical developments. They justify the mobilisation of different subsystems for conceptual and analytical reasons:

> "[the subsystems] are proposed because each one has been shown to have some semi-autonomous, and certainly not insignificant, influence on the process of economic growth (…), and most important of all, it is precisely the *relative* autonomy of each of these five processes that can give rise to problems of lack of synchronicity and harmony or, alternatively, of harmonious integration and virtuous circle effects on economic growth. It is thus essential to study both the relatively independent development of each stream of history and their interdependencies, their loss of integration, and their reintegration." (Freeman and Louça 2001:126-7, original emphasis)

In a similar vein, but with a different object of study, I suggest that destabilisation pressures in industry environments should be studied in their 'relatively independent development' as well as in their interaction. I thus here discuss two main processes:

a) conjunctures of individual pressures, and
b) interaction and alignment between multiple pressures

**Conjunctures of individual pressures**

With respect to changes in the economic, technological, political, and socio-cultural dimensions of industry environments, a number of insights can be mobilised from the building blocks of the various literatures covered in chapter 2. These rely mostly on views 1 to 3. However, as noted by McCarthy *et al.* (2010), it is a tricky exercise to generalise about the rate, intensity and scope of different types of pressures, as they are inherently dependent on the industry type and context, and are likely to vary over time. I here nevertheless try to provide some informed keys to the temporal unfolding characteristics of different types of pressures.

Changes in *market size* can be expected to be fairly frequent. The price of the goods in question, or re-adjustments of consumption patterns, can lead to minor demand fluctuations, depending on factors such as the elasticity of demand and the availability of substitutes for these goods. Certain fluctuations have a cyclical nature and are thus fairly predictable (e.g. seasonal and hourly variations for energy demand, or planned capital renewal schemes). Major demand fluctuations can be related to disruptive events affecting the supply and distribution of goods and their prices (e.g. oil shock, supply disruption related to strikes, etc.). Forward industry linkages with different markets mean that major changes affecting downstream industries can significantly affect overall demand patterns. More gradual and/or predictable demand changes arise with deeper changes in customer preferences (kinds of demand), technological substitutes, the renewal of the capital stock or infrastructure supporting the market.

Changes in *technological competition* are related to the introduction of innovative alternatives, often by new entrants. The rate of technological innovations is tied to their scope: small and incremental innovations tend to occur more frequently than more far-ranging innovations. Punctuated equilibrium theory also suggests that long periods of incremental change are punctuated by shorter upswings of radical innovation (Abernathy and Utterback 1978). Radical innovation can be disruptive and thus lead to substantial destabilisation pressure. Incremental innovation often has the opposite effect of strengthening established technical trajectories.

The *availability of essential resources* tends to wither when it is not maintained – that is, it has an inherent tendency for slow erosion. Thus, essential resources have to be regularly renewed. In the case of natural resources, gradual exhaustion can be offset by exploration or technological improvement, implying substantial costs. Similarly, financial or political support is acquired on the basis of periodic agreements or contracts, at the termination of which new negotiations are due. Therefore, the erosion of essential resources is a fairly predictable, routinised external constraint in most cases, and the frequency of change depends on the kind of resource. However, the availability of valuable resources is also exposed to less predictable downward trends and crises. For instance, political commitment to a given industry is a less formalised and palpable asset – yet, it is no less valuable – and is sometimes reversed on very short time scales (e.g. dissolution of established political ties following a general election).

Processes on *socio-political dimensions* tend to follow comparatively more gradual dynamics than market changes, but can exert significant and far-ranging pressure on industries. Societal values, norms and institutions are so persistent that they have traditionally been studied as fixed in the mainstream economics literature (which is less interested in long-term change). The notion of (policy) paradigm has been developed to explain how such deep-seated structures may change only slowly (Hall 1993). However, socio-political dimensions are also prone to more rapid forms of change such as in political crises, sudden public upheavals, etc. when large societal shifts may disrupt institutional logics (Pierson 2004). I would argue, however, that such rapid shifts result from the punctual opening of windows of opportunities in slow moving structures (Kingdon 1984).

Changes on *cultural dimensions* often follow gradual patterns that play out over many decades. This does not preclude from the possibility of major upheavals and rapid cultural change, but they are likely to be related to some form of external shock, and the availability of new discourses. Indeed, new discourses and cultural repertoires have to be elaborated before they can be widely adopted throughout society. The difficulty of such a process, involving cultural contests, resistance, and framing struggles, explains the relatively low frequency and rate of significant socio-cultural change. However, such changes can have profound implications, namely in allowing the alignment of multiple pressures.

*Regulatory pressure for change* typically builds up slowly, with numerous lengthy debates leading up to policy formulation. Many opportunities exist for actors to slow down the process. Implementation is usually comparatively diligent, and can thus lead to abrupt patterns of environmental change. Policy change is related to opportunity structures that may arise with regular frequency (e.g. related to electoral cycles), or less predictable changes in the salience of specific issues (e.g. issue lifecycle), which are sensitive to extreme events.

Although strong external pressures in one dimension may be sufficient for destabilisation, it is likely that industries face even bigger problems when multiple pressures interact to create a ‘perfect storm’. While firms tend to be skillful in responding to single pressures, unexpected alignments may overwhelm and destabilise them. This also means that destabilisation can follow different patterns, depending on the strength and speed of, and interactions between, pressures.

**Interaction and alignment**

I now turn to the interaction of multiple pressures, which I have suggested is likely to lead to more pressing destabilisation conditions. As changes in multiple interrelated subsystems become aligned, they are likely to lead to greater overall pressure for change. I formulate mechanisms within and across environmental domains by which various types of pressure interact.

It has been noted in the literature review that existing research on destabilisation tends to focus on the influence of isolated factors. Furthermore, whenever multiple sources of change are considered, one-dimensional explanations tend to prevail: destabilisation has been explained either as economic decline *or* as de-legitimation process. D’Aunno *et al.* suggest that crossovers between the influence of economic and socio-political forces provide a fruitful area for research:

> “Both institutional and market forces are likely to affect divergent change [i.e. abandoning institutionalized templates] to varying degrees in different organizational fields and, probably, in different historical periods. Moreover, institutional and market forces may interact in important ways to affect organizational change, and future research should aim to specify their roles more precisely” (2000:700-701).

Investigating *pressure interaction* between environments is thus relevant to a co-evolutionary understanding of destabilisation (see Figure 2.9). The literature on organisational environments has recognised the need for a better understanding of relations between environmental variables more generally (Judge and Miller 1991, McCarthy *et al.* 2010). The literature on co-evolution (Freeman and Louça 2001, Geels 2002a, Geels and Schot 2007, Smith *et al.* 2005, Volberda and Lewin 2003) further suggests that significant change can result from the interaction of dynamics in multiple interrelated subsystems. Socio-technical approaches provide a fruitful understanding of destabilisation as a process of de-alignment between multiple interlinked dimensions. They suggest that tensions in the alignments of markets, technology, industry, users, regulations may build up and lead to transformative change (Geels 2002a, Freeman and Louça 2001). Thus, structural crises may arise from tensions (i.e. mis-alignment) between the co-evolving sub-systems[10] that jointly produced stable configurations (Freeman and Louça 2001). Long-term structural regularity in socio-economic systems is punctuated by periods of *de-alignment*, which creates the kind of tension that is at the source of the destabilisation of socio-technical configurations. Destabilisation can thus be viewed as a process of de-alignment of interrelated sub-systems, involving decreasing mutual ‘fit’. Destabilisation is likely to involve change across multiple dimensions. When taking industry actors as the primary focal group, the destabilisation of industries can thus be seen as resulting from decreasing alignment between established industry trajectories and (multiple) environmental dimensions. *External destabilisation contexts become more pressing as multiple forces are aligned and coupled* (cf. ‘avalanche change’ – Suarez and Oliva 2005, Geels and Schot 2007). The study of destabilisation should be attentive to the unfolding of interaction processes at environmental level. I further unpack the multi-dimensional interaction of pressures in industry environments in 3.3.3.

#### 3.3.2.3 Landscape trends and shocks

Building on socio-technical and other approaches receptive to long-term unfolding processes, I now discuss the role of deep structural trends and events in destabilisation. I first introduce the notion of landscape dynamics, and then explore their interaction with destabilisation processes at the level of organisational field.

**Landscape dynamics**

---

[10] The sub-systems are seen as having distinctive features and relatively autonomous selection mechanisms.

Because industry destabilisation unfolds over extended periods of time, the process is likely to be influenced by deeper structural changes (Braudel 1958), sometimes referred to as 'landscape' developments (Rip and Kemp 1998, Geels 2002a).
I here consider the notion of 'landscape', as topographical constraining elements structuring the unfolding of evolution of societal dynamics (see Figure 3.4). Socio-technical landscapes are deep structural trends that influence organisational fields (Sewell 2005). They are likely to affect the course of development of technological change, economic policy, markets, and normative discourses and beliefs in processes of historical change,

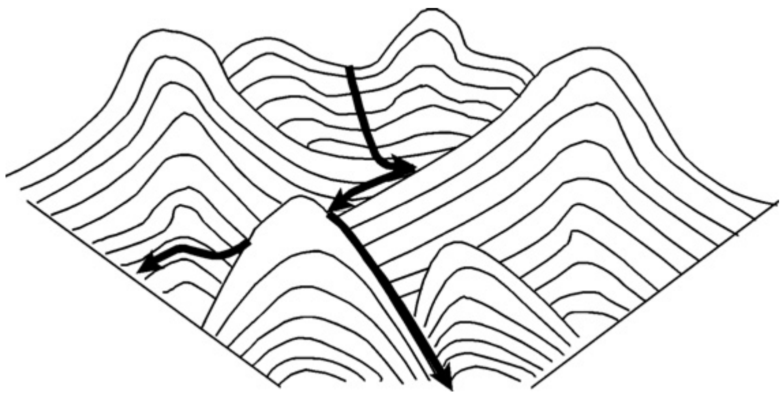

**Figure 3.4: The topography of technological evolution (Sahal 1985:79)**

Dynamics qualifying as landscape changes include slow trends (cultural changes, political cultures and ideologies, etc.), rapid events and shocks (van Driel and Schot 2005). Long waves of economic and technological change, urbanisation patterns, industrialisation, globalisation, liberalisation, the rise of social movements, but also oil price shocks, wars, etc. are historical examples. As time goes by, landscape changes re-define the very context of social activities and communities.
Landscape changes provide strong structuration of local activities, forming 'gradients for action' (Geels 2004). Landscape changes provide relatively stable developmental conditions, framing the evolution of change in industry environments. However, this context is also subject to change. Landscape structures change as novel deep structuring frames emerge. Through this process, landscape changes can favour the alignment of pressures in the environments of industries, carving out *avenues of environmental change*, and thus increasing the likelihood of concurring societal dynamics by deep structural alignment.

Shocks and extreme events are particularly disruptive occurrences in the landscape of industries: they have the potential to re-define environmental assumptions and lead to crises. Significant crises draw attention to particular problems, activate previously dormant tensions or difficult relationships:

> "Environmental jolts highlight institutionalized assumptions about the environment, and reveal unexpected relationships between institutionalized practices, technologies, organizational forms, and outcomes that may not be apparent in times of stasis" (Sine and David 2003:186)

This can lead previously neglected issues to rise to the highest level of decision-making agendas, and problems to gain momentum.

**Landscape-field interaction**

Within the multi-level perspective (MLP) (Rip and Kemp 1998, Geels 2002a), it is suggested that landscape processes and trends can create 'tension' in existing socio-technical configurations. I suggest, additionally, that landscape change can mediate industry environments by favouring the alignment of destabilisation pressures across domains in a given trajectory:

- newly legitimated ideas and values may change the mandate of government to regulate industries, eventually leading to an altered policy framework;
- newly legitimated ideas and values may lead to changes in societal aspirations and visions, which affect beliefs and discourses, the expression of normative problems, customer preferences and practices;
- changing socio-demographic patterns may facilitate the emergence of new behaviours, preferences, aspirations and customer demands;
- wars and economic crises have a disruptive effect on the pace of the economy, and thus affect material resource flows within organisational fields.

In destabilisation processes, shocks and extreme events can:

- dramatically reveal system failures and inability to deal with certain problems (Sine and David 2003);
- lead to sudden (but fragile) rises in attention for specific issues by raising their experiential commensurability (Geels and Verhees 2011) and perceived urgency;
- disrupt institutional logics and structures, motivate search processes, and thereby open up space for the breakthrough of alternatives (Sine and David 2003);
- accelerate and focus destabilisation processes (Sewell 2005);

Event-centred historical narratives have a tendency to attribute strong causal links to the immediate consequence of shocks (Burke 2005). While such accounts are partly true, a more accurate explanation consists in describing shocks as scarce events that provide opportunities for the acceleration of causal sequences:

> "crisis shakes the foundations of organizational fields by motivating scrutiny and search processes for causes and solutions. Crisis environments prompt powerful actors to engage in search processes that can ultimately result in profound institutional change. The resulting loss of taken-for-grantedness, recoupling of outcomes and behaviors, and redefinition and expansion of alternatives renders practices that were once taken for granted as "the way things are done" vulnerable to reform or replacement" (Sine and David 2003:188)

Furthermore, dramatic events do not necessarily lead to change, if they are not perceived, not understood, or concealed. This means that for a shock to have a significant system-destabilising outcome, it must be preceded by ongoing discussions and debates about problems and associated solutions.

So, landscape changes, and especially shock and extreme events are not only catalysts of change in industry environments (Sine and David 2003), they are opportunity structures that can be actively mobilised by external actors.

#### 3.3.2.4 Wrapping up

So, destabilisation processes include dynamics at multiple levels. How can these be combined in an integrative understanding?

Historians provide fruitful approaches to multiple levels of explanations and related temporalities that can here be mobilised to make sense of multi-level dynamics (Gaddis 2002, Sewell 2005, Geels and Schot 2010). Braudel (1958) suggests that longitudinal dynamics can be identified at different time scales and speeds: 1) structural patterns, 2) conjunctures, and 3) chains of events. I have already noted in chapter 1 that a multi-level conceptualisation of destabilisation should attend to these different timescales, but also formulate the relationships between different timescales as destabilisation unfolds.

Destabilisation processes unfold at multiple levels. I distinguish three levels, which are related to different organisational levels (see Figure 3.3). The mechanisms involved at each level operate according to different temporalities.

- At (intra-)industry level, events, actions and strategies exert a *proximate* influence on industry trajectories.
- At the level of organisational fields, domain-specific conjunctures and their interactions exert an *intermediate* influence on industry trajectories.

- At a landscape level, secular change and disruptive shocks exert a *distal* influence on industry trajectories.

Temporal interactions between different forms and levels of unfolding are likely to influence how destabilisation patterns play out. Most profound changes can be expected when processes between different levels link up (see Geels 2002b:93).

In the context of my empirical work, I will analyse relationships between dynamics at different levels, with a view to specifying mechanisms by which different levels of unfolding influence each other.

### 3.3.3 Destabilisation as a multi-dimensional and co-evolutionary process

Because I am interested in the *co-evolutionary* nature of destabilisation, I here attend to the *processes* by which environmental selection contexts change as an outcome of multi-dimensional pressure interactions. Building on contributions focused on change in industry environments (views 1, 2 and 3), I here suggest mechanisms and processes that participate in the articulation and acceleration of destabilisation contexts. This discussion thus provides informed assumptions about pressure interactions, guiding the direction of search for the analysis of cases.

Pressures are initially exerted locally by actors within a specific domain. However, under specific conditions, as actors interact with each other, pressures can cross environmental domains, be picked up by new social actors, and be expressed through multiple channels. Such interactions increase the intensity of pressures, but also alter their initial framing to fit the broadening base of relevant actors.

Building on the theoretical argument set out so far, and taking into account the research criteria, the conceptualisation of pressure interaction mechanisms should inform the understanding of:

a) *interactions in the economic environment*: processes of transmission between various economic forces (markets, technology, competition, etc.); this aspect allows me to bring together the more common explanations of destabilisation (Porter 1980, Ansoff 1987, Tuhsman and Romanelli 1985, McCarthy *et al.* 2010);
b) *interactions in the socio-political environment*: processes through which problems interact between the general public and policymakers, involving actors from civil society; this aspect is relevant to address my interest in societal

problems (and environmental problems in particular), but remains a neglected aspect of destabilisation (Morlacchi and Martin 2009);

c) *interactions between economic and socio-political environments*: processes through which socio-political concerns are linked to economic problems, and processes through which economic problems become socio-political concerns; these aspects are relevant to formalise the co-evolutionary nature of destabilisation processes.

Because a) and b) are extensively discussed in various literatures, and have already been covered in chapter 2,[11] I here focus on the third kind of interaction: between economic and socio-political dimensions. While these aspects will be further developed on the basis of the analysis of cases, I here mobilise relevant insights from various literatures.

**Interactions between economic and socio-political environments:**

Governments and policymakers intervene on markets via economic policies and changes in market regulations that frame economic transactions:

- Technology-oriented policies can stimulate the conditions of technological innovation through niche formation, niche protection, R&D support (Kemp *et al.* 2001, Garud and Karnøe 2003), or public procurement;
- Industrial policies provide support to industries (e.g. financial stimulation, subsidies, trade restrictions, performance requirements, etc.) in the form of 'buffers' and 'transformational shields' (Miner *et al.* 1990) that protect against economic pressures and decrease the need for transformational change (d'Aunno *et al.* 2000). Alternatively, weakening policy support can contribute to a negative economic climate, as it affects expectations throughout the supply chain, leading to doubts, reduced financial support, and the search for alternatives;
- Consumer-oriented policies stimulate changes in markets by providing incentives for new consumer behaviours and demands;
- Environmental regulations and policies seek to correct market externalities through the introduction of (dis)incentives, standards and regulations;

Social movements and normative contestation groups seek to influence the behaviour of economic agents. They develop strategies to stimulate the demands and preferences of customers, and the development of alternative technologies:

[11] See view 2 for a discussion of a), and 2.2.3 for a discussion of b).

- Strategies such as boycotts and awareness-raising campaigns can have substantial effect in threatening markets and consumer preferences;
- Technology-oriented movements involve collaborative alliances between normative pressure groups and firms in the design and mainstreaming of innovations with added societal benefits (Hess 2005);
- Social movements (typically players outside the firms' economic environment) may be at the root of institutional change and the creation of new industries (Lounsbury *et al.* 2003).

Economic pressures can also enter the socio-political environment of industries:

- The development of new technologies may offer policymakers new means to address societal problems, and contribute to the formulation of new policies;
- Economic problems in large industries can lead to demands for policy-support programmes (Nuttall *et al.* 2011). Conversely, sustained low industrial performance can lead policy-makers to lose faith in existing industries, decrease enthusiasm and support accordingly.

Numerous forms of pressure interaction can thus occur in industry environments. They increase the linkages between different kinds of pressures, and thus contribute to the overall alignment of pressures in destabilisation contexts.

### 3.3.4 The role of societal problems in destabilisation processes

Because of my background motivation in transitions to sustainability, I am particularly interested in the role of societal problems in destabilisation processes. I have already discussed the mechanisms by which societal problems are likely to increase momentum (see 2.2.3 and 3.3.3), and thus exert pressure on industry actors (see view 3). I now address how societal problems can be analysed in destabilisation processes in relation to the framework set out so far.

**Societal pressures and destabilisation**

The framework presented in 3.3 accommodates for the role of societal pressures in destabilisation processes.

Because societal issues may relate to social goods that are usually not valued in markets, industry actors and other economic agents in their environment are unlikely to raise or address such issues without the perception of a substantial demand for improvement. Societal pressures are thus initially raised in the socio-political environmental industries.

In 2.2.3, I have introduced literatures on issue lifecycles and social movements that provide useful building blocks as to how societal problems may evolve. Societal issues need to gather momentum before they can be addressed. Problem framing and awareness raising are crucial for an issue to attract public interest and lead to the expression of a societal demand. Societal demand for change may lead to the formulation of policies to introduce market corrections. So, interactions *within* the socio-political environment are crucial for an issue to become an industry concern. However, industry actors are likely to resist the evolution of societal issues that challenge their legitimacy. Furthermore, if regulated, societal issues may affect their business, incur greater costs and lead to market changes. Because industry actors are good at resisting adverse framings and policies, societal issues are unlikely to substantially influence industry trajectories unless they are coupled with changes on economic dimensions (e.g. changing user preferences, technological competition, etc.), and a new credible solution (policy proposal, technological alternative, business model, etc.). So, interactions *across* industry environments are also crucial for societal issues to influence industry trajectories.

Societal problems build up in the socio-political environment of industries (see 2.2.3), as socio-political actors challenge established industry practices in relation to specific problems. The build-up of normative contestation involves discursive framing processes, resource mobilisation, the search for political opportunity structures (Elzen *et al.* 2011), and the build-up of social movements, led by activists and supporting organisations. However, in industry destabilisation processes, *interactions* between these external processes and industry strategies, and their mediation by industry regimes are important (see 3.3.1). Normative contestation is relevant to destabilisation insofar as it challenges the legitimacy of industry actors and prompts responses 1) within regime boundaries, and 2) beyond the limits of established regimes.

1. Industry actors mobilise a variety of strategies in the face of early legitimacy challenges. These tend to be within the boundaries of existing regimes, and seek to protect it.

*Socio-cultural framing strategies: influencing meanings.* It is usually easier to deflect nascent legitimacy pressures than to address them with substantial change. For this reason, early responses to normative pressure are likely to involve counter-framing activities to contest the progression of adverse new meanings to a variety of publics (public opinion, decision-makers, customers, etc.), and protect established field frames.

Such framing activities are enacted in boundary spaces that span beyond organisational fields (e.g. public debate, media, political arenas, etc.). Because societal problems related to the natural environment and pollution often involve the elaboration of new scientific knowledge (Forsyth 2003, Thorsheim 2006), framing and counter-framing strategies are also likely to be targeted at the scientific construction of facts, i.e. industry actors may discredit new scientific findings, highlight uncertainties, etc.

*Political and lobbying strategies: influencing policies and regulations.* Because societal issues gather additional momentum when they are raised in political arenas, industry actors engage in those arenas via lobbying and policy framing strategies. When new issues are taken up by policymakers, industry actors may devote substantial resources to influence policy formulation processes, in an effort to reduce policy stringency. When policies and regulations are implemented, industry actors may seek to avoid compliance or find regulatory loopholes.

*Innovation strategies: corrections within technological trajectories.* Because normative activists may contribute to the elaboration of technological visions and expectations erected as alternatives to established industrial systems, industry actors also respond to societal pressure with corrective innovation strategies. Early innovative activity by incumbents tends to remain within established frames as a means to protect it. Such incremental innovation can be seen as 'sustaining' rather than disruptive innovation (Christensen 1997, Bowen 2011), as they seek to demonstrate that solutions can be sought *within* existing regimes. In the case of environmental problems, such early innovative activity tends to take the form of 'add-ons' or 'end-of-pipe devices' (e.g. higher smoke stacks, emission control and clean-up devices, etc.) that provide a (cheaper) escape route rather than a fundamental re-think of production methods. Such strategies might however not be viable in the long-run, if environmental problems are associated with successful alternative technologies.

2. When societal pressures gain momentum and become mainstream public and political considerations, defensive strategies that seek regime protection become less effective. Industry actors may then develop more long-term strategies that take into account the mainstream expression of societal demands as new constraints. Industry actors may thus take steps towards shaping alternative regimes with a view to abandoning historical commitments. The distinction between external claims and internal activities thus becomes increasingly blurred as industry actors envision the

possibility of regime change – thus signalling the erosion of regime commitment – and seek to establish a middle ground.

*Socio-cultural framing strategies* may then shift from contesting societal claims to ensuring the compatibility of alternative field frames with future industry activities. This may imply participation in the elaboration of visions and expectations as middle-range compromises towards the mutual adaptation of external claims and the necessity of dynamic industry continuity. In the case of environmental problems, established industries are likely to favour normative framings that do not rule out their ability to develop acceptable solutions in the future (e.g. 'coal could be clean', 'nuclear power will become safer', etc.).

*Political and lobbying strategies* may then shift toward gaining conditional support to ensure the medium-term viability of current activities, given proactive efforts to develop solutions to perceived problems. In the case of environmental policies, this may translate into the negotiation of delays in phasing out the most polluting technologies until cleaner technologies are available.

*Innovation strategies* may then shift towards greater diversification, and the simultaneous pursuit of short-term incremental solutions and long-term R&D projects. If societal pressure leads to profound transformation in environments, these framings and technological developments are likely to become an industry's last chance of survival. Industry survival is thus dependent, amongst other things, on its ability to re-consider its relationship with emerging field frames, shaping and stepping out of past commitments accordingly.

A main question that also needs to be addressed is whether and how societal issues can lead to industry destabilisation. As a preliminary answer, I propose that they are unlikely to be the main driving force, and that multi-dimensional and multi-level coupling is crucial.

Addressing the multi-level unfolding and multi-dimensional co-evolution has implications for the understanding of the role of societal problems in destabilisation, to which I now turn.

**Multi-level unfolding of societal problems**

Societal problems, because they relate to societal aspirations for change, can be inscribed in long-term dynamics. Proponents of societal change are aware of their inscription in historical processes (in-the-making).

With respect to the three levels of unfolding suggested in 3.3.2, it is worth mentioning that:

- The scope of industry responses to societal pressures evolves as the level of threat increases (see above). We can expect strategies to shift from defensive counter-framing to more proactive and exploratory diversifications as societal problems gain momentum.
- Societal pressure does not always increase gradually and linearly; we can expect societal issues and related pressure for change to follow ups and downs, in relation to swinging public and political attention. Furthermore, interactions with other forms of change are crucial for societal issues to gain momentum and thereby change environmental constraints on industry trajectories. Normative pressure groups actively seek such interactions. The timing of alignments between societal problems and other forms of environmental change is an important determinant of their influence on industries (Elzen *et al.* 2011).
- Societal problems are inscribed in broad transformational change dynamics. Aspirations for societal change are often motivated by expectations of a possible future where these claims could be addressed. Visions of possible futures allow imagining the kind of change that may be introduced, guide efforts towards the materialisation of such change, and thereby inform the activities of proponents of normative change to reach their goals. Furthermore, societal pressures may gain momentum when they are linked with broader change dynamics, such as the emergence of new cultural repertoires and the build-up of social movements (e.g. environmental modernisation, sustainability, etc.).

**Multi-dimensional and co-evolutionary aspects of societal problems**

The multi-dimensional aspect of societal problems in destabilisation has already been discussed in 2.2.3 and 3.3.3.

Industry actors face multiple pressures in their environments. So, societal pressures must be seen as one aspect of industry struggles on multiple fronts. This means that societal pressures are likely to compete and be overshadowed by other pressures for change. However, other forms of pressures and stress on industries (e.g. changing markets, technological competition, user preferences, etc.) can also be seen as opportunities for the expression of societal issues.

Because normative activists alone bear limited influence on industry trajectories (Elzen *et al.* 2011), they seek to mobilise the interest and support of influential actors (policymakers, the general public, customers, technology developers, etc.) to increase the momentum of their claims and associate their contestation to credible alternatives. Such interactions are more likely in later stages of destabilisation. The association of normative contestation with other forms of pressure in industry environments is crucial to enhance the inclusion of societal claims in industry destabilisation processes.

## *3.4 Wrapping up*

In this section, I have elaborated a conceptual framework that builds on the building blocks identified in chapter 2. This framework thus builds on existing perspectives, but has been tailored to the specific research challenges that this thesis seeks to address, namely:

- the multi-level unfolding nature of process of long-term change,
- the multi-dimensional co-evolution of changes in industry environments,
- the role of societal problems in destabilisation processes.

Destabilisation has been conceptualised as a process involving 1) pressures in industry environments, 2) industry responses to such challenges to its economic performance and socio-political legitimacy, and 3) changing patterns of commitment to institutional rules (industry regimes).

In the next chapter, I clarify the epistemological assumptions underlying the kind of explanation sought in this thesis, I develop a research design that accommodates the mobilisation of longitudinal case studies for the understanding of destabilisation processes, and formulate an analytical strategy.

The plausibility of this framework is assessed against empirical evidence presented in chapters 5 to 7. Results are discussed in the concluding chapter, in which I derive more general findings and reflect on the theoretical perspective.

# 4 Research design and methodology

This chapter presents my basic epistemological assumptions, the research design used to investigate real-world destabilisation processes, the data sources mobilised to substantiate claims with reliable evidence, and the analytical methodology.

## *4.1 Epistemological assumptions*

### 4.1.1 Basic assumptions

My theoretical perspective seeks not the individuation of factors, or the elaboration of general laws, but rather the specification of potential generative mechanisms, and how they might play out through time in processes of alignment, coupling, and field struggles that can be seen as jointly produce destabilisation patterns. I seek to attend to the complexities of the social world by developing a multi-layered form of explanation. But how should such complex social realities be understood and investigated?

> "the historical sociologist strives to appreciate all this complexity and yet find patterns by looking across cases, down branching paths, or within complex sequences [in search for the interplay of causal mechanisms]" (Clemens 2007:528)

Epistemological assumptions concern the way the social world is *understood* and *explained*. Poole *et al.* (2000) distinguish two fundamental research models (see Figure 4.1), based on different epistemological assumptions, and typically used to address different kinds of questions about the social world:

- Most traditional social science is based on *variance approaches* that describe change in the value of an independent variable as the result of a timeless relationship to its dependent variables. Such approaches rest on assumptions of deterministic causation (Poole *et al.* 2000:29) and the continuity of causal relationships between variables over time. Variance approaches have been central to the development and disciplinary specialisation of modern social sciences. They have emphasised the empirical testing of theoretical hypotheses through an emphasis on replicability and statistical significance of the *whys* of change. However, they fail to accommodate for attributes crucial to the understanding of the *hows* of change: changing entities and contexts, temporal contingency, multiple and mutable causalities, changing meanings and attributes, etc.
- *Process approaches* are better suited to the study of change. They provide an alternative to variance approaches that is especially attentive to dynamic system

properties. In process studies, researchers are concerned with explanations "that indicate how the process unfolds over time" (Poole *et al.*, 2000:12). Process is conceived of as a developmental event sequence (Langley 1999, Sminia 2009). Process researchers mobilise events and chains of events as data. Studying the sequencing of events allows for the identification of patterns, and underlying causal and generative mechanisms. Outcomes are explained as the result of temporal sequences of events and the timing and conjunctures of event-chains. Sequences of events can thus be seen as located within enabling and constraining structures, rather than the mere outcome of laws and variables (Abbott 1992). This results in rich forms of explanation:

> "Process theories may incorporate several different types of effects into their explanations, including critical events and turning points, contextual influence, formative patterns that give overall direction to the change, and causal factors that influence the sequencing of events." (Van de Ven and Poole 2005:1384)

Pettigrew (1997:340) suggests five guiding assumptions for processual research:

> "1. embeddedness, studying processes across a number of levels of analysis;
> 2. temporal interconnectedness, studying processes in past, present and future time;
> 3. a role in explanation for context and action;
> 4. a search for holistic […] explanations of process; and
> 5. a need to link process analysis to the location and explanation of outcomes."

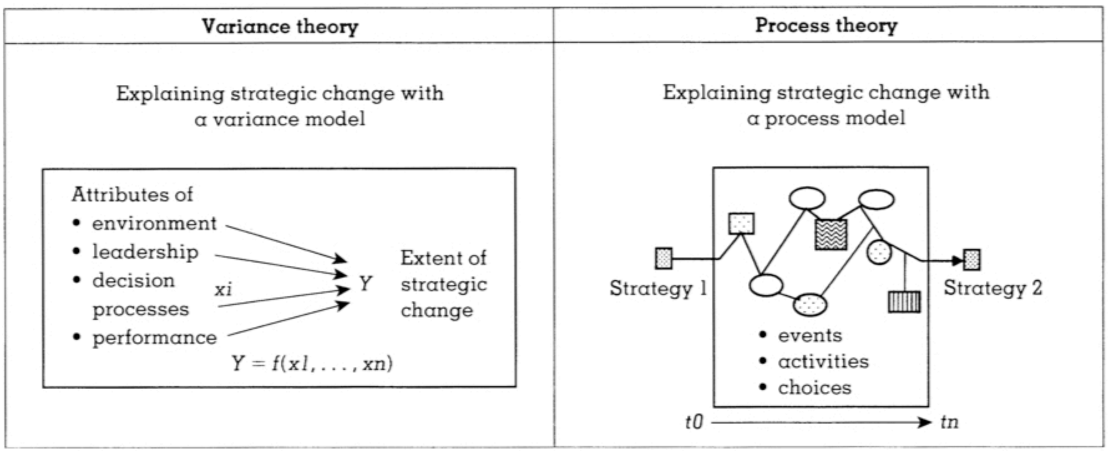


**Figure 4.1: Two approaches to strategic change (Langley 1999:693)**

My approach meets Pettigrew's criteria for processual research.

1. My conceptual framework recognises the role of unfolding at multiple levels in destabilisation processes. This means that it allows for the study of processes at multiple levels of analysis, as well as interactions between such levels.
2. My approach to destabilisation recognises the long-term unfolding of destabilisation processes, and allows for the study of processes along extended periods of time. Attention to historical change processes and deep structural transformation in destabilisation allows for explanations that transcend given historical contexts. I thus expect the framework to yield insights on past and present destabilisation patterns alike.
3. The conceptual framework combines external and internal views to destabilisation processes. By doing so, it gives a place for both changes in external context and the internal enactment of change.
4. While I mobilise a linear model as a heuristic for the study of destabilisation enactment, this approach is complemented by a search for deviations, and an attention to multiple sources of change. The approach is thus inherently path dependent, and accommodates for multiple destabilisation trajectories through the search for case-specific patterns.
5. The conceptual framework seeks the explanation of destabilisation processes. A clearly defined outcome of such a process is the implementation of substantial regime change or decline following the accumulation of pressure, which both lead to a new stable state in transitions terms. This initial diagnosis allows circumscribing each destabilisation process with a beginning and an end. In such a way, destabilisation processes are linked to destabilisation outcomes.

My approach thus fits with the processual assumptions set out by Pettigrew (1997).

### 4.1.2 A process approach to destabilisation

This study of destabilisation processes is concerned with understanding how systems change over time. My interest in the long-term unfolding of change can best be met with a rich longitudinal perspective, which allows getting closer to dynamics as they play out:

> "The ability to get closer to theoretical constructs is particularly important in the context of longitudinal research that tries to unravel the underlying dynamics of phenomena that play out over time. As scholars have increasingly begun to appreciate the role of dynamic processes (e.g., path

dependency or evolutionary processes), rich longitudinal research is needed to provide the details of how these processes actually play out." (Siggelkow 2007:22)

Destabilisation, understood as the interaction of external pressures and endogenous enactment, results from an inherently path-dependent process of pressure intensification, and wearing down of the sources of stability. A *process approach* is thus especially suited to the understanding of destabilisation and how it unfolds over time. The research set-up is centred on the reconstruction of event sequences, ordered through historical narratives that allow for process tracing, and the identification of patterns and generative mechanisms in various destabilisation trajectories.

**Narratives allow a particular kind of explanation that is attentive to *process***

The empirical investigation of destabilisation put forward here relies on narratives to make sense of temporal sequences of event, provide insight on how change unfolds (Van de Ven and Poole 2005), and identify generative mechanisms. Narratives are a useful element of the sociologist's toolkit:

"Narratives, the traditional rhetoric of the historian, allow us to capture the unfolding of social action over time in a manner sensitive to the order in which events occur. *Analytical narratives* – theoretically structured stories about coherent sequences of motivated actions – can contribute to the *construction of explanations of why things happened the way they did*. Such narratives construct causality and meaning in terms of temporal connections among events" (Aminzade 1992:457-8, my emphasis)

Considering external sources of change and internal enactment of change within industries, this means relating how sources of change are articulated over time, and providing interpretations for the sequences of change as they unfold in industries. While process research emphasises the influence of the context, the transient nature of entities, their attributes and causal determination, layered causation, and the singularity of individual cases, it does so not by shying away from explanation, but rather practices a different kind of explanation. Explanation is inherently attentive to real-world complexity:

"A process study not only supports causal inferences, but also has the additional advantage of enabling researchers to trace the mediating steps through which causes act. In principle, researchers can track how forces or influences initiated in one event are transmitted or dissipated in subsequent events. They can also trace how conjunctions of events produce interactions among causal factors that build momentum or lead to decay in the developmental process. These moves can greatly enhance the precision of tests of developmental models." (Poole *et al.*, 2000:13)

Explanation is focussed on the underlying logics behind observed temporal sequences, with an attention to case-specific contingencies, fundamental generative mechanisms and the conditions under which they operate (Van de Ven and Poole 2005).

Process theory approaches arguably put greater emphasis on accuracy and empirical reality, while achieving lower degrees of generalisability and simplicity in explanation than variance approaches (Langley 1999, Poole 2000). The search for accuracy is relevant for research that is exploratory in the sense that it interested in 'big' questions (Mahoney and Rueschemeyer 2003), opens up black boxes and seeks to unveil multi-dimensional interaction patterns. Indeed, one of the theoretical motivations of this thesis is to uncover the interaction dynamics at play in destabilisation processes across societal domains, levels of process, and temporality.

With respect to socio-technical transitions and a co-evolutionary perspective on industry evolution, single-lens approaches would miss out on one most salient feature of these processes: the 're-configurational' aspects of change. Indeed, transitions imply fundamental change in socio-technical configurations, spanning multiple co-evolving organisational levels and societal domains, often leaving the systems and sub-units barely recognisable. This means that units of analysis and active mechanisms may change over time, thus precluding a strict variable-based analytical approach. For this reason, process-based and narrative analysis will be preferred in order to convey and understand the 're-configurational' aspects of change in destabilisation processes.

Theorising from longitudinal case studies implies a more open relation to theory and social structure, one in which history and interaction mechanisms are taken seriously, in line with calls for truly co-evolutionary research:

> "The challenge for [co-evolutionary] research here is to go to a much finer analysis at both empirical and theoretical levels, and to move from the statement that everything is coevolving with everything else to the identification of what is coevolving with what, how intense is this process and whether indeed there is a bi-direction of causality" (Malerba, 2006: 18).

Process approaches rely on rich longitudinal data in the form of event sequences (Ragin 1997, George and Bennett 2004, Eisenhardt and Graebner 2007), which are mobilised to develop historical narratives. Event sequences allow understanding, in each case, how events are related to each other, and together make up a particular historical trajectory. Event sequences thus enable the researcher to attend to path-dependent and contingent change processes (Mahoney 2000).

Event-based methodological approaches come in a number of declensions, including the analysis of event chains, narratives, analytical chronology, statistical analysis of event data, etc. (Pettigrew 1997, Langley 1999, Sminia 2009). The groundwork for this thesis has relied on a mixture of such methods. However, I have privileged the use of a narrative strategy for the presentation of empirical findings. Indeed, while quantitative longitudinal data analysis and event-tracing have provided useful intermediary results on specific dimensions of change (e.g. policy change, technological innovation, issue attention, etc.), the co-evolutionary objectives and epistemological assumptions of this thesis justify a more qualitative approach that reflects the interwoven nature of industry destabilisation processes.

## *4.2 Research design*

To answer my research question, I have developed a broad understanding of destabilisation that draws on and combines multiple layers of explanation according to a 'meta'-logic of *unfolding*. In order to assess the plausibility, the usefulness and further explore the explanatory power of the conceptual perspective, I adopt a case study design. Indeed, my argument requires rich real-world evidence that reveals the long-term co-evolutionary nature of destabilisation.

The reason I choose rich *longitudinal case studies*, is that such case studies have several strengths with regard to the research topic, namely they allow:

- tracing multiple concomitant processes at multiple levels of analysis over extended periods of time (Yin 1994);
- searching for and discovering patterns (Tsoukas 1989) within and across cases;
- uncovering underlying generative mechanisms that contribute to a deeper understanding of the phenomenon of interest (Bennett and Elman 2006).

Furthermore, in order to overcome the conventional criticisms of single case study designs, I opt for a *multiple case design*. This allows increasing the robustness of generalisations by comparing and contrasting cases (Hakim 1987:63). Weick's suggestion on comparing events may be extended within and across longitudinal narratives:

> "what any event means, what is significant in its unfolding, may become clearer when it is compared with another event, and the observer looks for similarities and differences." (Weick 2007:17)

Comparing multiple cases allows asking under which circumstances specific causal mechanisms are activated. A focus on developmental patterns allows for the identification of the specific constellation of forces at play in each case (Pettigrew 1990). Destabilisation journeys are thus considered in their singularity. Openness to recurrence and variety of developmental patterns across cases leads to increasing precision and depth in the formulation of generative mechanisms:

> "A versatile process explanation can 'stretch' or 'shrink' to fit specific cases that may differ in their tempo and time span." (Van de Ven 2005:1384)

The cross-comparison of multiple cases thus allows for more robust, generalisable and testable theory development, often reaching a more appropriate level of abstraction for theoretical constructs (Eisenhardt and Graebner, 2007:27).

### 4.2.1 Case selection

**Case selection criteria**

Case selection should be based on theoretical considerations, and the expected potential for drawing generalisable insights (Eisenhardt 1989). Within a process approach case selection is guided by the *degree of phenomenon* (Flyvbjerg 2006). I now translate my research objectives into criteria to guide the selection of appropriate cases.

The cases selected for investigation should satisfy the following criteria:

1) Because of my interest in exploring the co-evolution of industries and economic and socio-political environments during destabilisation processes, a relevant selection criterion concerns the expected degree of interaction between these societal domains. The cases selected should thus not be solely about economic decline, but also include changes on cultural, political and technological dimensions. This leads me to choose an industry that is politically powerful and societally embedded.
2) Because of my interest in the role of societal problems in destabilisation processes, the cases should be selected with regard to the expected influence of such problems.
3) Because of my interest in the lock-in of established industries, the cases selected should display strong inertia and resistance to change. This will allow me to investigate interactions between external pressures, regime commitment, and industry responses in destabilisation processes.

4) Because of the exploratory nature of the research, the cases should be selected with a view to maximise insights on the phenomenon of destabilisation.

   > "When the objective is to achieve the greatest possible amount of information on a given problem or phenomenon, a representative case or a random sample may not be the most appropriate strategy. This is because the typical or average case is often not the richest in information. Atypical or extreme cases often reveal more information because they activate more actors and more basic mechanisms in the situation studied." (Flyvbjerg 2006:229)

   I thus choose *extreme* or *paradigmatic* cases.

5) Because of the ambitious nature of the research, the complexity of the phenomenon under study, and the in-depth nature of the investigation, the cases should be selected in accordance to the availability of empirical material in secondary literature.

**Overview of cases**

I now provide an overview of the cases, and explain how they meet the above selection criteria. Table 4.1 provides an overview of the cases. The cases cover various periods of the history of the British coal industry, ranging from 1880 to the present (see Figure 1.1). The history of the British coal industry in the twentieth century is marked by economic turbulence, overall decline, deep structural changes, strong competitive forces, societal problems, political conflict and technological innovation. Three distinct destabilisation processes can be identified, on the basis of underlying transitions and significant breaking points. The first case ends with a new energy policy framework that paves the way for the penetration of new sources of energy. The second case ends with the privatisation of the coal industry. The third case is 'in-the-making' and thus ends at a crossway for future developments, at which both decline and renewal are possible. The three cases back to back form one long case of the British coal industry from 1880 to 2011, featuring fundamental changes, decline(s), radical re-orientation(s), and an open question about future renewal.

**Table 4.1: Case summaries**

| | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| **Period covered** | 1880-1967 | 1967-1997 | 1990-present |
| **Unit of analysis** | British coal mining industry | British deep-mining for power generation | British coal-fired power generation |
| **Underlying transition** | To the four-fuel economy | To liberalised energy markets | To low-carbon power generation? |
| **Destabilisation outcome** | Decline in multiple markets | Near terminal decline | Decline or revival? |
| **Important dynamics likely to affect the destabilisation trajectory** | Shrinking markets, nationalisation, technological competition, the rationalisation of production techniques, the coal smoke problem. | De-industrialisation, oil crises, market reforms and industry liberalisation, new mining techniques, the ‘dash for gas’, acid rain. | Energy security concerns, planned decommissioning, the electricity market structure, climate change, expectations about CCS technology. |

From one case to another, the unit of analysis is changed, owing to the previous destabilisation process that has significantly altered the industry. Because of the long time periods involved in each case, and the process approach taken to change, the entities observed (e.g. industries) are bound to change throughout cases. The scale, importance, activities, meaning, etc. attached to industries are fundamentally altered throughout cases as destabilisation unfolds. This also means that the entities change between cases, as well as the unit of analysis.

In the first case, the British coal industry was deeply embedded in many socio-economic domains, and remained strong and robust, providing energy to virtually every activity in the UK until the early 20$^{th}$ century (industry, households, transport, etc.), but also moved from many firms to one nationalised organisation. The destabilisation process challenged its buoyant position. In the second case, following a first destabilisation process, the British coal industry is smaller, consolidated, and increasingly specialised in the power generation market, which means that relationships are more focussed and its overall societal relevance is weaker. Destabilisation leads to a near collapse of deep mining in the UK from the late 1980s. As a result, in the third case, a domestic extractive industry is virtually inexistent. However, coal still provides about a third of fuel input to power generation despite its significantly degraded symbolic importance and the pressure from climate change concerns. British vested interests in coal are thus increasingly dematerialised from the actual resource and seem to be eroding rapidly; yet new technological and discursive agendas generate enthusiasm about a possible renewal.

The temporal bounding of cases is related to the phenomenon under study. Cases are delimitated with regard to overall transitions and destabilisation outcomes, which are arguably historically circumscribed phenomena such as revolutions (Haydu 1998).[12] For each case, an overall transition process can be observed, or hypothesised for the third case. The historical cases end with a significant alteration of the industry's positioning on economic, cultural, political and technological dimensions, and relative stability, which means that it clearly enters a new era. This observation provides the confidence to delimitate the endpoint of cases. The beginning of cases is also determined in relation to the emergence of problems that lead to the destabilisation processes observed, so as to encompass their development.

**Suitability of cases**

These cases meet the five selection criteria suggested above.

1) All three destabilisation cases are likely to involve the co-evolution of multiple types of pressures. The last row of Table 4.1 suggests that changes in economic, socio-political, technological and normative dimensions are likely to affect the destabilisation trajectory in each case. For this reason, I can expect the cases not to be solely about economic decline, but rather to display interaction between multiple pressures. This will allow the investigation of spillovers and alignment between multiple sources of change.
2) For each case, the industry is confronted to a particular societal problem related to the natural environment: coal smoke, acid rain, and climate change respectively. The case narratives thus also allow for the tracing of the emergence of such problems, and their influence on industry destabilisation processes.
3) For each case, the incumbent industry displays strong inertia and resistance to change. This means that the influence of external pressures is likely to be mediated by prevailing regimes, the decreasing commitment to which can be investigated along the progression of destabilisation.
4) The historical cases fall into the ‘extreme’ and ‘paradigmatic’ categories defined by Flyvbjerg (2006). The cases can be qualified as *extreme*, because they are particularly rich and complex, involving many different sources of change, with strong degrees of interaction.

---

[12] The temporal delimitation of destabilisation processes however remains subject to the researcher’s interpretation, and the convincing argument made to justify such choices.

> "The *extreme case* can be well-suited for getting a point across in an especially dramatic way, which often occurs for well-known case studies" (Flyvbjerg 2006:229, original emphasis)

The British coal industry, because of its size, strategic importance, long-standing and deep embedding in British social life and its economy, is expected to feature high degrees of resistance to change.

The cases can be qualified as *paradigmatic*, because they "highlight more general characteristics of the societies in question" (Flyvbjerg 2006:232). Indeed, the coal industry, because of its central role in economic, political and social considerations in Britain, has been highly exposed to the radical changes affecting British society. The conflictual coal politics of the 1980s, for instance, have a paradigmatic character to the types of changes unfolding (de-industrialisation, market ideology, globalisation, etc.). Actors themselves saw coal as paradigmatic: Margaret Thatcher saw the reform of the coal industry as a critical test of the market ideology in practice.

The first case, ending with the institutionalised transition from coal to modern fuel alternatives in the 1960s, arguably marks a definitive break from Britain's industrial past associated with the industrial revolution. It is thus likely to be one of the most significant destabilisation processes in modern British industry. The sharp further decline of the British coal industry in the second case, marked by the sensational confrontation between Thatcher's government and the miners in the Great Strike, has become a symbol of the shift to neo-liberal economic institutions and away from 'old' industrial sectors in industrialised countries. The restructuring of the coal industry in the 1980s was one of the first steps in this broader transformation. It figures dramatic social consequences, as well as the embracing of new modes of resource flows in the emerging age of globalised 'free' markets.

The potential *extreme* and *paradigmatic* nature of the historical cases makes them ideal cases for the exploration of destabilisation processes. The third case is selected due to its relevance to current policy challenge and debates related to current transition debates: will climate change lead to the end of coal, or rather provide new opportunities for renewal with technologies such as CCS?

5) The choice of the British coal industry is also related to more pragmatic reasons. Indeed, the history of the British coal industry has been widely covered from a

wide range of academic perspectives. This wealth of available secondary sources provides a solid base for the investigation of industry change processes with respect to multiple dimensions (multiple specialised narrative accounts). Cases have thus also been selected "on the basis of expectations about their information content" (Flyvbjerg 2006:230), which could thus be confirmed early in the research process.

**Mobilisation of cases**

These cases thus provide a firm basis for the study of destabilisation. They allow for comparisons across time, with highly different – yet temporally related – contextual conditions. Each case displays a different destabilisation path, with its distinct balance of external sources of change and destabilisation enactment.

The two historical cases are mobilised for theory evaluation and extension, because they allow the capturing of fully realised destabilisation processes, with variations in the scope, role, interaction and sequencing of pressures. This is crucial to reach sensible conclusions about mechanisms and patterns.

The third case is different in nature, as the possible transition is still 'in-the-making' and presents high uncertainties as to future directions. Analysis will necessarily be of a more prospective kind. It provides the opportunities for the application of insights to an important and societally relevant question. It allows the exploration of theoretical relevance to a contemporary setting, as well as an opportunity to engage in policy-relevant arguments. The two historical cases are thus mobilised to generate lessons about destabilisation processes in transitions where normative goals are important, and are then applied to the third case.

Further distinctions are fruitful for the developments of insights on the relationships between destabilisation and specific processes:

- The first case, because of the novelty of energy alternatives to coal, allows for an improved understanding of the relationships between destabilisation and novelty.
- The second case, because of the salience of political discourse and policy reform, allows for a more detailed discussion of the political mediation of destabilisation.
- The third case, because of its incomplete nature, and the salience of the climate change issue, allows for the discussion of expectations and the role of environmental problems in destabilisation processes.

### 4.2.2 Data sources

Rich case studies rely on multiple types of data sources for their evidence. Combining multiple methods and data sources increases the robustness of findings as it opens up the opportunity for triangulation:

> "the triangulation made possible by multiple data collection methods provides stronger substantiation of constructs and hypotheses" (Eisenhardt 1989:538)

Variety of data sources and collection techniques is common practice for case studies, one that "allows a more rounded, holistic study than with any other design" (Hakim 1987:61). Types of sources may include histories, archival documents, interviews, official documents, etc. (George and Bennett 2005, Yin 1994).

The case studies draw on both secondary and primary sources. Secondary sources provide the basis for the preliminary formulation of case histories, which are contrasted, complemented, and critically reassessed using primary data.

When gathering and organising empirical material, in accordance with the conceptual framework, I search for longitudinal data concerning:

- problems and pressures on multiple dimensions (economic, socio-political, technological and normative), and
- industry response strategies (economic positioning, innovation, political lobbying, socio-cultural strategies).

**Secondary sources**

For the historical cases, secondary sources include historical accounts of the coal industries, but also detailed analyses of specific events (e.g. the Great London Fog, the Great Strike, etc.) or processes (e.g. nationalisation, liberalisation, etc.). Such accounts have a tendency to focus on a specific dimension (economic, cultural, technological, political, etc.) in great detail. They thus convey a deep analysis (which is their strength) but take the risk of bias in conveying causal mechanisms, and their (often unconsidered) interplay. The multi-dimensional historical case studies presented here aim to bring together, confront, and/or balance such varied explanations. The existence of many secondary sources enables me to draw on diverse viewpoints and perspectives:

- Useful sources for economic data include the Oxford history of the British coal industry (Ashworth 1986, Church 1986, Supple 1987) as well as myriad specialised publications on the coal industry (Beynon *et al.* 2000, Burns *et al.* 1985, Buxton 1970, Chapman 1999, Dintenfass 1992, Fine 1990, Glyn and Machin 1997, Grainger and Gibson 1981, Hall 1981, Hudson 2002, O'Donnell 1988, Parker 1994, Parker 2000, Rutledge and Wright 1985, Supple 1988, etc.). Noteworthy quantitative data series are also extracted from e.g. Fouquet and Pearson (1998), Ashworth (1986), as well as official statistics, e.g. from DECC and DTI.

- More generally, publications on British energy history provide relevant context and insight into the policy framework (Chesshire and Skea 1989, Helm 2003, Henney 1994, Newbery and Pollitt 1997, Sadler 2001, Scrase and MacKerron 2009, Watson 1997, Winskel 2002, etc.).
- Extensive longitudinal information on cultural, political and social movement processes regarding damage to the natural environment is available. For the smoke problem, Ashby and Anderson (1981), Brimblecombe (1987), Thorsheim (2002, 2006) are valuable resources. The acid rain controversy has also been extensively covered (Boehmer-Christiansen and Skea 1991, Dudley *et al.* 1985, Longhurst 1988, McCormick 1991, McCormick 1997, Rose 1990). Regarding the recent history of the climate problem in relation to coal, extant literature and commentary are available (Carvalho and Burgess 2005, Helm 2008, Ungar 1992, Lovell *et al.* 2009, Jordan and Lorenzoni 2007, etc.).
- A number of scholars have also provided valuable accounts of the social and political dimension of coal (Beynon *et al.* 1999, Gibbon and Bromley 1990, Hudson and Sadler 1990, Leman and Winterton 1991, Parker and Surrey 1993, Turner 1989, etc.).

**Primary sources**

Primary sources are mobilised to trace specific processes (qualitatively and quantitatively), to critically assess secondary material, and to provide additional original detail to deepen understanding of cases. The sources used include:

- Newspaper articles in the main broadsheets (*The Times, The Guardian, The Independent*) are used to gather information about public opinion and discourse. The availability of online databases and search engines for such sources allow for longitudinal data collection using keywords and search strings (e.g. 'coal AND smoke', 'coal AND electricity', 'coal AND (problem OR crisis OR decline)', etc.), which simplify and systematize information gathering.
- Where relevant, satirical cartoons are mobilised as graphical representations that capture collectively shared views, symbols and understandings in an explicit form.

- Because of the importance of policy and governmental intervention in the British coal industry, I have used government committee reports, parliamentary debates and policy documents in order to investigate political and regulatory dimensions.
- To gather industry-internal information, I have used the memoirs of industry chairmen (Robens 1972, MacGregor and Tyler 1986), annual reports from the National Coal Board (after 1946), and other publicly available material conveying the perspective of industry actors such as opinion articles in the press. Although such public statements should not be taken at face value, they do provide interesting data for discourse analyses that trace gradual changes in beliefs and orientation.

The variety of data sources enables triangulation (Yin 1994), and allows for a rich analysis of various contexts and response strategies (which does not yet exist in this form as far as I am aware of).

**Interviews**

Open-ended interviews were carried out for data collection purposes on the second and third cases (for which informants are still alive), after preliminary case histories had been elaborated. Industry members and former industry members, and actors in industry environments (environmental activists, scientists, etc.) have been interviewed because they were identified as relevant participants or observers of the destabilisation process. The experiences of such informants provide valuable insights on the timing of events, motivations of actors and causal mechanisms at play. However, interviews are necessarily selective and biased, and thus require the researcher to create distance with the points of view put forward by informants.

Besides getting answers to specific questions, an open-ended approach to interviews allows to gain additional contextual insight by letting informants set the scene, decide what elements are important to the story, and infer causal relationships from their recollection of events. New points are picked up during these interviews, and lead to local refinements in the case narrative, or cast a new interpretation of the case leading to more research. The interviewees were:

- David Brewer, Director General, the Confederation of UK Coal Producers, December 2, 2011.
- Andrew Kerr, former acid rain activist, involved with FoE and Greenpeace UK in the 1980s, February 9, 2011.

- David Merrick, former scientist at the Coal Research Establishment, February 18, 2011.
- Mike Parker, former chief economist at the National Coal Board, February 17, 2011.
- Jane Paxman, Director of Policy and Communications, 2COEnergy, December 13, 2011.

## *4.3 Analytical strategy: building rich multi-dimensional narratives*

### 4.3.1 Mixed methods

The process tradition is methodologically open, valuing any conjunctions of methods that are sufficiently coherent with each other and the focal phenomena such as to contribute to an improved understanding of change processes. Because of the emphasis on richness, historical detail and complexity, qualitative methods are more prominent, but quantitative methods are not excluded. I thus use a mixed methods strategy, combining qualitative and quantitative data collection and processing methods that allow me to convey the richness of event sequences in cases, yet enable synthetic analysis of destabilisation patterns.

A narrative strategy provides the methodological backbone for the development of the case studies. It is supplemented by the mobilisation of material elaborated with other methods, including:

- the systematic screening of textual resources with the use of search strings. Material screened included industry annual reports, newspapers, and parliamentary publications. Search strings (e.g. “coal AND smoke”, “coal AND crisis”, etc.) are a necessary step first step to rationalise the wealth of coverage available over such long periods of time;
- the analysis of key public statements (e.g. chairmen’s statements in industry annual reports) to industry observe changes in discourse, identity, beliefs and meaning systems over time. Such regime elements are hardest to analyse and require thorough interpretive analysis;
- quantitative data are used to identify and illustrate basic trends (production, consumption, technology diffusion, financial data, etc.) when appropriate. Such historical data series permit the preliminary identification of general patterns. Breaking points observed in these trends also provide the starting point for

periodisation and in-depth analysis of key events. Financial data has also been compiled to provide and indication of industry health.

### 4.3.2 From case histories to multi-dimensional case studies

Specialised historians have covered many aspects of the history of coal in Britain. The concern here being to infer insights on a specific process (destabilisation), and generalisations relevant to other contexts, the historical cases put forward are balanced between historical detail on events and the recognition of developmental patterns (e.g. sequences). For this, however, it relies on the vast amount of historical knowledge accumulated. These histories provide numerous narratives that usually focus on a specific 'layer' of the social world (social history, economic history, political history, etc.), specific events and episodes (e.g. the miners' strike or privatisation), all relevant to the work at hand.

The purpose of the narrative strategy is to move from case histories to rich and analytically relevant case studies (Pettigrew 1997). In practice, the narrative accounts put forward in this thesis include a main plot and sub-plots that reflect:

a) the multi-dimensionality of developmental patterns,
b) multiple levels of embeddedness, and
c) multiple time horizons accommodating processes operating according to multiple temporalities.

The multi-dimensional and multi-temporal coupling of sub-plots into one coherent narrative allows the formulation and further qualification of the generative mechanisms at play in each case. The main challenge with building co-evolutionary narratives resides in making sense of the numerous on-going processes and causal mechanisms involved. It requires a broad and open view on possible influences on the main process (here, destabilisation).

The case studies organising the empirical material are thus more than just case histories or sequences of events: they have an analytical structure and purpose that is geared towards the search for *patterns*, and *generative mechanisms*:

> "For the process analyst events and chronologies are crucial building blocks but only building blocks. The aim in a processual analyst is not to produce a case history but a case study. The case study goes beyond the case history in attempting a range of analytical purposes. Firstly there is a search for patterns in the process and presumably some attempt to compare the shape, character and incidence of this pattern in case A compared with case B. Secondly, there is a quest to find the underlying mechanisms which shape any patterning in the observed processes. The process analyst's

> repetitive questioning about how embodies this constant search for underlying mechanisms which drive the processes." (Pettigrew 1997:339)

The narratives are constructed in relation to categories derived from the analytical framework:

- a diagnosis of an overall transition process provides the basis for the 'temporal bounding' of cases

> "Judgements have also to be made about when a process begins and ends in any study and again a pragmatic mixture of the particular flow of events in any case, the core questions of the study and resource constraints all combine to inform the choice of the time series. The time framework in the study exposes a chronology which becomes the initial organising mechanism for analysis." (Pettigrew 1997:345)

- attention to important events, critical junctures, and broad phase changes identified in the secondary literature allows for the elaboration of a synthetic multi-domain chronology and a 'working' periodisation between significant events or conjectural shifts;
- within this temporally structured frame, and on the basis of analytical categories (types of environmental pressures, industry response strategies, changes to regime rules), a systematic narration is then developed to make sense of the sequencing of events and processes, evidence for which is further sought in primary and secondary sources;
- the resulting layered narrative is attentive to environment-specific threads, problem careers, multiple levels of strategy, etc.
- the case narratives are then checked for consistency across multiple organising logics: across time, across environmental domains, and between analytical categories within domains.

**Case study protocol**

Following these principles, it is possible to elaborate rich, systematic, and analytically coherent case studies. These case studies have a beginning and an end. They are segmented in periods (1 to n) based on important events and trends identified in the secondary literature. For each period, the analytical categories derived from the conceptual framework are systematically traced. This systematic structure is represented in Table 4.2. Following this systematic process results in rich and comparable case studies.

**Table 4.2: Analytical structure of cases**

| | | Periodisation | | | |
|---|---|---|---|---|---|
| | | P1 | P2 | … | Pn |
| Economic environment | Landscape changes | | | | |
| | Environmental pressures | | | | |
| | Strategies and regime change | | | | |
| Socio-political environment | Landscape changes | | | | |
| | Environmental pressures | | | | |
| | Strategies and regime change | | | | |

## Case analysis

For the analysis of each case, an analytical protocol is also followed, in relation to the categories developed in the conceptual framework. Case analyses (5.6, 6.5, 7.5) are thus structured according to the following sub-sections:

1. **Overall destabilisation context and relative significance of specific pressures**

The most significant pressures are summarized in an analytical table. Relative weightings are assigned to pressures, to provide an evaluation of their progression through time. The significance of different kinds of pressures to the overall destabilisation pattern is then discussed, thus allowing the comparison of a variety of destabilisation environments.

2. **Pressure interaction and spillovers**

Because environmental changes are not isolated, I then analyse interactions *between* pressures, and specify underlining mechanisms that can be observed. I also make an interpretive summary of the relative size and spillovers of external pressures in a multi-dimensional space. The schematic figures are based on the TEF (Figure 3.1), with the exception that the industry regime has been left out (because the figures focus on pressures rather than responses). The grey surface area in these figures represents the coal industry (with a rough indication of its size, pressures impinging on its shape, and protective measures as a thickening of its boundaries). Pressures are represented by arrows directed at the industry (thickness roughly indicating intensity). Spillovers are represented by arrows between pressures. Pressure alignment is indicated by their joint directionality towards the industry. Broader secular trends are represented outside the industry environments. I use these analytical representations as an interpretive heuristic in tracing multi-dimensional interactions between pressures in the TEF's economic and socio-political environments. The symbolic representations emanate from my interpretive weighting of pressures and their interactions, and their positioning in the multi-dimensional space.

3. **Destabilisation enactment: industry strategies and regime change**

I then delve into the analysis of the main industry strategies, distinguishing a) socio-cultural framing strategies, b) political strategies, c) economic positioning strategies, and d) innovation strategies. Strategic changes are put in the perspective of changes to core industry regime rules.

4. **Pattern matching**

The last analytical subsection is dedicated to pattern matching, comparing case developments to the ideal-typical enactment model presented in 3.3.2.1. The identification of deviations allows further conceptual refinements in chapter 8.

In the next chapters, I present my empirical contribution in the form of three case studies. Based on the theoretical elaboration and on this present chapter, I develop analytical narratives and discuss aspects relevant to destabilisation and the end of each case.

# 5 Case 1: The destabilisation of the British coal industry (1880-1967)

The case covers the period from 1880 to 1967 during which the British economy underwent a transition from the virtual omnipresence of coal in energy supply to a four-fuel[13] economy (**Error! Reference source not found.**).

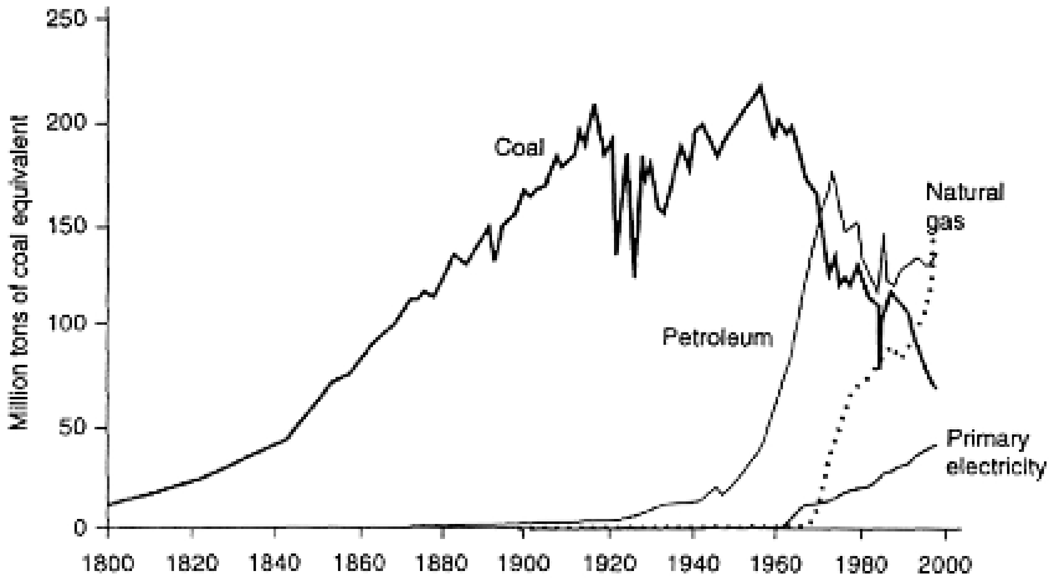


**Figure 5.1: The British transition in primary energy sources, domestic consumption (Fouquet and Pearson 1998:21)**

To divide the longitudinal case into several periods, I focused on changes in the external environments with lasting effects. I start in 1880, because the rise of a smoke abatement movement signalled the early external questioning of the coal industry. Coal output continued to grow, however, and peaked in 1913 (**Error! Reference source not found.**), so it is useful to discuss pre-developments as a background to the case. The first period (1914-1930) is characterised by disruptions and economic fluctuations, starting with the eruption of WWI (**Error! Reference source not found.**). The second period (1930-1946) is characterised by increasing economic problems due to the Great Depression and loss of export markets, by increased government influence (to provide protection) and by increased cultural sensitivity to the smoke problem. The third period

[13] It is worth mentioning that the denomination 'four fuel policy' (referring to coal, gas, oil and nuclear power) is a misnomer. Indeed, electricity is not a fuel, but an energy carrier. Different fuels and/or energy carriers entail different qualities and uses, and are not always directly substitutable.

(1946-1956) is characterised by nationalisation, by renewed optimism over growing coal markets, and by modernisation plans. The industry's cultural and political legitimacy were, however, damaged by the London Smog (1952). The fourth period (1956-1967) is characterised by tougher smoke regulations (the 1956 Clean Air Act), the gradual removal of policy protection, and increased competition from alternatives (oil, gas, nuclear). This led to a loss of faith in the coal industry, and rushed attempts to change the industry's mission, markets and technology.

The industry itself changed its character throughout the period, moving from a fragmented industry in the early 20th century, to a more organised entity in the 1930s (via cartels), into a single entity (through nationalisation in 1946).

## *5.1 Pre-developments: early pressure regarding the smoke problem (1880-1914)*

### 5.1.1 Pressures in economic environment

#### 5.1.1.1 <u>Landscape</u>

The British economy experienced continuous market growth domestically and abroad until World War I. However, it was organised around the proliferation of small, heterogeneous, local (often family-run) firms with little systematic integration and organised control, and thus contrasted with the emergence of more coordinated managerial forms:

> "Elsewhere, from the late nineteenth century (notably in Japan, Germany, and the United States) corporate capitalism was emerging to become the dominant mode of economic organization. Corporate capitalism was characterized by industrial oligopoly, hierarchical managerial bureaucracy, vertical integration of production and distribution, managerial control over the labor process, the integration of financial and industrial capital, and systematic research and development." (Elbaum and Lazonick 1984:571)

#### 5.1.1.2 <u>Markets</u>

Because coal was central to industrial expansion as the principal energy carrier, the coal industry enjoyed growing markets, and was profitable. Most economic sectors and households relied on coal (Figure 5.2). Between 1850 and 1913, markets grew around 4% per year (Church 1986). By 1913, exports accounted for 32% of volume sales (Court 1945).

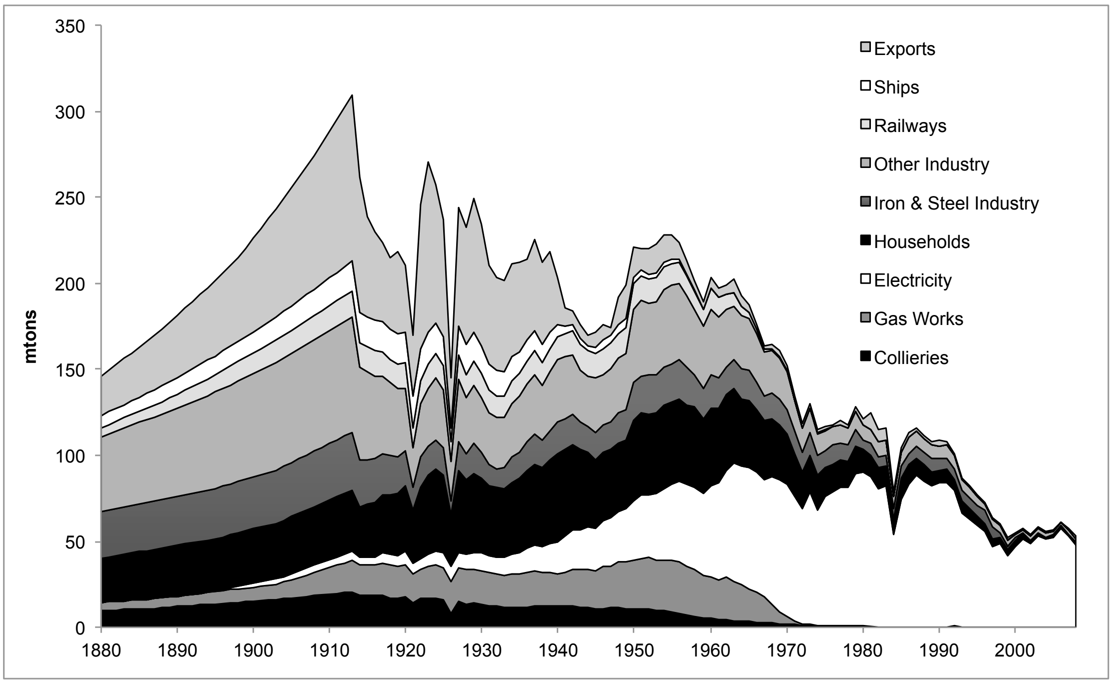


**Figure 5.2: British coal sales by economic sector (Data: Fouquet 2008, DECC Historical data)[14]**

### 5.1.1.3 Labour relations

Labour relations were strained, because the mining industry experienced frequent roof collapses, underground explosions, fatal accidents, poor working conditions, low wages, and limited worker rights. In 1889, workers created the Miners' Federation of Great Britain (MFGB), which strived for higher wages and safety measures (Church 1986). Between 1881 and 1913 nominal wages in coal mining increased by 86.8%, while the average increase across all sectors was 27.5%, and the cost of living rose by only a few percentage points. These wage rises (in nominal and real terms) in the coal industry were not only linked to union activism, but also to strong market demand and rising coal prices (Boyer 2004).

### 5.1.1.4 Technical alternatives

Coal gas and electricity were two new energy carriers, which on the one hand competed with the direct use of coal. On the other hand, they used coal as feedstock and thus formed growth markets for the coal industry. When electricity challenged gas in the lighting markets, gas industry actors shifted their attention to domestic cooking and heating, where it competed with the direct use of coal in stoves and fireplaces. Between

---

[14] The absence of noise in the data preceding 1913 is justified by reliance on average estimates before that date, while annual data is available from 1913.

1882 and 1912, the number of gas consumers increased from 1,972,000 to 6,876,000 (Barty-King 1984). The pressure of these alternatives on the coal industry was not substantial, because gas and electricity both derived from coal, and were thus seen as new markets for the industry.[15]

## 5.1.2 Pressures in the socio-political environment

### 5.1.2.1 Landscape

The late nineteenth century saw a relative growth of public health expenditures (Boyer 2004), and a general interest in issues such as hygiene and the social condition of workers (Thorsheim 2006).

### 5.1.2.2 Public opinion

The atmosphere in many industrial cities was filled with smoke, ash, and soot particles (Figure 5.3), which caused health problems and deaths, created visibility problems in traffic, and dirtied houses, building and laundry.

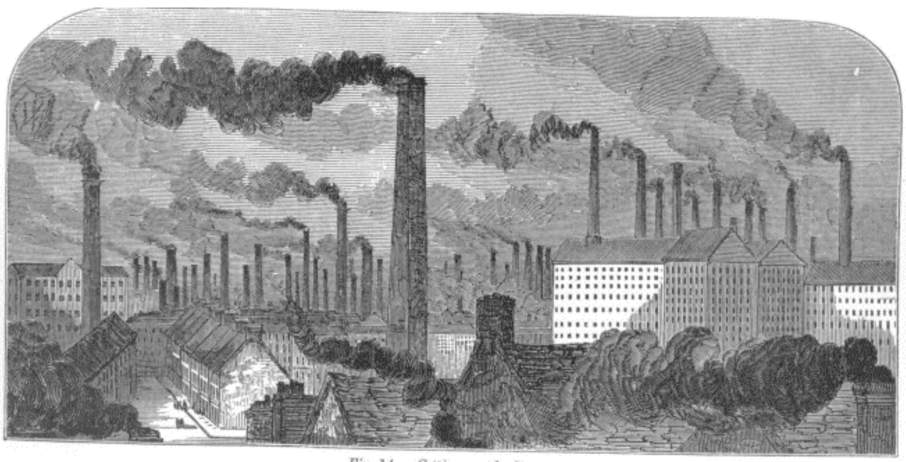

*Fig. 14.—Getting up the Steam.*

**Figure 5.3: Smoke problems in 19th century cities (Godwin 1854:60)**

Smoke problems were part of daily lives. They were seen as a nuisance, but also the price to pay for progress. In the 'Age of Coal' most people associated smoking chimneys with progress, wealth and employment (Church 1986). People sympathized with the industry and believed that coal-burning restrictions would constrain manufacturers (Stradling and Thorsheim 1999). People also appreciated the glow of

---

[15] Additionally, the efficiency losses from conversion to these different carriers actually implied greater primary consumption of coal for these substitutions.

coals and the "pokeable, companionable fire" (Ashby and Anderson 1981), which they perceived as homely and cosy.

#### 5.1.2.3 Policy makers

Although some cities introduced local smoke laws, they contained many loopholes and exemptions, were weakly enforced, and prescribed meagre fines (Thorsheim 2006). Local politicians were often sympathetic towards owners of smoky factories.

#### 5.1.2.4 Social movement

Victorian reformers such as medical doctors, hygienists, and urban planners, were concerned about the effects of smoke on health, living conditions, and civilization more generally (Thorsheim 2006). In the 1880s, smoke abatement movements emerged, which redefined smoke as a dangerous killer, responsible for respiratory diseases, deaths and general pollution.[16] To educate the public, activists sponsored public lectures about smoke, exhibitions about cleaner fuels (the first one in 1881), brochures and booklets. The Coal Smoke Abatement Society (CSAS) (1898) focused more on industry and greater enforcement of existing smoke laws (Thorsheim 2006). The Smoke Abatement League of Great Britain (SALGB), created in 1909, focused on policy, and lobbied for greater state involvement and national regulations. The gas industry, which marketed itself as clean in comparison to coal, gave financial support to smoke abatement groups and collaborated with them by sponsoring exhibitions (Thorsheim 2002).

### 5.1.3 Industry strategies – economic environment

#### 5.1.3.1 Economic positioning strategies

The coal industry was highly diverse, with thousands of undertakings of varying size competing on costs and quality, which varied between regions. In response to labour union demands, mine owners increased wages, introduced individual safety lamps, and increased ventilation. Additional costs were passed on to consumers (Church 1986).

#### 5.1.3.2 Innovation strategies

Technical operations were labour-intensive and relied largely on muscle-power (Court 1945). Men used picks to cut coal and used shovels to load it into wagons. Ponies and

---

[16] Early examples are the Manchester and Salford Noxious Vapour Abatement Association (1876) and the National Smoke Abatement Institution (1882).

rope-haulage systems transported wagons to vertical shafts, where coal was moved to the surface (Figure 5.4). Steam engines were introduced more widely in the late 19th century to power ventilation devices, water pumps, shaft haulage, and rope-systems. Electricity entered the mines to provide light and to power ventilators.

Innovation strategies were however not pursued systematically, and great disparity prevailed between mines. Already in 1903 a mine inspector complained that: “There is a sort of *vis inertiae* that you have to overcome at a great many collieries before you can get any new system introduced” (reported in Pollard 1989:27).


**Figure 5.4: Drawing of the 19th century Bradley Mine Bilston (Wolverhampton City Council Archives)**

### 5.1.4 Industry strategies – socio-political environment

#### 5.1.4.1 Political strategies

The coal mining industry hardly engaged with the smoke problem, because it framed smoke as being caused by the users of coal, e.g. factories, gas works, households. Factory owners and industrialists used *political strategies* to defend themselves against institutional pressures. They lobbied city councils, officials and judges to weaken smoke-regulations and apply these leniently (Stradling and Thorsheim 1999).

#### 5.1.4.2 Framing strategies

They also used *framing strategies*, arguing that jobs and economic welfare were more important than smoke problems. This view was regularly displayed in popular media. The Daily Mirror, for instance, on March 21st 1912, commented on comparative photographs before and during a potters' strike and argued: "No smoke means no work, and no work no money" (Figure 5.5).

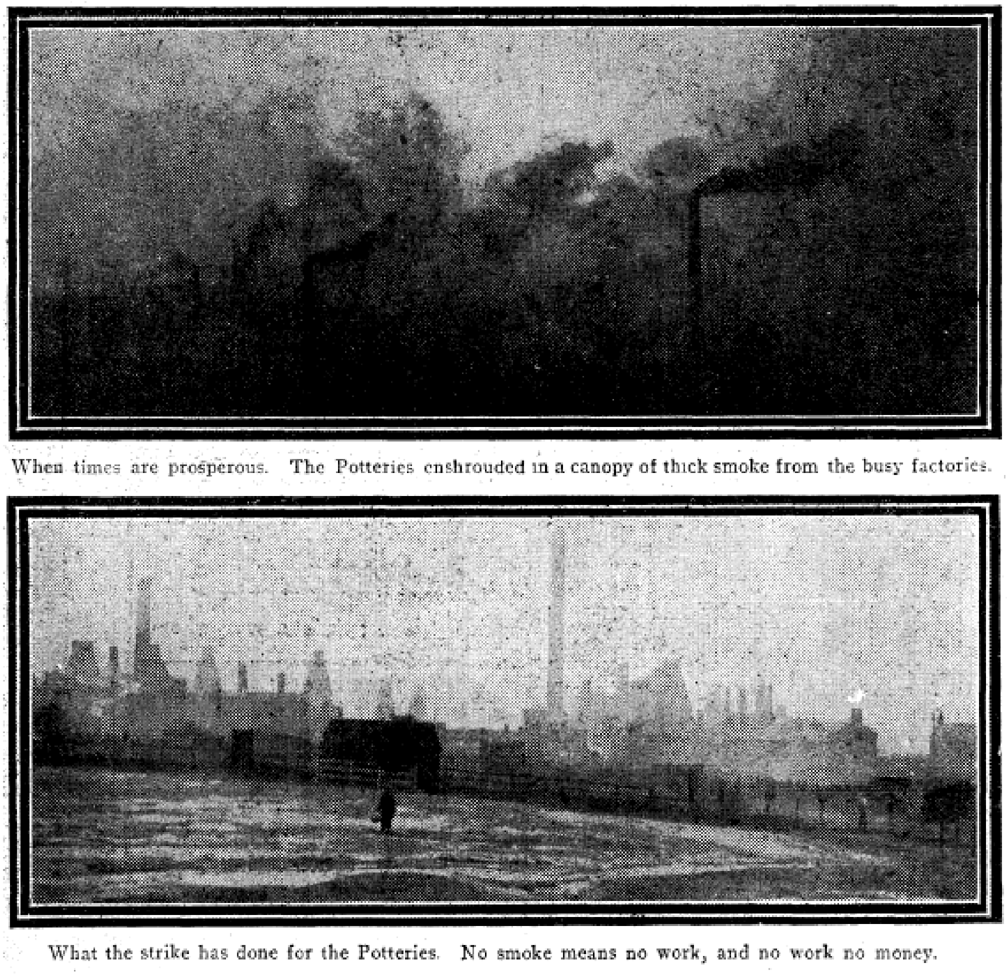


**Figure 5.5: Detail from the *Daily Mirror*, March 21st, 1912, p.9**

#### 5.1.4.3 Innovation strategies

Coal-using industries also employed *innovation strategies*, and adopted fuel-efficient boilers and furnaces that reduced smoke emissions and fuel costs. They also introduced higher chimneys that dispersed and diluted smoke over larger areas. The combined effect of these developments was a sensible alleviation of smoke problems since the 1890s (Ashby and Anderson 1981).

## *5.2 Economic fluctuations and ongoing smoke pressure (1914-1930)*

### 5.2.1 Pressures in economic environment

#### 5.2.1.1 Economic landscape

World War I disrupted international trade, but also domestic industry activities (Figure 5.2). The government took control of strategic industries to support the war effort. This change, although temporary, paved the way for the emergence of new issues to the public eye: labour issues, efficiency issues, industrial structure, etc.

**5.2.1.2 Markets**

After the war, export markets recovered in the early 1920s, but were disrupted by the 1926 strike and then decreased throughout the late 1920s and 1930s (Figure 5.6).

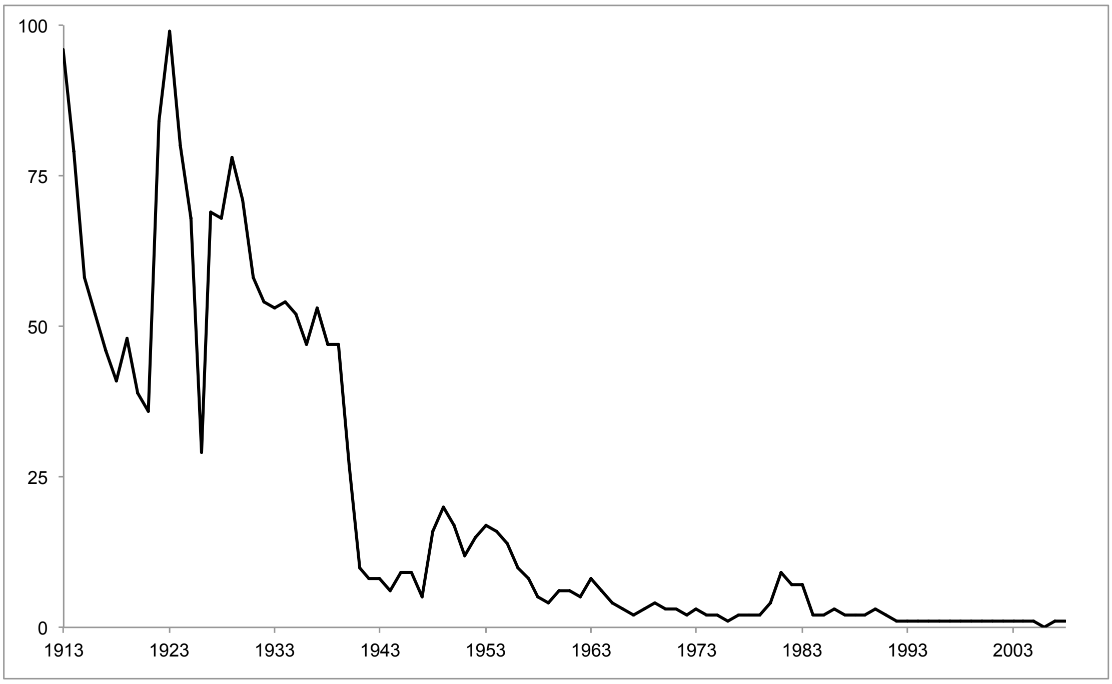


**Figure 5.6: British coal exports (1913-2008), mtons (Data: DECC historical coal data)**

Most domestic markets (households, iron/steel industry, other industries, railways) fluctuated or stagnated (because of price volatility or industrial fuel efficiency improvements).[17] Gas and electricity markets grew (Figure 5.2). Collieries and shipping decreased, with the gradual introduction of more efficient diesel engines. Aggregate domestic demand grew only 0.7% between 1913 and 1929 (Supple 1988).

**5.2.1.3 New entrants**

Because World War I seriously disrupted coal exports (Court 1945), foreign countries accelerated the build-up of their own coal industries. They adopted the latest mining methods, improving productivity and efficiency levels (Figure 5.7). British mines modernized comparatively slowly. By 1913, only 8% of coal was mechanically cut, and

---

[17] Between 1920 and 1935, electricity generation and iron production experienced fuel efficiency improvements of about 55% and 40% respectively (Buxton, 1979).

less was mechanically conveyed (Taylor 1961). After the war, foreign industries increasingly competed with British firms in (British) export markets.

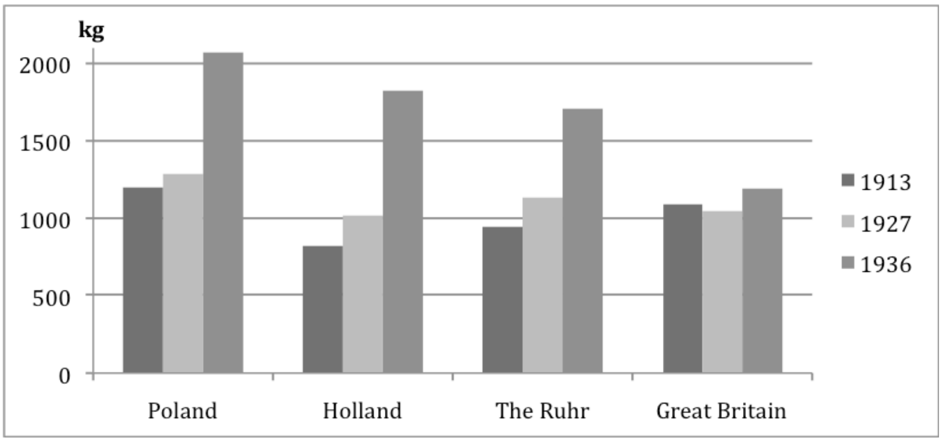


**Figure 5.7: Output per manshift (kg) (Data: Allen 1970, Court 1945)**

#### 5.2.1.4 Labour relations

Following state control, average wages increased substantially during the war (about 170% according to Ramsbottom, 1935). State control of the coal industry during WWI also led to better working conditions. After the war, labour unions (unsuccessfully) lobbied for nationalisation. When the government handed back the mines in 1919, owners halved wages in 1920 (Ramsbottom 1935). Labour relations became strained and when industrialists again proposed to lower wages and lengthen working days, unions responded with major strikes in 1921 and 1924. Unions won the fight and actually achieved wage increases of about 8% in that period (Figure 5.11). In 1925 proposals for wage reduction renewed tensions and culminated in the 1926 General Strike, which caused major market disruptions (Figure 5.2). Mine owners defeated the unions and subsequently implemented major wage reductions (Court 1945).

#### 5.2.1.5 Technical alternatives

After World War I, the production and consumption of coal gas accelerated (Table 5.1), because of scale effects, price decreases and the increased use of penny-in-the-slot meters. Electricity was increasingly used for lighting and powering machine-tools. Fuel efficiency improved as industries shifted from steam towards electric motors (using coal more efficiently).

**Table 5.1: UK Gas production (million cubic feet) (Data: Williams (1981:289))**

| Year | UK gas production (Mft$^3$) |
|---|---|
| 1887 | 56241 |
| 1902 | 91956 |
| 1912 | 126002 |
| 1920 | 295857 |
| 1930 | 313046 |
| 1937 | 341985 |
| 1946 | 446124 |

Fuel oil gained some early footholds in shipping and heavy industries. In 1913, for instance, the Admiralty shifted towards oil-burning vessels (Church 1986).

### 5.2.2 Pressure in the socio-political environment

#### 5.2.2.1 Landscape

Temporary government control of strategic industries during the war created a precedent, and led to a greater interest in industrial planning from policymakers.

#### 5.2.2.2 Social movement and activism

In the 1910s and 1920s, professional groups (doctors, chemists, architects and engineers) joined the anti-smoke coalition, changing the emphasis from behavioural change to technological solutions. Smoke reduction was reframed in terms of economies of fuel and win-win solutions, because industries could simultaneously reduce fuel costs and diminish smoke problems (Stradling and Thorsheim 1999). The expansion and professionalisation of the anti-smoke movement enhanced its credibility with policy makers. In 1921, the CSAS was invited to provide inputs to the Newton committee. Disappointed by the weak 1926 Public Health Act (Thorsheim 2006), smoke activists reoriented their strategy from regulatory lobbying towards influencing public opinion and educating citizens. The newly created National Smoke Abatement Society (1929) disseminated information and organized exhibitions.

The emerging (coal) gas industry also supported smoke abatement groups, and contrasted itself with (unprocessed) coal as a clean, convenient, and smokeless alternative (Figure 5.8).

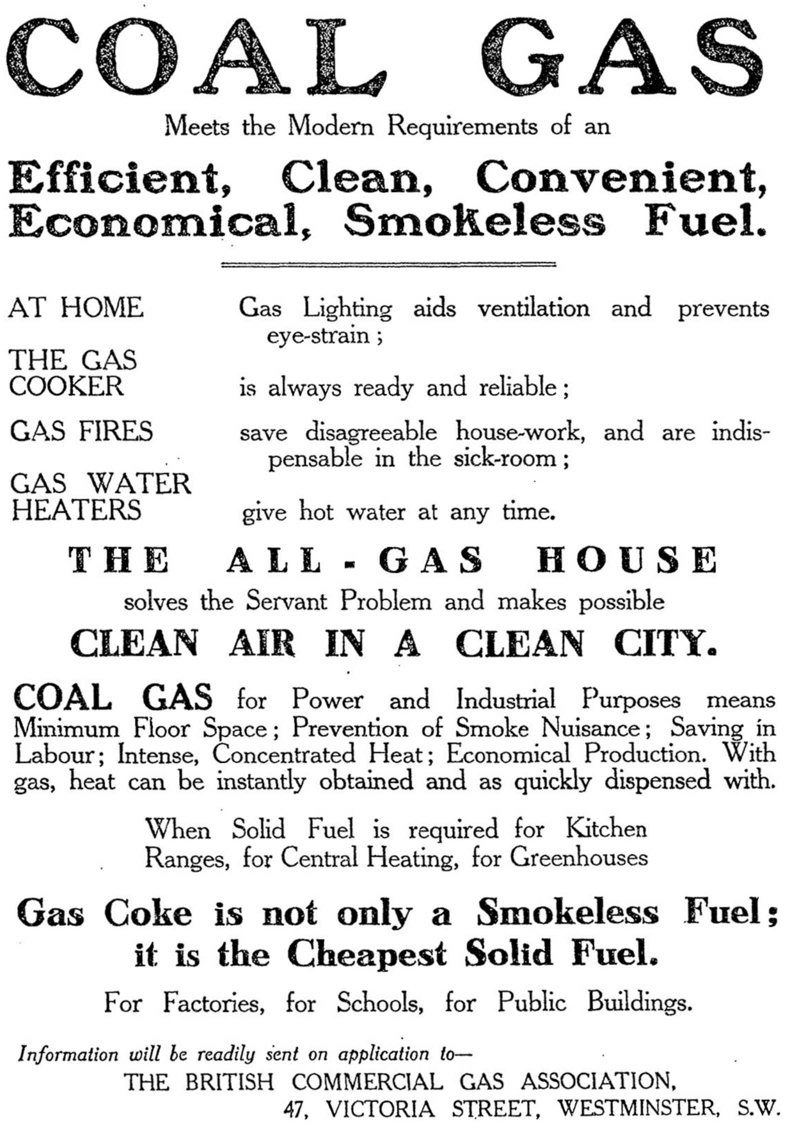


**Figure 5.8: Advert by British Commercial Gas Association (The Times, January 1, 1914)**

### 5.2.2.3 Public opinion

Because coal smoke was still generally associated with progress and economic prosperity, smoke activists were modestly successful in influencing public opinion. In 1921 (23 August) an editorial in *The Times* commented that "We are still far from the point at which compulsion [of domestic smoke curbing] is possible. Public opinion has to be educated" (cited in Thorsheim 2006:52).

### 5.2.2.4 Policy

The government was concerned about the industry's economic problems and, in 1925 and 1926, provided £23 million of direct subsidies and special trade favours (Allen 1970). Expert committees were formed to investigate the economic problems. The 1921 Sankey Commission concluded that the coal industry had too many production units, most of them of suboptimal size. The 1926 Samuel Commission reached a similar conclusion and promoted the amalgamation of small mines into larger undertakings. The industry did not implement these recommendations, which created political "disillusionment with the ability of the coal industry to govern itself" (Supple 1988:580). In the late 1920s, this frustration led to policy discussions of "compulsory amalgamations, cooperative marketing schemes, official subsidies and government-backed export cartels" (Supple 1988:585).

Policymakers gradually engaged with the smoke debate. During World War I, it sponsored research into coal smoke (Thorsheim 2006) and the efficient use of fuel. Smoke regulations for households were not considered, because this conflicted with the idea that the home was one's castle (Ashby and Anderson 1981). The Newton Committee Report (1921) concluded that domestic smoke had increased relative to industrial smoke, and recommended actions against commercial *and* domestic chimneys. Nevertheless, the subsequent Public Health (Smoke Abatement) Act (1926) was relatively weak, applied only to commercial installations and to 'black smoke' (which created definitional problems and legal loopholes), contained exemptions, and entailed insignificant fines (Ashby and Anderson 1981).

## 5.2.3 Industry strategies – economic environment

### 5.2.3.1 <u>Economic positioning strategies</u>

The industry was squeezed between supply side pressures from foreign industries, high labour costs that consumed a large part of net proceeds, and declining and stagnating markets that caused over-supply and decreasing prices (Buxton 1979). These economic problems, which were exacerbated by miner strikes, led to mine closures, bankruptcies (Table 5.2), and a decrease of 30% in the workforce (DECC Historical coal data).

**Table 5.2: Number of undertakings and mines (based on Allen 1970, Court 1945, DTI 2002)**

| | **Undertakings/companies** | **Mines** |
|---|---|---|
| **1913** | | 3000 |
| **1924** | 1400 | 2480 |
| **1944** | 740 | 1630 |
| **1948** | National Coal Board | 980 |
| **1956** | National Coal Board | 850 |

The industry's primary response strategy was the reduction of labour costs (Allen 1970). The recommendations from policy committees (to amalgamate the thousands of undertakings into larger ones) did not lead to targeted responses because of limited coordination in the industry (Supple 1987).

**5.2.3.2 Innovation strategies**

WWI starved the mines of equipment, lowering production efficiencies and outputs. Post-war diffusion of coal-cutting machines and pneumatic picks was slow in Britain compared to other countries (Figure 5.9).

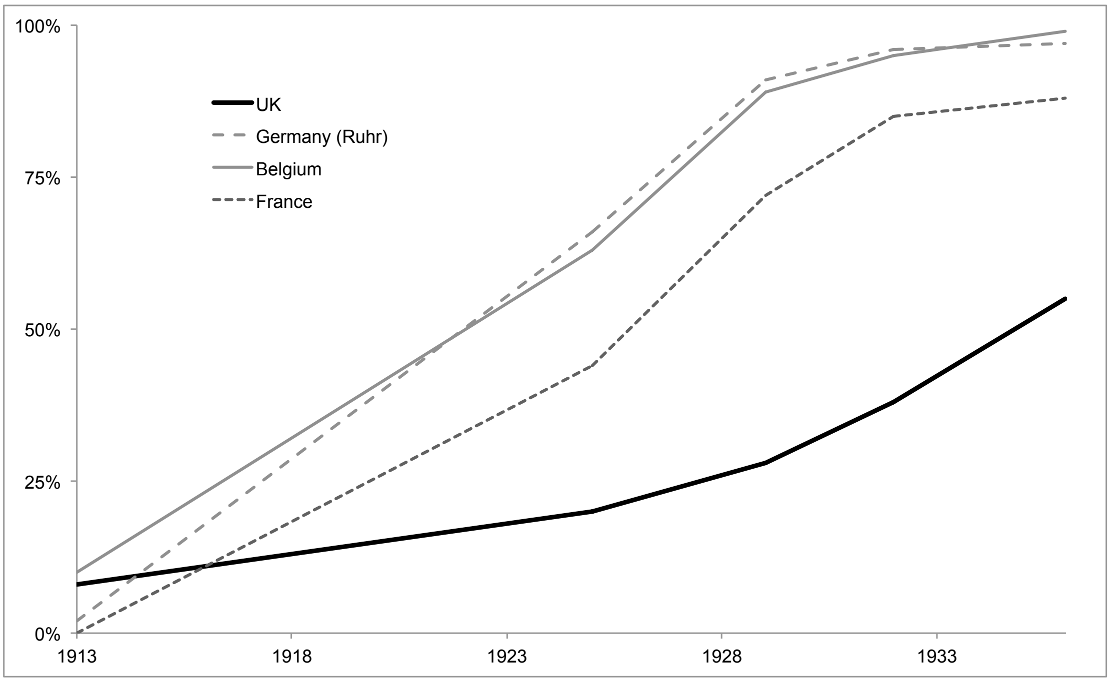


**Figure 5.9: Percentage of coal output mechanically cut in selected countries (Data: Buxton 1979)**

The percentage of mines with coal-cutting machines and pneumatic picks increased from 8% in 1913, 19% in 1924, to 42% in 1933 (Allen 1970). But the mechanical removal of coal (via conveyors) and the mechanical loading of cut coal onto conveyors (via power-loaders) diffused more slowly. Technical innovation thus remained sparse and partial (Church 1986). This also applied to the processing, washing, and grading of coal into different categories:

> "British companies (…) certainly did not set the pace in adopting sophisticated coal-processing techniques and marketing practices" (Dintenfass 1992:171).

Productivity improved only 10% between 1913 and 1936, while the coal industries in the Ruhr and Belgium increased their productivity by 80% and 50% respectively over the same period (Buxton 1979:61-2).

Some coal manufacturers began to diversify into (natural or synthetic) smokeless fuels (anthracite, briquettes, etc.), which were more expensive than normal (bituminous) coal and harder to ignite (Court 1945).

### 5.2.4 Industry strategies – socio-political environment

#### 5.2.4.1 Political strategies

After the war, the coal industry and the newly created Mineowners Association of Great Britain (MAGB) successfully lobbied against nationalisation proposals. Factory-owners lobbied city councils and judges to weaken smoke-regulations and apply these leniently (Stradling and Thorsheim 1999). The Federation of British Industries (FBI) influenced the Newton Committee Report (1921) and succeeded in watering down the Public Health Act (1926), "rendering the bill as innocuous as possible for business generally" (Sheail 1997:27-28).

#### 5.2.4.2 Framing strategies

The coal industry downplayed the smoke problem, arguing that jobs and economic welfare were more important. The FBI also warned that smoke regulations would undermine competitiveness and lead to unemployment (Sheail 1997).

## *5.3 Increasing pressures and piecemeal responses (1930-1946)*

### 5.3.1 Pressure in economic environment

#### 5.3.1.1 Landscape

The second half of the interwar period was marked by the Great Depression, which led to lean economic times and the search for cost reduction throughout the economy. The second world war also interrupted economic activities, and led to the mobilisation of strategic industries to contribute to the war effort.

#### 5.3.1.2 Markets

Household and industrial coal markets contracted during the Great Depression, picked up in the second half of the 1930s, and contracted again during World War II (Figure 5.2). Export markets decreased continuously in the 1930s, and collapsed during WWII (Figure 5.6). Collieries and shipping markets also decreased (Figure 5.10), the latter because of a shift to liquid fuels. These fluctuations caused bankruptcies and closures in the coal industry (Table 5.2), which came to be seen as a 'sick industry' (Supple 1988).

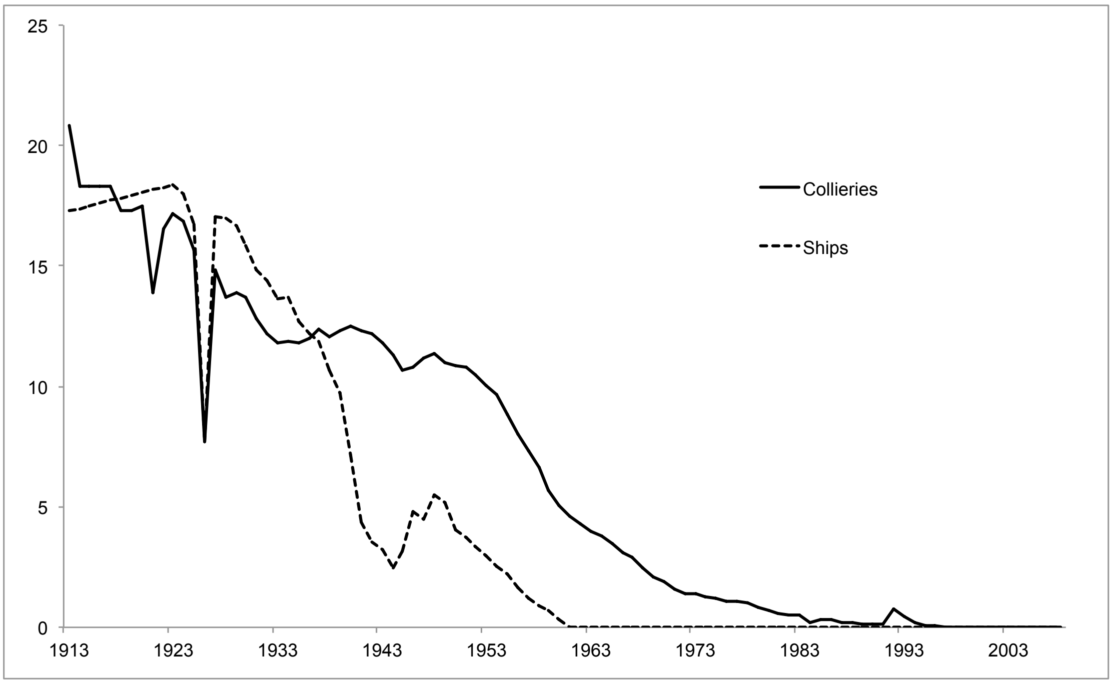


**Figure 5.10: Coal consumption by British ships and collieries (1913-2008), mtons (Data: Fouquet 2008)**

### 5.3.1.3 Technical alternatives

Fuel oil and diesel began to compete in heavy industries and railways, but did not diminish coal use, as they did in shipping. Electricity use in industry increased from 5,000 GWh in 1930 to 19,000 GWh in 1948.[18] In households gas and electricity increasingly competed with the direct use of coal (for applications such as lighting, cooking, heating and powering appliances such as irons, cookers, radios). By 1938, 60% of the gas industry's output was for domestic purposes (Ashby and Anderson 1981). Household grid connections rapidly increased from 32% in 1931, 65% in 1938, to 96% in 1961 (Corley, 1966). Electricity prices decreased nearly three-fold between 1935 and 1945, further encouraging its use in households and industry (Fouquet, 2011). But electricity and coal gas exerted limited market pressure since they used coal as feedstock and thus formed growth markets for the industry (Figure 5.2).

### 5.3.1.4 Labour relations

Since their defeat in the 1926 strike, unions had lost some bargaining power. Wages decreased substantially until the mid-1930s (Figure 5.11). Despite this reduction, relative British wage costs remained high by international standards (Table 5.2). Although the proportion of British wage costs to total costs decreased from 70% in

[18] Data from BEER, Historical electricity data: 1920 to 2007 (file 40583).

1927 to 63% in 1936, this ratio was higher than in other countries (44% in Poland, 46% in Germany, 49% in the Netherlands, in 1936) (Buxton 1979). Wages increased from the mid-1930s when markets grew again.


**Figure 5.11: Index number of wage rates for UK mining (1924=100) (Data: Ramsbottom 1935, 1939).**

| Country | Index |
|---|---|
| Poland | 48 |
| USA (bituminous) | 61 |
| Germany (West Upper Silesia) | 68 |
| Belgium | 81 |
| Germany (Ruhr) | 96 |
| Great Britain | 100 |
| USA (Anthracite) | 130 |
| France | 145 |

**Table 5.3: Index of relative labour costs per ton (common currency) of saleable coal, 1935 (British costs=100) (Data: Buxton 1979:57)**

Decreasing wages and increasing unemployment introduced bitterness in labour relations. To protect jobs, miners and unions did not wholeheartedly cooperate in the introduction of new innovations (Court 1945).

## 5.3.2 Pressures in the socio-political environment

### 5.3.2.1 Landscape

The difficult economic conditions of the 1930s and the disruption of WWII led to greater government involvement in economic affairs.

### 5.3.2.2 Policy

Policymakers stepped in to provide protection against harsh economic conditions.[19] The Coal Mines Act (1930) allowed the formation of cartels, which restricted output and guaranteed minimum prices, and intended to stimulate the consolidation of the industry (Allen 1970). The Act was motivated by: a) accumulated frustrations about the inability of the coal-industry to put its own house in order (Supple 1988), b) concerns over unemployment and social disruption of mining communities c) electoral interests and political pressure from labour unions, which had substantial political clout. Policy makers paid limited attention to smoke problems, because economic issues had priority.

### 5.3.2.3 Social movements

The smoke abatement movement continued its public information activities (Stradling and Thorsheim 1999). A leading activist still saw the lack of public awareness as a major barrier:

> "Until every citizen recognizes the fact that he or she is the cause of the dirty fogs nothing really adequate and valuable in the progress towards our objective, "clean air", can come to pass" (Des Voeux, 1934, *The Times*, March 2, 1934).

### 5.3.2.4 Public opinion

New visions of domestic life, which were advocated by the gas and electricity industries, began to erode coal's legitimacy in the 1930s. The electricity industry disseminated visions about the all-electric house that was modern, efficient, clean, and hygienic (Corley 1966). The Gas Council released movies such as 'The Smoke Menace', emphasising the dangers of smoke and portraying gas users as progressive citizens contributing to reduction of a social nuisance (Taylor 1937). These new visions resonated with cultural discourses around 'modernity', 'convenience', 'cleanliness' and 'health'. Smoke became part of a larger cultural 'package' that framed coal as old-fashioned, dirty, smoky and unhealthy.

---

[19] The British government introduced protective measures (tariffs, tolerance for collusion) in many industries in the interwar period (Bowden and Higgins, 2004).

### 5.3.3 Industry strategies – economic environment

#### 5.3.3.1 Economic positioning strategy

The cartel structure reduced competitive incentives for innovation and efficiency improvements (Court 1945), leading coal firms to focus on short-term survival and cost-reduction.

#### 5.3.3.2 Innovation strategy

Since the late 1920s, coal firms also accelerated the diffusion of coal cutters (Figure 5.9), resulting in productivity improvements from 0.9 tonnes per manshift in 1925 to 1.2 tonnes per manshift in 1936 (Buxton 1979). But these improvements remained slow relative to foreign industries. Mechanisation proceeded in a partial and piecemeal fashion, focussing on individual components, but not systemic modernisation:

> "faceworking, roadway development, haulage, winding, ventilation, and lighting all needed to improve together, if the technological improvement of one of them was not to have its benefits reduced by the stagnant techniques of others" (Ashworth 1986:63).

Technical inertia in the coal industry had several causes[20]: a) cartel legislation removed selection pressure and led firms to postpone expensive and systemic technical re-equipment (Court 1945), b) the mindset and identity of managers was characterized by rent seeking instead of entrepreneurship and a preference for craft-based styles over science and engineering (Buxton 1970, Dintenfass 1992), c) labour unions resisted the introduction of new machines to protect jobs, d) firms had limited resources for investment because of low profitability in preceding years (Buxton 1979), e) firms delayed investment in comprehensive modernization because of uncertainties about the recovery of export and domestic markets (Bowden and Higgins 2004).

In terms of product innovation, the industry developed some new appliances that produced less smoke. Diversification into smokeless fuels remained limited. To inform consumers about new appliances and more efficient coal use, the Coal Utilisation Council (CUC) was created in 1932.

---

[20] Many British industries were characterized by 'defensive and cautious reactions' and 'failures to adapt' in the interwar period (Bowden and Higgins 2004).

### 5.3.4 Industry strategies – socio-political environment

#### 5.3.4.1 Political strategies

The coal industry accepted the output limitations and price-setting mechanisms but lobbied against industry consolidation. Sustained resistance culminated in the dissolution of the Coal Mines Reorganisation Commission in 1936 (Ashworth 1986).

#### 5.3.4.2 Framing strategies

The industry made some attempts to restore coal's reputation. The CUC chairman suggested that coal was a 'modern fuel' that could be burnt in 'new-fashioned appliances':

> "But why must the word "old-fashioned" and "coal-kitchener" be necessarily coupled together? There are many new-fashioned and highly efficient cookers and ranges already on the market which consume coal with little if any smoke" (*The Times*, March 3, 1934).

## *5.4 Nationalisation, post-war reconstruction and the Clean Air Act (1946-1956)*

### 5.4.1 Pressures in the economic environment

#### 5.4.1.1 Landscape

In the wake of WWII, British industrial efforts were geared towards reconstruction: building up capacity to ensure shelter, food, and energy to the masses, as well as putting the economy back on its feet.

#### 5.4.1.2 Markets

World War II depressed domestic markets and collapsed export markets (Figure 5.6). The demand for coal picked up in the post-war reconstruction period, especially in the electricity, gas, iron/steel and heavy industries (Figure 5.12, Figure 5.14). Demand from railways decreased after the war, because of increasing competition from diesel- and electric-powered locomotives. But executive views that steam would remain the principal source of power led to a new construction program, resulting in 1518 steam locomotives between 1948 and 1956 (Chick 1998). This pushed up railway coal consumption in the late 1950s, before contraction in the 1960s. To prioritise industries, policy makers rationed growing household demand. The coal industry faced difficulties meeting this growing demand, because it "came out of the Second World War a vulnerable, smaller, and enfeebled industry" (Supple 1987:10).

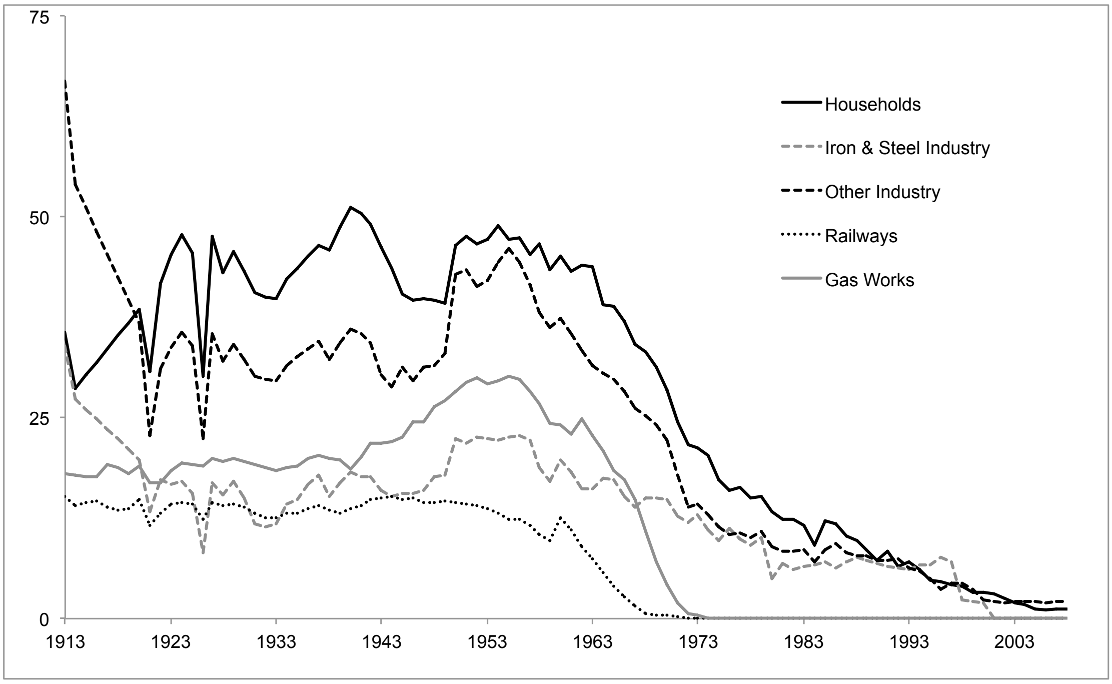


**Figure 5.12: Coal consumption by British households, industries, railways and gasworks (1913-2008), mtons (Data: Fouquet 2008)[21]**

### 5.4.1.3 Technical alternatives

Coal shortages stimulated the rise of (fuel) oil in iron, steel and heavy industries.
Nuclear power appeared as an option in electricity generation.
Households increased their use of gas and electricity, turning into multi-fuel environments (Table 5.4).

| | Cooking | Water heating | Room heating |
|---|---|---|---|
| **Coal** | 20-25% | 60% | 75-80% |
| **Coke and anthracite** | - | 20% | 15% |
| **Coal gas** | 70% | 15% | 5% |
| **Electricity** | 5-10% | 5% | 0-5% |

[21] Coal consumption by the electricity sector is not represented on this graph, but is displayed on Figure 5.14.

**Table 5.4: Division of domestic heat services among the different fuels (Ministry of Fuel and Power 1946:38)**

## 5.4.2 Pressures in the socio-political environment

### 5.4.2.1 Landscape

The reconstruction years marked a change in Government control and ownership of industries. A number of strategic industries were nationalised as a result of the newly elected Labour government's promise, and became associated with a 'social' function (controlled prices, mediation of employment, etc.).

The Great London Smog (1952) was a profound public shock that the public interpreted as an environmental disaster requiring immediate action.

### 5.4.2.2 Policy

The government nationalised the coal industry (1946) for several reasons:[22] a) to increase control over industries with perceived strategic importance for the economy, b) to improve efficiency and productivity (there was accumulated frustration over the industry's inability to consolidate, rationalise and mechanise (Allen 1970)), c) to resolve deep-rooted labour problems of the industry (Hannah 2004). The government initially adopted a hands-off approach, leaving day-to-day management to the newly-created National Coal Board (Ashworth 1986). The NCB had to rationalise the fragmented sector, modernise the mines, invest in R&D and create an efficient national enterprise. Financial support underpinned the Plan for Coal (1950), which proposed long-term schemes for modernisation, mechanisation and reorganisation. The main immediate short-term goal, however, was to increase coal output (Ashworth 1986). The NCB was granted the exclusive license to import, which provided protection from foreign competition. Other relevant energy policies included coal rationing for households (until 1958), encouragement of oil use in power stations and industry, and announcements of nuclear power ambitions (in 1953 and 1954).

The 1952 Great London Smog, which caused over 4000 excess deaths, was a major shock that created credibility pressures on policymakers (Thorsheim 2006). The government reluctantly installed the Beaver Committee (1953). The Beaver report (1954, p. 6) defined smoke as "a social and economic evil" and called for an 80%

---

[22] Other strategic industries (e.g. steel, railways, electricity, gas) were also nationalised.

reduction in coal smoke over 15 years and legislation to achieve this (Ashby and Anderson 1981). In 1955, an internal Cabinet memorandum assessed that "public opinion is ready for a strong government lead and would support measures on the scale proposed. Indeed, we do not think that anything less than positive action on a national basis would satisfy public opinion, or prove effective in abating pollution" (cited in Thorsheim 2006:181). This assessment led to the 1956 Clean Air Act (CAA), which began restricting coal use in people's homes and enabled cities to create smokeless areas. It also provided grants for the conversion of domestic grates to burn smokeless fuels (Ashby and Anderson 1981).

#### 5.4.2.3 Public opinion

The 1952 smog episode shocked public opinion and placed smoke high on public agendas (Sanderson 1961). It reinforced the public perception that coal was old-fashioned and outdated, and damaged coal's cultural legitimacy. Public letters and newspaper reports also created pressure on policymakers.

#### 5.4.2.4 Labour relations

Labour unions emerged from the war with a stronger bargaining position, and successfully argued for a substantial role in the newly nationalised industry (Brown 2004). Low levels of unemployment and the use of strikes led to higher wages in the 1950s.

### 5.4.3 Industry strategies – economic environment

#### 5.4.3.1 Economic positioning strategies

Expanding markets and government support created new optimism in the industry: "It is clear that industry and domestic consumers will continue to burn a very large tonnage of solid fuels" (NCB 1953:34). Given the difficulties encountered in scaling up capacity, alternative fuels (gas, electricity, oil) were not perceived as threats, but as welcome allies in temporarily addressing fuel shortages:

> "maximum use must be made of other fuels to fill the gap" (NCB 1954:27).

#### 5.4.3.2 Innovation strategies

The Plan for Coal (1950) assumed that demand would increase to 240 million tons/year by 1961-1965, and asked for £635 million of government investments to boost output through the introduction of power-loading, locomotive haulage, winding techniques, horizontal mining and training schemes for mining engineers (Allen 1970). Subsequent productivity improvements were slow, however, rising from 1.23 tons per manshift in 1950 to 1.30 in 1958 (Ashworth 1986). An interim evaluation, *Investing in Coal* (1956), increased estimated investments to £1000 million arguing that "the outlay proposed is large, but essential for the creation of the efficient and expanding coal industry on which the future of the British economy depends". Slow implementation of modernisation plans was due to: a) under-developed managerial and administrative skills (Hannah 2004), b) a shortage of engineers, and c) tensions between short-term output maximisation and long-term mine reconstruction (Ashworth 1986).

The industry also diversified into smokeless fuels (such as coke and briquettes), which resulted from process treatments of coal (e.g. carbonisation). This required the build-up of new capabilities in chemical and thermal engineering and heavy capital expenditures. Plans for new coke ovens were implemented slowly, however, because they conflicted with output maximisation requirements (and financial resources) for normal mines (Ashworth, 1986). The coal industry also engaged in appliance innovation, developing adjusted stoves and furnaces that better burnt smokeless fuels.

The NCB also invested in research, creating the Coal Research Establishment (CRE) in 1948 and the Mining Research Establishment (MRE) in 1952. The CRE focused on coal quality, briquetting, the mine environment and carbonisation, while the MRE applied engineering principles to underground mining (Ashworth 1986).

### 5.4.4 Industry strategies – socio-political environment

#### 5.4.4.1 Framing strategies

While the NCB acknowledged the need to address smoke problems, it defended the continuation of coal burn (Sanderson 1961, Scarrow 1972), arguing that the problem was the incorrect *use* of coal in old appliances. The NCB and CUC therefore advocated new appliances, smokeless fuels, and consumer education as solutions (Sanderson 1961).

#### 5.4.4.2 Political strategies

The coal industry and FBI successfully lobbied to weaken the Clean Air Act. "It was indisputable that a lot of the concessions had been made in order to make the Bill palatable" (Ashby and Anderson 1981:114).

## *5.5 Destabilisation: The way to the four-fuel economy (1956-1967)*

### 5.5.1 Pressures in the economic environment

#### 5.5.1.1 Landscape

From the mid-1950s, Britain recovered its industrial capacity, and even produced in excess of demand in certain sectors. Post-war economic recovery continued untamed until the early 1970s, although growth rates were comparatively lower in Britain than in countries like France, Italy and West Germany.

#### 5.5.1.2 Markets and technical alternatives

After 1957, overall coal demand declined (Figure 5.2). Alternatives increasingly displaced coal in various market segments. Oil use tripled between 1960 and 1973, to nearly 50 million tons of coal equivalent (Fouquet and Pearson 1998), substituting for coal in gas works ('oil gas'), iron/steel and heavy industries and on the railways (Allen 1970) (Figure 5.12). Coal sales to power stations increased but represented a decreased percentage of the power fuel mix. Fuel oil was also used for the heating of commercial and industrial premises and (some) domestic heating. Nuclear energy, which came online in 1959, competed with coal in power generation. Between 1960 and 1965, about 20% of the commissioned power station capacity was nuclear (Ashworth 1986). Natural gas, discovered in the North Sea in the mid-1960s, began to replace coal gas in the late 1960s. Household coal use began to decline after the 1956 Clean Air Act, which enabled cities to create smokeless areas. By 1970, 5 million premises were covered by smoke control orders, leading to a rapid decline of smoke emissions (Figure 5.13). Bituminous coal initially lost ground to solid smokeless fuels and (some) fuel oil, and then to natural gas (Scarrow 1972).

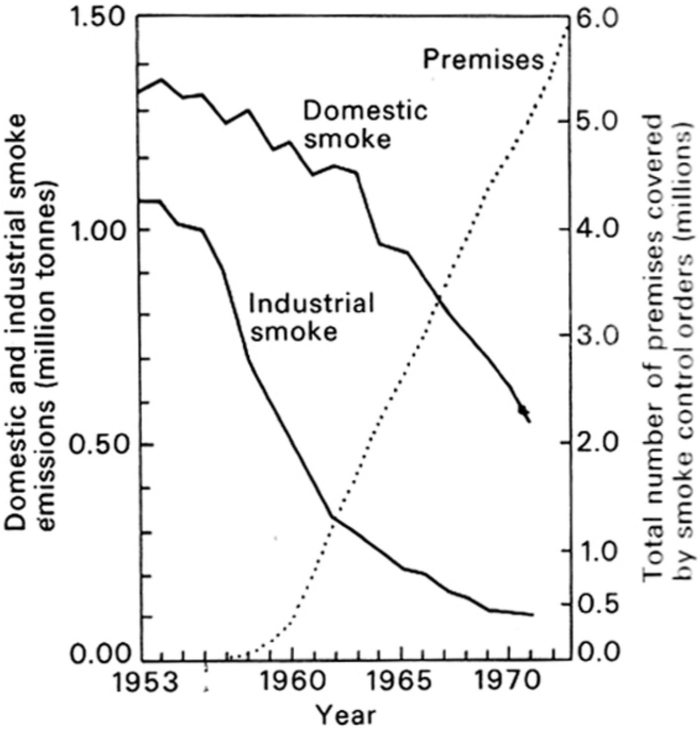


**Figure 5.13: Domestic and industrial smoke emissions (1953-1973) (Ashby and Anderson 1981:118)**

The primary growth market for coal was electricity generation (Figure 5.14). Coke and solid smokeless fuels also formed growth markets until the late 1960s when natural gas began to substitute coal gas.[23]

[23] Coke was a by-product of coal gas production.

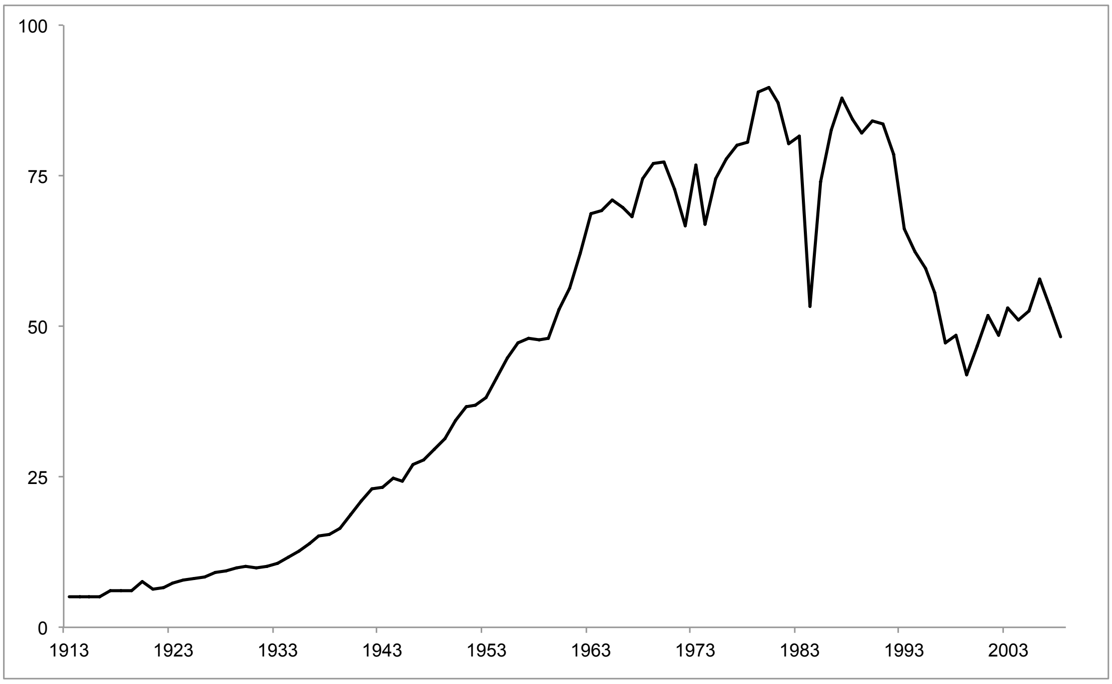


**Figure 5.14: Coal consumption by the power sector, million tonnes (Data: Fouquet 2008)**

### 5.5.2 Pressures in the socio-political environment

#### 5.5.2.1 Landscape

Concerns over British 'decline' and competitiveness became more prominent in public and political discourse from the mid-1950s, with rising frustration over the poor record of restructuring in British industries.

#### 5.5.2.2 Policy

In the late 1950s, macro-economic concerns over rising inflation, the international balance of payments and Britain's international competitive position formed the background for policy changes that increased pressure on the coal industry. With the creation of the Select Committee on the Coal industry (1957) the government increased the political scrutiny of the NCB (Ashworth 1986). The government wanted to downscale financial support for several reasons: a) macro-economic concerns and a desire to decrease government spending (Brown 2004), b) frustrations over escalating costs of the industry's modernisation plans (Ashworth 1986), c) positive expectations about nuclear energy. Coal policy subsequently changed from supporting expansion towards 'controlled rundown'. The Revised Plan for Coal (1959) focused investments on fewer mines and closed small and inefficient pits. A 1961 White Paper (Cmnd 1337) stipulated that nationalised industries should become self-supporting. This policy threatened the coal industry, which had experienced losses in the four preceding years

(Figure 5.17). The Conservative government therefore made some concessions, providing some ongoing protection through cheap loans, contracts for coal use in public buildings, contracts for power stations to restrict alternative fuel use, and an excise duty on fuel oil (introduced in 1961) (Allen 1970, Ashworth 1986). These protective measures were downscaled by the 1967 White Paper on Fuel Policy (Ministry of Power 1967), thus unleashing market forces on the coal industry. The White Paper institutionalized the shift towards a four-fuel economy, with decreasing shares for coal, and increasing shares for nuclear power, natural gas, and oil. This policy change was the result of increasing political enthusiasm about nuclear power and natural gas, accumulated frustration about slow mine modernisation and continued need for subsidies, and eroded cultural legitimacy ('outdated' and 'old-fashioned'). The reduction in coal production estimates (to 170-180 million tons in 1970) required "the most dramatic and ruthless contraction of the industry in post-war history" (Turner 1989:156, see also Figure 6.2). Although a declining coal industry was now seen as inevitable, policy makers were concerned about social and economic costs. To soften the impact, the government granted the coal industry long-term supply contracts for the electricity industry (NCB 1964), and wrote off almost half of its debts (£415 million).

#### 5.5.2.3 Labour relations

Labour relations soured in the late 1950s when the government became concerned about inflation, which it perceived to be linked to wage rises (Brown 2004). Throughout the 1960s, governments tried to persuade or coerce unions to moderate wage claims, creating a recurring source of tension.

#### 5.5.2.4 Public opinion

The wider public perceived coal as outdated and dirty, despite the reduction of smoke problems. The coal industry also lost its 'special status' as newer industries captured the public imagination. Figure 5.15 illustrates the relative loss of enthusiasm for coal in favour of alternatives: 'King coal' is pictured as being dethroned by 'King oil', itself under threat of 'Prince atom'.

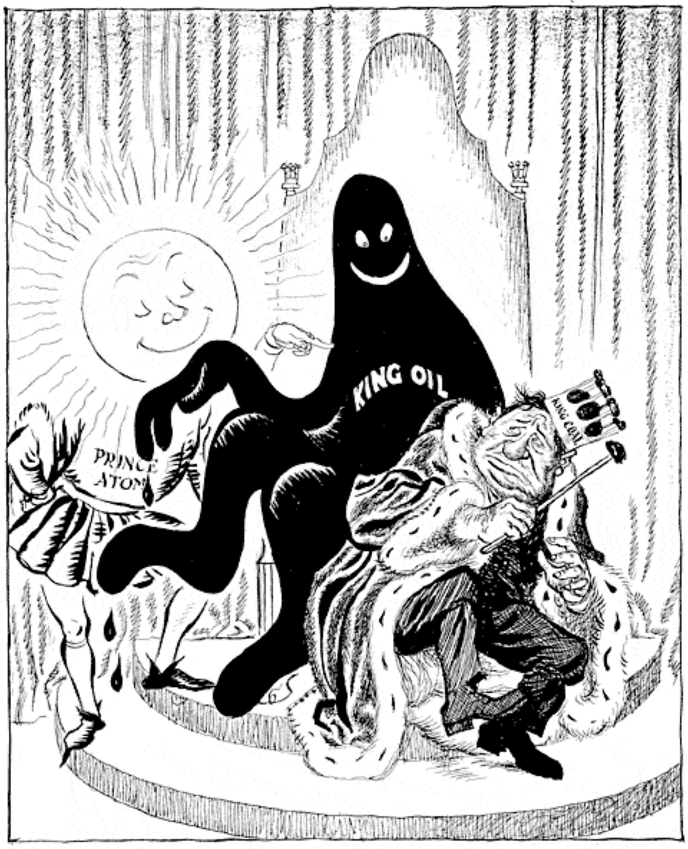


**Figure 5.15: King coal, King oil and Prince atom, *Daily Mail*, July 22, 1955.**

## *5.5.3 Industry strategies* – economic environment

### 5.5.3.1 Economic positioning strategies

In 1957, coal industry actors still believed in a bright future, expecting coal production to increase steadily to 250 million tons by 1970 (Figure 5.16). The easing of fuel shortages also contributed to industry confidence:

> "For the first time perhaps since the 1914 war, British Coal and every man in it can see clearly ahead to a future based on a secure and vital place in the national economy" (NCB 1957b:23).

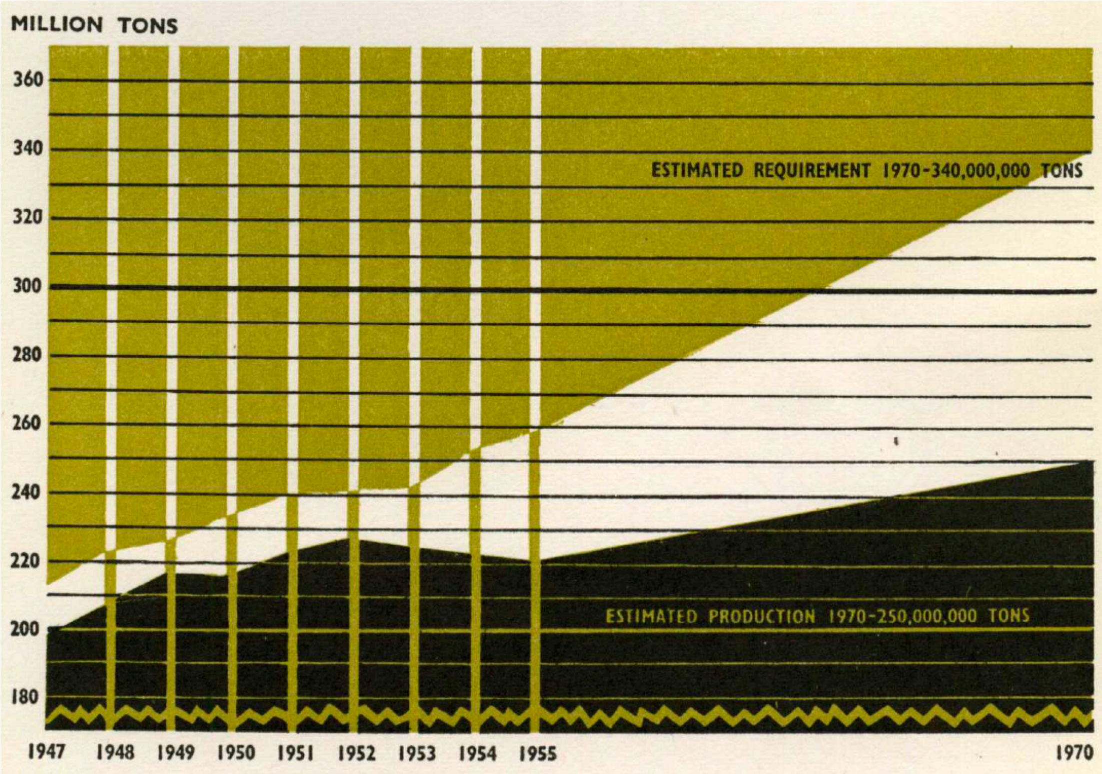


**Figure 5.16: Actual (until 1955) and estimated coal production and total energy consumption in coal equivalent (NCB 1957b:8)**[24]

The 1958 sales decline (of 13 million tons) was not interpreted as a structural development: “the period of recession in some British industries was a temporary setback in a long-term trend of industrial expansion” (NCB 1958:3).

But when declining markets accelerated financial losses in 1959 and 1960 (Figure 5.17), the industry became more concerned, adopting defensive strategic orientations:

> “The Board’s objective of a market for coal at around 200 million tons a year can be achieved by holding those markets where coal can effectively compete and by winning a share of the new business arising from future economic growth. Competition in the energy market is expected to remain fierce over the next few years” (NCB 1962:14-15).

---

[24] The left side of the figure (until 1955) represents actual data, while the right side presents a projection of current trends. The bottom area (in black) represents British coal production, while the white area (white) represents total energy demand in coal equivalent.

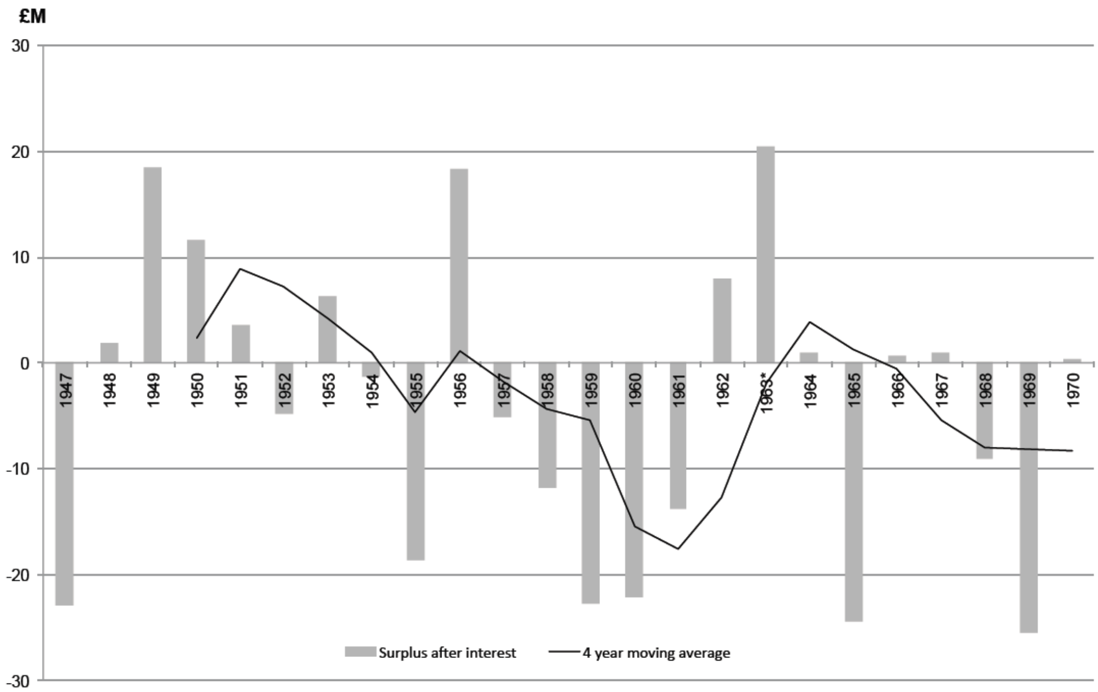


**Figure 5.17: Surplus after interest payment (£m, nominal value) (compiled from NCB annual reports)**

Concerns evolved into a loss of confidence, because of the 1967 White Paper, which projected rapid declines of coal.

> "The Government's White Paper "Fuel Policy" contained estimates that by 1970 the market for coal was unlikely to exceed 170-180 million tons a year. These estimates (…) led to a loss of confidence within the industry." (NCB 1965:xi)

Accelerated mine closures caused "cynicism and demoralisation in the mining industry" (Robens 1972:170).

#### 5.5.3.2 Innovation strategies

While the strategic orientation changed from confidence to loss of faith in a few years time, the industry transformed itself through various innovation strategies. The *Revised Plan for Coal* (1959) accelerated mine modernisation by improving mine layouts and tunnelling methods and enhancing the use of power-loaders. The combination of power-loaders, coal-cutters and conveyor belts transformed mining into an integrated continuous flow industry (Ashworth 1986). Productivity (output per manshift) increased substantially, from 1.25 tons in 1957, to 1.56 tons in 1962 and 2.1 tons in 1968 (Allen 1970, Figure 5.18). This improvement was also due to the closure of inefficient mines and focusing investment on fewer, more productive mines.

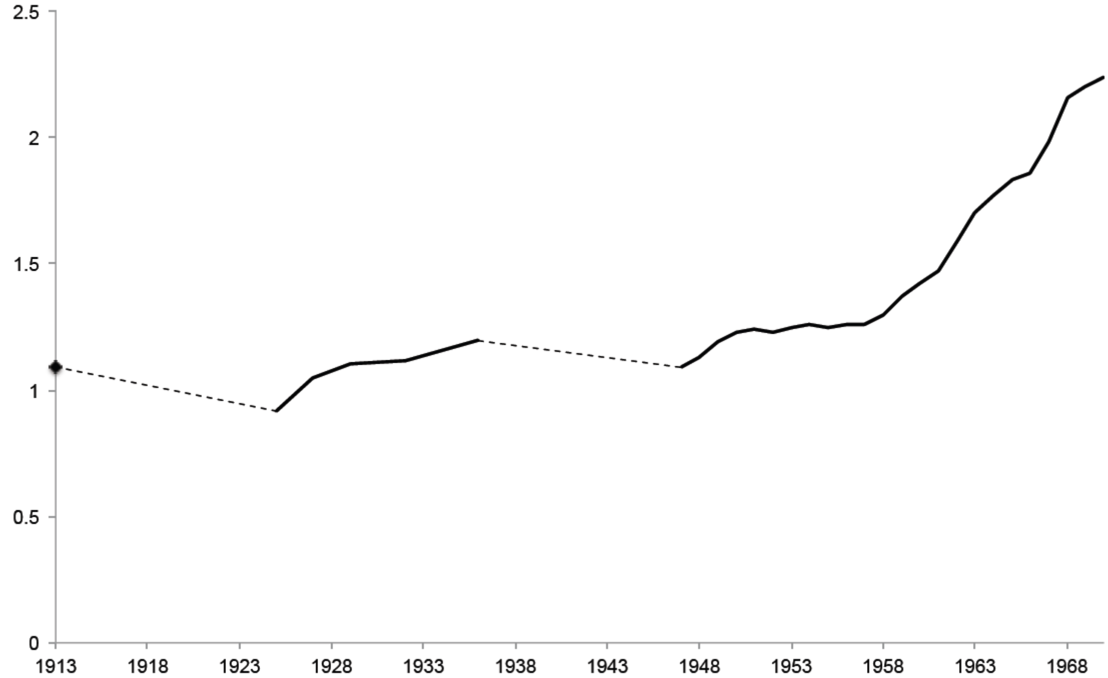


**Figure 5.18: Productivity in the British coal industry (Output per manshift in tonnes), dotted lines represent data gaps (Data: Buxton 1979, Ashworth 1986)**

To support the modernisation program, the industry created an integrated innovation system in which the newly-created Central Engineering Establishment (1956), which addressed *practical* developments and technology testing, interacted with CRE and MRE researchers, users, and equipment manufacturers (Ashworth 1986).

The industry also developed second-generation smokeless fuels, which could be used in existing appliances and grates (Ashworth 1986). Despite R&D successes, the coal industry failed to rapidly increase its smokeless fuel capacity. The NCB chairman blamed the government for not providing sufficient investments:

> "It was clear from our own experience as producers of smokeless fuels that a fantastic amount of capital would be needed to build smokeless fuel plants and that this would not be forthcoming" (Robens 1972:61).

The industry also collaborated with appliance manufacturers to improve domestic stoves and develop new central heating systems, which enabled it to move into new markets (central heating), where coal secured a lead position until the rise of natural gas in the late 1960s (Ashworth 1986). In some instances, the coal industry explored service-oriented business models such as "selling heat not fuel" (NCB 1967:23). More generally, marketing strategies began to pay more attention to the demand side, which the industry had long taken for granted. Accordingly, the NCB expanded sales services and advertising (NCB 1959).

### 5.5.4 Industry strategies – socio-political environment

#### 5.5.4.1 Political strategies

The coal industry employed political strategies to hinder the implementation of the Clean Air Act (Scarrow 1972). The industry also lobbied local councils and planning agencies to secure coal markets for individual electricity plants. “We widened our attack on other authorities and got the cooperation of people in the industry who served on local authorities to press our case, using briefs that we supplied to them” (Robens 1972:68). The NCB chairman also pushed to acquire planning permissions:

> “the [CEGB] were finding it difficult in the 1960s and onwards to get planning permission for new stations, and I weighed in to help them where a coal-fired station was involved. It was a mixture of propaganda and politics” (Robens 1972:66).

#### 5.5.4.2 Framing strategies

In response to negative public views, the industry tried to restore its reputation by engaging in public relations activities, e.g. the 'cosy coal fire' advertising campaign. It also framed coal and new appliances as ‘modern’:

> “One of the Board’s tasks is to make clear that coal – as distinct from some of the appliances in which it is still being burnt – is not “old-fashioned” (NCB 1960:7).

In 1960, the NCB launched the ‘progressive industry is going forward on coal’ campaign, which linked coal to modern industries (Figure 5.19).


**Figure 5.19: NCB advertisement in the 'Progressive industries' campaign (The Times, April 24, 1964)**

The early 1960s saw the rise of a critical discourse about the coal industry being featherbedded and protected, in response to which the industry developed a counter-discourse (Robens 1972), which argued that: (1) coal was the only indigenous fuel with proved long-term reserves; (2) the industry was a major employer, and rapid downscaling would have major social costs; (3) investments were beginning to boost productivity; and (4) phasing out coal was a waste of past investments.[25] This counter-discourse had little effect on the political debate. Following the 1967 White Paper, the industry could do little more than complain about "excessive national commitments to the development of natural gas and nuclear power" (NCB 1967:8) and make pleas for (some) ongoing support (via obligations and contracts).

---

[25] "Since 1947, £1,300 million have been invested in the coal industry (…) There is no national advantage to be gained from not using to the full the resources of an industry in which so much has been invested." (NCB 1964:5)

## 5.6 *Analysis*

### 5.6.1 External pressures

The case study shows that the coal industry experienced multiple pressures in economic and socio-political environments. Table 5.5 summarises the main pressures, and heuristically indicate how each pressure increased and decreased in strength for the various periods.[26]

**Table 5.5: External pressures for change on coal industry in economic and institutional environment (0/+ is weak pressure for change; + is moderate pressure; ++ is big pressure; - is stabilizing external pressure; -- is major stabilizing pressure)**

| | Shrinking markets | Changing markets and preferences | Technological competition | New entrants | Normative contestation | Public opinion and discourse | Political pressure |
|---|---|---|---|---|---|---|---|
| **1913-1930** | ++<br>especially export decline | | 0/+<br>coal gas and electricity in upper class households | ++<br>foreign competition in export markets | +<br>growing anti-smoke movement, alliance with alternatives | -<br>public support for coal (jobs and prosperity) | 0/+<br>Govt investigates industry problems; weak 1926 smoke regulations |
| **1930-1946** | +<br>export decline; home stagnation | +<br>new user preferences coupled to new cultural repertoires | 0/+<br>early competition from gas and electricity in specific markets | +<br>foreign competition in export markets | +<br>public education activities; alliance with alternatives | +<br>critical coal discourse but limited public concern about smoke | -<br>economic government protection (price control, cartel) |
| **1946-1956** | --<br>post-war market expansion | 0/+<br>growing interest in alternatives; dis-satisfaction with coal | +<br>competition from oil; plans for nuclear; diffusion of coal gas and electricity | 0/+<br>coal imports via NCB | +<br>Great London Fog boosts credibilty | ++<br>public outrage over Great London Fog | --<br>government support (nationalization and modernisation plans) |
| **1956-1967** | ++<br>declining markets; power generation is the industry's life line | ++<br>'Modern' consumers and industries switch to alternatives | ++<br>Nuclear energy, oil and (natural) gas | | | ++<br>coal is outdated'; coal industry seen as less attractive | ++<br>CAA; frustration with coal and more scrutiny; enthusiasm for alternatives; 1967 White Paper |

Some pressures existed almost continuously (e.g. from smoke abatement movements). Other pressures gradually increased (e.g. public opinion). Yet other pressures alternated between positive and negative orientations (e.g. market size, policy support). In the 1956-1967 period, most pressures increased, aligned, and created a 'perfect storm' that overwhelmed and destabilised the coal industry. This basic pattern only becomes visible, because I made a longitudinal analysis on multiple dimensions, which supports the general usefulness of the framework.

[26] This mean that the 'scoring' of pressure strength should only be read *within* columns, and cannot easily be compared *across* columns.

As a next step, I aim to draw conclusions about the relative significance of various pressures. In the economic environment, I suggest that *new entrants* only played a moderate role in the early periods. The most important pressures in causing full destabilisation were *technological competition* and *changing user preferences*, which translated into *shrinking coal markets*. In the institutional environment, I suggest that *pressure from social movements* had limited immediate effects on destabilisation. Despite decades of activities, smoke abatement organizations were moderately successful in influencing policies or public opinion (although they played some role in stimulating alternatives and articulating an anti-smoke discourse). More important pressure came from *changes in societal beliefs/discourses* and *changing government policies*. Especially the linkage of new cultural repertoires to households (modernity, cleanliness, smokelessness, convenience) undermined the cultural legitimacy of coal since the 1930s. *Political pressure* initially supported and protected the coal industry, but changed directionality in the last period, when policy makers became enthusiastic about alternatives, introduced strict anti-smoke regulations, and complained about the lack of coal's self-sufficiency.

But the analysis of individual pressures has limited explanatory power. I suggest that destabilisation is not just about the *relative* importance of single pressures, but also about their interactions between economic and socio-political environments. The next sub-section identifies the main interactions patterns.

### 5.6.2 Interaction between pressures

For this case, I draw the following conclusions about the relationship between economic and socio-political environment. I suggest that pressures in the economic environment were the *direct causes* of full destabilisation: changing user preferences, technological competition, and shrinking markets undermined the financial performance and economic viability of the coal industry. I further conclude that socio-political pressures were *mediating factors* that enhanced the vulnerability of the coal industry to economic pressures (when decreasing legitimacy eroded public acceptance and decreased political support in the late 1950s).

On a more *specific* level, I find many interaction mechanisms between pressures. For each period, except the first, I summarise these and graphically represent the interactions in a multi-dimensional characteristics space.[27]

***1914-1930.*** The main pressures came from declining export markets (due to foreign new entrants), strikes and domestic demand reduction (Figure 5.20). The first two pressures entered the political environment (leading to government inquiries and incidental subsidies). There was also some societal pressure from smoke activists, which *interacted* with proponents of the gas industry but achieved limited *interactions* to policy or public opinion. Direct pressure from coal-based alternatives (coal gas, electricity) was relatively small.

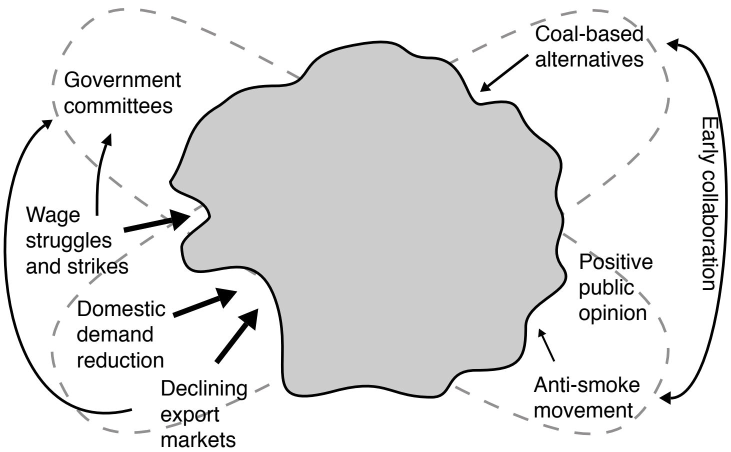


**Figure 5.20: Multi-dimensional pressures interactions (1914-1930)**

***1930-1946.*** The main pressures came from market problems, related to Great Depression and the loss of export markets (Figure 5.21). The economic problems entered the political environment, leading to government protection that propped up the

[27] The graphic representation of pressure interaction is based on the TEF (see 3.2), with the exception that the industry regime has been left out. The grey surface represents the industry (with a rough indication of its size, pressure fronts impinging on its shape, and protective measures as a thick line tangent to its boundaries). It is embedded in economic and socio-political environments in which pressures are exerted. Pressures are represented by arrows directed at the industry (thickness roughly indicating intensity), interactions are represented by arrows not directed at the industry, the alignment of pressures is indicated by their joint location on a single industry front. Broader secular trends (referred to as 'landscape developments' in the transitions literature) are represented outside the industry environments.

industry (e.g. cartel and price regulations). There was also some weakening of coal's cultural legitimacy, because the anti-smoke movement, gas industry, and electricity industry *collaborated* in translating new cultural repertoires into a negative coal discourse and positive visions about gas and electricity. These visions were translated into user preferences in the economic environment.

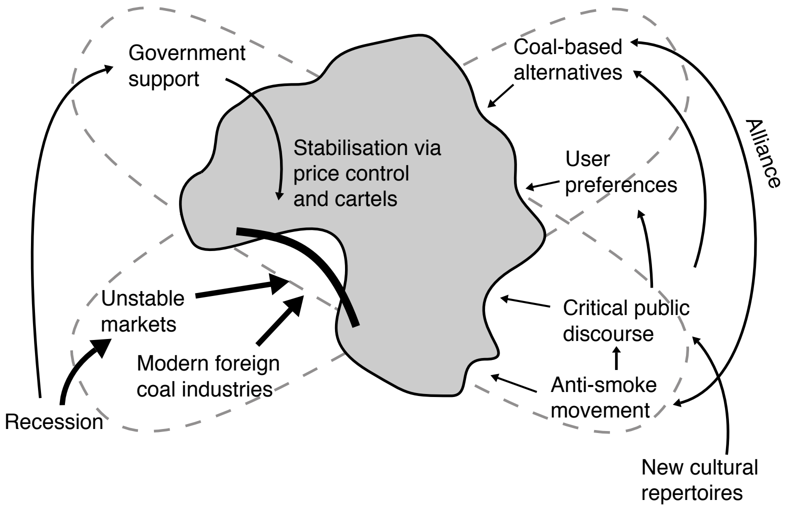


**Figure 5.21: Multi-dimensional pressures interactions (1930-1946)**

***1946-1956.*** Expanding coal markets and government support for modernization programmes created positive pressure (Figure 5.22). The government also modulated pressures from gas and electricity industries (which were also nationalized). Substantial negative pressure came from the socio-cultural environment, where the Great London Smog caused public outrage that damaged the cultural legitimacy of coal and put pressure on to policy makers. The negative views on coal also affected user preferences, thus entering the market environment.

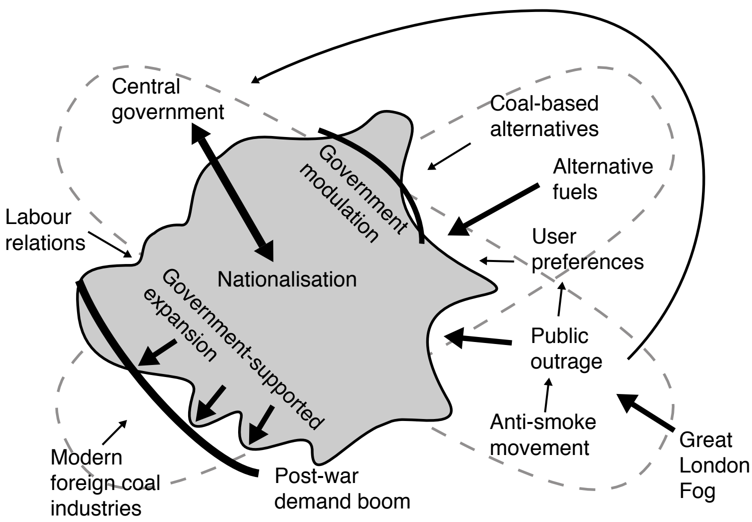


**Figure 5.22: Multi-dimensional pressures interactions (1946-56)**

***1956-1967.*** Strong and negative pressures came from multiple sides (Figure 5.23). Firstly, societal pressure led to the Clean Air Act, which put pressure on household coal markets. Secondly, the CAA was feasible because technical alternatives were sufficiently developed. Thirdly, macro-economic concerns affected policy makers who increased their scrutiny of the NCB and initiated a managed rundown by downscaling support. But, policy makers also provided some protection (e.g. oil tax, contracts for electricity industry). Fourthly, public discourses about outdated coal were translated into consumer preferences, which stimulated alternatives.

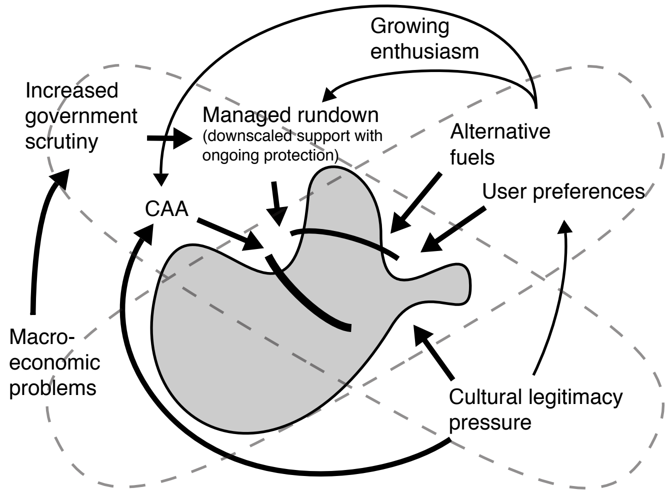


**Figure 5.23: Multi-dimensional pressures interactions (1956-1967)**

The 1967 White Paper removed protective measures and unleashed market forces from alternative fuels, causing full destabilisation. Politically secured contracts for electricity generation formed the industry's only lifeline (Figure 5.24). The 1967 policy, which changed the economic environment, was the outcome of several interacting developments: a) shifts in policy discourse (from 'strategic fuel' to 'self-supporting industry'), b) accumulated frustration about slow modernisation and continued need for subsidies, c) political enthusiasm for alternatives, which undermined coal's legitimacy, d) decreasing economic importance and political clout, e) eroded cultural legitimacy ('outdated' and 'old-fashioned' industry). The coal industry assumed a new form, which remained relatively stable for about a decade: a much smaller industry dedicated to a single market (power generation), which depended on institutionally supported contracts.

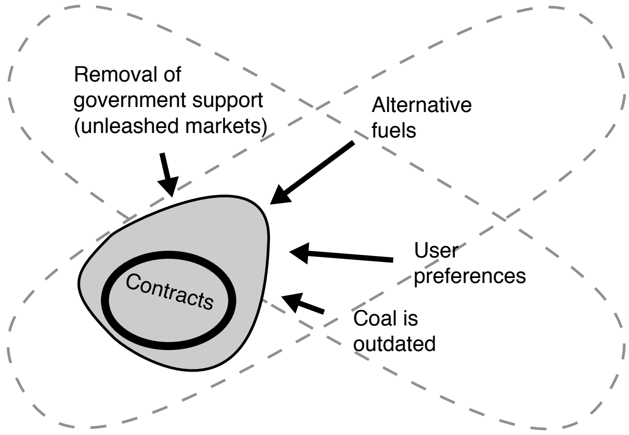


**Figure 5.24: New state after destabilisation (post-1967)**

This case thus shows how interactions between the analytically differentiated pressures are important, because they can increase the rate and intensity of destabilisation. I offer two further observations with regard to landscape mechanisms involved in alignments and interactions in this specific case.

**Shocks and extreme events can reinforce and align existing pressures.**

The Great London Smog, for instance, was interpreted as public outrage and added a sense of urgency to political debates about anti-smoke policies, which stimulated the (further) diffusion of alternatives. The smog event (as it became framed) accelerated this alignment because it could build on decades of preceding 'work' by smoke activists, new cultural discourses, and technological alternatives that had gathered momentum. *Extreme events can thus act as 'catalyst' for emergent pressure alignment*.

**Secular 'landscape' developments reinforced certain trends in economic and socio-political environments.**

The 1930s recession, for instance, reinforced market instability, which had already plagued the industry since the 1920s. Another example is that the emergence of new cultural repertoires (around modernity, cleanliness, smokelessness and convenience) reinforced the framing activities of the anti-smoke movement and the gas and electricity industries. The general professionalisation trend in the early 20$^{th}$ century also reinforced the rise of an anti-smoke movement as new professional groups aligned with smoke activists.

### 5.6.3 Endogenous enactment of regime destabilisation

To develop the role of agency in destabilisation, the case study not only described external pressures, but also multi-dimensional response strategies by the coal industry. Table 5.6 plots the main strategies for different periods (except the first).

**Table 5.6: Development of strategic orientations and specific strategies in coal industry**

| | **Socio-cultural framing strategies** | **Political strategies** | **Economic positioning strategies** | **Innovation strategies** |
|---|---|---|---|---|
| **1913-1930** | Influencing the smoke debate ('smoke means jobs', 'households are more polluting than industry') | Coal interest groups lobby against nationalization and smoke regulations | Cost competition via labour costs | Fuel efficiency improvements by coal-*using* industries |
| **1930-1946** | Attempts to restore public image ('coal is not old-fashioned') | Organized resistance against restructuring policies but acceptance of protective measures | - Cartels and price controls<br>- Slow changes in marketing, processing, cleaning<br>- Early diversification into smokeless fuel (but no real commitment) | Slow and piecemeal mechanization of mines |
| **1946-1956** | - Recognition of smoke problem, but not responsibility ('problem is use of coal in old appliances')<br>- Raising and maintaining strategic profile of coal industry | - Stable relationship with government, but frustration on pricing policies<br>- Lobbying to weaken the CAA | - Focus on increasing output<br>- Expansion in familiar markets<br>- Diversification into smokeless fuel, but capacity mis-management | - Modernization plan (but delays and high cost)<br>- Some creation of research facilities and R&D |
| **1956-1967** | - Public relations campaigns ('modern coal industry')<br>- Arguing for the strategic importance of coal | - Political strategies to secure coal-fired power plants<br>- Lobby for ongoing government support<br>- Lobbying against (local) CAA implementation | - Increasing dependence on electricity generation market<br>- Explore new markets (heating, appliance manufacturing, etc.)<br>- Users and services (consumer education) | - Full modernization of mining systems<br>- Expansion in smokeless fuel supply capacity<br>- Creation of an innovation system (RD&D and user feedback) |

In chapter 3, I proposed that the commitment to industry regimes decreases along a five-stage pattern. The case study matches this pattern quite well, but also shows some deviations. It suggests that the coal industry was unable to overcome the inertia of the industry regime in a timely fashion, despite pressure accumulation. In the different periods, the industry was not very pro-active in terms of foreseeing or preparing for possible future changes.

***1880-1914***. The industry responded to pressure from smoke activists by *denying* and *downplaying* the problem, using *framing strategies* to focus attention on the positive aspects of coal. This strategy was relatively successful, because smoke activists had limited power and credibility. Economic problems hardly existed at the industry level.

***1914-1930***. Major economic problems caused economic turbulence (bankruptcies, mine closures), but did not lead to substantial changes in the institutional logics or governance system. The industry implemented some incremental changes (coal cutters) that stayed within the bounds of the existing regime. Recommendations from government committees about the need for coordinated amalgamation and modernization were not implemented. The industry downplayed smoke problems with political and framing strategies.

***1930-1946***. Economic problems continued in the Depression years. But industry actors did not adopt comprehensive innovation strategies to close productivity gaps with foreign mines. Instead, they implemented piecemeal mechanisation (and diversified somewhat into new products such as smokeless fuels). Industry actors remained committed to the institutional logics of the existing regime: a) the industry's mission and identity remained those of the Age of Coal (a supply-side oriented extraction industry); b) the core belief system was that Britain was built on coal in the past and would remain so in the future; c) technical operations remained relatively labour-intensive and craft-based (mechanisation was piecemeal). Major changes *did* occur in the governance dimension of the industry regime: the 1930 Coal Mines Act provided protection against economic pressures (and arguably allowed the other regime elements to remain relatively unchanged).

***1946-1956***. Industry governance changed again with the 1946 nationalisation. Together with expanding markets this created new confidence in the industry. This reinforced the dominant belief that coal would remain the primary fuel and that alternatives would (temporarily) fill supply gaps in particular market segments. This belief led the industry to underestimate the threat from alternatives and ignore structural problems (slow mechanisation, low productivity, weak international competitiveness). The Plan for Coal (1950) signalled an ambition to change technical capabilities (mechanisation and modernisation of mines), but lacked urgency in its implementation. Commitment and investments in diversification (smokeless fuels) were also limited, leaving the industry unprepared for the CAA. Using Tushman and Romanelli's (1985) distinction, the strategy was more 'reorientation' (some change in strategy and technology) than 're-creation', since core beliefs and mission/identity remained unchanged.

***1956-1967***. The commitment to the regime's institutional logics collapsed in the late 1950s and early 1960s, when increasing and aligning pressures caused financial and legitimacy problems (which translated into downscaled support). Because the industry was relatively unprepared, these problems caused a *sense of crisis*, leading to various change programmes (the Revised Plan for Coal, advertising campaigns on progressive industries, and a frantic struggle for markets). The 1967 White Paper destroyed the industry's hope of restoring coal markets, leading the NCB to talk about *loss of confidence and demoralisation*. Subsequently, industry actors drastically recreated institutional logics of the industry regime: a) industry beliefs changed, recognising the threat from alternatives and accepting that coal was only one fuel amongst others, that it could not take customers for granted, and that the electricity industry increasingly formed its lifeline; b) mission and identity changed to encompass both supply *and* demand-side issues (as visible in increased attention for fuel consultancy, appliances, central heating, district heating and energy services); c) in terms of technology, the industry modernized the remaining mines, accelerated smokeless fuels processing, and created an integrated innovation system. These changes had characteristics of a crash program when the damage had already been done in terms of cultural legitimacy, competitiveness and political protection. Nevertheless, the changes improved productivity and restored some legitimacy, which halted further decline in the 1970s.

### 5.6.4 Destabilisation pattern

Some deviation from the predicted five-stage pattern occurred in the third stage. While the theoretical pattern predicts that increasing problems lead to early doubts in the regime's viability, this did not happen in the case. Although there were some minor concerns in the 1950s, the coal industry was generally confident and made optimistic market forecasts. The reason for this mismatch is that the theoretical pattern assumes gradually increasing pressures, whereas real pressures may also decrease (see Table 6). A deviation in the fourth phase is that the industry implemented some reorientation in mining operations (1950 Plan for Coal), but only limitedly diversified in terms of products (limited coke production). A deviation in the fifth phase is that it contained both 'reorientation' (the 1959 Plan for Coal and enhanced coke production) and more drastic 're-creation', which happened rapidly after the 1967 White Paper led to a sense of crisis and loss of faith. So, the boundaries between the five stages and underlying mechanisms are less clear-cut in the case than in the theoretical pattern.

The coal industry was unable to overcome the inertia sustained by commitment to the industry regime in a timely fashion, despite the accumulation of pressures. The industry was not very pro-active in terms of foreseeing or preparing for possible future changes. In particular, the industry did not recognize that the post-war boom was an exceptional time, which did not signal 'real' revival (since many underlying weaknesses remained unsolved). So, when multiple external pressures increased and aligned, the industry was relatively unprepared and destabilised within 8 years (1959-1967). The (more minor) countervailing attempt at 're-creation' of the industry in the 1960s had characteristics of a crash program when the damage had already been done in terms of cultural legitimacy, competitiveness and political protection. Nevertheless, industry 're-creation' improved efficiency and restored some legitimacy in its last remaining market, and halted further overall decline in the 1970s.

# 6 Case 2: The destabilisation and decline of British deep coal mining (1967-1997)

In this second chapter of the destabilisation of the British deep mining coal industry (1967-1997), I focus specifically on the relationship between the British coal industry and the electricity supply industry (ESI). Indeed, the earlier major contraction phase (1913-1967) has brought the (reduced) British coal industry to a new state of relative stability (see Turnheim and Geels 2011). In the 1960s, the industry saw power generation as its main growth market, and pursued a specialisation strategy. A 'coal-electricity' complex thus emerged from the first phase of contraction (1957-67).
This second destabilisation period (1967-1997) is strongly related to a weakening of the relationship. Coal input to electricity grew from 30 mtoe in 1960, to 50 mtoe in 1980 (see Figure 6.1). However, competition with international coal, alternative fuels, the acid rain controversy, 'chronic inefficiency', and polarised industrial relations put pressure on coal-fired power generation. While coal had represented over 80% of the fuel input to electricity generation in the early 1960s, this figure dropped below 60% from 1992, and plunged under 40% from 1997, a large proportion of which then came from abroad (see Figure 6.23). The case study traces how British coal lost its hegemony in its last growth market, and how it managed the consequences. The coal-power complex has given way to a liberalised electricity industry favouring low costs and fuel diversity. In the event, the British coal industry shrunk dramatically (see Figure 6.2).

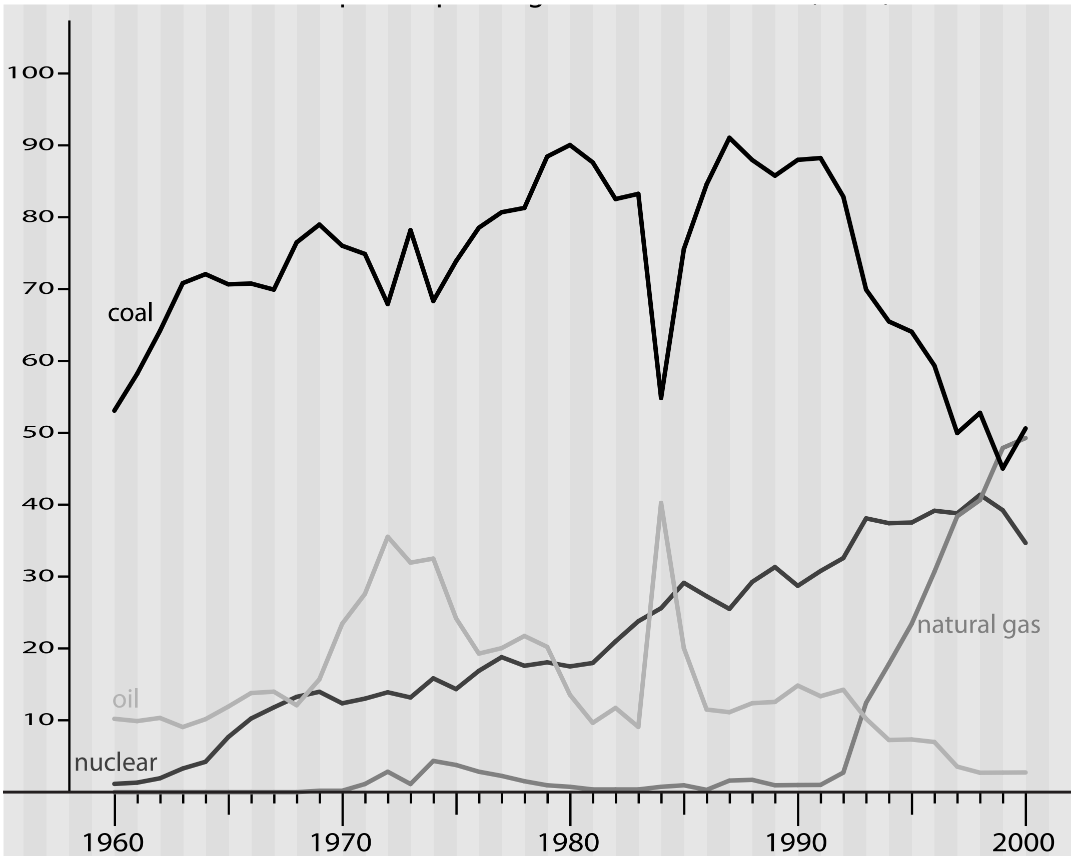


**Figure 6.1: Fuel input to power generation in the UK 1960-2000 (mtce)**

To divide the longitudinal case into several periods, I focused on changes in the external environments with lasting effects. I start in 1967, which marks a new era for energy policy in the UK, with a downgraded role for coal. The second period (1973-1981) starts with the oil crisis, which deeply affected the positioning of various fuels, and ends with the long-term instalment of the neo-liberal ideology. I chose 1981 rather than Thatcher's election (1979), because it took a number of years for the new Conservative government to gain credibility and strengthen its line. The next period (1981-1990) is marked by strong political influence over the coal industry's restructuring. The last period (1990-1997) begins with the liberalisation of the electricity industry with dire consequences for the British deep mining coal industry.

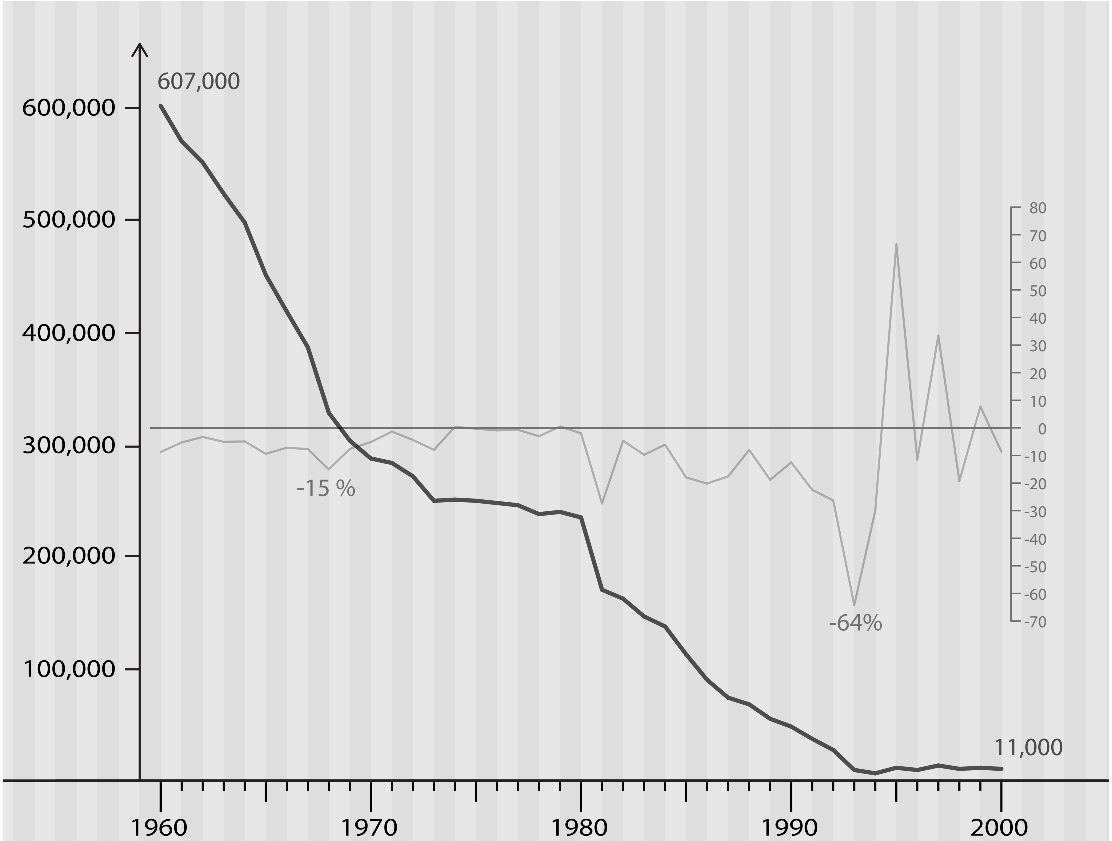


**Figure 6.2: Employment in British mines (number of miners, black line), and annual growth (percentage, grey line) (Data: DECC 2008a)**

## *6.1 1967-1973: Coal-fired capacity expansion and mining erosion*

The British deep mining coal industry had become in the 1960s a much smaller industry – total inland consumption had fallen from 221 million tons in 1956 to 122 million tons in 1972. The 1967 White Paper on Fuel Policy (Ministry of Power 1967) signalled coal's diminished role in society, as policy makers embraced the contribution of alternatives such as nuclear power and oil. In symbolic terms, "coal was widely regarded as the has-been fuel" (Smil 2003:229). However, the coal industry had also implemented a modernisation and innovation programme, which delivered a more productive industry with high mechanisation rates (see chapter 5). In terms of markets, the industry accepted that coal would be only one fuel amongst others, that it could not take customers for granted, and that the electricity industry increasingly formed its lifeline. So, it was believed that a smaller modernised coal industry could survive.

### 6.1.1 Pressures in economic environment

#### 6.1.1.1 Landscape

Britain experienced a process of 'deindustrialisation' and relative industrial decline from the 1960s. This created an uncertain climate for energy industries. While traditional sectors were declining, depressing the general demand for coal, there was a great deal of political enthusiasm for new energy sources, large publicly funded civil technological projects, and research in general.

#### 6.1.1.2 Markets

During the 1960s, the industrial and domestic markets accelerated their shift away from coal (see chapter 5). The power sector was the last sizeable expanding market for coal. The shift away from coal led to difficulties for the industry to mobilise resources for restructuring projects and capital investment, but also to cope with the social costs of closures. The industry, successfully implementing its rationalisation programme, had limited access to capital. This substantial financial pressure undermined the continuity of investments (Figure 6.3) – so crucial in an extractive industry.

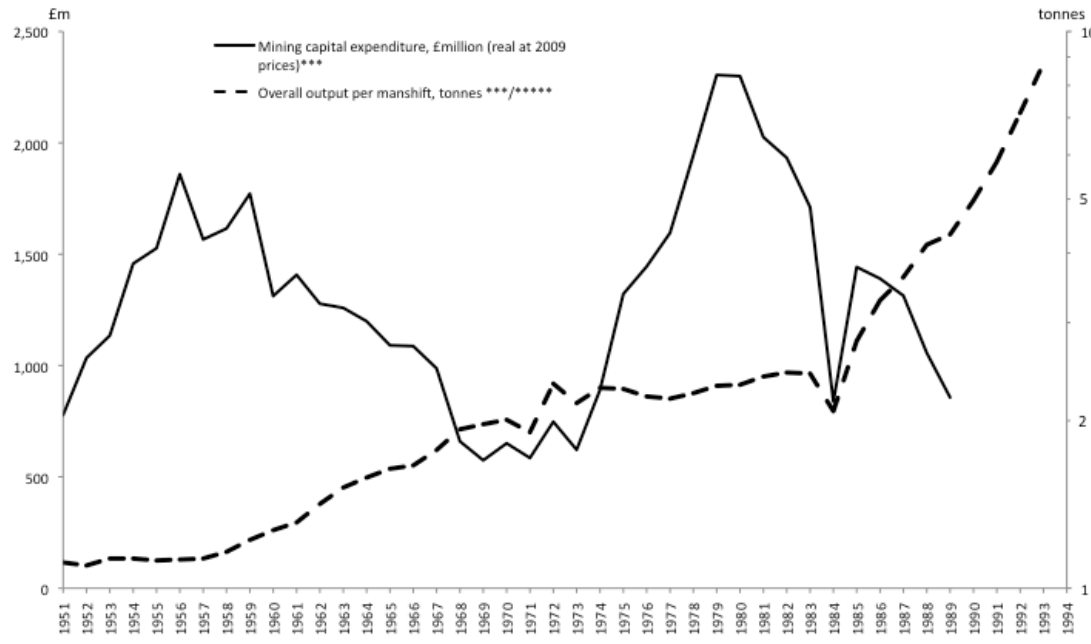


**Figure 6.3: Mining capital expenditure and productivity improvements in the British coal industry, Data: NCB Annual Reports[28]**

### 6.1.1.3 Customer relations

The electricity supply industry was the principal customer of the British coal industry. Figure 6.4 illustrates how the power sector grew until the early 1970s (see Lehtonen and Nye 2009). The coal industry geared its efforts towards this particular market. With the assistance of Government, it benefited from mutual agreements, and recent long-lasting infrastructure investments,[29] which provided a blanket of predictable long-term coal sales. In a way, the CEGB had become since the 1960s a tool of protection of the coal industry (Henney 1994).

---

[28] Average productivity improvements followed a noticeable increase throughout the period, which can be broken down into three main phases: rise (until 1972), stagnation (1973-1984), and rise (1985-1993).

[29] The standard lifetime of coal-fired power plant was then taken to be 30 to 40 years.

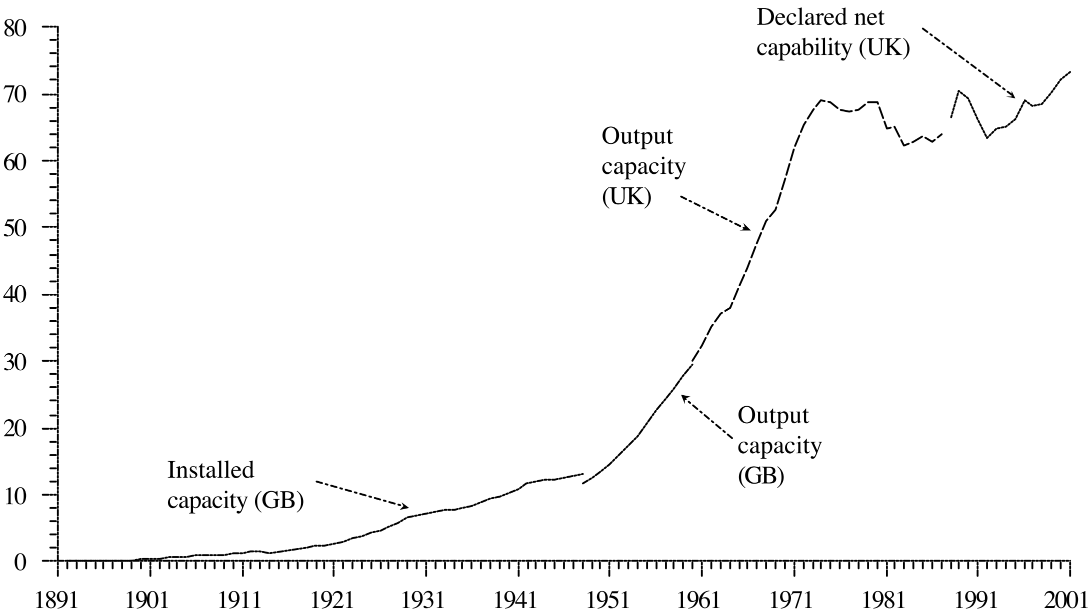


**Figure 6.4: Growth in UK generation capacity, GW (1891-2001), DTI (2002:20)**

Some early tensions within the coal-power complex grew out of CEGB frustration over the strong political intervention that characterised the sector. Political control of the electricity industry was particularly constraining, in three main ways: 1) price controls, 2) pressure to purchase coal of British origin, and 3) a requirement to purchase equipment from British suppliers, as well as some unnecessary plant investments (MacKerron 2001:531-32). The forced marriage of coal with electricity had secured a future for the NCB, but the CEGB perceived itself as the "captive purchaser of a single or largely preponderant basic fuel" (CEGB annual Report 1970-71 cited by Henney 1994:12), and was vulnerable to price increases, shortages and supply disruptions. These lasting inefficiencies, while insuring the NCB's future, contributed to the *erosion of customer relations*, and the search for lasting alternatives by an unsatisfied customer.

#### 6.1.1.4 Competition with alternatives

Coal's virtual monopoly in the power generation sector was being challenged (Figure 6.1). Coal's share of the electricity market had gradually eroded with the penetration of oil-fired generation in the 1950s, and then nuclear power in the early 1960s. Its virtual monopoly of 95% fuel input to power generation in 1956 subsequently decreased to 80% in 1960, and was as low as 56% in 1972.[30] Oil was a serious competitor that had

---

[30] 1972 and 1974 were exceptional years due to major strikes in the coal industry, reducing available output of coal for power generation, as is apparent from Figure 6.1.

already taken coal over for many industrial processes (iron and steel, gas, etc.), and had entered the power generation market. The post-war nuclear programme was delivering its increasing share as nuclear stations came on stream. The NCB noted a "considerable increase in the use of oil at power stations" (NCB 1970:18). Despite this trend, total coal sales to the power market grew from 53 Mtons in 1960 to 77 Mtons in 1969, and then stabilised (see Figure 6.1). So, the coal industry actually managed to keep a foothold in the power generation market (Posner 1993).

### 6.1.2 Pressure in the socio-political environment

#### 6.1.2.1 Landscape

Britain was, in the late 1960s, still enjoying a relatively stable socio-political landscape, inherited from shared political goals and societal requirements of the post-war era (Pearce and Stewart, 1992:507). This macro-political regime stability showed signs of *erosion* from the late 1960s. There were concerns about public spending, as illustrated by Figure 6.5.

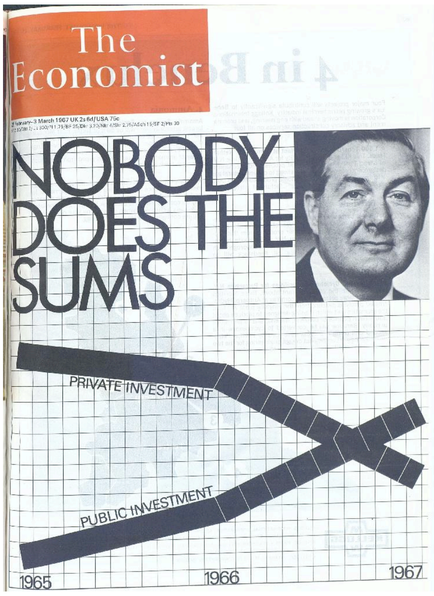


**Figure 6.5: Front page of *The Economist*, 25 February 1967, illustrating the projected investment figures with public expenditure on the rise, here linked to Callaghan's financial negligence.**

Rising inflation in the early 1970s led to macro-economic policy changes. Figure 6.6 illustrates the emerging worries and their sequence: rising inflation, rising employment, and the possibility of Sterling devaluation. These macro-economic landscape pressures were translated into counter-inflationist policies (pay rise caps, price controls, etc.). The resulting sentiment of injustice and austerity led to general workers' discontent, which was particularly important in the coal industry.

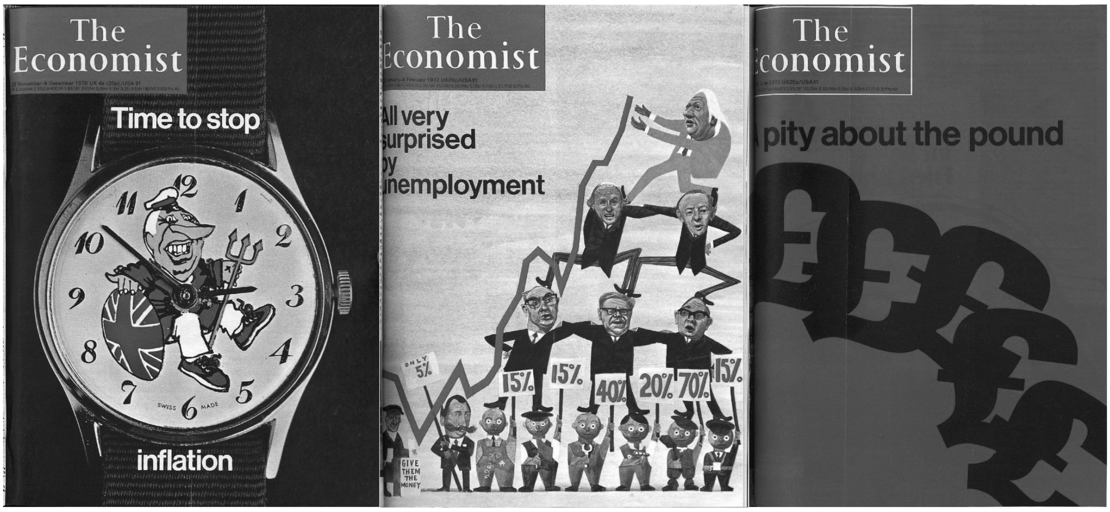


**Figure 6.6: Covers of *The Economist*, 28 November 1970, 29 January 1972, June 1972.**

### 6.1.2.2 Policy

The White Paper (1967) marked a turning point from post-war reconstruction and relatively lax spending rules. Infused with growing anxieties in economic policy (over British economic decline, vulnerability, and the need to control spending), the new fuel policy showcased a novel approach to policy formulation (Chapman 1999:20), based on 'science-based' principles, strict accounting procedures, guiding targets, and a general ambition to 'roll back the state' (see chapter 5). The White Paper set out the framework for a coordinated fuel policy, which provided official sanction for the view that the coal industry was entering a phase of contraction in light of the new status of oil. The NCB did not fully accept this view (see political strategies below).

A new approach to public policy was emerging, geared towards less public spending and a gradual disengagement of Government from business and industry. In a context of increased scrutiny and tighter financial rules within nationalised industries, new accounting methods were imposed. They sought to bring what were seen as over-protected, unhealthy, industries closer to the 'rules of the market' (see chapter 5). The direct consequence was reduced investment for the coal industry (Figure 6.3), and the acceleration of a major closure programme.

Simultaneously, the enthusiasm of the 1960s for large civil technological programmes disproportionately encouraged developments in nuclear energy, which took up most of the available political and financial support from the new fuel policy, to the detriment of investments in the coal industry. These dynamics relied heavily on competing expectations:

> "The early Magnox reactors seemed then to promise a future of increasingly cheap fuel, which (in the language of the time) would be based upon the developments of science rather than inhuman labour in the mines (…) drawing upon an increasingly optimistic view of economic change, technological development and social progress." (Beynon *et al.* 1999:1)

So, competing technological beliefs and expectations were translated into reduced commitments of financial and political support. This strain in the availability of essential support structures affected the long-term prospects of the coal industry.

#### 6.1.2.3 Labour relations

Rapid industry rationalisation led to mergers and mine closures in a considerable adaptation effort by the coal industry (NCB 1969:x). Between 1965 and 1970, the number of NCB mines and employment figures fell dramatically (Figure 6.2). Employment opportunities in other industries and miner redeployment schemes smoothened the social consequences. Labour relations were mostly non-conflictual until the end of the 1960s.

Rising inflation and unemployment in the early 1970s changed this picture. Industry decline and dramatic pit closures led to growing distance between management and workers (Turner 1989). The National Union of Mineworkers (NUM) responded with discontent to pay-rise caps. Anti-capitalist forces grew within the union. The miners went on national strike for higher wages in January 1972 (Figure 6.7). Reduced coal supplies had a severe effect on the country and the Government's perceived ability to run it, forcing it to call the 'state of emergency' in February. The Wilberforce Committee of Enquiry looked into the miners' claims, making the case for a 'special treatment' of the miners, thus putting an end to the crisis. The 1972 strike had a substantial impact on the coal industry's yearly results – estimated at around £150 million (NCB 1972:4) – hence illustrating the potential of labour conflicts to influence the industry's economic environment.


**Figure 6.7: Photograph of miners' rally in Trafalgar Square, 1972, Papers of Clive Jenkins, Modern Records Centre, University of Warwick; MSS.79/6/CJ/3/44.**

### 6.1.2.4 Environmental problems

The coal industry had long been facing the coal smoke problem, which was substantially addressed (Thorsheim 2006; see chapter 5). In the 1970s, a new kind of environmental problem emerged: acid rain and long-range transboundary air pollution. Acid rain entered the British air pollution discursive space in 1972 with the UN Conference on Human Environment held in Stockholm (Hajer 1995), where the problem of ground-level acidification from airborne pollutants was put on the agenda. Acidification was originally controversial and met scepticism from scientists and policy-makers. The problem entailed new scientific and political complexities. Indeed, acidifying air pollutants travel great distances before being deposited, which meant that the sulphur and nitrogen emitted in the UK could end up acidifying the lakes and forests of Nordic countries. Acid rain "challenged jurisdictional borders of the nation-state but also social and cultural boundaries, not least the one between science and policy" (Sundqvist *et al.* 2002).

## 6.1.3 Industry strategies – economic environment

### 6.1.3.1 Economic positioning strategy

Under significant pressure in most market segments, the NCB sensed its virtual dependence on the growth of the electricity market, and its share in it. Figure 6.8 illustrates its gradual *market specialisation*. However, as the CEGB was reducing its exclusive reliance on coal, maintaining its market share became a strategic priority of the NCB:

> "We [at the NCB] were relying absolutely upon an increase in requirements from the power stations to keep our pits open, or at least to prevent them from closing more quickly. We therefore had to fight oil and nuclear power – our rivals for this business – with every weapon that we could command." (Robens 1972:66)

The NCB developed two main *strategies* directed at power generation: 1) political bargaining for new power plant and contracts to secure long-term markets (NCB 1968), and 2) research and collaboration with power equipment suppliers to improve coal-fired plant and insure coal's future position.

Over 30 GW of additional installed coal-fired capacity had been built between 1960 and 1975. However, power plant commissioning receded in the mid-1960s. The Drax power station was the only coal-fired power station to be approved between 1964 and 1971 (Robens 1972:72).


**Figure 6.8: Coal industry specialisation: power generation's share of the UK market for coal (%), (Data: DECC 2008a)**

### 6.1.3.2 Restructuring strategies

The financial and market constraints of the coal industry led to dramatic contraction (Turner 1989:156), entailing 200 closures, and the loss of 149,000 jobs between 1965 and 1969 (see Figure 6.2). The coal industry came out of this process in much better economic shape, believing that output and employment would stabilise (NCB 1970; NCB 1971). Productivity was improved year on year, especially in the late 1960s (Figure 6.3), thanks to the mechanisation of coal-winning, large projects coming on stream, and closures and mergers (increase in size, and concentration in best regions) (WOCOL 1980:401). By 1971, the NCB claimed that 88% of all its coalfaces were mechanised, that 92% of output came from mechanised coalfaces, and that overall productivity neared 2 tonnes per manshift (NCB 1971). Major longwall faces were equipped with shearers, trepanners, rapid ploughs, slicers, power roof support, etc. (see Figure 6.9 and Figure 6.10). Much needed work concerned the improvement of the main power-loading equipment, as well as underground coal and miner transport (NCB 1972:49).

The industry's consolidation – under significant Government arm-twisting – provided a *hopeful outlook*:

> "Given the time for these policies [of industry consolidation] to fructify, the 1970's will see a strong and virile coal industry playing a major part in the national economy." (NCB 1969:6)
>
> "Despite the rapid contraction of past years, the industry is now in good shape and increasingly seen to offer a secure and promising future to recruits." (NCB 1971:6)

Lord Robens commented:

> "Both on price and security of supply [coal] is now well able to stand up to oil and nuclear power. (…) Coal has proved its staying power, and its value to the nation is now being tardily recognised. There's no friend like an old friend." (Robens 1972:87)

Opencast mining also gained strength under Lord Robens (Beynon *et al.* 2000:14), reaching 10 Mt in 1973 (Figure 6.23).

However, expansion strategies on the supply side and mining capacity were neglected. Mining expenditure was relatively low (see Figure 6.3), which jeopardised future production.[31] The declining investment in mining from the mid-1960s, reaching a low point in the early 1970s, was a consequence of tighter financial constraints and the relative *loss of enthusiasm* and attention from policy makers and the ESI, more attuned to the promises of nuclear energy. Competing technological aspirations, visions, and expectations had thus influenced the availability of political and financial support, thereby hindering future industry performance.

#### 6.1.3.3 Innovation strategies

The coal industry's R&D budget remained relatively stable over the 1960s, around £4 million annually (or £50 million at real 2009 prices) (NCB 1960-72). R&D was concentrated on productivity improvements and the diffusion of best-practice techniques (Surrey and Walker 1975:95), leading to high rates of coalface mechanisation. The Mining Research and Development Establishment (MRDE) was active in domains such as mining, tunnelling and underground transport. In the 1960s, the MRDE focussed on remote controlled operations and ROLF (remotely-operated longwall faces). These early experiments showcased an emerging vision of the "fundamentally more productive mining system" of the future. Research was looking

---

[31] Extractive industries are constrained by inevitable resource depletion, which means that a given mine has a tendency to decrease its yield as production increases. Capital injection must be sustained to maintain a stable production rate. Long lead times for pit sinking further complicate this problem.

into “the feasibility of extending systems for manless operation and remote control” (NCB 1972:47). ‘Retreat mining’ – which consists in tunnelling before face operation – was expected to reap further productivity improvements, along with heavy-duty machinery and mining systems.

Early *diversification strategies* were devised. The Coal Research Establishment (CRE) concentrated on coal utilisation. In line with the growing importance of the Electricity Supply Industry (ESI) for the coal industry, major projects concerned improved innovative burning techniques such as Fluidised Bed Combustion (FBC). Developments around new fuels from coal (by gasification and hydrogenation) were mentioned as a promising area for future research – one that the US were “vigorously” pursuing (NCB 1972:48). These *innovation efforts* were justified by exploratory motives with little strategic thinking about commercial exploitation or ‘market defence’ (interview Merrick).

The NCB also delved into non-coal activities. Notably, it engaged in oil and gas exploration in the North Sea. NCB (Exploration) Ltd had interests in the Viking gas field and a number of oil fields. Its shares were transferred to BNOC in 1973.


**Figure 6.9: Anderton Shearer (AB16) (available from http://coalmine.proboards.com, accessed May 12, 2010)**

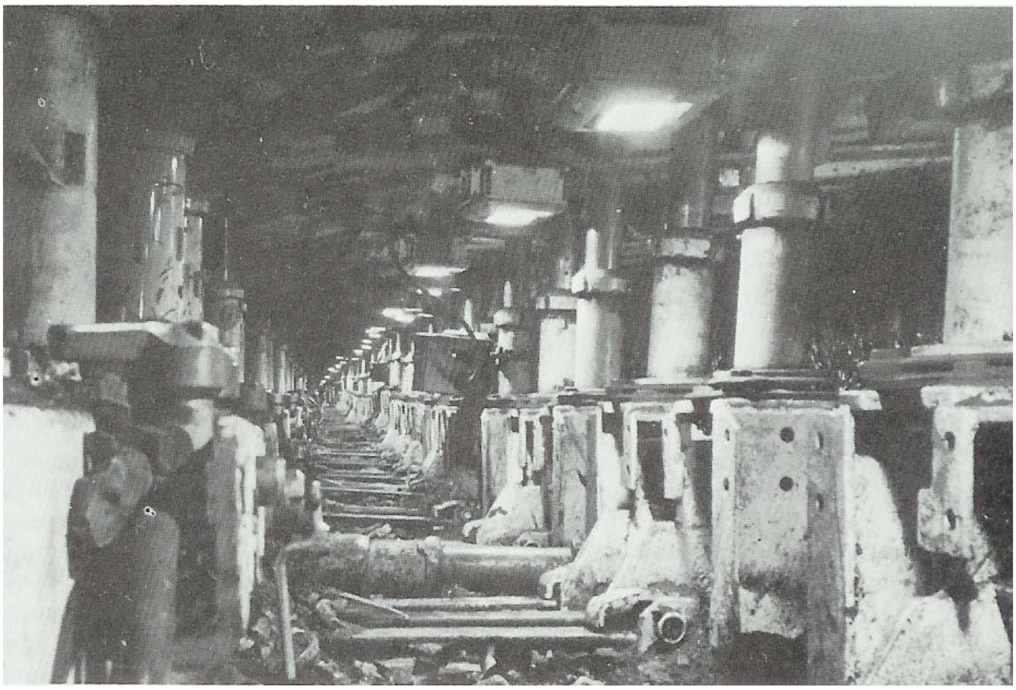

**Figure 6.10: Powered roof support, 1960s (available from http://coalmine.proboards.com, accessed May 12, 2010)**

## 6.1.4 Industry strategies – socio-political environment

### 6.1.4.1 Political strategies

Unwilling to accept a diminished role for the coal industry, the NCB repeatedly published statements that conflicted with the Government's plans, advocated a smoother transition by underlining uncertainties concerning alternatives, and the need to maintain confidence in the coal industry:

> "The Board are confident of being able to produce large tonnages of coal at competitive prices in the 1970's – much larger ones than envisaged in the White Paper." (NCB 1968:xi)

> "A more gradual development from a two-fuel to a four-fuel economy than that proposed in the White Paper would provide freedom to take account of future developments without commitment at the present time to excessively high capital investment programmes in North Sea gas and nuclear energy (…) There must now be a slowing down in the number of colliery closures so that confidence within the industry can be restored." (NCB 1969:5)

The NCB mobilised *political strategies* to underline the Government's responsibility for its difficulties, blamed the policy of cheap energy (NCB 1968; NCB 1970; Robens 1972), and sought Government financial assistance. To ensure that the industry's "continued decline would not be accompanied by undue hardships for the labour force" (Bailey 1974:153), the Coal Industry Act 1971 covered some of the social costs of colliery closure through social grants. Notwithstanding this concession, the

Government's attitude to the rundown had sown the seeds for bitterness and the hardening of the line to come in the next decades. Miner discontent in 1971-2 forced the Government and NCB to concede temporary 'special treatment' and to commit to wage increases.

### 6.1.4.2 Framing strategies

The British coal industry engaged in public discourse *framing strategies*. Anxious to restore the symbolic importance of coal, and to counterbalance the enthusiasm for alternative energy sources, the NCB advertised productivity improvements and claimed the merits of coal. The two main advertising slogans used in the late 1960s and 1970s were 'You can depend on Britain's new coal industry' and 'Coal – Britain's most important natural product' (see Figure 6.11).

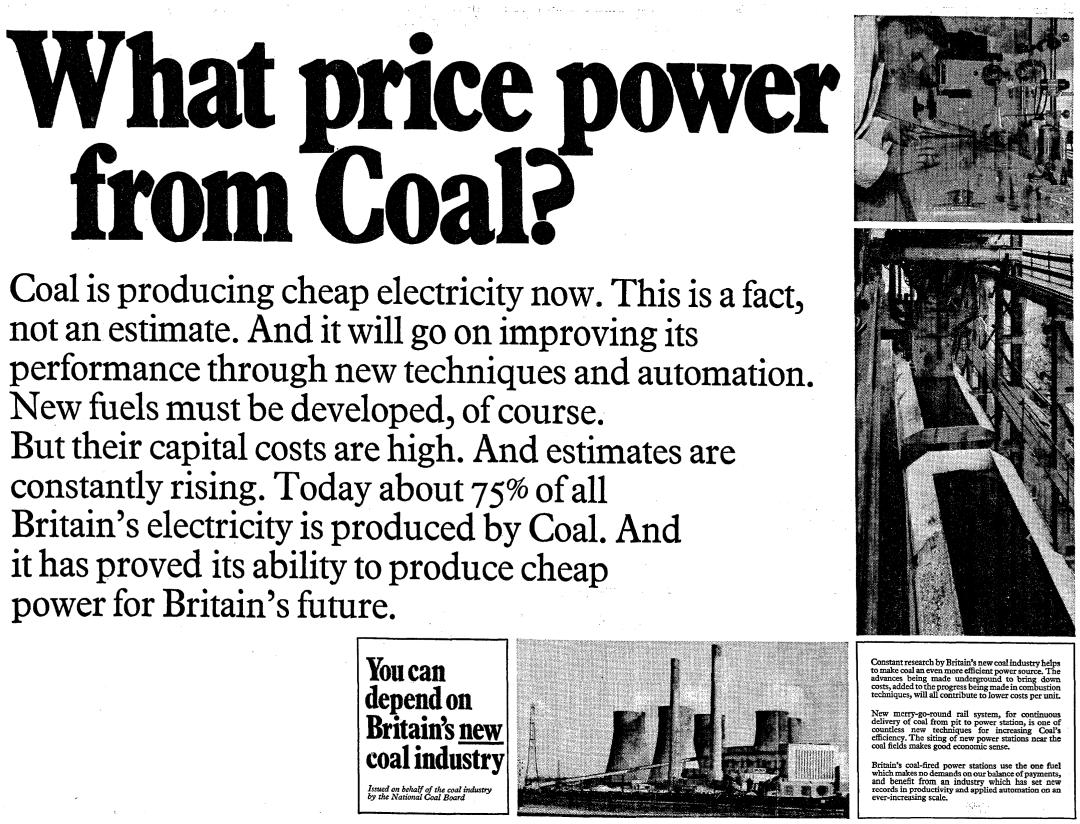


**Figure 6.11: NCB advertisement, *The Times*, 4 April, 1968, highlighting the competitiveness of coal for power generation under the new slogan 'You can depend on Britain's new coal industry'.**

The NCB also engaged in *framing strategies* in the face of the supply-side pressure resulting from reduced financial and political support. Government commitment to new fuels was a source of concern for the NCB, which wanted "to ensure that [competitively produced] coal is not excluded from its markets by excessive national commitments to the development of natural gas and nuclear power, on which the Board's reservations have been expressed" (NCB 1968:7-8) and sought to restore *political legitimacy*. The NCB needed the opportunity to continue substantially contributing to British energy supply. Nothing was less certain, however, as reminded by the then NCB chairman in his memoirs:

> "There was no scrap of evidence at any time that the CEGB wished to remain with coal: indeed, all the comparisons with nuclear power were weighted by them against the use of coal." (Robens 1972:72)

As acid rain had barely entered the British environmental discursive space, it was not perceived as an important threat to the British coal industry. The CEGB mobilised political and 'scientific' *framing strategies* in the early 1970s: it "dealt with the early complaints by talking-down the problem and querying evidence" (Rose 1990:117).

## *6.2 1973-1981: The climb back?*

### 6.2.1 Pressures in economic environment

#### 6.2.1.1 <u>Landscape shock</u>

The 1973 oil crisis had a tremendous impact on economies around the globe, and particularly on the UK, which did not yet produce oil. The hidden assumption of stable oil prices was suddenly wiped away (Figure 6.12) and radically changed the basis of competition between fuels. Uncertainty crippled energy markets. Coal became a serious economic proposition again overnight.

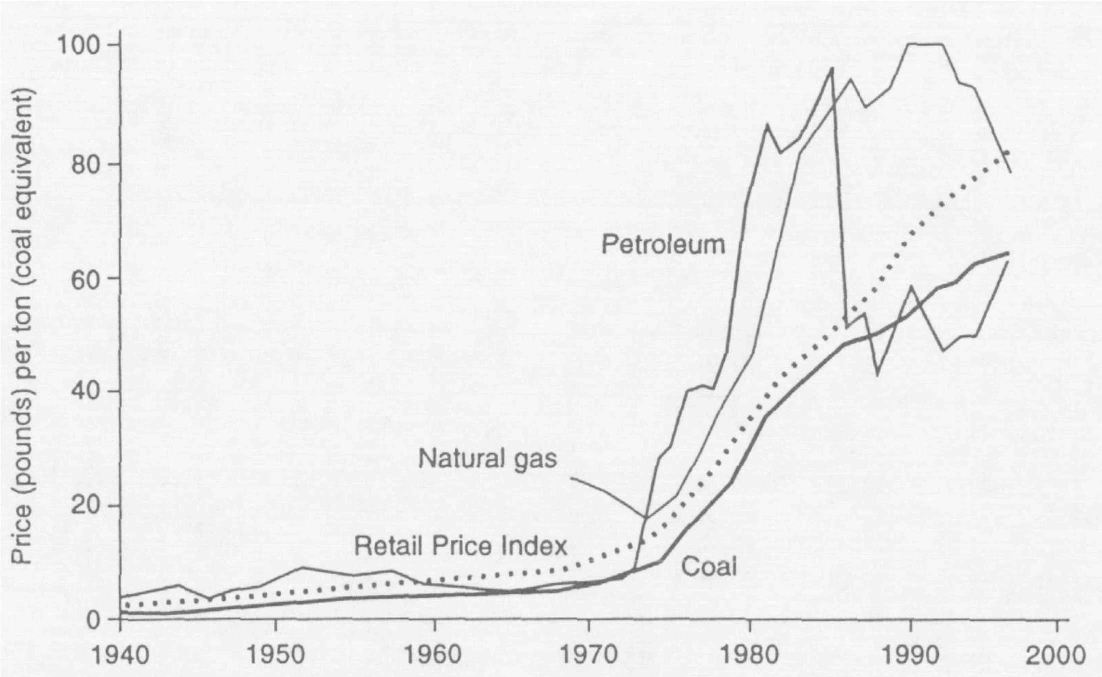


**Figure 6.12: Fuel prices, and retail price index in the UK (Fouquet and Pearson 1998:24)**

#### 6.2.1.2 Technological alternatives

The oil crisis had renewed interest in diverse energy options. The third nuclear programme promised a substantial expansion of nuclear capacity in 1974. However, controversy on cost, reactor choice, overestimated capacity requirements and societal contestation delayed the programme (Helm 2003:90-5). Nuclear power deteriorated its public reputation, but maintained a high degree of political support. Despite these hiccups, costly nuclear power generation steadily increased over the years and put pressure on the coal industry by diverting resources away from it.

Natural gas started flowing from the North Sea in the late 1960s. It competed strongly with coal, gradually replacing coal-gas and coal in most markets. Electricity was exempt from this trend, as the use of gas was still considered a ‘premium’ fuel and was reserved for other applications (Parker 2000).

Following the second oil shock, coal use at power stations reached an unprecedented level of 50 mtoe (nearly 90 million tons) in 1979 and 1980 to fill in for oil (Figure 6.1).

#### 6.2.1.3 New entrants

The oil shock triggered the diversification of large oil companies in the coal business. These large new entrants in the international coal market had the power to impose new rules: 1) price competition, and 2) new modes of production (opencast strip mining – borrowing from civil engineering) that were inherently more large-scale, faster to set up and cheaper. The 1970s and 1980s witnessed a revolution in coal mining, allowed by the timely conjunction of technological advances (in mining and in shipping) *and* the investment climate created by the oil price hike (Koerner *et al.* 1995:662). A *regime change* was occurring in the international coal business. New attitudes emerged: large-scale corporations acquiring mines in the USA, Australia, South Africa or Colombia were tailored for export, a successful strategy illustrated by a 50% increase in world hard coal exports between 1970 and 1980, and spectacular figures for South Africa and Australia (see Table 6.1). European coal markets were supplied through the ARA ports (Amsterdam-Rotterdam-Antwerp). In Britain, import restrictions restrained this pressure, but the "CEGB made frequent reference to ARA spot prices which contrasted sharply with those being offered by the NCB" (Beynon *et al.* 1999:5). It was recommended that the NCB include 'international productivity comparisons' in its annual reports (NCB 1979:5).

Opencast companies were becoming a growing sector. However, they were not perceived as a threat, but rather as a strategic means to meet short-term demand increases.

**Table 6.1: Hard coal exports 1970-1980, million tonnes, Source: Rutledge and Wright (1985:307)**

| | 1970 | 1980 | % increase |
|---|---|---|---|
| South Africa | 1.5 | 28.5 | 1800 |
| Australia | 17.9 | 42.8 | 139 |
| USA | 65.1 | 83.2 | 28 |
| Poland | 28.8 | 31.3 | 9 |
| West Germany | 15.9 | 12.7 | -20 |
| World | 169.3 | 257.3 | 52 |

#### 6.2.1.4 Customer pressure

The CEGB – the NCB's main customer – saw itself as the captive of a monopolistic supplier. It had been in the early 1970s opposed to any new coal-fired power station being built, but faced strong pressure from the NCB and Government. Its chairman condemned coal's likely expansion in power generation:

> "the board already has sufficient coal-fired capacity to burn all the indigenous coal likely to be available. New coal-fired capacity ordered now would increase the board's already heavy dependence on one fuel and deny it the flexibility that new oil plant would give to meet what must remain an uncertain future." (reported in *The Times*, 6 July 1973, front page)

The necessities of the oil crisis, and the successful search for support by the NCB had thus amplified CEGB discontent and frustration. Positive developments in the North Sea and related expectations nurtured CEGB emancipation prospects:

> "With discoveries being made almost weekly, the oil companies will have a very substantial amount of North Sea oil for the British market in the 1980's. The Central Electricity Generating board is known to be thinking of North Sea oil as a power station fuel as part of its policy of increased flexibility by reducing its overall dependence on coal." (*The Times*, 19 June 1974, p.17)

### 6.2.2 Pressures in socio-political environment

#### 6.2.2.1 <u>Landscape</u>

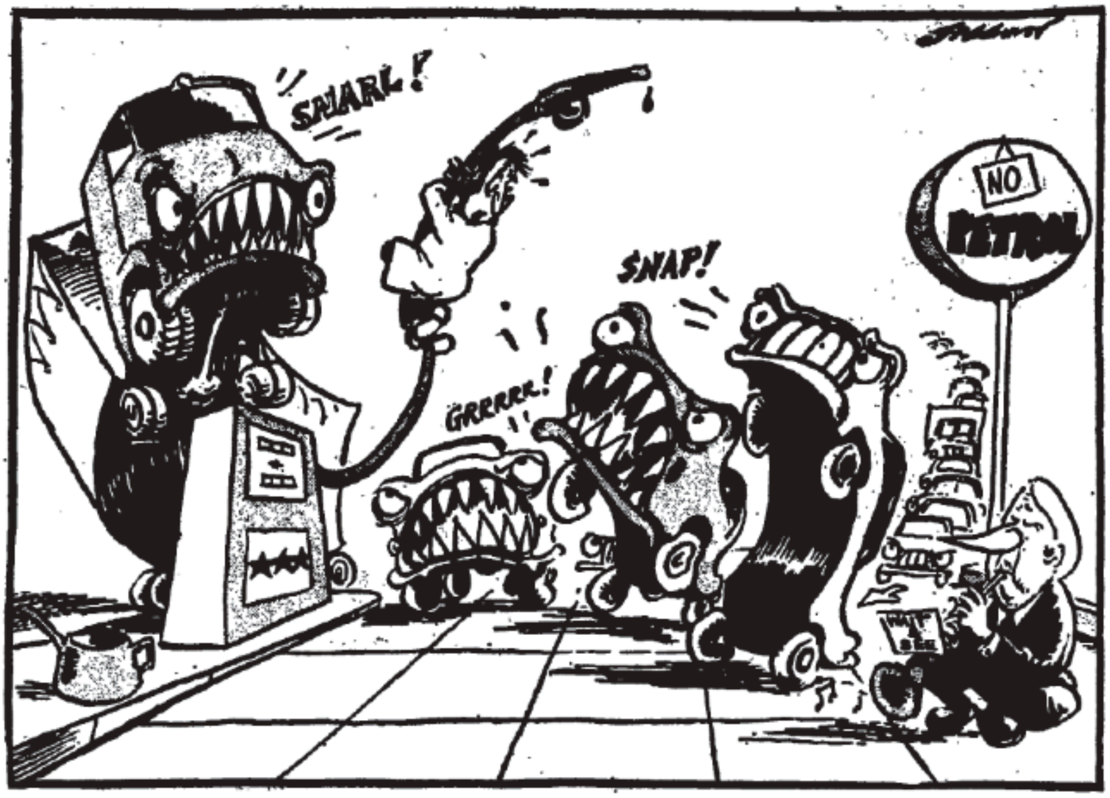


**Figure 6.13: Cartoon illustrating consumer anxieties over the oil crisis as angry drivers fight over petrol (*The Guardian*, 5 December 1973, p.1)**

'Energy shocks' disrupted energy supply and revealed dependencies. Sudden resource scarcity provoked widespread anxieties (see Figure 6.13). The combination of the miners' strikes and the oil crisis brought energy issues to the very top of public and political concerns. The 1970s became the years of energy, and 1973 the *turning point* of this shift in energy consciousness and mentalities.

Along with new anxieties came an interest in solutions. The enhanced symbolic and strategic position of energy justified the creation of the Department of Energy in

January 1974. Energy self-sufficiency programmes were developed. Energy issues reached unprecedented levels of media attention, public awareness and engagement. Figure 6.14 illustrates the high ranking of energy in social and political considerations, and Britain's confidence and pride in its energy ventures. The 1979 oil shock renewed the alarm around energy security. It confirmed the uncertainty of energy markets and strengthened the political case for self-sufficiency.

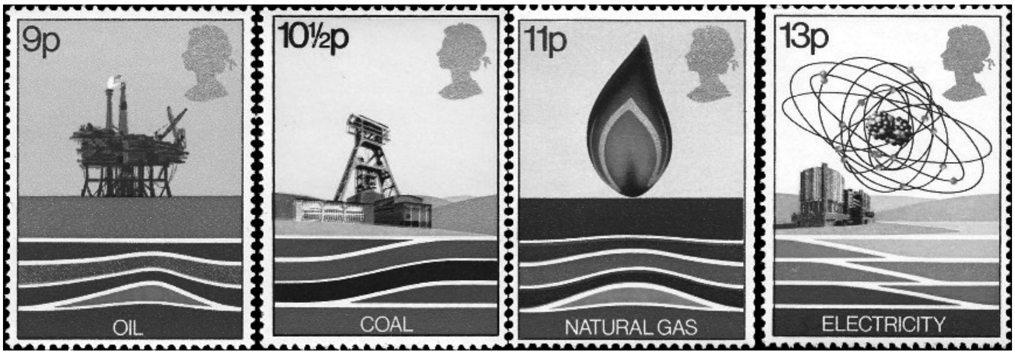


**Figure 6.14: Great Britain Energy Sources, stamp collection, Design: Peter Murdoch, 1978**

### 6.2.2.2 Labour relations

Miners took advantage of the energy crisis to formulate wage claims in 1973. The inability to reach agreement with the NCB led to an overtime ban in November. The strategic position of the miners was inflated by the serious threat they posed to electricity supply. Regular blackouts were endured. Indeed, the CEGB no longer had the option to compensate by burning more oil, and was experiencing delays and technical difficulties with its nuclear programme. Heath's Government, surrounded by multiple crises (Figure 6.15), called the state of emergency, petrol rationing, and a three-day work week to keep the lights on. The ensuing political crisis brought the Government down, and led to renewed commitment to coal and the miners (Hall 1981:222).

These events 1) established the disruptive potential of labour relations, 2) led to miner wage increases, adding to NCB costs (Chapman 1999:148), 3) reinforced the miners' position, and 4) revealed (and reinforced) pre-existing tensions. Older undertakings (characterised by traditional mining methods and the exhaustion of high-quality seams) experienced increased unemployment and harsh economic condition. Younger undertakings (having benefitted from recent investments and technological innovation) came out of the 1970s striking successfully for higher wages, and reassured about their strategic role in a climate of fuel anxiety (Beynon *et al.* 1999). These structural divisions were supplemented of a political dimension, which articulated the tension into a resistive discourse (interview Parker).


**Figure 6.15: Cartoon depicting Heath and his Chancellor surrounded by (energy) crises (*Daily Telegraph*, 19 Nov 1973)**

### 6.2.2.3 Policy and politics

In the new frame of energy policy, coal scored very high[32] and was portrayed as a quasi-unlimited indigenous fuel resource. The prospects for coal were seen with optimism, and "in 1974 both Westminster and Whitehall perceived a future for the coal industry" (Chapman 1999:154). This hopeful period has been labelled the "second coming of coal" (Hall 1981), the "renaissance for the industry" (Chesshire 1991:137). The energy crisis allowed the industry to negotiate a comfortable plan for the future, with limited involvement of the CEGB (Chapman 1999:161). The Plan for Coal (1974) provided strong support with the aim of stabilising and increasing output.

However, in the late 1970s, the coal industry faced credibility problems and eroding *political legitimacy*. Plan for Coal experienced delays, which increasingly prompted

[32] The energy policy directions favoured by the UK in the 1970s is often referred to as 'CoCoNuke' (Coal, Conservation and Nuclear).

questioning and public inquiries, and added to long-lived dissatisfaction with national ownership and management practices. The extravagant spending of nationalised energy industries was seen as a cultural consequence of industries dominated by engineers trained to become managers, and thus more interested in technology than costs (Hannah 1982, interview Parker). The 1978 White Paper on nationalised industries (Treasury 1978) specified financial control rules and objectives, thus breaking with the earlier emphasis on economic efficiency, pricing and investment criteria (Heald 1980). The NCB was expected to break-even after interest and social grants by 1983-4 (Heald and Steel 1981). These changing rules put pressure on the coal industry that could no longer claim an exceptional status.

The Conservatives in opposition gathered around the emerging promises and visions of economic liberalism. This *broad political discourse* coupled together a number of problems and solutions: 1) ideological ('rolling back the state' and expose nationalised industries to the rules of the market); 2) public finances (cut public spending); 3) political threat (lifting the power of the miners); 4) industrial policy (putting order in an industry considered as 'sick'). The policy proposal consisted in replacing political relationships, interpreted as the cause of the problems (financial, social and managerial), with market structures (Chapman 1999:174). This *emerging vision* gained momentum, providing a counterpoint to the inflated optimism cultivated by the coal industry. The Ridley report on Nationalised Industries (1977), famously leaked in 1978 to *The Economist*, suggests muscular intervention to come:

> "we might try and provoke a battle in a non-vulnerable industry, where we can win" (Ridley 1977:24);
>
> "these policies should enable us to hold the fort until the long term strategy of fragmentation can begin to work." (Ridley 1977:26)

#### 6.2.2.4 Environmental problems

The acid rain issue gathered pace in the international arena in the 1970s. The OECD (1977) pointed to Britain as the largest European sulphur dioxide emitter, and largest net exporter of pollution. Media coverage ensured public exposure to the issue. The Department of Environment startlingly admitted its responsibility in a report of the Central Unit on Environmental Pollution published in 1976 (Park 1987:17). However, this early step towards public recognition was exceptional, and the debate in Britain was rapidly re-centred around uncertainties and costs to justify inaction.

The timing of the acid rain controversy was unfortunate. Indeed, acid rain discredited coal's *legitimacy*, but the energy crisis meant that coal had become essential. Additionally, the very way it was framed in Britain (in a climate of reduced ground-level SO2 concentrations) "reinforced the official post-1956 story-line that suggested that air pollution was an issue on its way out" (Hajer 1995:106). The recently acquired strategic importance of energy meant that it became tightly coupled to economic objectives, and relatively immune to alternative framings (e.g. environment):

> "[For] the United Kingdom, energy crisis meant that the doors of the core of the state were locked still more firmly against environmentalism." (Dryzek *et al.* 2003:60-1).

### 6.2.3 Industry strategies – economic environment

The energy crisis radically shifted the industry's market outlook, the underlying cost structures and balance of power. The coal industry utilised this new position to stabilise its future.

#### 6.2.3.1 Economic positioning strategies

The Plan for Coal created a positive outlook for the coal industry. UK coal consumption was projected to be 130 Mt by 1985. The industry started a substantial investment programme. The pace of decline of the 1960s was halted (Beynon 1999:2). Reversing the industry's fate proved very difficult in the short term. Plan for Coal was subsequently revised (after 3 years), to adjust for stagnant performance. The NCB faced delays and disparate performance levels. The readjusted strategy included long-term planning and short-term incentives. Later in the decade, the NCB called for an extension of the Plan, as justified by the Coal Review (Dec 1978):

> "unless investment in new capacity is kept up beyond the Plan for Coal programme (which goes up to 1985), output would fall progressively from the mid-1980s" (NCB 1979:5).

#### 6.2.3.2 Innovation strategies

The NCB faced two major options for technological development: "pin its hopes on penetrating premium markets through coal conversion processes or give priority to improving the competitiveness of coal combustion in bulk heating markets, especially power generation." (Surrey and Walker 1975:97). While the industry did increase its R&D expenditure (Grainger and Gibson 1981:475-6) and continued exploratory work on new products and new markets (gasification, hydrogenation, fluidised bed combustion, etc.), it focussed mainly on improved mining processes to deliver more and cheaper coal to established markets (bulk heating and power generation). So, instead of engaging seriously with new product/market combinations – involving substantial changes in the industry's technical base, strategy and markets –, the industry improved its production process.

Accordingly, the NCB developed three main *innovation strategies*: 1) (mining) process innovation in existing capacity; 2) new capacity development exploring the latest mining technology; 3) R&D, diversification and exploration.

Capital expenditure in mining was greatly increased (Figure 6.3). Modernisation was geared towards reduced labour costs, standardisation, and economies of scale. Initial enthusiasm stalled upon major problems:

> "Simply to keep output at existing level was quite a task, because the pits were on average eighty years old and many were therefore nearing exhaustion. The industry was suffering, and would continue to suffer, from the lack of investment in the sixties." (Hall 1981:223)

A systems' engineering approach was introduced to mining. Besides routine mine maintenance and the diffusion of machinery, improvements at existing pits were directed to industry structure and the organisation of work (Burns *et al.* 1985:96). Such new attitudes to mining emphasised labour productivity, capital productivity, and control. Controversial productivity incentives and voluntary early requirement were introduced in 1977/78. The incentives helped raise productivity levels locally, relieving "the sluggish levels of performance in the industry" (NCB 1978:2). The industry increased automation in mining (Figure 6.16), "facilitated by the development of micro-electronics" (Burns *et al.* 1985:94). The MINOS (Mine Operating System) project introduced remote control and systematic monitoring of mining operations. The new perspective on mining skills and practice was highly centralised, and based on new information and communication technologies. It has been criticised as de-skilling workers, introducing unnecessary amounts of control and hierarchy, and leading to dramatic reductions in employment (Winterton 1994).

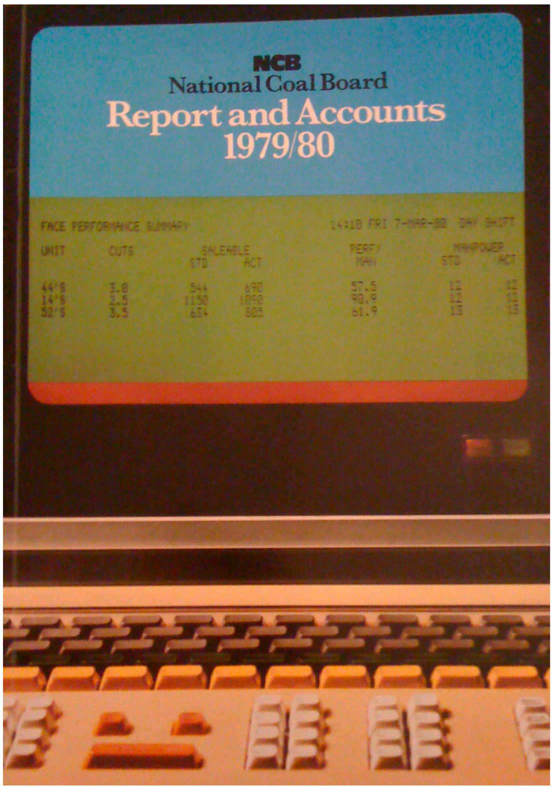


**Figure 6.16: Front cover of the NCB Annual report 1979/80, illustrating the ongoing revolution in mining automation.**

The development of radically new mines spurred a lot of enthusiasm. The industry invested in 'superpits' – enormous mining complexes, combined with large power stations to be supplied directly – as a way to follow the upward shift in scale imposed by developments on the international coal market (see illustration in Figure 6.17). The Selby project was approved in 1976. It was to become the world's largest deep-mining project: 5 collieries to be joined together underground, remotely operated from a central drift mine, to produce 10 million tons annually for the power station market. Such mines were designed to host the latest technology, promising the highest output rates and lowest labour intensity achievable in deep mines. They became the symbol of the 'new' coal industry. However, they ran into technical problems, such as irregularities in the seams. The Selby complex started marginal production in 1983, and only produced at full capacity in 1991. At its peak (1993-4), it produced 12 million tons of coal. Retrospectively, 'superpits' proved to be costly investments (interview Merrick, interview Parker).

Opencast output was scaled up in the 1970s (Figure 6.23). The Opencast Executive (OE) gained in confidence with Plan for Coal (1974) (Beynon *et al.* 2000:15). The NCB had a monopoly over the resource. It contracted specialised firms to extract coal from surface or low-depth seams, but also sold licenses to smaller independent mining companies. Opencast mining was "the most profitable part of the Board's activities"

(NCB 1972:11). Opencast production was seen as useful to meet the projected demand growth underlying Plan for Coal.

Thirdly, renewed interest for coal led to enthusiasm for *diversification strategies.* Research in coal utilisation, mainly done at the Coal Research Establishment (CRE), was "aimed at strengthening existing markets and developing new uses for coal" (WOCOL 1980:417), with a budget of £7.3 million in 1977-78 and £8.9 million in 1978-79. Two main axes were to 1) develop advanced coal combustion equipment in the medium term, and 2) investigate coal conversion processes (gasification and liquefaction) in the longer term. The intensified development of fluidised bed combustion (FBC) was a direct response to the 1973 oil shock in what has been labelled a "policy reversal" (Watson 1997:192).

The UK was a pioneer of FBC development. It took responsibility for the International Energy Agency (IEA)'s Coal Research and Development Group, developed prototypes, and the construction of a 80MW pilot plant at Grimethorpe (Ashworth 1986:423-4). A license for the basic technology was held by NCB Combustion Systems Limited, and FCCL (a company set up for FBC project contracting and engineering) owned by Babcock and Wilcox (WOCOL 1980:418-421). The budget for coal utilisation R&D was increased from £1 million to £10 million throughout the 1970s (Grainger and Gibson 1981:470-6), which remained a limited commitment. According to former CRE scientist David Merrick (interview), the NCB's inability to develop commercial applications and capitalise on excellent research resulted from 1) the absence of capacity expansion in the ESI, and 2) the inability to develop full-scale advanced combustion projects.

#### 6.2.3.3 Markets

The oil crisis justified an "all-party support for a substantial programme of coal investment as a strategic route to reduce the UK's energy import dependence" (Chesshire 1991:137). This positive climate provided the context for the Plan for Coal in 1974. The Plan's output scenarios were based on optimistic demand forecasts resting on 2 basic assumptions: 1) continuous growth in energy demand, and 2) increased share of coal in UK energy (Beynon *et al.* 1999:3). These assumptions were swept away by the slowing down of the economy, the absence of new electrification plans, and further expansion of nuclear investment. 1978-9 was the post-oil crisis peak of coal consumption in the UK, at around 130 Mtons of coal, and 1980 was the all-time highest coal consumption by the ESI (Figure 6.1). MacGregor later added 2 critical reasons for these market problems: 3) assumed sustained demand by the steel industry (which was allowed imports of coal, and declined drastically); and 4) very little overall productivity improvements despite substantial investment (MacGregor and Tyler 1986:124-5).

The NCB had to ensure lasting demand for British coal in power stations through the expansion of coal-fired capacity, increased levels of coal burn and preference for British coal despite growing international competition. It addressed these pressures with *lobbying* and *commercial strategies*.

Applying constant *lobbying* pressure for new coal-fired plant and refurbishments was an important aspect of the NCB's market strategy (Ashworth 1986:398-399). Despite a stagnating ESI, this strategy led to a new major 2,000 MW coal-fired power station, Drax B,[33] after eleven years without coal-fired capacity increase, and the lifetime extension of large coal-fired plants following the second oil shock. This success was welcomed by the NCB:

> "The decision to build Drax is consistent with the Board's long term strategy for expanding the coal industry. It is a major step towards ensuring that the electricity industry has enough coal-fired capacity available in the longer term to burn the quantities of coal which the Board are planning to produce and which they believe will be economic." (NCB 1979:9)

*Commercial strategies* were aimed at increasing coal's share in the power sector. Record coal sales to power stations were reached in every year from 1976 to 1979 (Figure 6.1). By 1980, the NCB had accomplished its *market specialisation strategy*, as the power sector reached over 70% of its sales (see Figure 6.8) – other markets being disappointingly weak. In an effort to *stabilise the sales pattern*, the commercial relationship with the CEGB was strengthened through the negotiation of a Joint Understanding (JU) on sales, with Government oversight, in 1979, which "gave the NCB a better basis for the planning of operations and sales" (Ashworth 1986:400). The NCB recognised it as a crucial achievement:

> "A five year programme to sell a minimum of 75 million tonnes a year to the [CEGB] (…) will play an important role in securing the short-term future for coal." (NCB 1980:2)

---

[33] Approved in 1977, Drax power station – the largest in Western Europe – was directly linked to the Selby mining complex. Their combination can be seen as a paradigmatic case of the British coal-power complex as envisioned in the mid-1970s.

In return for ensuring this sales volume, the CEGB exerted a downward pressure on price (interview Parker), with reference to the international coal price and the possibility of imports.

#### 6.2.3.4 Customer relations

With improved prospects from the energy crisis, the NCB gained confidence, and overlooked relationships with customers. In the policy process leading to the Plan for Coal, little attention had been given to CEGB anxieties. The CEGB was only consulted, leading to oversimplifications, namely concerning fuel competition:

> "The CEGB suggested that it would *be able to burn* about 90 million tons in 1985 to which the SSEB added a further 10 million tons. However, the amount it actually *would burn* would depend on coal's relative price vis-à-vis oil and other alternatives (…) The NCB, the NUM and the Government assumed, in 1974 and beyond, that the amount of coal the ESI *would* burn equalled to the amount they *could* burn and the ESI's 'competitive' caveat faded into the background" (Chapman 1999:163-4, original emphasis).

This exacerbated pre-existing tension, marking a *turning point* in the deterioration of customer relationship.

### 6.2.4 Industry strategies – socio-political environment

#### 6.2.4.1 Political strategy

According to Chapman (1999:154-5), Plan for Coal "was essentially the product of the NCB". The proposal pre-dated the energy and political crises. The Coal Industry Examination (DoE 1974), quickly officialised Plan for Coal, and accepted the principles to maximise production to reverse the industry's decline. The decision-making process has been criticised for being opaque:

> "In short, the Government needed a plan, the Board had a plan and it was one that was acceptable to the NUM, who could no longer be ignored." (Chapman 1999:165)

The coal industry now had access to finance – and hope – for urgently needed renewal activities. Forecasts were devised for total UK coal demand of 130 mt in 1985, and as much as 200mt by 2000 (MMC 1983).

### 6.2.4.2 <u>Framing strategies</u>

The energy crisis "heightened the political urgency of consideration of the coal industry's future" (Parker 2000:4). *Discursive framing strategies* made sure that such commitment would last:[34]

> "The investment programme has now [1980] built up to over 0.5 billion pounds per year and it is essential that this momentum is maintained (…) This requires continuity of government policy and the avoidance of planning delays." (WOCOL 1980:369-370)

The continuity of public and political support depended on the industry's perceived strategic role and good management. It was crucial to maintain the strategic importance of energy security, and to emphasise the advantageous coal/oil price ratio in public documents:

> "there is little doubt that a healthy expanding coal industry will be a valuable asset in the difficult years ahead as the world adjusts to limited availability of oil and gas" (WOCOL 1980:376)

> "The importance of coal, which became evident once again after the massive oil price increases of 1973/4, has been further underlined by the disturbance in the oil market occasioned by the troubles in Iran (…) The case for a long term policy for developing our own energy resources seems now generally accepted." (NCB 1979:3)

The new competitive advantage of coal and the resulting coal demand boost was interpreted as long-lasting structural change (Chapman 1999; Parker 2000).
Building on a recently recovered symbolic position, the NCB *constructed an image of a glorious re-born industry*, and capitalised on new understandings of energy security. In 1978, an advertisement campaign was run under the theme 'Coal: a source of energy that will last for 300 years'. Other campaigns focussed on the industry's technological advances, energy security, and the lasting nature of commitment (see Figure 6.17).

---

[34] The World Coal Study (WOCOL) had been instrumental to disseminating a positive framing of coal interests worldwide.

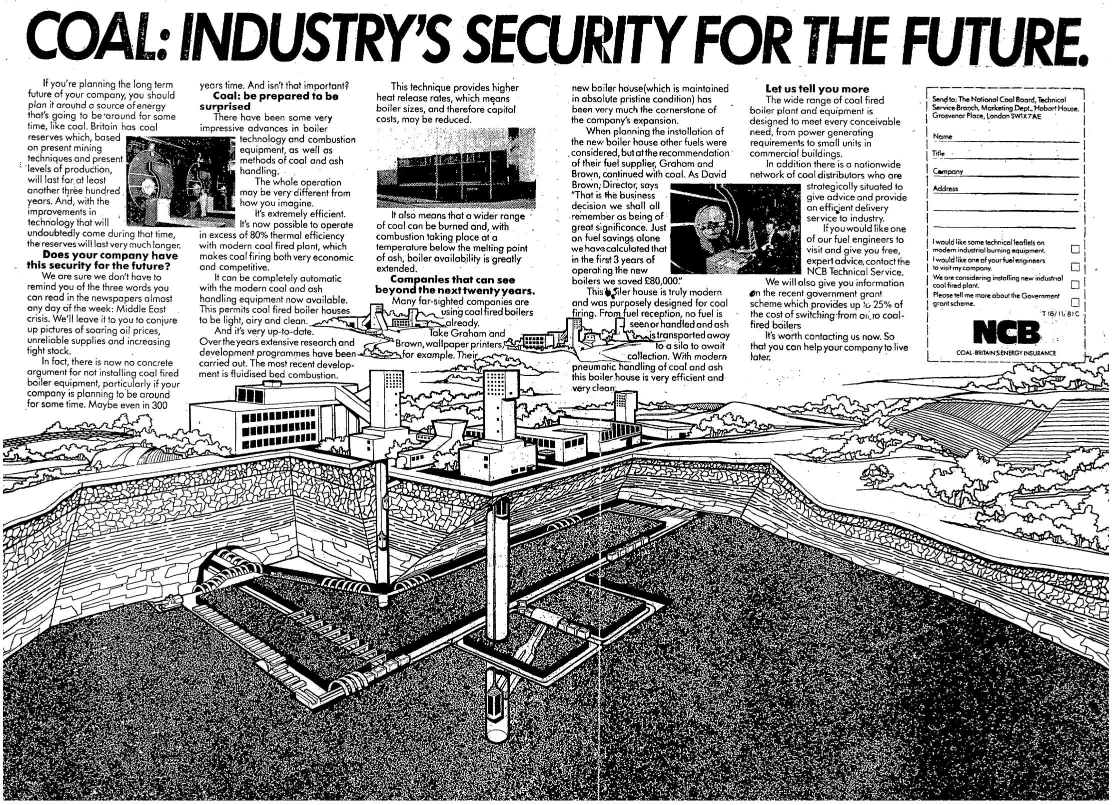


**Figure 6.17: NCB advertisement, showcasing the latest technology developments and associating the industry with the future (*The Times*, 19 November 1981, p.9)**

The new *hopeful vision* for coal reached the mentalities and expectations of decision-makers within the industry, who planned its future with confidence. Highly optimistic forecasts ('guestimates') were regularly issued as the basis for planning (Chapman 1999:169). Bad news (e.g. demand reductions, efficiency improvements, etc.) was (publicly) framed as temporary, while good news (renewed support, price advantage, etc.) were framed as lasting trends.

The NCB celebrated improvements. The NCB chairman, pleased with recent achievements, interpreted them as hopeful signs of industry recovery:

> "1979/80 was a year of achievement for the industry. After a difficult year in 1978/9, the industry recovered strongly."
>
> "financial objectives were achieved."
>
> "These results are a welcome sign that the industry is turning the corner after the long decline that started in the Sixties, and that the benefits of Plan for Coal are now beginning to appear." (NCB 1980:2)

#### 6.2.4.3 Environmental lobbying

Acute concerns over energy, and coal's prime circumstantial role in addressing them, reduced relative attention for other issues. Official *framing strategies* associated coal with jobs and security of supply to deflate environmental criticism:

> "coal production and utilisation have a considerable impact on the environment and society [which] should, however, be seen in the context of the benefits which the coal industry contributes to the economy" (World Coal Study 1980:409)

The NCB included a chapter 'Environment' in its annual reports from 1979 onwards, suggesting rising concerns. However, the NCB language remained fuzzy, mentioning the need for "close co-operation between all concerned", "proper evaluation of what should be done", "appropriate environmental measures", "detailed examination of environmental questions", "reassurance", and underlining that the current proceedings are "more environmentally acceptable than those which were characteristic of the past" (NCB 1980:31). The main environmental concerns identified were "tipping colliery dirt, mining subsidence, opencast mining restoration and air pollution" (NCB 1980:31).

## *6.3 1981-1990: Working out the privatisation machine*

### 6.3.1 Pressures in economic environment

#### 6.3.1.1 Landscape

The 1980s were difficult times for Britain. Inflation skyrocketed again in 1980. The recession led to catastrophic increases in unemployment, especially in heavy industries (Figure 6.18).


**Figure 6.18: UK unemployment rate (%) (Source: Hicks and Allen 1999:24)**

#### 6.3.1.2 Markets

The British coal industry had come out of the 1970s with renewed hope:

> "coal is once more king, and the miners need no longer worry about their future" (Hall 1981:251)

However, the very particular economic environment created by the oil crises was halted, wiping out the assumptions of the 1970s. Demand continued to fall from the local peak reached in 1979, putting significant pressure on the coal industry:

> "There can be no doubt that the plans to expand the coal industry in the aftermath of the energy price shocks of the 1970s (…) are now totally outdated." (Robinson 1988:203)

The NCB seemed to recognise the end of good times:

> "The NCB told [the Mergers and Monopolies Commission (MMC)] that by early 1980 it no longer regarded the production targets contained in Plan for Coal as valid, because the specific numerical targets had progressively been overtaken by events." (MMC 1983:80)

An imbalance between improved supply and depressed demand, and an imbalance between prices and costs triggered industry anxiety (NCB 1983:1):

> "the belief was gaining ground that the consensus of support for the industry was coming to an end. By the end of 1980 many in the coalfields were predicting that the possibility of closures could lead to conflict." (Hall 1981:251)

Market problems increasingly exposed disparities in the industry's unprofitability.

#### 6.3.1.3 Supply-side stress

The industry had entered the 1980s with a substantially improved mining outlook, thanks to recent investment, technical innovation, and productivity schemes:

> "The year 1980/1 showed further positive improvements in the efficiency of mining. Output of the long-life collieries continued to rise, and coal-face productivity reached record levels. These represent the progressive benefits of a policy of high investment under 'Plan for Coal', and of technical innovation." (NCB 1981:3)

However, reduced mining investment (Figure 6.3) combined with inherent exhaustion dynamics led to declining returns by the mid-1980s.

#### 6.3.1.4 New entrants

Developments of the international coal trade had led to "the creation of the world 'coal chain' as envisaged by the World Coal Study" (Koerner *et al.* 1995:665). The number of players increased with investments that would come on stream in the late 1980s. Transnational coal corporations pursued a price strategy to crush smaller companies. After nearly a decade of adjustments (shipping and handling technology and infrastructure), international steam coal trade rapidly increased. The ARA price of steam coal denominated in Sterling fell by 59% in 'real' terms between 1982 and 1990 (Parker 2000:67), amplifying the price pressure on the British coal industry.

While the price mechanisms in the JUs provided a protective buffer (Parker 2000:68), international exporters became a problem:

> "like other British producers, the Board faced competition from imports in certain markets because of the strength of sterling." (NCB 1980:2)

> "the future of the British coal industry in 1980 was tied to that of the electricity generating industry. However, this industry was increasingly looking toward the international coal market." (Beynon *et al.* 1999:5)

Developments on the international coal scene had triggered a re-think of commercial and technical rules in domestic coal industries. International price benchmarks were increasingly used as performance comparator to determine the future of the British coal industry (Koerner *et al.* 1995:666). By focussing attention towards low-cost mining, the international price pressure contributed to driving deep mines out of business, and opencast mines to gain in relative importance (Beynon *et al.* 1999:9).
The Government was keen on opening up coal production to new entrants from the private sector (Prior 1989:213). The expansion of opencast mining was one way of encouraging this (Sadler 2001:7). The greater productivity levels of opencast mining added to the price and productivity pressures on deep mining.

**6.3.1.5 <u>Customer and import pressure</u>**

The strengthening of Sterling challenged the competitiveness of NCB prices (MMC 1983:75) internationally. The CEGB signalled its dissatisfaction:

> "the CEGB expected that in the long term United Kingdom coal prices would reflect the value of NCB coal in international trade." (MMC 1983:72)

and lobbied to maintain the possibility to import coal open:

> "All the coal consumers who gave evidence to [the MMC] were keen that importing coal should remain an option open to them, as they regarded it as a way of ensuring that NCB prices were competitive." (MMC 1983:75)

The threat of imports came to be seen as a welcome instrument of discipline against NCB's monopoly power:

> "imports serve to safeguard fuel supplies and provide some discipline on NCB prices" (Tombs, 1983:100)

> "[the NCB] must, like any other business, avoid offending its (in the short term) captive customers [the CEGB], who otherwise will make the investment necessary to switch to alternative sources of power." (Robinson 1988:207-8)

The CEGB repeatedly stated its frustration with the NCB:

> "Every major increase in coal prices brought a letter of protest from the chairman of the CEGB." (Ashworth 1986:397)

In 1985, in a move closer to its own privatisation, the electricity supply industry entered the international spot market and purchased a large amount of Colombian coal (Beynon *et al.* 1999:9). While the Government had until then supported the protection of the British coal industry through pricing mechanisms, it now sought to apply the international price pressure through targets and objectives. So, the boundary between domestic markets, international trade, and politics became increasingly blurred. The Government and the CEGB had a strengthened argument against the NCB's established way of doing things (monopolistic coal trade at above-world prices). The NCB's ability to resist competitive price pressure was clearly waning.

#### 6.3.1.6 Competition from alternatives

Within the power generation market, the main competition came from nuclear power and oil. Gas was not yet a threat in the electricity market. The collapse of the oil price in 1986, given a politically unstable coal industry, led to serious difficulties for the NCB to hold on to its influence over the power market (see Figure 6.19):

> "[The oil price changes] have not escaped the [CEGB], which is currently negotiating a reduction in the price of coal. The CEGB's position is strengthened by its experience in using oil-fired generating stations during the coal strike (…) The CEGB can thus, unusually, threaten an *immediate* and *massive* switch from coal to oil unless prices come down." (Robinson 1988:218)

This radical commodity price shock had a tremendous influence on the prospects of the British deep-mined coal industry, and can arguably be seen as a main *trigger* of change in energy markets, business and policy (Parker 2000, interview Parker). The oil price collapse wiped away any perceived need to retain a UK coal industry of a strategic size. It was interpreted as the beginning of a new era of cheap and abundant energy – oil, gas, and imported coal – wiping away energy security arguments for the retention of indigenous coal capacity.

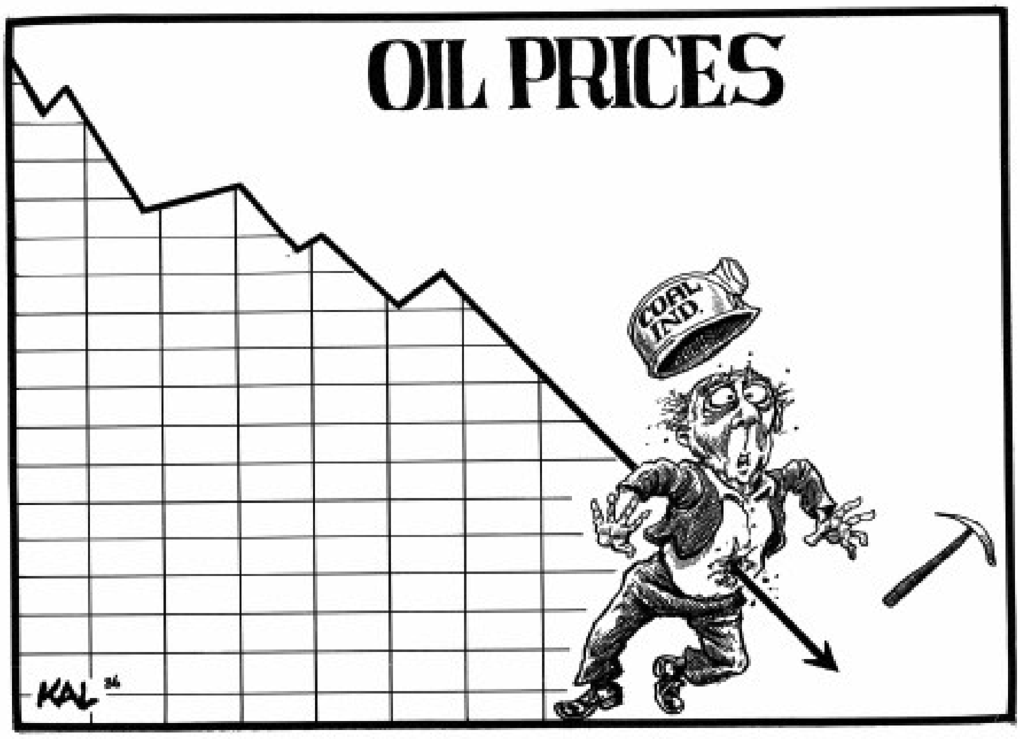


**Figure 6.19: An explicit representation of the effect of the oil price collapse on the coal industry, *Today*, 29 April 1986.**

### 6.3.2 Pressures in socio-political environment

#### 6.3.2.1 Landscape

This period saw the election of Margaret Thatcher and the instalment of the market doctrine and 'authoritarian liberalism' (Dryzek *et al.* 2003). In energy policy, there was a "broader political enthusiasm for private ownership and the promotion of competition." (MacKerron 2009:77). This new frame had been gradually built-up since the 1960s, and culminated in the 1980s-1990s.

High-level political and strategic interest in energy was sustained into the mid-1980s. However, the focus shifted from energy security concerns to the search for economic efficiency and market competition (MacKerron 2009:76-9), as the liberalisation agenda pervaded every strategic aspect of Government. The new ideological frame and methods (private ownership and the promotion of competition) were applied to the energy sector with conviction. In the 1980s, there was a move from a state that was mediating the effect of market forces, to a deliberate choice to "roll back the influence of the state and to give a freer range to market forces" (Chesshire and Skea 1989:60).

This *new ideological frame* and the resulting *discourse* became a major determinant of change in the coal industry.

#### 6.3.2.2 Policy and politics

The Government intended to put in order the house of nationalised industries, which were seen as unprofitable and costly. This meant tighter financial control and closer managerial control. The Coal Industry Act of 1980 required the NCB "to become profitable by the end of the financial year 1983/4" (Burns *et al.* 1985:105). The Monopolies and Mergers Commission (MMC) was set up to

> "investigate and report on the question whether the Board could improve its efficiency and therefore reduce its costs [in the development, production and supply of coal]" (MMC 1983:1).

It noted a problem of over-capacity, recommended to reduce operation costs, and to increase the capital intensity of the industry. The official solution involved:

> "a maximisation of output from low-cost capacity with relatively low marginal costs and reduction of the high cost capacity" (MMC 1983:54)

The industry was thus to get rid of its low-performance tail: 141 out of 198 pits were defined as 'unprofitable'. The industry's heavy dependence on various financial sources and grants was also emphasised, arguing that the industry's funding should be "closer to those of a commercial organisation" (MMC 1983:54).

The industry's reform began with the framing of problems and the search for appropriate policy solutions. These *framing* activities, infused by the *new repertoire of the market ideology*, focused on defining what was an 'uneconomic' pit, whether it should be closed, and how, and how capital and labour should be reallocated (Turner 1989:160). The policy debate thus no longer appreciated the industry's social role. Free market advocates argued that closures would lead to 'natural' healthy re-allocation of labour and economic activities. Opposition believed that there was an alternative to mass unemployment, and that the coal industry should not be governed strictly by market logics. The NUM, especially, argued that special attributes and costs of coal had to be taken into account (irreversibility of closures, coal as basic commodity, future costs, pricing policies, etc.). As market reformists gained power over the miners, the monolithic yardstick of costs per ton prevailed.

After 1981, the debate on the future of the British coal industry became increasingly polarised. For market reformists, the British coal industry symbolised the country's industrial past, a paradigmatic case in market reform, a drain of public money, and the miners represented the radical socialists – the 'Enemy Within' – that threatened to bring the economy to a standstill. Since the success of the miners in 1974, and Plan for Coal, it had become "almost impossible to establish a bipartisan approach to the nationalised coal industry's affairs" (Parker 2000:7-8). On the other side of the political spectrum, the coal industry was portrayed as the proud contributor to Britain's economy, the symbol of the mobilisation against capitalism, the right of workers. Solidarity with the miners initially provided substantial public support.

Discursive polarisation turned into an ideological and political struggle over the coal industry, escalating into the 1984-5 miners' strike (the Great Strike), which is so deeply imprinted in the British collective memory.[35]

Turner (1989:165-6) argues that the whole decade had been dedicated to preparing the industry for privatisation. Important hurdles included: 1) breaking Scargill's power, 2) the introduction of flexible working (more profitable, longer worked pits, and flexible use of machines), and 3) the move to profitability (closing down 'uneconomic pits' and concentrating production in 'superpits').

#### 6.3.2.3 Labour relations

*Radicalisation.* The National Union of Miners (NUM) actively resisted mine closures (Turner 1989:152). Its position was radicalised with the election of Scargill as president: no mine should be closed other than on the grounds of exhaustion. It won a symbolic battle in 1981 when the threat of a national strike led to Government capitulation and withdrawal of its closure programme (Figure 6.20). Thatcher's defeat was received as a humiliation (Turner 1989:159). As long as the miners held strong, there was little chance for the Government to implement its restructuring programme. Government improved its tactics and strategy to break the power of the unions (stockpiling, conversion to oil at power stations, etc.). New laws reduced the power of unions, making secondary striking and flying pickets illegal, and increasing the legal responsibilities.

---

[35] Reasons for this particularly important trauma include the paradigmatic nature of the political divisions, the dramatic tension provided by the caricature characters of Thatcher and Scargill, the profound cultural and world-view clashes they represented, and the particularly painful process of the 1984-5 strike.


**Figure 6.20: Margaret Thatcher pictured as forced to withdraw as she gets burnt from upsetting the coal industry (*The Observer*, 22 February 1981)**

*Managerial shake-up: new appointments.* Re-elected with a large majority in 1983, the Government replaced the people in charge to fit its agenda. Lawson replaced Howell as Secretary of State for Energy. Ezra was replaced by MacGregor as chairman of the NCB (see Figure 6.21),[36] "he was put in place specifically to challenge Scargill", while England was replaced by Marshall as chairman of the CEGB, with the main task to "prepare the ESI to withstand a coal strike and promote the nuclear power industry" (Chapman 1999:188). So, there had been a deliberate Government intervention to shake up the organisation and reduce internal political pressures. The Secretary of State for Energy defined new rules and objectives for the NCB:

> "the justification for coal production, like that for any other business, lies in the ability of those engaged in it to earn a satisfactory return on capital while competing in the market place. The basic objective for the National Coal Board therefore must be to earn a satisfactory return on its assets in real terms after payment of social grants (…) the Board should not plan on any continuing tranche of sales which will not be profitable." (NCB 1983:3)

---

[36] MacGregor had a record for turning organisations upside down. He confessed that the main motive for his appointment, as far as he understood it, was to break the bureaucratic culture of loyalty, resistance, and risk-aversion inherent to the coal industry (MacGregor and Tyler, 1986).

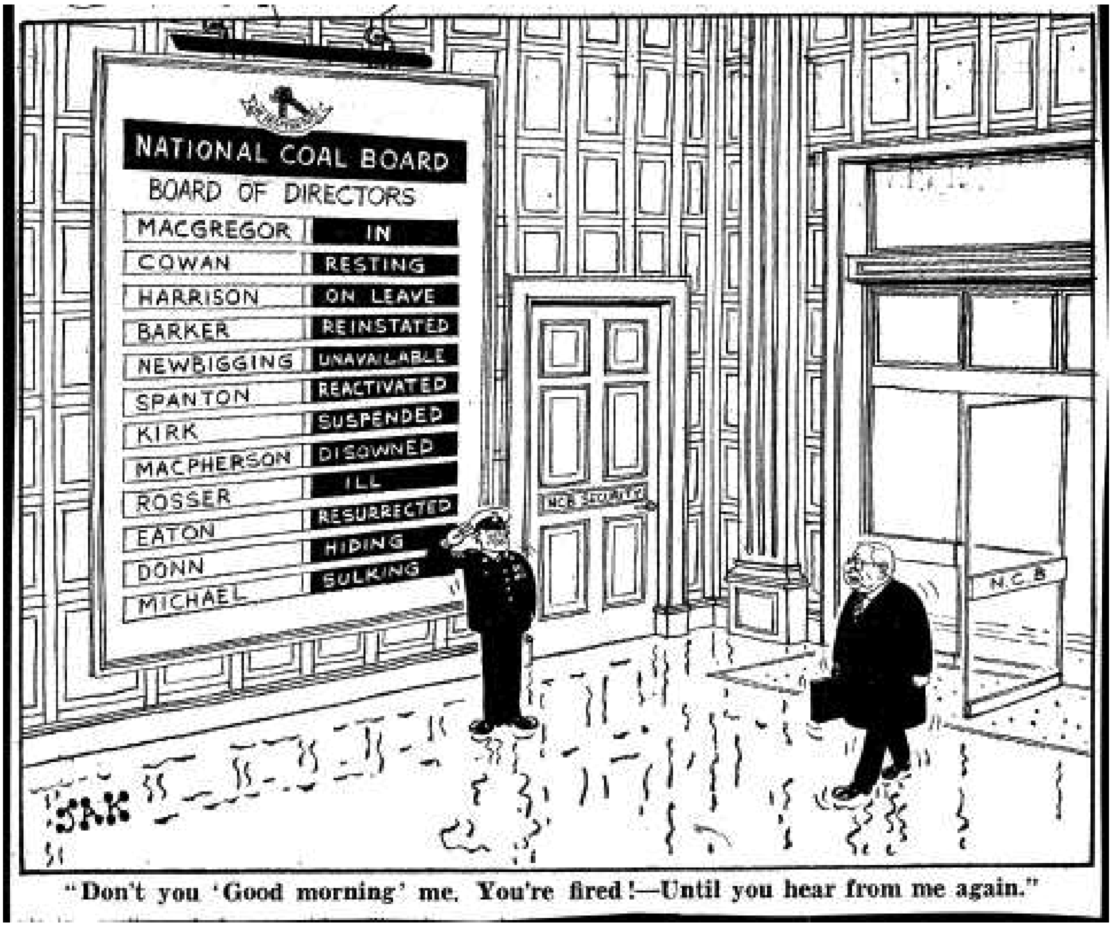


**Figure 6.21: MacGregor portrayed as lone dictator of the NCB, after having dismissed nearly the entire Board of Directors, *Evening Standard*, November 5, 1984**

*The Great Strike*

The Great Miners' Strike (1984-5) is an important episode of British industrial history. I here outline events relevant to destabilisation. In late 1983, the NUM submitted a wage increase claim, which was rejected by the NCB. An overtime ban followed from 31 October 1983. On 6 March 1984, MacGregor announced a 4 Mton production cut, which corresponded to around 20,000 job losses. Local strikes ensued from Yorkshire to Scotland, spreading around the country. Confrontations in the streets, outside collieries, power stations, coke ovens, and strategic coal transportation points involved miners and police forces. The battle also occurred in courts, as various NUM procedures were deemed unlawful. Growing division between striking and non-striking miners (pointed out as 'scabs' by their counterparts) was fully exploited. The winter was difficult for striking miners and their families. The strike faded as the balance of power became overwhelming and the striking fraction's internal drive gradually eroded (due to nearly undisturbed power supplies, NUM's low budget, and miners' extreme poverty after a year of strike). On 3 March 1985, the strike ended without a new agreement. The defeat of the NUM was crucial to the reform of the British coal industry. The newly acquired degree of freedom allowed the implementation of restructuring in line with the market ideology (Chapman 1999, interview Parker).

#### 6.3.2.4 Customer pressure

Crucially for the achievement of the Government's goal, the managerial and diplomatic skills at the CEGB had allowed the lights to be kept on. After the miners' strike, as the ESI liberalisation proposal gathered momentum, one of the objectives of Government and the CEGB was to reduce dependence on the British coal industry. There were social limits as to how quickly this could be done. With the NCB's power greatly reduced, the general strategy for power generation became detrimental to British coal: 1) nuclear power as base load, 2) opencast coal, and 3) imported coal became the priorities (Beynon *et al.* 1999:9).

#### 6.3.2.5 Environmental problems

The acid rain controversy created substantial political pressure specifically on the CEGB and the coal industry. Indeed, coal-fired power stations were identified as the prime source of acid emissions, and the target of environmental campaigns. Two major solutions were commonly viewed as effective to curb acid emissions from power plants: Flue Gas Desulphurisation (FGD) and low-sulphur coal (e.g. non-British and more expensive).

The acid rain crisis gathered momentum on the international scene and at the level of European institutions. The UNECE Convention on LRTAP in 1979 led to international *political* pressure on large emitting countries for a commitment to reduce emissions. Major European emission exporters, led by the UK, at first rejected the conclusions of the CLRTAP. Germany's reversal in 1982 with the 'Waldsterben'[37] controversy left the UK virtually alone (Dickson and Clark 1995:4-5). The UK became known as the 'dirty man of Europe' (Rose 1990).

In British media, and on the public scene, there were signs of activity:

> "In May 1983, acid rain gained a dominant position in the discursive space of environmental politics. It kept a prominent position until at least 1987." (Hajer 1995:109)

---

[37] Relates to a controversy particularly salient in Germany, about the dieback of forests due to acidification.

The public was regularly stimulated, educative material was written by environmental groups, scientists, and widely diffused. The discourse focussed on clarifying the chemical process (Figure 6.22), illustrating the environmental damage, and framing Government inaction as irresponsible:

> "A Government which allows such an ecological catastrophe to continue has thrown up all pretence at a real environmental policy." (Interview with Chris Rose, FoE spokesman, *The Guardian*, 15 April 1985, p.4)

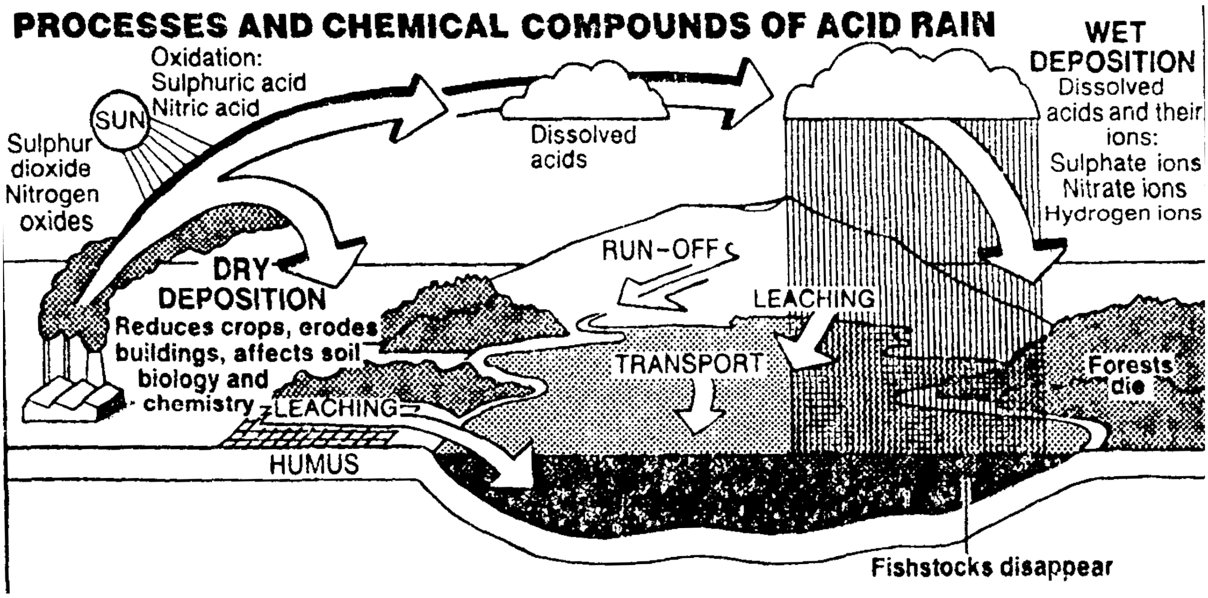


**Figure 6.22: Schematic representation of the processes causing acid rain, *The Times*, 17 December 1984, p.2**

Environmental pressure groups actively mobilised in advocacy, education and research campaigns (e.g. FoE, RSNC (with e.g. the Watch Acid Rain campaign), Greenpeace, etc.). Environmental activists regularly demonstrated to contest and challenge Government policies and the CEGB's position (interview Kerr). At the peak of official denial, in 1984, when no proposal existed besides more research, Parliamentary pressure grew, and the Government's position was portrayed as 'lamentable'.
Despite growing support, the influence of environmental pressure groups on the British political position was limited in the early 1980s (Boehmer-Christiansen and Skea 1991; Hajer 1995; Dryzek *et al.* 2003).[38] The 'official' discursive coalition attracted attention

[38] Dryzek *et al.* (2003:43-50) contextualise the limited influence of non-producer interests and pressure groups in the 1980s to the very 'special' conditions characterising Thatcher's 'authoritarian liberalism',

away from the environmental crisis towards costs, scientific uncertainty, and the economic risk of unjustified action.

International pressure increased with the suggestion, in 1983, of an EC Large Combustion Plant Directive, and later with the Helsinki Protocol in 1985 (where signatories, UK excluded, agreed on 30% SO2 reduction of 1980 levels by 1993) (Longhurst *et al.* 1995:2632). Political pressure also increased domestically in disagreement with the official stance. In 1984, two Select Committees recommended serious action.[39] Both sets of recommendations were rejected by Government on terms of high costs (Ling *et al.* 2000:257). In 1988, the EC LCPD (88/609/EEC) was finally signed, requiring member states to set out national plans to meet agreed SO2 and NOx limits.

### 6.3.3 Industry strategies – economic environment

#### 6.3.3.1 Re-creation strategy

Optimism receded, and proponents of *radical managerial change* were increasingly supported.[40] In 1983, ahead of the publication of the MMC report, an editorial of *The Times* called for an abandonment of the logic of Plan for Coal, interpreted as poorly managed waste of public funds:

> "[The PfC] envisaged a high level of demand which was unrealistic then and is merely fantasy today. The Government has met its side of the bargain in its rates of investment in the industry, though much investment which might have gone to developing pits with long lives has been devoted less usefully to the rescue of pits with poor prospects." (*The Times*, 11 March 1983, p.11)

According to this increasingly acceptable view, the British coal industry was 'sick'. In a *cognitive shift*, the new management had identified the main problem in its capital

---

which entailed "the imposition of a free market agenda, a corresponding suppression of dissent in civil society, and an 'individuation' of social and economic life".

[39] The Select Committee on the European Communities recommended that at least two power stations be retrofitted with FGD (HoL 1984), while the Environmental Select Committee recommended 60% SO2 reduction by 1995 (HoC 1984).

[40] The pressure for change was supported by a number of discourses: a) Britain's manufacturing and economic decline storyline (the 'British Problem') justified the kind of radical reform that Thatcher promised to implement, b) the competitive problems of the NCB justified radical restructuring, and c) the notion of 'flexible' working eroded miner solidarity and encouraged competition in work practices.

structure, which would guide a major *re-creation* strategy along overriding competitive criteria. Specifically, the tail of 'unprofitable pits' became the focus of attention:

> "The Board's intention is to tackle this burden [of unprofitable pits] with determination, for the future of the industry demands that we should." (NCB 1983:1)

Industry managers recognised the new types of competitive threats that had emerged worldwide from the increasing availability of cheap foreign coal (NCB 1984:5). The NCB explained its recently acquired objectives and strategy, signalling the aspirations of *regime re-creation*:

> "building a secure, high-volume, low-cost industry which will pay substantial wages to the people who work in it, at the same time enabling us to become a regular, reliable sources of high-quality low-cost energy to all our customers." (NCB 1984:1)

According to MacGregor, an important problem stood *within* the British coal industry: loyalty and resistance to change, from management to miner. The prevailing management style was depicted as procedural and complacent – a hindrance to business (MacGregor and Tyler 1986). The miners' bargaining power was considered artificially inflated and problematic. There were also inner tensions across and between mining areas (performance, social mobilisation, and positioning vis-à-vis industry reform). NCB management crucially identified that these tensions could be harnessed. It developed 'divide-and-rule' strategies in areas with anti-Scargill pre-dispositions in order to gain worker support (MacGregor and Tyler, 1986).

As the Union of Democratic Mineworkers (UDM) came to represent the cooperative workers and the NUM the old structure of industrial relations, NCB management emphasised their differing attitudes:

> "whilst the attitudes and conduct of the UDM leadership has been generally constructive and reasonable, some of the leaders of the NUM have been much less willing to recognise the very difficult market position which we all now face." (NCB 1987:1)

MacGregor's managerial style in handling the situation was bold. He identified his allies within the Board, and crushed the resistance (Figure 6.21). The miners' strike was treated as any other form of internal resistance to change: it was interpreted as problematic, isolated and crushed. With the NUM's defeat, the British coal industry had acquired freedom to implement radical change.

#### 6.3.3.2 Economic positioning strategy

The economic diagnosis of the MMC (1983) and the defeat of the miners (Chapman 1999:222, Beynon *et al.* 1999:7) were crucial steps that allowed the implementation of a radically new strategy. The NCB unveiled its 'New Strategy for Coal' in 1985. The plan had 2 main goals: 1) to phase out the industry's dependence on subsidies, and 2) to get it to sell at competitive prices. This new strategy led to an increased number of mine closures, and the "Wheeler Plan" (heavy duty faces and retreat longwall mining) in 1986.

A "fundamental change in the management approach" was operated in response to the mounting market pressures (Chesshire and Skea 1989:41-5). It promised an internal 'cultural revolution' (Parker 2000:70). The *new guiding principle* for the industry was profit, with little attention to social constraints. This change reflected the recognition of coal as an internationally traded commodity, and the ambition to *remove protective measures*. Demand-following output targets (tons) were replaced by objectives in terms of cost per GJ (heat content). The new cost objectives provided the base for investment appraisal (Table 6.2).

**Table 6.2: Production cost objectives set out in New Strategy for Coal (1985)**

| | Operating costs | |
|---|---|---|
| | £/GJ | £/tonne |
| All collieries | 1.65 | 41 |
| New pit investment to maintain output | 1.50 | 38 |
| New investment project to increase output | 1.00 | 25 |

The stated objective was to achieve 80% of mines below 1.65 £/GJ by 1986-7, to break even by 1987-8, and to finance investments from profits by 1990-1. The *heuristic* determining the industry's future aimed alignment with markets:

> "We will never forget that the size of the industry will be determined by the size of our market with our customers telling us what they are prepared to buy and at what price." (NCB 1985:1)

The new management was determined to change the spirit, culture and identity of the industry, and implement a symbolic break with the misfortunes of the past. The industry was re-named 'British Coal' (BC) to further symbolise this new era:

> "In recognition of the transformation in the industry's performance which has taken place, and the opportunity this presents for a new start, in which we can put our problems of the past behind us, the Board have decided to trade under the name of British Coal." (NCB 1986:1)

The new corporation was infused with a new business culture that looked to the future and contrasted with the 'bureaucratic and administrative' managerial style of the NCB:

> "We have established at the very top and at area level a 'management' approach to the enterprise. There is a restlessness and enthusiasm in the management now, a continuing desire to improve results and to find new ways of doing things. Of this I am proud." (MacGregor and Tyler 1986:369)

The achievements of the 'new coal industry' were celebrated. A sense of pride and unity was emulated by showing gratitude to miners and emphasising improvements:

> "In large measure [the all-time productivity record] was due not only to the efforts of managements but also to the new spirit of realism and co-operation shown by our workforce, who enjoyed the highest earnings ever paid in the industry, reflecting the benefits of our productivity incentive scheme." (NCB 1986:1)

#### 6.3.3.3 Commercial strategies

The Joint Understanding regime was revised in 1986, with the introduction of a third negotiated price tranche to reflect the price of oil and imported coal. This protection – although decreasing – was priceless to weather the substantial market pressures from international coal and CEGB dissatisfaction. It provided temporary market continuity, securing 80% of BC sales, at predetermined prices well above international market levels (Parker 2000:59-60). The revision was however a sign of BC's reduced negotiating power with the CEGB and signalled the gradual opening of the market for power station coal.

As BC's bargaining position further deteriorated in the late 1980s in the face of increasing economic pressures, it engaged in deals with the ESI. The Government, eager to make the industry attractive to investors and to avoid its collapse, facilitated these negotiations. In 1990, BC signed three-year supply contracts with National Power (NP) and PowerGen (PG), the privatised successors of the CEGB. It secured a market for at least 70 million tons a year for two years, up to 65 million tons for the third year, and a price agreement (decreasing over the period from £1.70/GJ) (Sadler 2001).

#### 6.3.3.4 Production strategies

Under the new strategy, production forecasts were greatly reduced (from 170 million tons to around 100). A new productivity target of 6 tonnes per manshift was often referred to (O'Donnell 1988:2). In order to achieve these objectives, a consolidation programme and a productivity-enhancing plan (the 'Wheeler Plan') were set up. The main features of this plan included six-day weeks, new incentive schemes, fewer collieries, more productive coalfaces, and the generalisation of heavy-duty technology and automation (Gibbon and Bromley 1990, Moses 1986, O'Donnell 1988, Wheeler 1986). The consolidation of British coal mining involved: 1) the introduction of new capacity, 2) the introduction of new technology in existing capacity, and 3) the closure of pits with high operating costs (Leman and Winterton 1991:55).

The introduction of new capacity was derived from investments in highly mechanised and automated capacity (e.g. Selby) and the reorganisation of existing pits. Brand *new hopes* were invested in superpits. They would showcase the latest machinery, high productivity rates and 'flexible' working. These projects took time to come on stream, and were delayed well into the 1990s.

Opencast mining, still performed by contractors, increased in scale and productivity during the 1980s. Opencast contracting was BC's most profitable business. BC actively influenced the sector's technical strategies (Beynon *et al.* 2000:16-22). Notable technical change concerned the capacity of onsite dump trucks, the size and manoeuvrability of shovels, and the intensification of draglines. All of this was made possible by the involvement of 1) equipment manufacturers who "rapidly extended and developed their machinery" and 2) BC, which had a flexible approach to encouragement and financial subsidies (Beynon *et al.* 2000:18-21). Opencast production increased to nearly 20mt (Figure 6.23), with average output per manshift of 14.6 tonnes in 1988.

*Technical innovation* was introduced in existing mines at a sustained pace to improve productivity and to enter the age of Advanced Technology Mining (ATM) (Winterton 1994). New technologies included "microelectronic control and monitoring technology" and Heavy Duty Face Equipment (HDFE). The percentage of longwall faces using retreat-mining techniques grew from 8% in 1972 to 52% in 1989 (NCB 1973-1990). While technical achievements over this period were impressive, it is noteworthy that mining expenditure peaked in 1981 (Figure 6.3). The industry was living off past investments without sustaining them, thus inevitably fomenting the exhaustion of economic reserves.

The main restructuring element consisted in the closure of higher-cost pits. The performance threshold was a moving target. In times of decreasing markets, it had a tendency to lead to more closures (Leman and Winterton 1991:55). According to Robinson (1988:210), the NCB wished to close pits making a substantial loss. It had, 'in strict accounting terms', an 'overwhelming' case for it. However, it was "by no means obvious that a wider public interest [would be] served by closure". The closures of the 1980s were concentrated in the peripheral coalfields, in sharp contrast with the central coalfields, where most capital injections were targeted. The geography of restructuring thus confirmed established tensions between coalmining regions (Leman and Winterton

1991, Hudson and Sadler 1990, Sadler 2001). Figure 6.2 illustrates the very dramatic closure rate. The restructuring programme attracted attention from the media and subsequently the public. The NCB/BC insisted on the voluntary nature of redundancies. Politics played an important role in mediating the possibility and rate of closures. The implementation of the closure programme had to be carefully weighed against local community discontent, and its potential to affect public opinion, which would eventually play out in the urns:

> "political expediency plays a large part in closure. With a general election looming in the next two years, it can be expected that more pit closures may be put on ice, particularly where collieries are the mainstay of local employment." (*The Guardian*, 21 February 1986, p.2)

Industry consolidation led to a near doubling of average productivity between 1981 and 1990 (Figure 6.3).

#### 6.3.3.5 Innovation strategies

The general attitude to R&D changed in the 1980s. Gradually, Margaret Thatcher began asking questions about the usefulness and purpose of nationalised industrial organisations. When it came to R&D facilities: What is this research for? Who is the beneficiary of this research? (interview Merrick). In the absence of a coal-fired generation capacity expansion programme, most of the research on coal utilisation had unclear development potential. There was also a lack of full-scale commercial demonstration of advanced coal-fired technologies (PFBC, IGCC, etc.). The potential beneficiaries of technologies developed at the CRE (power plant manufacturer and power producers mainly) were also judged too remote from the coal industry for the research to be viable in a privatised future. Under such short-term and narrow criteria, it was difficult to defend the sustained existence of substantial research structures, which were progressively abandoned.

Similar considerations applied to research at the MRDE. Given the scale of industry contraction, there were no clear incentives for substantial in-house research capabilities. The beneficiaries of mining research were the mining equipment manufacturers, so MRDE was closed down. Some of its functions were retained within the new structure of the Headquarters Technical Department (HQTD) in 1989, then Technical Services and Research Executive (TSRE) in 1990 (Durucan *et al.* 2010).

### 6.3.4 Industry strategies – socio-political environment

#### 6.3.4.1 Framing strategies

During this period, state involvement in industry restructuring meant that BC now stood on the Government's side, and so no longer resisted its influence. The politically controversial nature of the reform of the British coal industry required astute justification. The NCB mobilised *framing strategies* to legitimise restructuring, and emphasised great achievements. Productivity improvements were celebrated yearly, and contextualised as outstanding given extreme circumstances:

> "further productivity records" (NCB 1982:3)
>
> "1985/6 has been a year of great achievement for the British coal industry" (NCB 1986:1)
>
> "During the past year the coal industry has faced the toughest competitive pressures in its history. It is therefore particularly gratifying that we have been able to make such substantial advances in our performance. Productivity increased by 21%, and records were achieved by each of our deepmine areas and by the Corporation as a whole." (NCB 1987:1)

During the strike, the industry's public relations strategy was targeted at deflating criticism, and putting forward the thesis of 'uneconomic pits' and 'business sense':

> "It was necessary to run a fairly sustained campaign to put the record straight about Scargill's outrageous claims, and to point out that the industry had a future if only we could get it down to size and get our costs right." (MacGregor and Tyler, 1986:304)

#### 6.3.4.2 Political strategies

The rationalisation of the coal industry also implied huge costs. Securing the support of financial and political actors was difficult, as a history of broken promises had *weakened* BC's *legitimacy*. The Government was reluctant to give away grants to the coal industry. But the eagerness to see BC privatised justified punctual assistance. It became increasingly clear that BC's case for Government support for new and replacement activity was greatly weakened (Chesshire and Skea 1989). The Government was inclined to cover the social costs of rundown and closures (Parker 2000:78-82), and neglected more structural capital injection. The two main components of financial assistance to the industry concerned social grants (including pensions and redundancy payments), and punctual deficit grants (Table 6.3).

**Table 6.3: Grants to the coal industry, £million (real at 2009 prices, using GDP Deflator), Data: NCB/BC Annual reports**

| | Social grants | Deficit grants | Total grants |
|---|---|---|---|
| 1981/82 | 337 | 1201 | 1612 |
| 1982/83 | 350 | 977 | 1358 |
| 1983/84 | 669 | 2166 | 2835 |
| 1984/85 | 447 | 5267 | 5714 |
| 1985/86 | 1147 | 112 | 1259 |
| 1986/87 | 1284 | 623 | 1907 |
| 1987/88 | 979 | 410 | 1389 |
| 1988/89 | 574 | - | 574 |
| 1989/90 | 1114 | 11072 | 13034 |

Crucially in 1989, the NCB chairman engaged in talks with the Government over the financial reconstruction of the coal industry. Parliament approved to intervene to reduce BC's accumulated debt and interest charges. The Coal Industry Act 1990 provided for an impressive £11bn deficit grant (Table 6.3) to cover the write-down of fixed assets, potential liability for miners claims (health and concessionary coal), and accumulated losses from high interest and restructuring (DTI 1993:95). The NCB was grateful for the opportunity provided by a clean accounting sheet (NCB 1990:5).

#### 6.3.4.3 Environmental strategies

Ten years after the Swedish Government's call for action on acid rain, the British position remained reluctant until the late 1980s. Resistance to change was embedded in industrial practices and the established environmental discourse (Hajer 1995), as well as the incompatibility of controls on industry with the broader liberalisation discourse. Fear of increased costs (especially concerning FGD retrofitting) and the expectation of technical fixes (FBC, nuclear, gas, etc.) were more motives to delay action (McCormick 1997, Dudley *et al.* 1985, Hajer 1995).

As pressure mounted, the Government and the targeted industries engaged in active counter-information. In 1983, the CEGB and the NCB jointly funded a £5 million research programme into the problem of acid rain: the Surface Waters Acidification Programme (SWAP). Results were mobilised to reinforce the main discursive emphasis on uncertainties in science and the cost-benefits of abatement technology (Ling *et al.* 2000:254), and "to build a body of information that could be used to deflect criticism." (McCormick 1997:85). The CEGB-NCB coalition's *discursive strategy* had a selective approach to scientific evidence. It capitalised on a major credibility advantage as the

CEGB had been involved in air pollution research since the late 1960s (Hajer 1995:112) and pursued active links with the Royal Society for further legitimation. The CEGB produced a £200,000 'educational' video on acid rain for dissemination purposes (Rose 1990:127-8).

This *discourse* on acid rain was "reinforced by the external influence of the political ideological commitments of Thatcherism" (Hajer 1995:170). Investing in (costly) abatement solutions (FGD or low-sulphur coal) contradicted with commitments to decrease public spending and Government intervention. Achieving significant sulphur cuts with FGD was estimated at around £1.5 billion, while buying time with 'research' cost only £1 million/year (Rose 1990:126). This argument also suited the taxpayer.

As political pressure mounted in 1984, *lobbying strategies* revealed their strength. The rejection of the Select Committee's Report marked "a remarkable victory for the [CEGB] in the face of growing evidence and political pressure both at home and abroad" (*The Observer*, 2 December 1984, p.3).

The first major political change on the acid rain problem occurred in 1986, when Waldergrave (Secretary of State for the Environment) stated that the UK would revise its position on acid rain (Ling *et al.* 2000:249-50). The CEGB planned the retrofit of 6 GW of coal-fired capacity with FGD between 1993 and 1997, and the likely building of up to 8 GW of new capacity equipped with FGD by 2000 (Longhurst 1988).

The Thatcher administration "had finally run out of negotiating space, finding itself painted into a corner by a combination of domestic policy aspirations and the requirements of its membership of the [European] Community" (McCormick 1997:91). The programme succeeded in shifting attention away from the problem, as suggested by Hajer (1995:110):

> "The 1986 decision had taken the sting out of the tail and NGOs had put their campaigning money and manpower elsewhere. Acid rain now had to share discursive space with new issues like the greenhouse effect and the diminishing ozone layer."

Britain subsequently agreed to the terms of the EC LCPD. In June 1988, after rounds of negotiations and hefty *industrial lobbying* to impact "the shape of future UK legislation" (NCB 1987:14), a compromise was reached. Britain would reduce emissions of SO2 by 20% and NOx by 15% by 1993 on 1980 levels. These very low targets were partly negotiated over the earlier promise to install FGD, but British officials later preferred gas-fired plants and low-sulphur coal (Rose 1990:133). By 1994, only 6 GW of coal-fired generation had been fitted with FGD (Parker 1994:61). After 3 years of apparent concessions to the pressures on acid rain, the British solution was determined by the privatisation agenda, and the avoidance of investments:

> "despite seeming to lose every argument, the CEGB probably came close to achieving its original goal. In the end, the environmentalists had almost no impact on real action." (Rose 1990:132)

With respect to the Greenhouse Effect, BC was eager to lobby against an issue that questioned coal utilisation, instead emphasising progress on new generation of coal combustion:

> "British Coal welcomed the Committee's conclusion that, with reference to coal, 'the country cannot afford to turn its back on its largest indigenous source of fuel resources' and the recommendation that, 'in view of its clear economic advantages', the Government 'should ensure that the next stage of work at Grimethorpe is completed.'" (NCB 1990:18)

BC refuted the understanding according to which coal combustion was the most important single source of greenhouse gas emission:

> "British Coal believe that the contribution of coal combustion to the Greenhouse Effect has been overstated." (NCB 1990:18)

## *6.4 1990-1997: The alignment of pressures*

### 6.4.1 Pressures in economic environment

#### 6.4.1.1 <u>Landscape</u>

The energy landscape was fundamentally altered in the 1990s by the liberalisation of energy markets (discussed below).

#### 6.4.1.2 <u>Market shock</u>

The liberalisation of the electricity sector was key to the destabilisation of British Coal. BC's survival had become literally dependent on ESI demand, and loyalty in the face of increasing international competition. Protective agreements had stabilised this market and tempered the rundown of the coal industry. Breaking up the electricity industry dramatically changed the balance of powers, and *triggered the chain of events that led to the near-terminal decline of the coal industry*.

The privatisation of the ESI, implemented from 1990, represented the "most radical reorganisation of any comparable industry (…), long-established and apparently highly stable organizational forms and their technological affiliations were broken down and replaced" (Winskel 2002:564). The generation activities of the CEGB were split up, and passed on to Powergen and National Power. The National Grid Company took over transmission activities. Generation and distribution were opened up to *new entrants*, and market competition.[41] A market was set up to trade electricity – the ‘Pool’ – with bidding on a half-hourly basis. The liberalisation of the ESI *radically changed the environment* of the British coal industry, leading to 1) new determinants of fuel choice and capital investments, 2) a re-evaluation of the necessity to buy British coal, and 3) the emergence of new technical and organisational opportunities.

#### 6.4.1.3 Customer pressure

ESI liberalisation “broke the vertical link with the coal industry” (Helm 2003:176), and created a system geared towards profitability and competitive decision-making, rather than long-term strategic goals. This increased market uncertainties:

> “The coal industry certainly has a future in Britain [in the late 1980s], but it is an uncertain one. Once the British electricity, generation and distribution, is privatised, that future will become less certain still as British Coal’s main customer looks around the world for the cheapest source of coal.” (Turner 1989:166)

Fuel choice and capital investment decisions for power generation became determined by short-term economic prospects, with limited support:

> “Since the technical constraints of coal mining (geological, engineering, managerial) really take several years and much investment to circumvent or change, it is no surprise that the still publicly owned British Coal is inclined to abandon hope for nearly half its existing business. In the old days, it might have hoped for continued and increased subsidies, but those days have passed.” (Posner 1993:82)

The margin for political mediation was reduced. Inevitably, this weakened BC’s ‘commercial’ bargaining power, and ability to negotiate favourable contracts. The electricity spot market and new investment practices led to the downgrading of coal in the merit order of power generation, implying new constraints for the planning and operation of coal-fired power stations (Whittington and Bellhouse 2000).

#### 6.4.1.4 New entrants

Between 1990 and 1994, the CEGB manifested an eagerness to import more coal. From 1994, while the demand for coal plunged, the relative share of imports skyrocketed. Imports were above 10mt since the 1984-5 events, and around 20 mt from 1991. In relative terms, imports contributed 4%, 10%, 21%, 34%, 53% and 71% of British coal use in 1983, 1988, 1993, 1998, 2003 and 2008 respectively (Figure 6.23).

---

[41] This led in the 1990s to the internationalisation of the British energy market, with the entrance of multinational corporations (MacKerron 2001).

"The 'sequencing of events' (…) has been bad luck for British coal, and very bad news indeed for 20,000 miners, their families, and the districts in which they have been working. No doubt, by contrast, this has been good luck for some new mining ventures in the Americas or Australia, using new technologies, new sites, mobile labour forces." (Posner 1993:82)

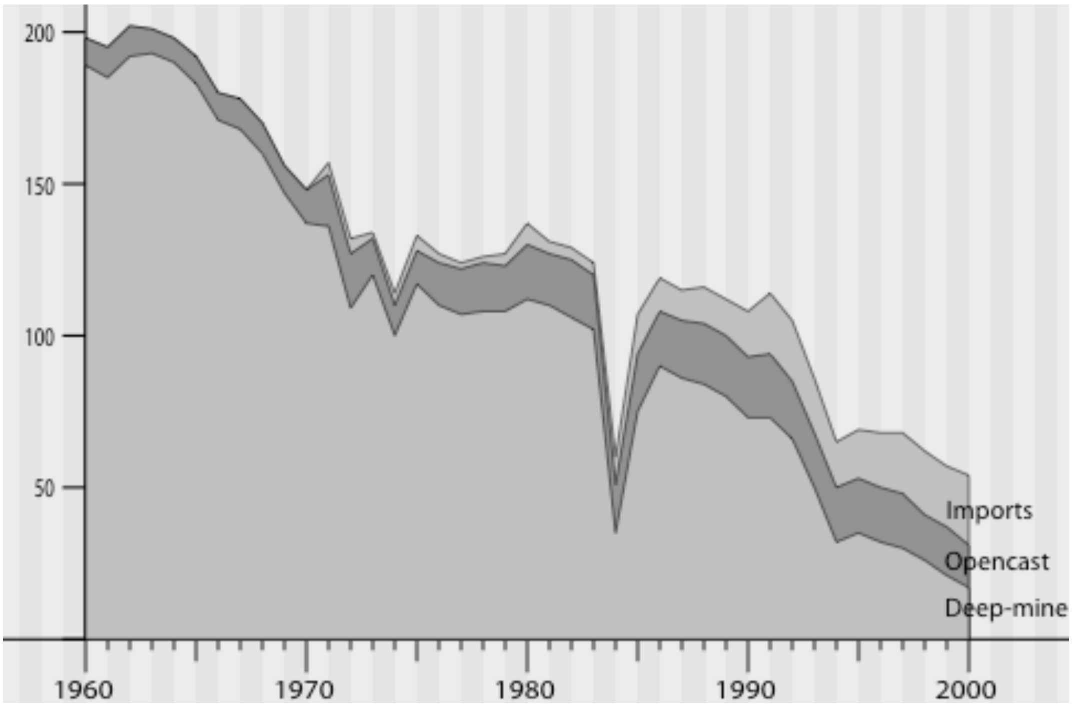


**Figure 6.23: Provenance of coal in the UK (mtons)**

The Coal Industry Act 1990 raised the maximum size for private mines, thereby widening the door for new entrants in the domestic coal market (Beynon *et al.* 2000). In this context, opencast mining and imports remained very stable while deep-mining collapsed.

### 6.4.1.5 Technological alternatives

The introduction of competition and private ownership transformed the way investments were planned, and in turn technological choice. According to Chesshire and Skea (1989:62), new generating options were becoming more attractive, including "plant life extension; high efficiency combined-cycle gas plant; and, potentially in the future, advanced coal combustion technologies".

New gas-fired generation technology *broke through* in the 'dash for gas' of the 1990s, when regulations limiting the use of gas for power generation were lifted. Combined Cycle Gas Turbines (CCGTs) became the prime choice for investment in the early years of market competition, uncertainty in energy markets, the quest for rapid returns on investment, and increasing environmental commitments. *New entrants* in the generation

market invested in this cheaper option and were quickly followed by NationalPower and Powergen, who "built CCGTs to defend their market share" (Parker 1994:14).
The conjunction of the new criteria of a liberalised electricity market, a renewed interest in capital stock replacement and expansion (Figure 6.4), and the availability of plentiful gas supplies[42] and innovative low-risk technology led to the 'dash for gas'. By 1997, 13 GW of gas-fired capacity had been built, 5-6 GW were under construction. Gas accounted for 30% of electricity generated in England and Wales (Sadler 2001:9, see also Figure 6.1) – or, roughly the displacement of the equivalent of 50 million tonnes of coal.
The dash for gas had a game-changing influence on fuel choice within the given infrastructure (Winskel 2002). The 'take or pay' gas contracts tailored for CCGTs ensured long-term commitment to gas (Posner 1993:80-1), to the detriment of coal. While the dash for gas had started almost by accident, and largely unexpected, it soon became the strongest pressure facing the coal industry:

> "The real threat to the British coal industry now lay not so much from imported coal as from displacement in its main market by an alternative fuel source." (Sadler 2001:9).

Gas came to represent everything that coal was not: cheap, exciting, low-sulphur, high thermal efficiency, low lead times, responsive to market changes, etc. It was both made possible by, and came as a further justification of, the liberalisation agenda.
The Thatcher administration also had a clear interest in nuclear energy. On the way to ESI liberalisation, the high cost of nuclear energy was revealed to the public. No one was willing to take the financial risks involved on board. The Government provided protective measures. Past investments were written off (Helm 2003:191), and a number of mechanisms ensured that nuclear costs would be met.

### 6.4.2 Pressures in socio-political environment

#### 6.4.2.1 Landscape

Since the early 1980s, British policy and regulatory processes have been dominated by the search for efficiency, with market competition as the preferred solution (MacKerron 2001:553). In the 1990s, the liberalisation of the ESI and later of British Coal marked

---

[42] While almost ¼ of the gas used in the 1980s was imported, this proportion fell below 10% from the 1990s.

an irreversible shift in the public administration of energy industries. The two industries were radically re-organised in a highly politicised (and ideologically loaded) process.

**6.4.2.2 <u>Political crisis</u>**

BC had emitted warnings about likely consequences of ESI privatisation. Continued closures were foreseeable as market and productivity gains slowed down. In autumn 1991, the first Rothschild Report to the Government suggested a dark picture of the demand prospects for coal, such that only 14 pits would survive,[43] whether privatisation plans went ahead or not. On October 13, 1992, Neil Clarke (Chairman of BC) and later Michael Heseltine (Board of Trade) announced the closure of 31 out of the 50 existing pits within 5 months, and 30,000 direct job losses (Parker and Surrey 1993). This was justified by a background of record expected reduction in power station demand: from 70 million tons in 1991, to 40 million tons in 1993, and 30 million tons subsequently. It was no longer possible to simultaneously encourage competition and diversity in the electricity sector *and* maintain outlets for the coal industry (Chapman 1999:197).

The issue was debated widely in the papers, and spurred a popular movement as it entered the public sphere:

> "The bungled announcement of the closure of 31 pits and 30,000 sacked miners triggered a spontaneous outburst of popular revulsion against the Government unprecedented in the Tories' 14 years in office (…) up to a quarter of a million people demonstrated in London twice one week (…) opinion polls continued to show more than 90 per cent majorities against pit closures and a campaign of protests and demonstrations carried on throughout the winter in the Midlands and the North." (*The Guardian*, 7 June 1993, p.22)

The issue entered the political arena. The pronouncement sparked a "backbench revolt" (*The Independent*, 18 October 1992), and "provoked a furious political reaction":

> "Tory MPs were besieged by angry constituents and the Government was forced to retreat in the face of a backbench rebellion" (*The Guardian*, 7 June 1993, p.22)

There was a generalised sense that the scale and speed of the announced rundown was not necessary. In a nation-wide controversy, fingers were pointed at Government mishandling of the situation, leading to a political crisis. The president of the Confederation of British Industries (CBI), while lauding Government's attempts to revert the recession with growth measures and incentives for new industries, heavily

[43] It reached these conclusions by focussing on the market for coal, rather than the supply capacity for a given 'competitive' price (Chapman 1999:196-7).

criticised the "'irresponsible, insensitive and maladroit' handling of the pit closures", which he qualified as a 'monumental cock-up' (monthly CBI meeting reported in *The Independent*, 22 October 1992, p.28).

The non-valuation of the social consequences and the lack of consultation provoked indignation. With such strong opposition, a re-evaluation was necessary. Heseltine announced a moratorium on 21 of the 31 proposed closures (DTI 1993), and a number of reviews were set up.

In practice, the implementation followed pretty much the October 1992 programme, the planned closures were spread over two years, and the closed pits became available for private investors. A small proportion of the £500 million subsidy was delivered. So, the whole review process had a purely symbolic function in practice:

> "British Coal managers believe that the Government's review of the coal industry, including its white paper, changed absolutely nothing. The situation is as it was at the end of 1992 – except that projected markets for coal are now even smaller." (*The Observer*, 14 August 1993)

the review was met by very little public or political reaction, which reveals the shifting attention of public opinion and mobilisation:

> "All this has been executed with scarcely a murmur from either government or opposition, media or trade unions." (*The Guardian*, 7 June 1993, p.22)

#### 6.4.2.3 <u>Policy reform</u>

Although it had been an objective of the market reform programme, the privatisation of BC was long held back. Steps had been taken towards reducing BC's monopoly position, allowing for new entrants in British coal production, especially in opencast mining. After ESI liberalisation, "John Major's government began in 1991 seriously to prepare for coal privatisation" (Parker 2000:210). Output had to be reduced to envisage the sale. The 'dash for gas' became the trigger and imperative justification for rapid industry contraction. From there on, the Government demonstrated eagerness to get on with the privatisation agenda:

> "The Government intends to bring forward the necessary legislation as rapidly as possible." (DTI 1993:9)

In 1993, preliminary regulation allowed the Government to get rid of excess capacity and to 'test the water' by putting unwanted pits on the market (Parker 2000:140). In December 1994, the coal industry was privatised. Administrative functions were transferred to the Coal Authority. Assets were sold in 5 regional packages. RJB Mining (a substantial player in opencast mining, under license form BC) acquired the 3 English coal regions, Scottish Coal acquired the Scottish assets, Celtic Energy acquired South Wales mining, and smaller players acquired individual collieries. RJB dominated the scene with 80% of UK output.

The once glorious policy objective of coal privatisation (the 'ultimate privatisation' in the words of Cecil Parkinson, Secretary of State for Energy), was implemented hastily, following the 'coal crisis':

> "There is no doubt that the privatisation of the British coal industry failed to live up to the Conservative Party's expectations (...) The rumours and doubts over the process of the sale invited images of second-hand car dealers rather than something in which the nation might glory (…) It had been a market transaction; nothing more." (Beynon *et al.* 1999:19)

The Government had in theory had gotten rid of the 'economic burden' of the coal industry, but it "failed to depoliticize the industry, or indeed to secure its longer-term future." (Helm 2003: 176). It would continue to provide strong assistance in the form of grants, environmental liabilities, and oversight for contract negotiations.

#### 6.4.2.4 <u>Environmental problems</u>

According to Dryzek *et al.* (2003), environmental questions in the UK had been largely determined by collaboration between industry and government regulators, with little space for the influence of environmental groups. Environmental pressures increased in intensity as the energy liberalisation project was implemented. A number of converging dynamics were favoured by the context of energy market reform: 1) international (especially EC-level) environmental policy pressure (Newbery 1993), 2) the dash for gas and the increasing availability of cleaner energy sources more compatible with environmental demands, 3) receding political influences in favour of coal use (Parker 1994:72), 4) the mobilisation of positive framings and narratives to "present the new electricity industry as something more than a private monopoly replacing a public one" (Beynon *et al.* 1999:10), and 5) the competitive and political strategies of the electricity industry willing to reduce its dependence on BC. Environmental pressures on the coal industry not only increased in the 1990s, but they were also coupled and aligned with a series of highly adverse pressures. The alignment of environmental problems and the economic dynamics of privatisation were merely coincidental, but enhanced each other (Collier 1998:100-2).

Policy commitments to curb SO2 and NOx emissions required a solution. Neither Government nor CEGB were keen on implementing the costly FGD programme. The import of low-sulphur coal imports was not politically sensible given the problems of the British coal industry. The replacement of coal-fired capacity by gas provided an ideal, non-controversial means to fulfil SO2 and NOx targets. As the acid rain pressure became more acute, abatement options abounded. The strategy to buy time had proven successful for industrial interests. The UK signed the second Sulphur Protocol in 1994, committing to Sulphur reductions of 50%, 70% and 80% on 1980 levels by 2000, 2005 and 2010 respectively (Churchill *et al.* 1995:184), which were relatively easy targets to achieve with the CCGT technology (MacKerron 1999).

### 6.4.3 Industry strategies – economic environment

The conjunction of ESI liberalisation, the coal import threat, the dash for gas, and growing environmental pressure led to the alignment of forces for change highly unfavourable to the coal industry. This rapidly changing context, managed by a maladroit Government, suddenly wiped out the foundational support structures and regime supporting the British coal industry. The bulk of BC's strategy in this context of rapid change was mobilised in an effort to *make sense of* and *cope with* market changes, securing ongoing protection, and rapid contraction in view of privatisation.

#### 6.4.3.1 Market collapse

The coal crisis revealed the full extent of the consequences of recent energy policy choices. It was now clear that the market for coal would *collapse* (which it did between 1991 and 1997), and that the industry would have to close mines at a dramatic pace. British Coal headquarters were nicknamed 'Chateau Despair' during the coal crisis, illustrating the *loss of hope* in the future. BC was forced to accept now inevitable contraction: its new chairman (Neil Clarke) confessed the need to cope with "the bear squeeze on demand" (*New York Times*, 14 October 1992).

Since the coal crisis, BC's objectives were re-evaluated:

> "the Corporation had to address the fundamental shifts in the market for power station fuels while positioning itself to take maximum advantage of the altered market opportunities which remained (…) [and] pressing on with the immensely complex task of preparing the industry for its return to the private sector." (NCB 1994:5)

#### 6.4.3.2 New ownership

When handing the industry over to private investors, BC was confident that the few remaining mines would be profitable, and given the four remaining years of contracts, would provide the foundations to "secure the longer term future of the industry" (BC 1994:7). Indeed, dramatic contraction and restructuring since the coal crisis had brought the industry back in line with its reduced market, and this *ahead of* privatisation. The Government had left a clean financial sheet for the new owners (Parker 1994:49, Table 6.3).

Richard Budge, CEO of RJB Mining, brought a new managerial style to British Coal. He provided incentive structures for miners (bonuses, free shares) and expanded the industry's involvement in opencast development and production. Productivity increases were achieved in the first few months, substantial profits were recorded in the first semester (Beynon *et al.* 1999:19). But this initial success was short-lived. RJB shares peaked in 1996. Between 1996 and 1997, sales dropped from 42mt to 26mt, and profits from £171m to £40m. (Sadler 2001:25), putting it in a difficult situation:

> "The company faced a difficult choice between three options: managed decline, vertical integration into power generation, and overseas expansion" (Sadler 2001:25).

According to Beynon *et al.* (2000:213), "RJB stuck to what it knew best – persistent lobbying for Government support in the face of an impending disaster" (see political strategies).

#### 6.4.3.3 Commercial strategies

The only way to retain some of the dramatically reduced market was to negotiate contracts with the power generators, ensuring a threshold of minimum purchases. Ahead of ESI privatisation, contracts were signed up to 1993, securing minimum sales of 205 million tonnes for the new generating companies over 3 years: at least 70 million tonnes for 1990/1 and 1991/2, and at least 65 million tonnes for 1992/3. Government oversight of the process was crucial (Parker and Surrey 1993:403). However, BC's reduced bargaining power meant that it had to concede significant price reductions in real terms (NCB 1990:4-11). A second wave of contracts with the privatised ESI was negotiated in the midst of the coal crisis, to cover the years 1993-98. These contracts reflected BC's weakened bargaining position: they covered 40 mt in the first year, declining to 30 mt. Unable to persuade NP and PG to buy more coal, BC was forced to continue contraction. The relief provided by contracts was highly valuable but not sustainable, as they were each time negotiated in worse conditions, and "by 1998 the threat of import competition would inevitably re-emerge" (Helm 2003: 178).

Towards 1998, RJB Mining was only able to reach some – if short-lived – contractual commitment from generators (PowerGen, Eastern and National Power) and delay the 'rush from coal' thanks to the moratorium on new gas power stations introduced in 1998 (Sadler 2001:10-11).

**6.4.3.4 Productivity increases**

Substantial closures were implemented. Between 1990 and 1994, the number of deep mines owned by BC fell from 65 to 16, while total employment was cut from 49,000 to 7,000 (Figure 6.2). The rate of contraction reached unprecedented levels, leading to impressive productivity improvements (Figure 6.3), as only the best performing pits survived (Glyn and Machin 1997). BC, "by 1992, had achieved dramatic increases in productivity and a capability of competing with imports – unlike the remaining coal industries of other EC countries which have survived by virtue of subsidy." (Koerner *et al.* 1995:666).

The involvement of the privatised industry in opencast mining changed substantially. The large coal companies (RJB Mining, Scottish Coal and Celtic Energy) started to develop opencast sites, instead of contracting them to smaller companies (Beynon *et al.* 2000:31-33).

**6.4.3.5 Investment strategy**

The level of capital expenditure in deep mining had fallen consistently since 1980 (Figure 6.3). This jeopardised industry long-term survival, given the looming pressure of resource exhaustion. With a bleak market situation, BC was "very short of finance" in the 1990s (Posner 1993:81). RJB Mining continued investing in deep mines, but at a highly reduced level (HoC 1998:83). The deep-mining industry rapidly exhausted its best quality reserves. Inevitably, productivity and output levels declined dramatically from 1995. The Review of energy sources for power generation (DTI 1998) drew a dark picture of British coal reserves, predicting a collapse to 10 mtonnes of deep-mined coal by 2010 if no new mine was opened. This was the legacy of past contraction and lack of investment. Even the glorious superpits were to be closed (Beynon *et al.* 1999).

RJB did diversify in overseas ventures, investing £12 million in an Australian coal company (CIM). This strategic move was justified by weakening assets:

> "In the UK our business is at best a dwindling asset base, because we will be unlikely to see coal production increasing. My duty as the Chief Executive is not just to manage the reducing asset, it is to look for potential expansion" (Richard Budge answering to Trade and Industry Committee, HoC 1998:79)

This diversification attempt was however not highly significant in financial terms.

### 6.4.4 Industry strategies – socio-political environment

#### 6.4.4.1 Lobbying strategies

BC warned the Government of the devastating effects of new gas power stations resulting from the ESI liberalisation project (Chapman 1999:196), but lobbying for protection against the dash for gas was not highly effective:

> "British Coal's chairman, Neil Clarke, met Heseltine and Eggar at the DTI on 3 June in a last-ditch attempt to press the case for coal, but made no progress. Although the Government was beginning to see the impact of the dash for gas, it would not mitigate its effect on the coal industry. Further, it would not cease to approve new gas power stations: in August, two new licences were granted." (*The Independent*, 18 October 1992)

With the political change of 1997, new opportunities arose

> "understandably there was a major coal industry campaign to slow the 'dash for gas', directed at the new Labour Government and led by the major coal producers, in particular by RJB Mining (UK) Ltd" (Glasson and Chadwick 2000:230)

The coalfield communities campaign (CCC), regrouping local authorities from mining districts, lobbied for more protection. In the late 1990s the coal community lobbied against tighter environmental policies, for restriction on the 'dash for gas' and against the 'unfair competition' of European subsidies to coal exporters.

An Energy Review (DTI 1998) reaffirmed the Government's commitment to market competition in power generation, but recognised the possibility of market distortions. Indeed, if unabated, gas-fired generation could grow to represent between 50% and 80% of electricity supply, thus threatening diversity of fuel supply. There was also some evidence that FGD retrofitting was cheaper than new CCGT.

A moratorium on new CCGT was issued in 1998, justified by energy security concerns. The fuel policies of the late 1990s stabilised coal use in power generation around 50 mtonnes (Figure 6.4). This only provided short-term relief for RJB Mining. Overall, the Energy Review (DTI 1998) "envisaged a very clear medium to long-term future for the coal-mining industry in Britain: near-terminal contraction" (Sadler 2001:11).

The conditions reached in the early 1990s (more environmental policies expected *on top of* the liberalisation agenda and LCPD) not only have weakened coal's position, but virtually removed all reasonable hope for investment in coal-fired generation in the medium term. The moratorium on CCGT halted the decommissioning of coal-fired capacity and the incentives for FGD fitting provided incentives for pollution abatement in coal-fired generation.

## *6.5 Analysis*

This period stands out as one of unprecedented contraction of the coal industry (see Figure 6.2), in a process that was highly politicised and confrontational. The main pressures for *contraction* of the coal industry have been exerted within the market domain. These pressures have however been strongly mediated by an emerging political agenda guided by normative and ideological prescriptions. The *new institutional frame* for energy markets introduced in the 1980s, centred around liberalisation ('efficient' market competition, capital injection and 'diversity' of energy sources), provided solutions to what had been identified as recurrent problems (monopoly power, energy security, inefficiency and market protection, environmental problems). In this process, however, a number of voiced concerns have been actively suppressed or left unattended (the power of trade unions, the vitality of mining communities, the maintenance of long-term indigenous energy supply, environmental modernisation, consumer benefits, etc.). The resulting *re-configuration* led to the *extreme* alignment of pressures against coal. Throughout the destabilisation process, the erosion of slack and essential resources further reduced the industry's ability to re-create itself (see 6.5.4).

The destabilisation process was also characterised by a strong embedding in landscape and niche-level changes. The decline of the coal industry has occurred at the confluence of these profound transformations, which accelerated and provided direction to the contraction process.

### 6.5.1 External pressures

The case study shows that the British coal industry experienced multiple pressures in its economic and socio-political environments. These pressures are summarised in Table 6.4, and analysed below.

**Table 6.4: External pressures for change exerted on the British coal industry, as located in economic and socio-political environments (the sign (+/-) indicates whether pressures are challenging/enhancing industry stability, the value (+, ++, +++) provides an indication of the importance of the pressure, [*] indicates a shock, [L] indicates a landscape dynamic)**

| | **Essential supply-side resources** | **Shrinking markets** | **Changing markets and preferences** | **Technological competition** | **New entrants** | **Normative contestation** | **Public opinion and discourse** | **Political pressure** |
|---|---|---|---|---|---|---|---|---|
| **1967-73** | (++)<br>reduced financial support | (+)<br>Market collapses but ESI expansion | (0/+)<br>CEGB frustration | (+)<br>oil-fired & nuclear | | (+)<br>'coal outdated' | (+)<br>disruptive unions & early acid rain | (+)<br>Govt scrutiny but ESI protection |
| **1973-81** | (-)<br>stabilised outlook but high labour costs and financial | (-)<br>oil crisis demand increase but end of ESI growth | (+)<br>CEGB tensions and later price pressure | (--)<br>oil crisis and nuclear delays | (+)<br>international coal regime at doorstep, opencast and import threat | (-)<br>energy security, enthusiasm for a coal future | [L]<br>energy crises impact g$^{al}$ public | (-)<br>Plan for Coal but early denationalisation pressure |
| **1981-90** | (++)<br>erosion of financial support; erosion of cheap reserve | (++)<br>ESI growth halt; oversupply | (+++)<br>CEGB tension & import threat; price pressure; oil price collapse (1986) | (++)<br>new nuclear capacity on stream; strike proves coal dispensable | (++)<br>international coal price war; opencast & imports increase | (*/++)<br>Great Strike | (+)<br>coal industry framed 'sick'; environmental concerns increase | (+++)<br>market ideology; restructuring; coal politics; acid rain political pressure |
| **1990-97** | (+++)<br>extreme contraction rate; end of support | (+++)<br>market collapse | (+++)<br>ESI liberalisation: radical environmental change | (+++)<br>'dash for gas; capital-intensive generation dislike; nuclear increase | (++)<br>new generators | (+)<br>environment as new constraint | (*/-)<br>coal crisis shocks opinion | (++)<br>ESI liberalisat$^{o}$; coal crisis: political 'cock-up'; BC privatisat$^{o}$ |

The period studied stands out as the theatre of a substantial pressure, especially during the 1980s and 1990s. This was however expected in a mature industry with a history of decline and survival prospects based on compromise. The case displayed *extreme variations* (ups and downs) of external pressure. There was indeed a striking balance difference between the relatively positive context of the 1970s, and the gloomy 1980s. Both instances can be related to major swings in commodity prices (1973 oil shock, 1986 oil price collapse), and are thus illustrations of the re-defining nature of shocks and transformations in the landscape of industries (here economic).

As a next step, I aim to draw conclusions about the relative significance of various pressures. The most important pressures leading to the industry's destabilisation arose from constraints on 1) *essential industry resources* on the supply side and 2) *technological competition*, in a context of 3) weaning *market growth* and 4) *political pressure* for market reform and industry contraction.

1) The very low level of capital injection in basic infrastructure, reduced financial and political legitimacy, and inherent resource exhaustion, led to the erosion of the

industry's *essential resources* (coal reserves, financial support), and jeopardised its medium- and long-term prospects.

2) The industry faced a sequence of *technological challenges*: a) within coal production, a new *competence-destroying* international coal regime – relying on a new set of opencast mining technologies and capabilities – redefined the nature of competition exerted on British coal when protective barriers faded from the mid-1980s, and b) within power generation, *technological alternatives* competed with coal-fired generation (first oil and nuclear since the 1960s), and then gas-fired CCGTs substituted for coal in the 1990s.

3) While the British coal industry had captured a substantial share of the power generation sector, expected growth did not materialise in the 1980s, and led to *market collapse* when alternatives kicked in.

4) The particular importance of the *political pressures* is related to a) strong political embeddedness due to the industry's inherited nationalised status, b) the raised strategic importance of energy from the 1970s, c) the political project of liberalisation (joining together political ideology and market pressure), and d) the resulting social/political problems. Political intervention in the industry amplified existing market uncertainties by removing protective barriers, but also provided coherent signals as to future direction.

Contrastingly, *normative contestation*, *public opinion* and *discourse* played only a marginal role. While activists and pressure groups did intervene in the socio-political environment of the coal industry (on environmental questions, worker claims and conditions, opposition to market reform), their ultimate influence over the course of events remained limited and highly dependent upon compatibilities identified with the prevailing political discourse.

However, normative and ideological concerns originating in the landscape *did* influence the industry's destabilisation trajectory significantly. The deep market reforms implemented in the 1980s and 1990s radically redefined the environment of energy industries, providing an ideal *opportunity for the alignment of destabilisation pressures*. In this inherently political process, an emerging *normative discourse positioning* on the role of the state in the regulation of markets and industries provided an ideological basis for policy reform and a policy paradigm shift (Mitchell 2008). The industry's environment and its basic principles have been intentionally reshaped from the outset, in the rigorous and cautious implementation of the market reform agenda, and provided the basis for a transition from the socio-political considerations of a nationalised industry to the competitive imperatives of a 'free' market. This case thus lends some support to the argument that *normative aspirations and ideological change can actively shape transitions*.[44] It is important to note that these changes emerged in the political landscape but penetrated the industry's direct environment.

The case also stands out for the importance of *landscape pressures* and *shocks*. In the 1970s, the energy landscape was dramatically altered by the oil crisis, which redefined the role of energy in society, but also the competitive structure within the overarching fuel and power regimes. An international coal regime emerged in this context, harnessing landscape transformations in civil engineering technology and international trade rules (globalisation), to compete with the existing coal regime. Macro-political and ideological concerns about British nationalised industries (and coal in particular) emerged long before leading to the imposition of deep structural changes of the 1980s. The implementation of market reforms in the 1980s and 1990s marked the institutionalisation of a solution to what had been identified as problems in industry structure and performance – and thus a direct interference of landscape with industry

### 6.5.2 Interaction between pressures

The *immediate cause* of industry destabilisation was the *radical market change* brought about by the ESI liberalisation, which put a definitive end to the historical commitments of the industry's principal customer, and opened a *window of opportunity* for competing industries and technological options to break through. So this case stands out as one in which the regulation of the economic framework has led to the re-configuration of the economic environment, leading to the rapid contraction of the industry, and thus reveals a mechanism by which socio-political transformative forces can lead to the *alignment of destabilisation pressures* across multiple environments.[45] Most of the pressures unleashed in the 1990s had been *gradually building up* (reduced competitiveness,

---

[44] It should be clear from the above that societal and political forces of change did not play out alone, but rather were articulated around existing market pressures. Additionally, the paradigm shift in economic policy had major implications for numerous industries.

[45] Strong cautions however apply to this statement, as the market reforms orchestrated by the Thatcher Government were of a radical nature (i.e. a rare occurrence in practice), and have been implemented in stages with remarkable determination, rigour, caution and coherence (see for instance Parker 2000 and Helm 2003).

customer dissatisfaction, international coal regime emergence, more opencast, erosion of political and financial support) and were subsequently legitimised and strengthened, while others *emerged* from the newly created opportunity structures (dash for gas, environmental concerns). The forces of change *intensified* in the 1980s. They *accelerated* in the 1990s with the removal of protective barriers (direct support, import restrictions and contracts).
On a more *specific* level, I find many interaction mechanisms between pressures. For each period, I summarise these and graphically represent interactions in a multi-dimensional space.[46] In this case, the length and number of steps involved in the interaction chains are striking.

***1967-1973.*** The collapse of the non-power market and the negative framings of coal provided the background to the expansion of coal-fired generation. The White Paper on Fuel Policy in 1967 institutionalised the 4-fuel economy and the collapse of the non-power market for coal. This policy framework provided a *stable policy landscape* for the *alignment of pressures* in the economic environment, leading to clear negative signals: 1) reduced financial support, thus degrading the industry's capital structure, 2) the encouragement of the nuclear and oil industries, thus intensifying market competition within power generation. In the context of depressed markets for coal aside from power generation, lasting commitments to coal were however secured by the accumulation of substantial coal-fired generation capacity. Degrading labour relations led to important miner strikes.

[46] The keys to these figures have been provided in footnote 24 in chapter 5.

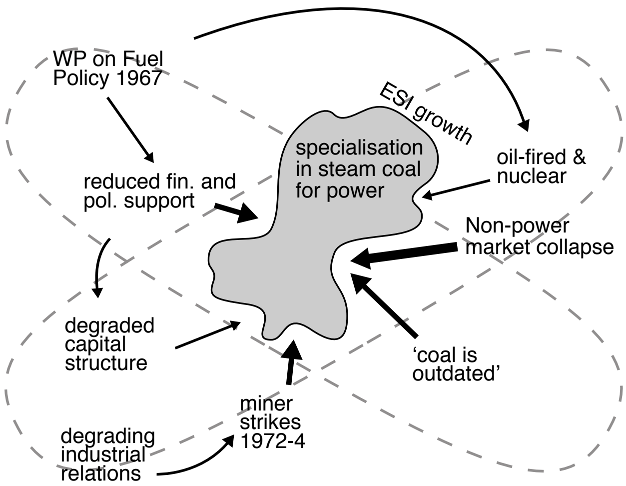


**Figure 6.24: Pressure interactions 1967-73**

***1973-1981.*** An *extreme event* (oil crisis) fundamentally redefined the destabilisation context, and the assumptions regarding coal's positioning. It influenced a) the industry's economic environment by damaging the competitive position of the main alternative, b) its socio-political environment as it reconfigured the conditions of political (and financial) support and expectations in favour of coal, and c) the public through cultural anxieties leading to demand reductions. Coal rapidly regained strategic and symbolic relevance. Medium-term *stabilising commitments* were secured (Plan for Coal). The coal regime was strengthened by a seemingly hopeful outlook, which masked long-lived dissatisfactions and liberalisation ambitions. Meanwhile, a new international coal regime had *emerged* from new technological and market opportunities worldwide, but proved no direct threat as import restrictions were applied. Tension with the industry's main customer arose from a feeling of captivity.

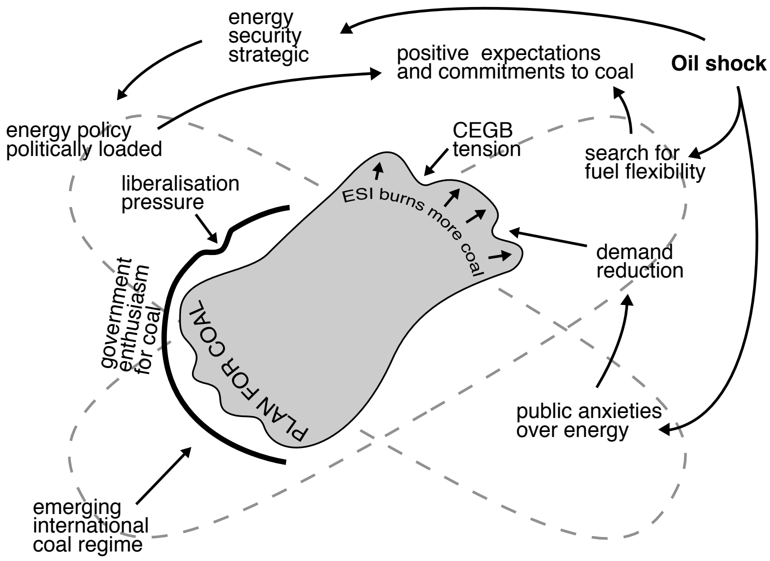


**Figure 6.25: Pressure interactions 1973-81**

***1981-90.*** The macro-economic and political contexts changed again in the 1980s, with the consolidation of political aspirations for liberalisation and market reform. These landscape developments penetrated the industry's environments, via a new pervasive policy discourse and practice. Political and financial support became limited and conditional on the industry's deep restructuring: the 'sick' industry had to acquire a culture of profitability and get rid of its resistive attitude. Internal resistance to change was crushed in a heavily politicised context, which accelerated the implementation of radical market and organisational reforms towards its privatisation. The robustness and coherence of the ideological framework, and the determination in its implementation provided an ideal frame for the *alignment of market pressures*. The active dismantling of slack and support structures prevented the industry from pursuing promising innovation and diversification pathways. The oil price collapse *reinforced and accelerated* this destabilisation context, decisively damaging British Coal's competitiveness and perceived strategic importance. The tardy *penetration* of new environmental problems in British political and public spheres added pressure in the landscape.

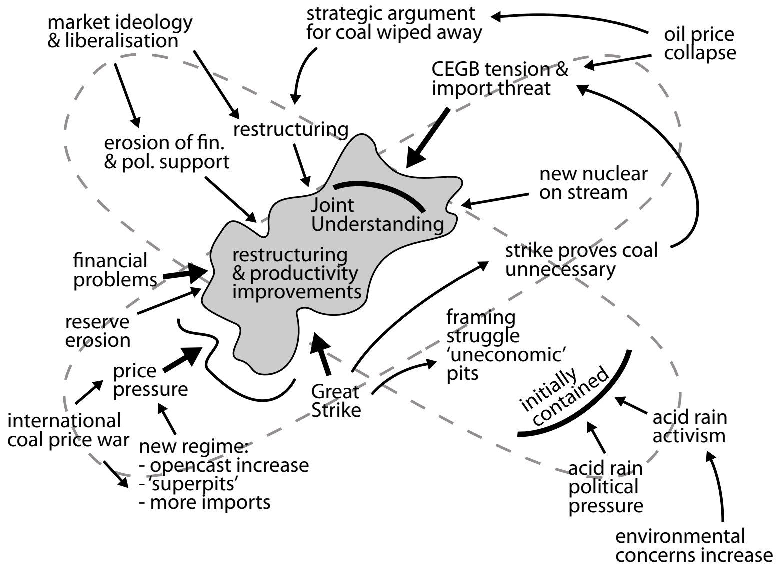


**Figure 6.26: Pressure interactions 1981-90**

***1990-97.*** The ESI liberalisation was decisive. Based on the market ideology, it radically changed the market for British coal, *intensified existing pressures*, and created a frame with a clear direction for the *alignment of existing pressures*. It destabilised existing norms and beliefs in the energy domain, and provided new ground for the development of technological competition. A novel technology (CCGT), put forward by new entrants in the power sector, quickly became the most attractive proposition in the newly transformed environment, and recursively changed the rules of the electricity regime. The 'dash for gas' was interpreted as a demonstration that liberalisation 'works', a discourse that was opportunistically *coupled* with a newly adopted interest in environmental issues. The new framework also opened up the market for imported coal. So, new technologies and new entrants could exert their (nearly) full pressure upon the British coal industry, leading its market to *collapse*. Without political support, and awaiting its own privatisation, the British coal industry underwent extreme contraction. The 'rush from coal' (Sadler 2001) left behind a radically reduced industry in private hands. Deep-mining gave way to an increasing proportion of opencast and imports.

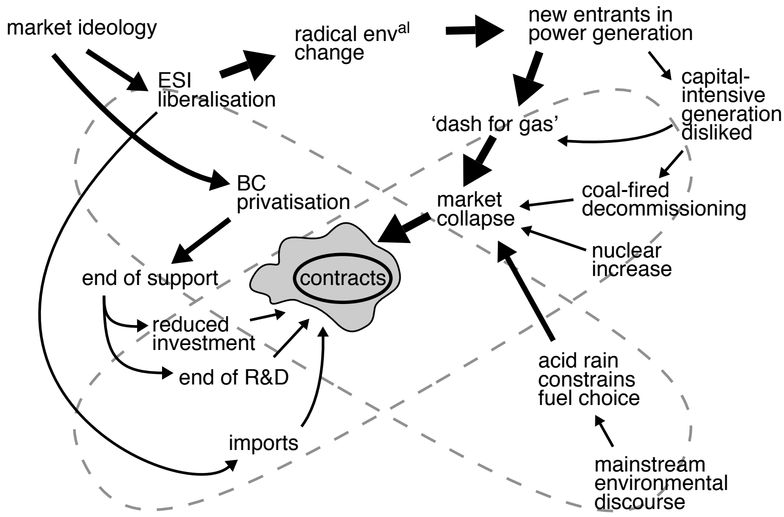


**Figure 6.27: Pressure interactions 1990-97**

So, the destabilisation process has been characterised by the co-evolution of multiple pressure streams, which were aligned at different points in time. The destabilisation process intensified during the 1980s, and accelerated in the 1990s, leading up to major market reform, the dash for gas and the rapid decline of the British deep-mining industry. Pressures initially increased on multiple fronts, but were then articulated and aligned via a coherent environment-changing policy framework operating at the level of socio-technical configurations (interlinkages across industry environment and landscape). Lasting problems and dissatisfactions with coal were coupled with a new 'solution' and vision for the future of energy, thereby creating the opportunity for its own actualisation. The articulation and enactment of the radical reform fundamentally changed the rules of the energy system, leading to its re-configuration, dismantling the coal industry's support structures, and opening up opportunities for new entrants.

Furthermore, this case stands out for the salience of two processes:

- radical policy intervention and heated politics;
- multi-level dynamics involving shocks and landscape trends.

**Political mediation**

The destabilisation context has been significantly articulated by political ambition to see the industry become competitive or else decline. The policy reform process joined long-lived problems (mostly economic) and articulated them via a coherent transition discourse – based on neo-liberal ideology – that became the crux of the destabilisation process. Three features of this articulation and coupling process stand out as crucial: 1) the narrowing down of the scope of issues involved, 2) the alignment of previously disjoined problems with the elaboration of a legitimated narrative for change, and 3) system-wide re-configuration.

1. The formulation and enactment of the neo-liberal view of the world provided *directionality* for alignment in a turbulent industry environment. The primacy of (short-term) competitiveness criteria and the abandonment of the industry's social and strategic functions formulated the governing principles of the coming transition: without protective support, only economic selection criteria would matter. Price signals and economic issues became the prime determinants of the industry's future. The political agenda and its implementation provided a new frame for the interpretation of external signals (both for incumbents and for new actors). Newcomers were thus encouraged to invest in build-up activities. The now overtly dispensable industry faced the quasi-unrestricted pressure of customers, new entrants, technological alternatives, and activists against acid rain, for which the coming downfall of British deep-mined coal brought new opportunities.[47]
2. Beyond narrowing down the selection criteria at play in the industry's environment, the politics of coal's end also crucially *coupled newly reframed problems with a clearly identified solution*. The neo-liberal discourse capitalised on long-lived dissatisfaction with the industry's economic performance, its privileged nationalised status and the disruptive political power of unions to make a case for structural reform. Coal was to ascribe to this new logic and become a competitive business. In practice, this meant that it should have positive balance sheets and that its size should be radically reduced, along with all excessive costs. Lasting taboos and untouchable privileges were thus broken. The dismantling of coal's economic and political monopoly was a highly political process that implied the imposition of new managerial methods and objectives.

---

[47] However, long-term policy programs are also vulnerable to sudden environmental change when fundamental assumptions are questioned. This has been the case with the oil shock that reverted the institutionalised move away from coal.

3. Economic policy reform is an important source of *interaction* that may involve the translation of societal ideals into profound changes to framework conditions in the economic environment. In this case, the scope of the policy initiative led to radical environmental change that cut across established logics and opened up opportunities for system-wide *re-configuration*. The energy market reform process, starting with the power sector, provided a timely and coherent frame for the removal of protection against existing pressures, and the *alignment* of pressures previously diverging or unattended (customer fuel choice, new technologies, environmental problems, etc.). For instance, the ESI reform process led to the 'dash for gas', with largely unanticipated consequences for the coal industry. Niches had developed (international coal, CCGT), but had until then been kept at bay by various protection mechanisms. With ESI liberalisation, they provided matching solutions to existing problems, and benefited from the *re-configuration* of the energy system as a *window of opportunity* for breakthrough. Subsequently, the availability of better performing technology also allowed the inclusion of other concerns, such as acid rain.

**Shocks and landscape trends**

The period of study has also been marked by important landscape changes, and specific environmental shocks. These bear an important role in destabilisation processes. Indeed, their deep structural level means that they have great influence not only on industries, but on the entire socio-technical system to which they are associated. Three main findings emerge:

1. *Shocks and extreme events can fundamentally re-define industry selection environments and the articulation of pressures within them*. For instance, the oil crisis (1973) was such a profound commodity price shock that it radically altered coal's economic and strategic positioning amongst energy alternatives, thus effectively providing lasting support structures and halting its destabilisation trajectory. By stimulating enthusiasm for alternatives to oil internationally, it also led to the emergence and growth of an international price-cutting coal regime that later generated substantial destabilisation pressure.
2. *Shocks can trigger the acceleration of destabilisation sequences through the activation of 'latent' interaction mechanisms*. For instance, the oil price collapse of 1986 *triggered* change in energy markets, business and policy as it reinforced

existing customer dissatisfaction with British coal, justified fuel substitution in power generation, wiped away the energy security argument of maintaining domestic coal supply capacity, and thus accelerated the restructuring process. This pressure interaction sequence spread like ripples across industry environments, providing greater coherence to the overall destabilisation pressure front.

3. *Landscape changes, when appropriated locally, can provide the external frame of reference for the funnelling and coherent articulation of previously unaligned pressures*. During the period of study, important landscape trends fundamentally altered the interpretive schemes of relevant actors in the industry's environment. The instalment of the liberal doctrine and modern global trade (globalisation) at roughly the same time (early 1980s) together altered the socio-economic order. Actors in the organisational field appropriated these trends in their local domain: a) the Thatcher administration embraced the opportunity to modernise British industrial policy, developed new problem framings based on the cultural repertoire of 'international competitiveness', and proposed the 'market solution' to put order in 'sick industries', b) new entrants in coal mining were better adapted to the changing regime rules that they co-produced, c) the ESI expected clear benefits from the opening of markets and the primacy of price-based competition, while d) the unions resisted the change, engaged in counter-framing, and in ultimately unsuccessful strike action. Through an actively constructed modernising discourse, these landscape changes thus penetrated the industry environment, providing a shared orientation for most actors within it and thereby contributing to the alignment of pressures for change.

Pressure interactions are thus important in destabilisation processes. In this case, specific events and processes have been important in *accelerating* and *directing* the destabilisation process.

While the external destabilisation context is punctuated by extreme events and radical transformations, these build on and allow making sense of the gradual accumulation of problems, thus accelerating their development and the resulting pressure for change.

### 6.5.3 Endogenous enactment of regime destabilisation

The destabilisation of industries results from external pressures and internal enactment processes. I now turn to regime changes and strategy developments from an industry perspective. These are summarised in Table 6.5 and analysed below.

**Table 6.5: The development of industry strategies**

| | Socio-cultural framing strategies | Political strategies | Economic positioning strategies | Innovation strategies |
|---|---|---|---|---|
| **1967-1973** | Marketing the 'new' coal industry | Political bargaining for continued support | Specialisation, 'battle for fuel' in power generation, Closures and restructuring | Productivity improvements, coal-face mechanisation, lower grade coal, world-class R&D |
| **1973-1981** | Framing coal as the fuel of the future, raising customer confidence, re-affirming coal's social role | Lobbying for long-term commitments | Stronghold in power generation, some early diversification, Stabilisation (PfC) | Beginnings of opencast and superpits, R&D diversification in coal use |
| **1981-1990** | Discursive focus on improvements, limited ability to resist | Bargaining for contracts, protection against imports, and worker compensations | New competitive objectives, consolidation: pit closures, cost cutting, flexibility | productivity improvements, automation, end of R&D |
| **1990-1997** | | Lobby for a moratorium on CCGT | Cost cutting, further closures | |

***1967-1973***. In response to declining markets, the coal industry *positioned* itself on the only growing market. Industry actors responded to pressure accumulation through the abandonment of shrinking markets (*decline*) and specialisation in a secure market pocket (*re-orientation*). This strategy maintained a reduced, yet relatively stable *economic environment*. *Political bargaining* and *market defence strategies* succeeded in securing lasting commitments in the power generation market. *Technological strategies* focussed on improved productivity (contraction, mechanisation) for a lower grade product with very limited investment.

***1973-1981***. The opportunity window brought by the oil crisis was seized. *Political lobbying strategies* reversed the industry's position with Plan for Coal. *Socio-cultural framing strategies* centred on coal's strategic importance and its ability to renew itself fostered new hopes about Britain's coal industry for the future. *Revived expectations* and the *availability of support* led to a strategic reversal: *innovation strategies* were directed at productivity improvements, new pit designs, the beginnings of automation, and *early diversification attempts* in numerous directions opened up by the oil crisis.

***1981-1990***. As new policy imperatives called for deep restructuring, the industry tried to *re*-create itself, implementing drastic changes in its *mission*, *identity*, *values*, and *strategies*. These changes were only possible by crushing miners' resistance and getting rid of the industry's 'social' mission. New competitive objectives and culture guided *technological strategies* (productivity improvements and automation), *commercial strategies* (contract negotiation and protection from imports). As financial and political support structures were dismantled, *innovation* and *diversification strategies* were abandoned in favour of *domain defence* along familiar lines: improving competitiveness through greater mechanisation, automation, de-manning and flexibility. Tremendous productivity improvements from consolidation provided hope that British Coal would be competitive in relation to international coal price cutters.

***1990-1997***. Market collapse and the end of support led the industry to negotiate worsening contracts. With its agency limited to implementing the Government's market reform towards privatisation, the deep-mining coal industry continued its contraction and reached an insignificant size.

### 6.5.4 Destabilisation pattern

In this case, full destabilisation was accelerated with the rapid and dramatic penetration of landscape dynamics into the industry's environment. However, these transformations had been gradually building up, largely unforeseen by an industry preoccupied with coping with imminent threats to its survival – which it did successfully (deep restructuring, productivity improvements, etc.). In directing its response strategies to short-term adjustment and compliance to local pressures (living a permanent crisis), the British coal industry failed to attend to the long-term influence of landscape changes to which local pressures were linked.[48] BC's technical and managerial re-orientation strategy was not in tune with the scale of the radical external changes it was facing. Increasing match at the local level concealed a growing gap with landscape changes. When strong turbulence (shake up) was introduced at regime level (liberalisation), landscape pressures and competing technologies were joined together and destabilised the coal industry, which could only delay its terminal decline.

The more gradual decline path (characterised by the foreseeable accumulation of pressures) of the late 1960s was thus rapidly shifted in the early 1970s to a stabilisation path with pressures ignored and deflected by the raising of protective barriers. This

---

[48] However, it should be noted that the autonomous agency of the coal industry was limited, as it was operating under state ownership and within Government control.

exceptional outcome was triggered by a profound *shock*. Meanwhile, dissatisfaction with features of the regime accumulated but remained loosely aligned and articulated. In the 1980s, the industry trajectory shifted in an attempt of *re-creation*, in which the industry adopted new goals, mission and identity compatible with the altered newly institutionalised policy framework (*paradigm shift*). However, the erosion of slack reduced its scope for resource mobilisation and thus increased its vulnerability to economic pressures and prevented the success of the industry's *re-creation*. In the 1990s, the industry entered the *dissolution* stage as socio-political and market pressures achieved *extreme alignment* and *radical environment change*.
So, the British coal industry has made important advances in adapting to external pressures, but could not cope with the dramatic increase and alignment of pressures in multiple domains spanning multiple levels. As destabilisation progressed, the coal industry increased its dependence on external support (financial and political), and on the loyalty of a single customer/market – both of which turned their back in the 1990s.

A number of explanations for industry failure can now be proposed:

- The industry pursued *myopic adaptation* to singular and localised pressures in the first two periods, which *led to short-sighted crisis management rather than long-term renewal strategies*. Regime rules were modified incrementally to include new competitiveness (price/performance) criteria, flexible working, and technological improvements. However, more forward-looking diversification strategies and re-creation trajectories (e.g. advanced coal combustion technology development, investments abroad, etc.) were abandoned in the 1980s when the big 'resource squeeze', the loss of *political legitimacy*, and the withdrawal of support took effect. So, in this case, the adverse context became an inhibitor of industry re-creation, because the industry did not enjoy the degree of freedom necessary to develop creative response in the mid-1980s. The implementation of market reform suppressed choice in the strategic options available to the coal industry, as it was paralleled by the forced abandonment of diversification attempts. With respect to its market and commercial strategies, the industry followed a specialisation strategy in a threatened market, but accorded little attention to maintaining good customer relationships. With respect to innovation strategies, the industry persistently followed an obsolete technological trajectory, resulting in incremental performance improvement, at a time when technological alternatives offered much higher performance.

- the industry *neglected the long-term implications of profound landscape changes*. The threat of international competition and the consequences of the coming liberalisations was perceived in the 1980s, but interpreted as the need to improve performance and drive prices down, *not* as a stimulus to search for viable long-term strategies. This means that both hope and ability for re-creation had vanished by this point.
- As external conditions worsened, the industry *increasingly depended on commercial and political protection* in a crowded market. Prolonged reliance on artificial protection from external pressures increases their destabilising potential once they are removed. Indeed, the intensity of the industry destabilisation in the 1980s-90s can be partly attributed to the incoherence of maintaining 'uneconomic' production capacity requiring protective barriers and subsidies for survival. This is however, a consequence of the inflated enthusiasm of the 1970s that was based on exceptional commodity price fluctuation. Industry strategy, relying on this temporary economic climate, was no more than a house of cards, with in-built instability based on external dependence. The associated inflated expectations increased the dramatic nature of the subsequent collapse.
- the industry's degraded resource base led it to live off past achievements, increasingly *eroding its slack*. Starved of investment (in R&D, in mining), the industry concentrated on reaping the benefits of past investments without complementing them with sustained investment and creative strategies. The resulting improved performance concealed a degraded industry capital structure, and inhibited substantial re-creation strategies.
- Ultimately, the consequences of radical environmental change (dash for gas, coal crisis, acid rain constraints, etc.) were unanticipated, *surprised* the industry, and left it no choice but to rapidly contract.

These sub-processes all participated in the enactment of industry destabilisation, which can be synthesised as a downward spiral resulting from a) worsening conditions, b) erosion of slack and c) narrowing down of options. The final decline phase was engaged when the coal industry lost any future market prospect and engaged in extreme downsizing. This process led to the milking of cheap assets (material, and commercial) before and after the industry privatisation.

# 7 Case 3: Climate change and the destabilisation of coal-fired generation in the UK (1990-2011). Possible revival?

This case study focuses on coal-fired generation as a proposition in the British energy mix between 1990 and the present. It particularly investigates the role of the climate change issue, which gained momentum in the 1990s. It also investigates the role of a technological promise – carbon capture and storage (CCS) – to address this challenge within the hypothetical frame of a high coal future. This chapter is thus an application of the framework to an open question: How does climate change relate to the destabilisation or recreation of coal-fired generation in the UK?

The case is temporally inscribed within a possible underlying transition ‘in-the-making’ (to low-carbon energy systems). This transition is a prospective one, as it is not yet accomplished, and (the form of) its materialisation remains uncertain.[49] This condition complicates the assessment of a destabilisation trajectory.

Following an overall declining trend, coal-fired generation in the UK today finds itself at a crossroads between further decline and renewal in relation to new challenges (in particular climate change). Figure 7.1 provides an overview of fuel sources for power generation in the UK over the period. The case has been partitioned in three sub-periods, corresponding to major events or direction shifts: ESI liberalisation in 1990, the halt of the dash for gas and political change in 1997, the step up of climate policies and energy security concerns from 2005.

---

[49] The possibility that this transition will never materialise cannot be excluded.

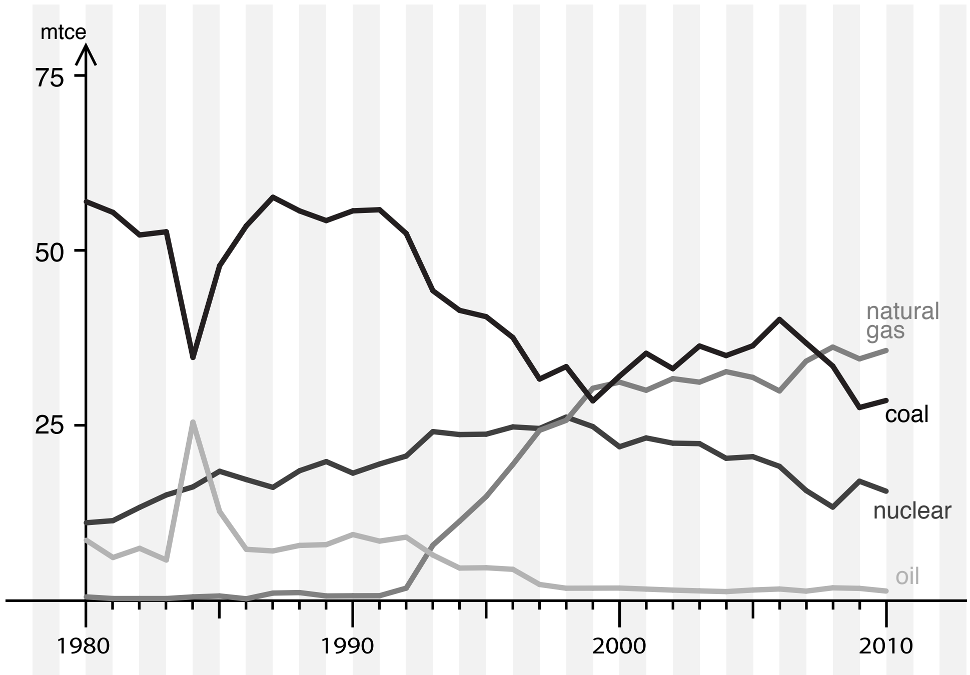


**Figure 7.1: Fuel input[50] to power generation in the UK, mtce (Data: DECC Historical electricity data)**

## *7.1 1990-1997: Adjustments to liberalised energy markets*

### 7.1.1 Pressures in economic environment

#### 7.1.1.1 Landscape

The 1990s were marked by structural transformations encouraged by neo-liberal reforms (see chapter 6). The British economy accelerated its shift from manufacturing to a service economy and the growth of its financial sector, while markets became increasingly open to international investment and trade.

Oil prices remained relatively low since 1986. Based on beliefs related to a new age of plenty (Smil 2003), energy decision-making relied on optimistic assumptions for oil and gas prospects and thus disfavoured coal.

[50] By looking at fuel input, this graph understates the relative importance of electricity generated from fuels with higher conversion efficiencies, such as natural gas.

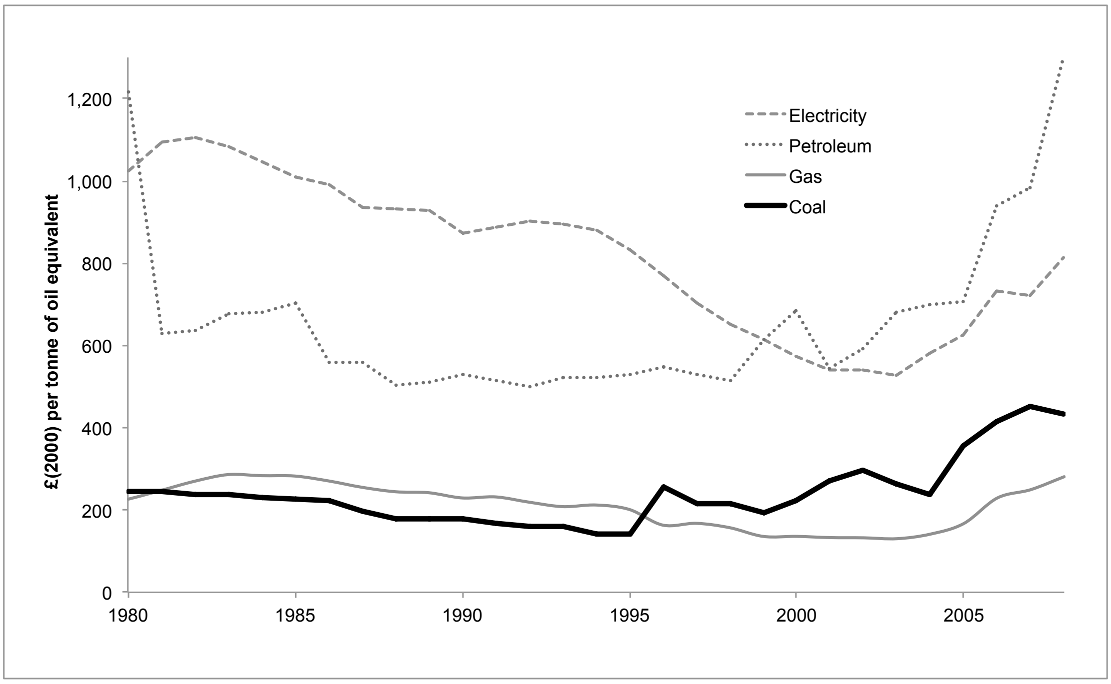


**Figure 7.2: The price of primary fuels (Data: Fouquet 2011)**

#### 7.1.1.2 Markets

The electricity market adopted a new form when it was liberalised in 1990. The emphasis was set on making way to competition in the energy sector. The privatisation of the ESI split the supply part of the business into two main private companies. National Power (NP) and PowerGen (PG) were less constrained by political obligations, and adopted a different style of decision-making and investment planning. This mainly translated into increased freedom of fuel choice. The liberalisation of the ESI also opened the industry to new entrants. A wholesale spot market for electricity price-setting (the 'Pool') was introduced, promising the injection of competition and new strategies. However, the industry initially remained dominated by PG and NP, which raised the concerns of the regulator (OFFER) (Thomas 2006).

The decade started with an expected upcoming shortage in electricity supply, and related new opportunities for investment in power generation. However, as a result of the new market arrangements, the market for coal-fired generation plunged in the 1990s (Figure 7.1), and looked as though is was going to continue to fall (interview Brewer).

#### 7.1.1.3 New entrants and technological competition

The energy gap was initially to be filled by nuclear and coal-fired plant, in accordance with previous commitments and practices:

> "In February 1988, the Board applied for planning consent for two 1800MW coal-fired power stations, based on 900MW steam turbine units newly developed by the CEGB in collaboration with GEC, one of the British plant manufacturers." (Winskel 2002:572).

So, there was still some confidence that coal would continue to play a dominant role in power generation. This hope was short-lived, as the CEGB later announced the deferral of the construction of these new coal-fired stations (CEGB Annual Report 1988-1989:15). When NP and PG took over the CEGB's activities, the programme to build coal-fired plants was abandoned in favour of the new enthusiasm for CCGT projects. The emerging 'dash for gas' was taking shape. New entrants in power generation invested in CCGTs, followed by incumbents who now preferred gas:

> "dominant generation technologies were cast aside in favour of a previously unused form: in a sudden 'dash for gas', all proposals for new coal-fired steam turbine and nuclear power plants were abandoned in favour of combined cycle gas turbine (CCGT) schemes" (Winskel 2002:564).

The combination of new opportunities in power generation, the availability of cheap natural gas, and a liberalised market favouring quick returns on investment led to the rapid expansion of CCGTs (Patterson and Grubb 1996). By the end of 1994, the CCGT capacity under construction or in service amounted to 13146 MWe, of which 6944 MWe owned by new generators, 3160 MWe owned by NP and 3042 MWe owned by PG (Thomas 1997:66). The resulting rapid decline in the demand for coal was largely unforeseen by the government, industry, or commentators (Winskel 2002).

Gas- systematically replaced coal-fired generation:

> "the advantages of using gas has meant that gas-fired generation has moved from its original peaking position in the merit- order to base-load generation, displacing coal-fired plant" (Whittington and Bellhouse 2000:206)

The shorter payback times of CCGT investments meant that investing in coal-fired generation became less favoured. Furthermore, gas had environmental benefits over coal.

Nuclear power continued to supply an increasing share of electricity output in the 1990s (Figure 7.1), as it benefitted from political support and corresponding investment schemes (Thomas 1997). However, nuclear power was not an easy proposition to maintain in a privatised setting. Policy support was necessary to sustain the costly technology, effectively creating an (embarrassing) special case of technological regulation (MacKerron 1999). A moratorium on new nuclear was followed in 1994 by an announcement not to go forward with the construction of new nuclear, thus halting the long-term expansion of nuclear power (Verhees 2012).

#### 7.1.1.4 Price pressure and imports

The Secretary of State for Energy (Cecil Parkinson) responded to concerns in opposition about the expected consequence of ESI privatisation on coal imports and the related public interest of supply security:

> "The generators do not want to be over-dependent on a single United Kingdom supplier – they have been bitten by that bug four times in the past 20 years. They also know that there is an enormous advantage in having a secure, reliable, home-based supplier, and that being over-dependent, or dependent to any major extent, on imports can be dangerous." (HC Deb 26 June 1989 vol 155 cc763)

The phase-out of contracts between the major generators and British Coal led to the penetration of coal imports. Within five years, "coal prices delivered to power stations fell by 20% in real terms and purchases of British coal fell from 74 million tonnes to 30 million tonnes" (Newbery and Pollitt 1997:270).

The British coal mining industry collapsed (Figure 7.3):

> "The British mining industry, which had no other credible markets for its coal [besides power generation], was effectively destroyed. The implausibility of long-term contracts for British coal beyond 1998 meant that investment in new mining capacity could not be justified and needs from 1990 to 98 were largely met by depleting already developed seams." (Thomas 2006:590)

From the perspective of coal-fired generation, however, the decline of the coal industry was not too much of a problem, as imported coal was cheaper.

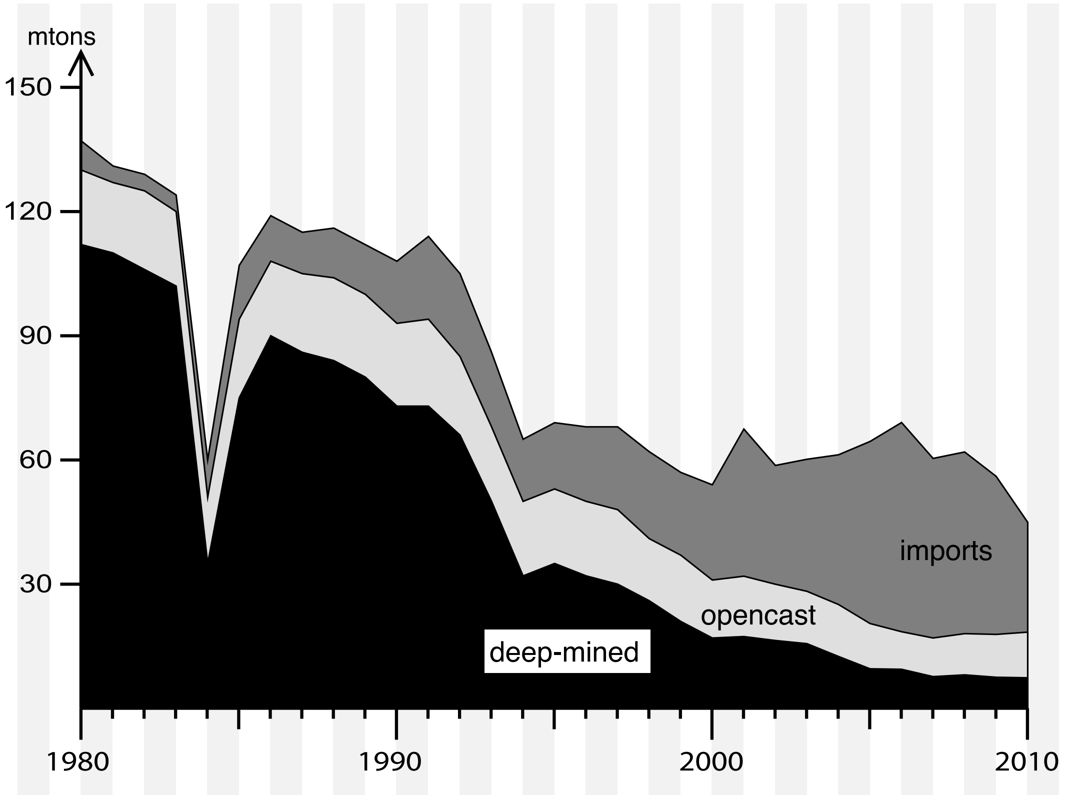


**Figure 7.3: The provenance of coal used in the UK (mtons)**

## 7.1.2 Pressure in the socio-political environment

### 7.1.2.1 Landscape

This period saw the instalment of market liberalism beyond political divides in the UK, and more generally at the European and global levels. Global environmental problems and their governance also became dominant policy concerns.

### 7.1.2.2 Policy

The 1990s were marked by the implementation of the liberalisation agenda, and the instalment of a generalised understanding that efficient market allocation will solve energy problems. Furthermore, environmental problems (acid rain and climate change) became increasingly recognised and led to new policy objectives.
Decision-making in the electricity industry, traditionally performed by engineers (Hannah 1982), was now replaced by market allocation mechanisms and short-term financial considerations. The "Pool" system was a wholesale price-setting mechanism in which suppliers made bids for generation options (price and capacity) and traders

purchased the required amount determined by demand, thus setting the Pool price.[51] The new system, in the name of the market, replaced engineers by traders, and led to changes in the merit order of fuels.

However, this new system also attracted criticism, namely concerning the manipulation of the rules of the game by the two main suppliers:

> "The generation structure was clearly not competitive and by 1993, the Regulator had become impatient with what he saw as manipulation of the wholesale (Pool) price by the duopoly" (Thomas 2006:586)

The liberalisation of the ESI was accompanied by strong rhetoric about the success of market reform and associated long-term benefits (Newbery and Pollitt 1997). These included a doubling of labour productivity, dramatic cost reductions in the short-term, as well as reduced emissions of sulphur dioxide, nitrogen oxides and carbon dioxide. This apparent success can however be largely attributed to contextual variables such as 1) favourable fossil fuel markets, 2) improvements in nuclear generation, and 3) a resource transfer from taxpayers to consumers (Thomas 2006).

The Thatcher government, after having obstructed debate on the environment for nearly a decade, operated a U-turn and embraced the need to reduce polluting emissions and GHG emissions. Thatcher's speech at the Royal Society in 1988 is commonly seen as the landmark of the reversal of the British position to recognise the challenge of climate change. This reversal was opportunistically tied to fuel switches in power generation, which now promised easily achievable targets for acid rain:

> "Coal's contraction could now be justified on *both* economic and environmental grounds." (Helm 2003: 347)

The acid rain problem gathered political clout in the late 1980s, leading to commitments and regulations. In 1986, the CEGB announced the retrofit of 6GW of coal-fired plant between 1988 and 1997 (*The Guardian*, September 12, 1986). Planning permission for the Drax retrofit was given in 1988 (HoC 1990). Following Britain's reversed position on acid rain, the EU LCPD (88/609/EEC) was finally agreed in 1988, requiring an additional 6GW of FGD retrofits.

However, the LCPD was not immediately transposed into UK law, and emission targets were preferred over technological mandates, as it became clear that gas provided a

---

[51] The highest accepted bid thus became the Pool price, which all selected generators would receive for the electricity sold.

cheaper way to reduce emissions and fulfil targets than fitting expensive FGD to coal-fired power stations. Acid rain regulation thus provided a further argument in favour of the replacement of coal by gas. In the remaining coal-fired plants, another effect of sulphur regulation was to shift away from British coal in favour of sulphur-leaner coal suppliers.

The policy position towards climate change followed a similar progression to that about acid rain: it was inscribed in a move away from the British reputation as the ‘dirty man of Europe’. Because of the dash for gas, the British government saw itself in a position to actively support GHG emission reductions, the UNFCCC, and be actively engaged in the issue internationally (Lovell *et al.* 2009). In 1992, the UK supported the UNFCCC (signed in Rio).

A number of national policies were formulated in the 1990s. The Non Fossil Fuel Obligation (NFFO), established in 1990, was presented as a means to encourage the development of renewable energy. In practice, however, it was designed merely as a way to support the nuclear option (Helm 2010).

*This Common Inheritance*, the White Paper on the Environment (DoE 1990), raised climate change as an environmental policy priority, underlining the need for educating the public, for global cooperation, and for reversing the energy growth trends. In 1994, the first UK Climate Change Programme included emission reductions objectives by 2000. It led to the set up of a value added tax on fuel, and the Energy Saving Trust to encourage climate-friendlier behaviour (Lovell *et al.* 2009, Collier 1997, Pearson and Watson 2012).

#### 7.1.2.3 <u>Societal concerns</u>

In the 1990s, climate change emerged as a new environmental concern for the British public. The geographical and time horizons involved were truly global. It required the ability to integrate damage made to future generation in current decision-making. Furthermore, climate change is a fairly complex phenomenon that required the establishment of a robust scientific consensus for its legitimation (Doyle 2007). Indeed, scientists have had a prominent role in raising the issue of climate change, and were, together with environmental groups, the early advocates of change.

The Intergovernmental Panel on Climate Change (IPCC) was created in 1988. It established itself as the most authoritative scientific organisation in the area of climate change (Doyle 2007, Turnheim and Tezcan 2010), assuming a leading international role in collecting and assessing the latest scientific findings on climate change. Its first assessment report, issued in 1990, was a landmark in building global consensus on anthropogenic climate change.

Environmental NGOs, such as Greenpeace, Friends of the Earth (FoE) and the Climate Action Network, were instrumental in establishing climate change as a major societal concern (Doyle 2007, Gough and Shackley 2001). Their activities included lobbying for policies, public campaigns, and the production of scientific reports. They involved the public through communication campaigns, notably by mobilising graphic images that illustrated the early effects of climate change and conveyed symbolic meaning to the issue (Doyle 2007). They provided a more popular form of communication as alternatives to the scientific consensus-building apparatus of organisations such as the IPCC (Forsyth 2003). However, Carvalho and Burgess (2005) suggest that while media attention to climate change was high in the early 1990s, it subsequently receded until 1997 (Figure 7.4).

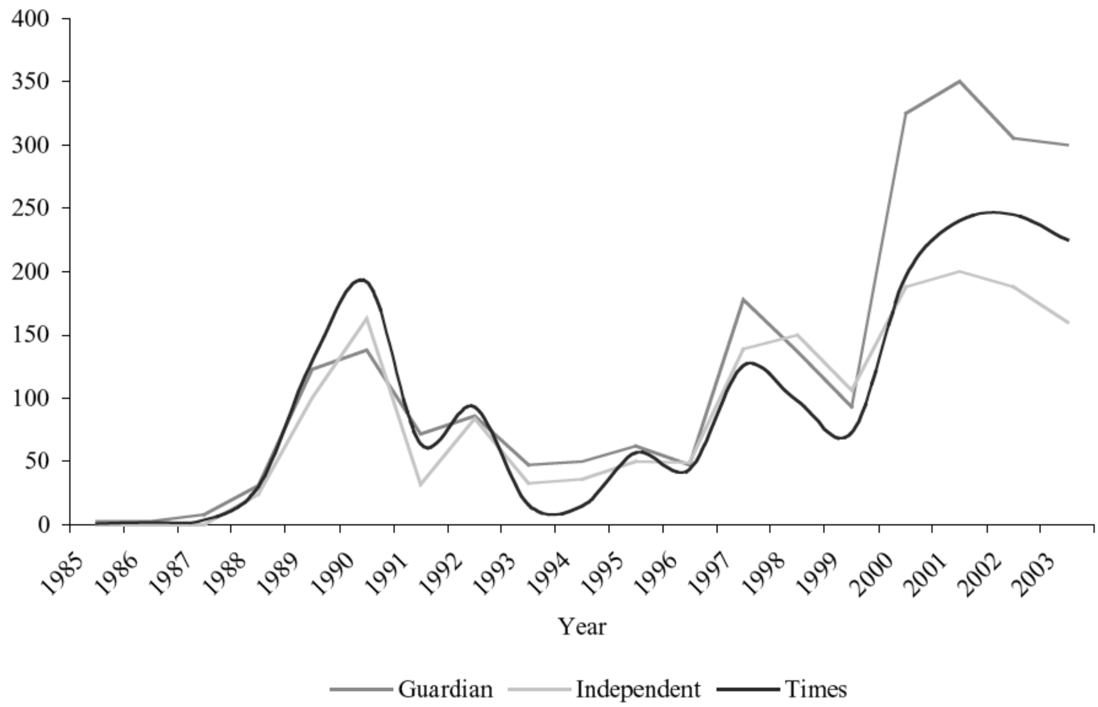


**Figure 7.4: Distribution of newspaper articles on climate change (1985–2003), number of articles, Carvalho and Burgess (2005:1462)**

## 7.1.3 Industry strategies – economic environment

### 7.1.3.1 Economic positioning strategy

New entrants brought new *economic positioning strategies* to the market, such as investment in capacity with shorter payback times like CCGTs. NP and PG swiftly followed this practice.

The liberalisation of energy markets, in conjunction with the rise of global corporations, led to the entrance of international energy companies (Patterson 2000), the assets of which became internationally traded and regularly changed ownership:

> "In country after country, assets previously assumed without question to be essential for national security became the property of foreign owners, changing hands internationally and repeatedly. Electricity became an international activity." (Patterson 2000:1)

The new electricity market structure, the dash for gas, and the major costs involved in the retrofitting of FGD led to the (sometimes premature) closure of coal-fired plants:

> "Between 1990 and 1995 National Power and PowerGen together closed a total of 18,960 MWth of coal-fired generating capacity." (Eames 2000:41)

, resulting in lower levels of coal-burn (Figure 7.1).

The drive to reduce costs in the electricity sector led to strategies for improved labour productivity. The new owners implemented drastic cuts in employment:

> "Labour shedding became a sustained feature of the UK electricity industry long before American investors arrived. A pre-privatization workforce of around 150,000 was halved during the 1990s and cuts of more than a third were made in the first 5 years following privatization." (Colling and Clark 2006:1637)

, leading to substantial productivity improvements:

> "Employment in PowerGen fell from over 9,000 in 1990 to 3,700 in 1995, as productivity more than doubled." (Arrowsmith 2003:154)

#### 7.1.3.2 Innovation strategies

R&D budgets had been an early liability of the introduction of the market solution in the energy sector from the 1980s (Margolis and Kammen 1999, interview Merrick, Jamasb *et al.* 2008). Table 7.1 shows a clear downward trend in R&D investments by electricity utilities following liberalisation.

**Table 7.1: R&D investments in the electricity sector (£million), Source: Thomas (1997:79)**

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|
| **CEGB** | 135 | 162 | 199 | 201 | | | | | |
| **NP** | | | | | 22 | 26 | 17 | 20 | 24 |
| **PG** | | | | | 5 | 14 | 12 | 10 | 9 |
| **NE** | | | | | 116 | 95 | 71 | 64 | 51 |
| **NGC** | | | | | 7 | 7 | 8 | 8 | 8 |
| **Total** | 135 | 162 | 199 | 201 | 150 | 142 | 108 | 102 | 92 |

Recognising the need to develop more environmentally acceptable ways of burning coal, the Department of Trade and Industry created the Clean Coal Technologies Programme in 1994. It identified several market opportunities for the development and export of technologies, such as advanced combustion equipment. The increased budget remained relatively insignificant.

British Coal, seeing its last remaining market crumbling under the threat of imports and shift away from coal, was willing to engage collaboratively in *innovation strategies* to demonstrate the possibility of clean coal-fired generation. However, BC was unable to secure capital funding or a market for a 150MW 'clean coal' demonstration plan (Winskel 2002).

In the 1990s, the IEA was already suggesting the capture and storage of CO2 (CCS) as a promising future solution to reduce carbon emissions from the combustion of fossil fuel in large stationary sources. This solution, it was argued, would "allow continued use of the fossil fuel infrastructure, built up over many decades, and avoid the disruption of changing to alternative sources of energy" (Riemer 1996:665). Furthermore, IEA scientists did not point to major feasibility problems, besides the significantly increased costs, which "still remain favourable compared to many renewable energy options" (Riemer 1996:669). This position was thus compatible with the protection of interests in fossil fuel generation.

### 7.1.4 Industry strategies – socio-political environment

#### 7.1.4.1 Political and lobbying strategies

Faced with substantial pressure, actors with interests in coal-fired generation (coal mining and power generation companies) developed *political* and *lobbying strategies* to minimise the effects of liberalisation and to gain protective support. The coal industry lobbied for the introduction of changes to the electricity wholesale market ('the Pool'), which was seen as discriminating against coal (Green 1999). The negative effects of the dash for gas on energy diversity were repeatedly highlighted as an argument for maintaining substantial coal-fired capacity. This strategy led to commitments in the late 1990s (see next period).

The coal mining industry also lobbied for continuous support (and subsidies) in historical coal constituencies, namely via the Coalfields Community Parliamentary group. Resulting measures only tempered the rate of contraction in the industry:

> "In the new order after 1990, the cross-subsidy in favour of coal continued, though at a declining rate, especially after 1993." (MacKerron 2001:564)

Energy-related industries opposed proposals of an EC carbon tax:

> "The business sector response to the [EC proposal of a carbon] tax has been hostile. The intensity of the anti-tax campaign has surprised some national governments and parts of the Commission." (Ikwue and Skea 1994:6).

, arguing instead for technology and innovation policies

> "This Commission proposal to raise a carbon tax caused concern to the coal industry. CEPCEO clearly condemned the discriminatory character of such a tax. The Ad Hoc Committee prepared the document "Advanced Clean Coal Technologies", forwarded to the European Commission and again arguing that a clean technology was more constructive with respect to the environment than any carbon tax. This document was received favourably both by the European Commission and the European Parliament." (Euracoal 2010:17)

The abandonment of the carbon tax proposal in the UK suggests the success of these *lobbying activities*.

#### 7.1.4.2 Framing strategies

Climate change and air pollution emerged as significant concerns for power generators in the 1990s. The new momentum on climate change led fossil fuels interests worldwide to develop *counter-framing strategies*:

> "Fossil fuels interests disputed the science, economics and policy proposals put forward by the IPCC. They were also prominent in negotiations at the UN Conference on Environment and Development, the world's largest-ever environmental conference, in Rio de Janeiro 1992." (Patterson 1999:71)

The Global Climate Coalition (GCC) was formed in 1989, in the wake of the IPCC's first meeting. It was formed of major international companies with interests in fossil fuels (oil, coal, car, etc.). It engaged in continued *counter-framing activities* against climate science until the late 1990s, influencing, among other things, the US official position on climate negotiations (Kolk and Pinkse 2007). It engaged in a denial of climate science, and targeted *lobbying* on policy proposals. A central part of this strategy consisted in the involvement of 'experts' to highlight the uncertainties of climate change science (Dunlap and McCright 2010). According to Ikwue and Skea (1994:6) the coal industry in Europe has tended to "argue that conclusive evidence for climate change does not exist and that any action is unwarranted" in the debate around a EU carbon tax proposal.

## *7.2 1997-2005: Climate change and maintaining coal-fired capacity*

### 7.2.1 Pressures in economic environment

#### 7.2.1.1 Landscape

The period was marked by shifts in the international dimension of energy trades. The growth of emerging countries in the global economy led to rising global energy use (Smil 2003). Oil prices became less stable and started rising (Figure 7.2). The UK became a net energy importer in 2004 in relation to the erosion of North Sea reserves.

#### 7.2.1.2 Markets

With no major plans to invest in coal-fired generation, the market for coal depended on the amount of coal-burn in the existing capital stock, declining with plant decommissioning. The dash for gas had put coal-fired generation under a substantial amount of pressure to maintain its share of the market. However, declining demand for coal in power generation stabilised around 45 million tonnes towards the end of the

1990s (Figure 7.1). This stabilisation was related to changes in markets and prices, but also to the role of policy intervention in mediating the competition from alternatives (gas and nuclear). Crucially, the 'Pool' was reviewed in the late 1990s and was replaced by the introduction of bi-lateral contracting, which allowed fuel suppliers to negotiate their selling price and thus levelled the playing field between different alternatives (interview Brewer). From 2000, the market for coal in power generation experienced fluctuations, largely related to changes in gas/coal price ratios, but on average tended to rise again. In the context of rising fuel prices, coal's relative low cost (Figure 7.5) contributed to the stability of coal-fired generation, thus levelling-off its decline.

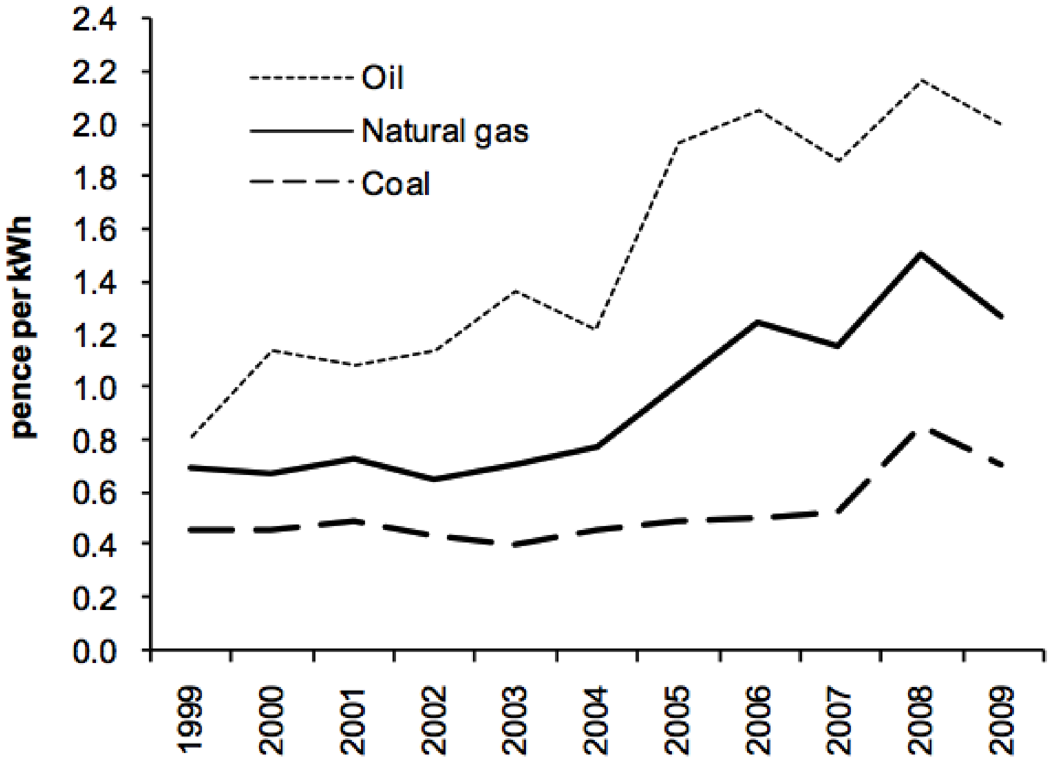


**Figure 7.5: Average fuel prices paid by UK power producers at delivery point (DECC 2010:28)**

Furthermore, the generalisation of coal contracts allowed some form of stability for domestic coal producers, who were able to plan their investments over 3-4 years. This tended to favour investment in surface mining over the more capital-intensive deep mining (interview Brewer).

### 7.2.1.3 Technological competition

The intense technological pressure on coal-fired generation resulting from the dash for gas was relaxed in the late 1990s. In 1998 a moratorium on new gas-fired plants was imposed to slow down further development. This was justified by concerns about fuel diversity in power generation, but was also inscribed in a political move by the newly-elected Labour Party to show its support to coal communities (Beynon *et al.* 1999). Coal-fired generation was temporarily relieved, and the dramatic contraction rate of the coal industry was stabilised. The coal industry welcomed this sign of support (Coal Authority Annual report and accounts 1998-99:2). This relief was only temporary, as the moratorium was lifted in November 2000 (Simmonds 2002), thus increasing the technological pressure again.

The decommissioning of nuclear plants without replacement (Verhees 2012) led to the continuous decline in nuclear power until 2007 (Figure 7.1).

Meanwhile, despite some early policies to stimulate the deployment of renewable energy technology, very little progress has been observed (Mitchell and Connor 2004), so that in practice renewable technologies did not represent a substantial threat for coal-fired generation.

#### 7.2.1.4 New entrants

The liberalisation of British power generation had attracted foreign investors, namely American companies such as Edison and AES (Colling and Clark 2006). However, American investors were quick to sell back these activities, unlike other investors such as the German E.On and the French EdF.

### 7.2.2 Pressure in the socio-political environment

#### 7.2.2.1 Landscape

The British model of privatised and liberalised energy markets became widely adopted worldwide (Thomas 2006). An EU directive (96/92/EC) generalised the gradual introduction of competition in electricity markets across the European Union, followed by moves towards a single European electricity market (2003/54/EC).

In the UK, the apparent benefits of the free market were embraced beyond political boundaries. The incoming Labour government continued to support and reproduce the institutional dimension of the market ideology (Scrase and MacKerron 2009:96, Fudge *et al.* 2008:41). The uncontested instalment of the market logic in energy regimes manifested itself in

> "the view that efficiency is best pursued through competition wherever competition is possible." (MacKerron 2001:553)

However, beyond this rhetorical veil, the market design was far from perfect, and a number of problems called for regulations. Notably, the short-termism dominating investment decisions hindered investment in capital-intensive projects, and created great difficulties for raising funds to build new plants (Roques *et al.* 2005). Furthermore, growing concerns about energy security and climate change led to calls to reconcile privatised energy markets with public interests.

#### 7.2.2.2 Policy

Given the acquired nature of market competition goals, energy policy revolved around two major (new) concerns: climate change and energy security (especially from 2003). These new issues were framed as externalities, which markets do not take into account but relate to public goods, and may require financial assistance or policy signals. So, in a sense, 'free' markets started to expose their limits.

Climate change concerns increased their political salience in the 1990s. The Kyoto Protocol was agreed in 1997, paving the way for GHG reduction targets. Britain was willing to assume a leading role in this global challenge early in the process:

> "The Labour party made climate change a central component of its 1997 election campaign. In July, Labour declared that, if elected, it would reduce British CO2 emissions by 20 percent [on 1990 levels] by 2010." (Cass 2007:45)

Beyond such political announcements, which have been criticised for being mere 'targets' rather than actual commitments (MacKerron 1999), interest in climate policy seriously picked up in 2000:

> "an influential report by the UK Royal Commission on Environmental Pollution (RCEP, 2000) catalysed reinvigoration of the climate change debate, and brought this issue squarely onto the agenda of energy policy. The RCEP proposed that the UK adopt an ambitious, long-term, target of a 60% reduction in greenhouse-gas emissions from 1998 levels by 2050. It was also important in focusing attention on the need for the state to reengage with the energy sector, after the `hands- off' approach of the 1990s." (Lovell *et al.* 2009:95)

Greater policy interest in addressing climate change led to proposals and debates on the best course of action in the energy sector. Early policy instruments included the Climate Change Levy (CCL), launched in March 2000. In practice, it was a rather complicated arrangement, on taxing energy output regardless of carbon content, concerned only industrial sources, and included a lot of exemptions. The CCL thus illustrated the influence of energy-intensive industries on climate policy:

> "The negotiated agreements were complex, involved much bureaucracy, and needed to be monitored and enforced. From an environmental perspective, they represented a retrograde step, helping to support the very industries which are most energy intensive." (Helm 2003: 356)

Initiating a true shift in energy policy from the imperatives of economic efficiency to those of long-term carbon reduction strategy seemed to require "greater public and stakeholder involvement in policymaking" (MacKerron 2009:80). The White Paper on energy policy (DTI 2003) institutionalised a *central role for climate change in energy policy*.

There was an emerging agreement at national and EU levels that emissions should be reduced, but positions varied as to the means to meet such objectives (e.g. a mixture of market instruments (such as a tax or cap-and-trade system), regulations, and innovation policy to support the development of low-carbon alternatives). In the UK, the emission reduction policy revolved around

> "a climate-change strategy to achieve [its emissions] target through renewables (the Renewables Obligation and the Renewables Obligation Certificates) and energy efficiency, with some support from emissions trading (the UK ETS and then the EU ETS)." (Helm 2008:226)

So, it mainly focussed on (relatively weak) incentives for cleaner energy rather then the regulation of the most carbon-intensive sources such as coal. The emphasis was put on more readily 'acceptable' market mechanisms to curb emissions.

The idea of an emissions trading scheme, although initially unfavoured, gained momentum in Europe and in the UK at the turn of the century (Voss 2007). The UK wanted to take a head start to gain early experience with trading, and so developed an emissions trading experiment. An EU Directive was adopted in 2003 for a first trading period starting in 2005:

> "From 2005 onwards, the EU ETS established a European market of allowances for 2.2 billion tons of carbon emissions from 11,500 installations. In 2006 the daily transaction volume in emission allowances reached 60 million Euro." (Voss 2007:113)

The EU ETS reframed climate goals by establishing a strong link with the liberalisation framework, thereby giving "a stronger role for economic expertise as well as a reframing of the pollution problem from moral condemnation to efficient allocation" (Voss 2007:114).

Observers suggested that the EU ETS would dramatically affect the level of coal-burn:

> "The 2001 energy plan expected coal's share of power generation to fall from 35% to 20% as the European Union cap on carbon emissions bites." (*The Business*, 29 August 2004, p.10)

The emerging consensus on the need to address climate change with stringent policies could potentially translate into *serious challenges for coal-fired generation*, namely in the form of economic disincentives for coal via carbon pricing, the eventual translation of domestic emissions targets through regulatory limits, and technological pressures resulting from incentives to low-carbon technologies. These developments negatively affected perceptions of the future of coal and coal investments.

Energy policy debates were also affected by fluctuations in energy prices. These market changes led to the re-emergence of energy security on the horizon. While these concerns would truly materialise in the next period, they already provided hints that coal could play a greater role in the near future, if it could position itself positively in relation to such debates.

#### 7.2.2.3 Societal problems

Public concerns around energy related to climate change. By 2000, there was “a new sense of urgency attached to risks from climate change” (Carvalho and Burgess 2005:1466),

> “By 2000, there was a wide, if not unanimous, consensus that global warming was a fact, and that the greenhouse gas emissions projections on the basis of business-as-usual over the first half of the twenty-first century would not be remotely sustainable” (Helm 2003: 369-70)

The IPCC’s third assessment report (2001) marked a *turning point* in the recognition of the science of climate change, and so contributed to raise the issue’s international profile. By this time, the general public had become convinced that something had to be done about climate change (interview Brewer).

Major environmental NGOs, such as Greenpeace and WWF, became increasingly involved in developing ‘grey’ literature, which bridged the gap between academic research and the public (Gough and Shackley 2001), and disseminated this information to the public. Furthermore, they developed powerful imagery to engage the public about the manifestations of the effect of climate change (Doyle 2007, Gough and Shackley 2001). News reports on climate change focused on the more dramatic events such as floods and abrupt weather, which were good news selling items (Carvalho and Burgess 2005).

In this context, the long-term prospects for coal-fired generation were bleak. Indeed:

> “nobody [saw] any coal revival in the EU, only further decline” (Smil 2003:236)

Because of the rise of climate change concerns, the *legitimacy of coal-fired generation was further downgraded*.

### 7.2.3 Industry strategies – economic environment

#### 7.2.3.1 Economic positioning strategy

While the early years of liberal electricity markets had led to the vertical disintegration of the business, and the influx of new entrants, the emerging trend shifted towards greater concentration and the re-integration of generation and retail activities. Full competition was applied in 1998. Through mergers and takeovers of exiting firms (Collier 1998:100), the industry's structure evolved towards an oligopoly in which six companies of similar size (the 'Big Six') share the virtual totality of the market.

> "Leading energy companies, whatever their historical origins, are racing to stay at the cutting edge, pursuing mergers and takeovers, invading new markets, redefining the ways they do business and even the business they are in." (Patterson 2000:2)

Financial power and economies of scale have become important success factors in liberalised electricity industries.

Coal-fired generation was relieved temporarily by the moratorium on gas and in the medium term by the reform of the Pool, which allowed bi-lateral contracts of typically 2-4 years to be negotiated between coal suppliers and generators (interview Brewer):

> "The successful conclusion to the contractual negotiations for the supply of British coal to the electricity industry [provided a more level "playing field" for British coal]." (Coal Authority Annual report and accounts 1998-99:2)

However, barriers to the development of new coal-fired projects remained high. One exception was the American AES' new coal-fired station at Uksmouth, coming on stream in August 2000.

#### 7.2.3.2 Innovation strategies

While the UK had led a number of world-class coal generation research programmes up to the 1980s, most of its capacity had been abandoned. This was particularly true of coal utilisation research, which was an early liability of the industry's restructuring in the 1980s (interview Merrick).

However, pressing environmental constraints required the development and deployment of 'cleaner' technologies, and thus raised the question of raised concerted efforts and state involvement with coal research once more.

Improving the environmental performance of coal-fired generation focused on:

- cleaning up flue-gases in response to acid rain and other forms of pollution,
- improving efficiency through advanced combustion technologies, and
- investigating the possibility of capturing and storing CO2 emissions

Firstly, most British coal-fired plant had been fitted with low-NOx burners. FGD had been fitted at a small number of plants (Watson 2005), and further adoption would be required for continued operation under the LCPD and related sulphur limits. The adoption of these 'cleaner' coal technologies were acclaimed and publicised as the future of coal:

> "Coal, one of the world's dirtiest forms of fuel, is set to make an unlikely comeback as power companies invest millions of pounds in technology to clean it up (…) "[FGD technology] is the future for coal-fired power stations. Using this technology ensures that coal can still hold a key place within a balanced portfolio of energy assets," [the chief executive of EDF Energy] said." (*The Times*, November 1, 2004, p.50)

Secondly, besides these relatively well-known technologies, progress in coal combustion had focussed on improved thermal efficiency (Oliver 2008). Supercritical pulverised coal technologies, developed in the USA in the 1960s and 1970s, diffused worldwide from the late 1990s (Watson 2005). They could reach thermal efficiencies of 40-45%. Integrated Gasification Combined Cycle technology (IGCC) relies on the gasification of coal for use in CCGTs, allowing thermal efficiencies of 40-45%. However, this technology remained very costly (Watson 2005), and experienced difficulties competing with supercritical technologies (Lockwood 2008).

These research efforts were supported by a strong rhetoric about future prospects for exports to India and China, where coal-fired generation experienced high growth rates, justifying state involvement in supporting clean coal development:

> "[The Chinese] market represents one of the biggest export opportunities for UK plant and equipment companies worth up to £300 billion over the next decade or so - with much more beyond. The UK's share of this market, if it can retain its current proportion of the world power equipment market, could be some £30 billion over the next ten years or so." (DTI 1999:6)

Thirdly, early exploration of CCS technological options was seen as a more distant technological trajectory to be pursued.

### 7.2.4 Industry strategies – socio-political environment

As climate change established itself as an important issue, the space for industry to openly contest it was reduced. Consequently, industry socio-political strategies focussed on the details of policy implementation, the search to delay and direct responses, and the establishment of a role for coal within the new constraints, rather than denying the scientific basis.

#### 7.2.4.1 Political and lobbying strategies

British and European coal industries sought to firmly re-establish a role for coal, and thus engaged in *political* and *lobbying strategies* to build support. In response to perceptions that coal would be the ideal target for CO2 reductions, organisations representing coal interests suggested that coal will necessarily play a role in tomorrow's energy systems, and that efforts should focus on developing appropriate solutions:

> "[The European Committee on Solid Fuels] drew attention to the fact that climate protection and security of energy supply were much better responses than eliminating coal from the energy mix thanks to modern technology and Clean Coal Technology." (EURACOAL 2010:22)

The British Government recognised the potential of clean coal to deliver on climate challenges:

> "The Government Energy White Paper "Our energy future – creating a low carbon economy" (published in February 2003) leaves open a number of important options for the future for coal and some critical clean coal technology initiatives were supported, together with a package of indigenous coal support through investment aid." (Coal Authority Annual report and accounts 2002-2003:2)

With respect to specific policies, coal-related interests *lobbied* policy arenas to influence decision-making. The EU ETS was seen as problematic, and efforts were mobilised to reduce its influence:

> "Emissions trading was the topic causing concern for the coal industry, especially for coal-fired power plants (…) EURACOAL obviously monitored the development of this directive very carefully." (EURACOAL 2010:24)

Because of their sheer weight, carbon-intensive industries had a significant influence over policy formulation:

> "Policymakers have mainly responded to corporate lobbying of Europe's largest emitters to ensure their participation (…) because they provide the necessary trading volume and liquidity for the EU scheme to succeed" (Kolk and Pinkse 2007:204)

*Lobbying* efforts led to the allocation of free allowances to emitters in the EU ETS on the basis of 1990 emissions.

Another area for *lobbying* consisted in limiting external support to alternatives. Indeed, as renewable energy became increasingly discussed as one way to reduce carbon emissions, carbon-intensive industries systematically tried to play down the role of alternatives such as renewables. Support to renewables was portrayed as a costly option. Niche-protection was interpreted as the introduction of market distortion.

The industry also needed long-term support to develop an R&D programme that would be able to make the vision of 'clean coal' and low-carbon coal-fired generation possible. The DTI Cleaner Coal Technology Programme was driven by the will to support activities that industry would otherwise not develop for lack of short-term incentives:

> "Government involvement by initiating a new Cleaner Coal Technology Programme should, by contributing some financial support to projects and encouraging collaboration, accelerate development work on cleaner coal technology which would otherwise be on a smaller scale and much slower in being progressed" (DTI 1999:10)

At the same time, CCS gained momentum as a possible low-carbon energy option for the future. The IPCC assessed the status of the technology and steps that could favour its development (IPCC 2005).

#### 7.2.4.2 <u>Framing strategies</u>

In a time of raised environmental concerns and awareness, coal had become a problematic fuel and was pointed as both the main source of CO2 and the priority target for abatement:

> "According to the informal and official opinions of the European Commission, climate problems linked to the amount of CO2 were due to coal. The simplest solution, to respect the Kyoto commitments, would be to close down coal plants." (EURACOAL 2010:22)

Indeed,

> "coal plants will become less economical to run as the carbon emissions trading, which will be introduced in the country from January, is introduced. Britain's dirtiest coal plants will begin to close down from 2008, when much tighter restrictions on emissions of sulphur dioxide will come into force." (*The* Times, 11 November 2004, p.50)

At the European level, it was recognised that *coal's strategic significance had been seriously downgraded*:

> "Nuclear energy and solid fuels are the undesirables among energy products" (EC 2000:31)
>
> "coal's future depends largely on the development of techniques which make it easier to use (…) and lessen its environmental impact in terms of pollutant emissions through clean combustion technologies and CO2 sequestration." (EC 2000:38)

Acknowledging coal's importance to future energy supply needs thus meant that other challenges would have to be addressed. The 2003 White Paper thus still recognised a role for coal with conditions:

> "Coal fired generation will also have an important part to play in widening the diversity of the energy mix provided ways can be found materially to reduce its carbon emissions. We will continue to support relevant research projects, including internationally, to develop options for cleaner coal technologies and for carbon capture and storage." (DTI 2003:12)

## *7.3 2005-2011: the energy gap, carbon constraints, and the CCS promise*

### 7.3.1 Pressures in economic environment

#### 7.3.1.1 Landscape

Energy prices continued their ascension since the late 1990s (Figure 7.2, IEA 2011), with oil experiencing the sharpest rise in relation to the troubled geo-political situation in the Middle East, and concerns about fuel availability. These market developments raised anxieties concerning the ability to continue pursuing energy-intensive development patterns.

The financial crisis of 2008 has triggered economic difficulties and plunged the world in global recession and uncertain prospects. The downgrading of banks and financial institutions, as well as the implementation of national austerity measures, has further degraded the investment context. As a result, the investment climate for the energy sector has become highly uncertain (IEA 2011).

While the climate change issue had made it on the discursive space of energy policy (long-term trend), the economic crisis coincided with a notable downward shift in attention (Figure 7.7) and political ability to find acceptable compromises.

#### 7.3.1.2 Markets

In this gloomy context, global markets for coal are thriving. Anxieties about rising oil and gas prices are leading economies worldwide to fall back on cheap and domestically abundant fuel sources. While coal prices have been seriously affected by global energy price rises (although to a lesser degree than oil and gas), coal markets have continued to expand globally, especially in large rapidly-growing countries such as China (IEA 2011):

> "For all the talk about natural gas and renewables, coal unquestionably won the energy race in the first decade of the 21st century" (IEA 2011:355).

It is noteworthy that most of this capacity expansion did not involve most efficient plant designs. Furthermore, this trend is expected to continue under current energy policies (IEA 2011).

The British market for coal did not experience this expansion. Coal-fired generation was the main option affected by the decrease in total demand for electricity between 2006 and 2009 (Figure 7.1). As of 2006, the international coal price rose in response to the global appetite for coal. As a result, domestic coal supply was becoming increasingly competitive again in the UK (interview Brewer). Figure 7.6 illustrates the rise and subsequent fall in imports of steam coal into the UK as of 2006, which can be explained by reliance on stockpiling, rising international coal price, and a temporal decrease in coal-burn. Furthermore, it displays the growing importance of Russian imports, and more recently Colombian coal, as well as the decreasing importance of imports from South Africa.

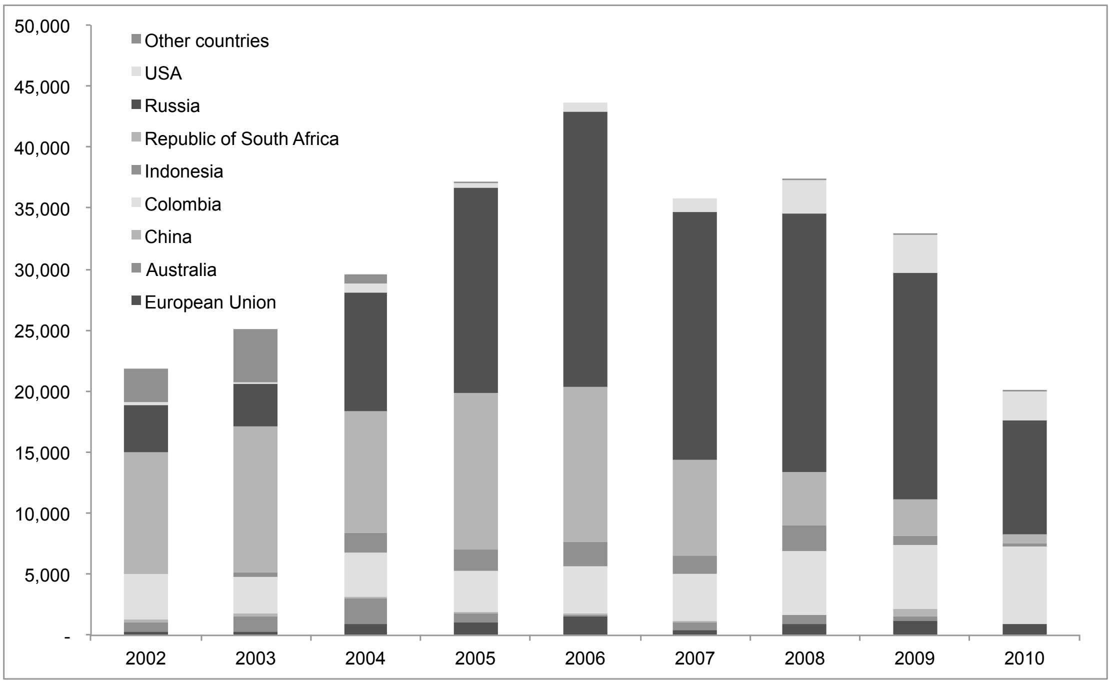


**Figure 7.6: Steam coal imports to the UK (Data: DECC, available online at http://www.decc.gov.uk/assets/decc/statistics/source/coal/et2_4.xls, accessed October 23, 2011)**

Britain's ageing power plant capital stock called for new investment decisions to fill the 'generation gap'. The decommissioning of older (nuclear and coal) capacity, requiring replacement ahead of 2015-6, re-opened the debate on fuel and technology choice. The upcoming capacity renewal created a *window of opportunity* for the re-positioning of various fuel options. Because of very long investment cycles characterising the power sector (IEA 2010:6), and additional delays for planning permissions, this issue became pressing by 2005. While the general tendency was towards the decommissioning of coal-fired capacity, there was a *renewed interest in the coal option*, provided it would be clean.

**7.3.1.3 <u>Technological alternatives</u>**

Coal-fired generation faced competition in current and future markets. Coal absorbed most of the slump in electricity demand (Figure 7.1). In terms of future fuel choice for generation, coal had to compete with plans for nuclear power, oil- and gas-fired generation and renewable energy.

From 2005, with the rise of energy security and climate change concerns, a hidden agenda emerged about re-opening the nuclear option, which was framed as the main solution to the climate issue in power generation (Carvalho and Burgess 2005). This official positioning was made public in Tony Blair's speech to the CBI in 2005, where he assert the need to re-evaluate the nuclear option. This comeback was highly controversial, as witnessed by Greenpeace's successful application for a judicial review on the lack of consultation (MacKerron 2009). However, commitment to future nuclear expansion was confirmed in the 2008 White Paper on nuclear power (DBERR 2008). The government progressively developed serious plans to build an additional 16GW of nuclear capacity to come on stream by 2025 (www.decc.gov.uk, accessed October 20, 2011). The Fukushima nuclear disaster of 2011 has led to additional 'safety and emergency preparedness' requirements, but hasn't yet altered these plans substantially (ONR 2011).

Comparatively, the contribution of renewable energy to power generation by 2010 remained relatively low in Britain, with a total of 9GW of installed capacity (predominantly onshore wind), contributing to around 7% of net annual power generation. Renewable energy development has been admittedly slow in the UK, especially given the substantial rhetoric efforts invested at governmental levels. This situation is arguably due to change with planned investments for nearly 30GW additional capacity, notably in onshore wind power (DECC 2011e).

So, there is, and can be expected to be substantial technological competition within power generation. 'Clean coal' is increasingly assumed to have its part to play:

> "It has become accepted that there are limitations to the amount of renewables that can be incorporated on the grid, that it is becoming too late for new nuclear to make a significant contribution before 2016 and that the generation gap, which is now widely recognised as being 20–29 GW, will need to be filled by a combination of renewables, gas and clean coal." (Farley 2007:16)

### 7.3.2 Pressure in the socio-political environment

#### 7.3.2.1 Landscape

A number of developments led to increasing concerns about a looming energy crisis in Britain, due to dependence on gas imports from troubled regions, the ageing of power plant capacity, and the slow development of new capacity.

Another source of concern was related to climate change. The unprecedented degree of public attention contrasted with the slow progress of international climate negotiations, and the relative dilution of international concerns from 2009 (see Figure 7.7). Indeed, while Europe and the UK seemed to have made theoretical and political positioning advances on the subject, global disagreement on the means to tackle carbon emissions resulted in the inability to achieve binding international agreements (most recently at the climate talks in Copenhagen 2009 and in Durban 2011).

Furthermore, the financial crisis, which hit America and Europe most violently from 2008, refocused policy interest and political action towards economic imperatives, thus shifting attention away from public good concerns such as climate change. Political discourse became embroiled around the themes of jobs and spending cuts. In Britain, long-term structural investment plans were weakened.

So, while energy security and climate change established themselves as policy priorities, energy decision-making and markets were also fraught with uncertainties.

#### 7.3.2.2 Societal pressure against climate change

A number of authoritative publications contributed to increase the traction of the climate change problem internationally and domestically. The Stern Review (Stern 2007) increased the momentum of the climate change issue in the UK and worldwide. By making explicit links between climate imperatives and the costs and benefits of abatement, it has contributed to increase the sense of urgency and introduced a new form of pragmatism for energy-related policymaking.

Furthermore, the Stern Review drew substantial media and public attention to the issue of climate change, as witnessed by rising media coverage of the issue from 2005, peaking in 2009 (Figure 7.7):

> "In October 2006, climate change succeeded in making headlines across the UK, even in media outlets that are not normally inclined to give environmental stories much airtime. The trigger for this sudden and much more heightened interest was the publication of a wide-ranging study of the economic costs and benefits of climate change, pulled together by Sir Nicholas Stern, the UK Treasury's chief adviser on climate change issues." (Jordan and Lorenzoni 2007:310)

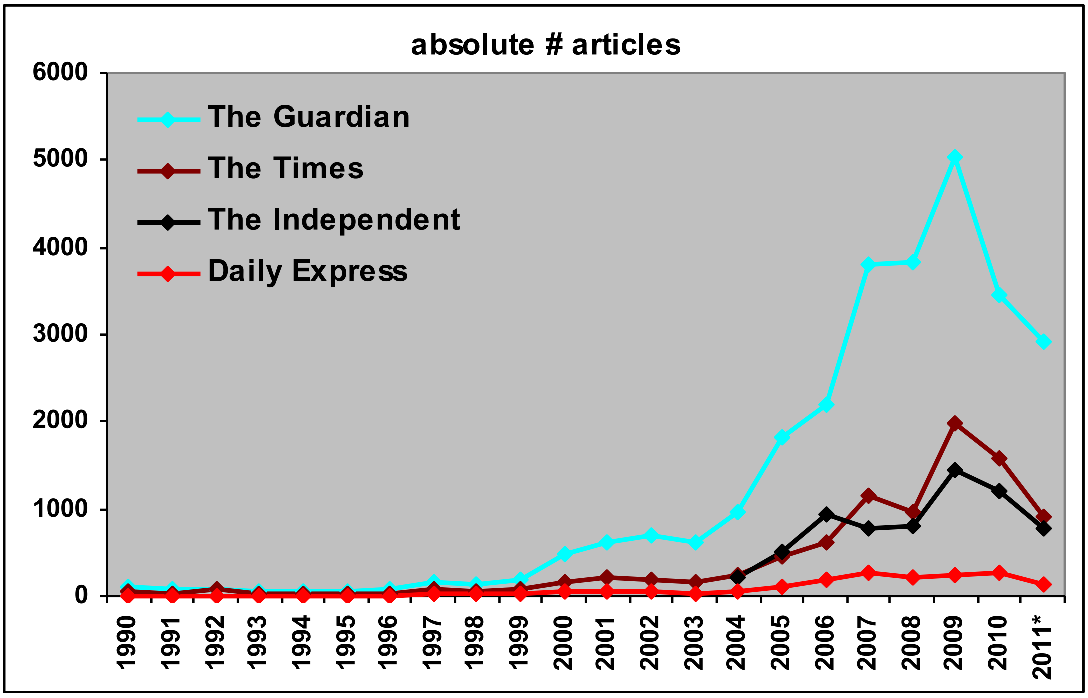


**Figure 7.7: References to 'climate change' in major British newspapers, wordcount, Data courtesy of Bram Verhees (originally compiled for Verhees (2012: 230))**

The IPCC's fourth report (2007) also made headlines when it was released, and added a sense of certainty to the claims of climate scientists (Jordan and Lorenzoni 2007:317). Al Gore's 'An inconvenient truth' released in the UK mid-September 2006 (Boykoff 2008), contributed to raise awareness and understanding of the climate change problem and related challenges. The attribution of the Nobel Peace Prize jointly to the IPCC and Al Gore in 2007 signalled the important efforts towards making the scientific and policy case against climate change.

These high-level landmarks resonated with a wider audience and contributed to *raise the issue's public profile*:

> "public perceptions – and with them concerns – that the climate is changing have strengthened appreciably in the past few years." (Jordan and Lorenzoni 2007:313)

, leading to a raised level of urgency

> "While concerns about environmental degradation have a long history, the past five or so years have seen the emergence of an environmental politics that makes new claims about the urgency of climate change as a problem to be addressed if a catastrophic future for human society and the wider ecosystems it depends on are to be avoided." (North 2011:1581)

However, despite the involvement of high-level scientists, activists, environmental groups and members of the public, it remains unclear whether they will be enough to address the immensity of the challenge faced:

> "the extent to which activism is generating a large enough social change movement that will enable humanity to avoid serious problems associated with future climate change is challengeable." (North 2011:1581-2)

Furthermore, there is a notable downward trend in media attention to the climate issue since 2009 (Figure 7.7), which is likely to be related to the shadow cast by the financial crisis and related economic considerations.

Climate change framings also faced the opposing claims of climate denial. Climate scepticism received disproportionate media coverage (North 2011, Pearce 2010), and seized opportunities to construct scandals. The "Climategate", for instance, involving the hacking of a climate research centre in 2009, was mobilised to dismiss climate science as fraudulent, and attracted substantial media coverage.

**7.3.2.3 Policy**

The issues of 1) energy security and 2) climate change firmly established themselves as central determinants of energy policymaking.

Firstly, energy security came to the fore with anxiety about energy dependence. According to MacKerron (2009:79), the energy debate changed substantially in the UK, owing to the gradual return of energy security concerns with rising oil and gas prices. Indeed, "oil and gas prices became much less stable and on occasion very high" (MacKerron 2009:79). These fluctuations opened the debate on the import-dependence of the British energy system, and were framed as a major policy challenge. The new framing relied on:

> "official scare mongering about an alleged (but implausible) major dependence on Russian gas supply in the future, and assertions that Russia would inevitably prove an unreliable supplier. By 2006 the rhetoric of vulnerability to malign foreigners had become strident, and government was advancing the twin ideas of advancing energy insecurity and pursuit of carbon emission reductions as the heart of energy policy objectives." (MacKerron 2009:80)

Secondly, Britain was committed to reducing its carbon emissions within the Kyoto Protocol, and increasingly sought to become a leading figure on climate change in the international arena. Policies translated implicit choices in the means to tackle climate change. The preferred solution would require international cooperation, a stable economic framework for investment and support to promising large-scale technological options. The White Paper 2007 (DTI 2007), "laid primary stress on international strategy, and the *need to tackle climate change and energy security jointly*" (MacKerron 2009:87, my emphasis), asserted the importance of the EU ETS mechanism, supported technological options such as nuclear power and CCS, and favoured "streamlined (more centralised and authoritarian) processes for planning approvals".

The results of the Stern Review (Stern 2007) were very influential. They not only suggested that tackling climate change was urgent and necessary, but also made an economic case for emissions reductions. Soaring energy prices also meant that energy security became a strategic domestic policy issue once more. Both policy objectives became interlinked in energy policy discourse:

> "We need therefore, to establish a strategy which delivers both energy and climate security. It is not sustainable to achieve one without the other. The investment decisions taken over the next two decades, will be critical in determining the world's energy and climate security and, therefore, its economic future." (DTI 2007:28).

These commitments were confirmed in the following years, when policy emphasis shifted to implementation:

> "In the years since 2007, there has been an increasing emphasis on detailed policy implementation" (Pearson and Watson 2012:27)

Indeed, in 2007, EU leaders agreed to 20% emissions reductions on 1990 levels by 2020 (the so-called '20-20-20'). In response to domestic political debate about the lack of serious commitments to emissions reductions, the Climate Change Act (2008) introduced a legal framework for the implementation of an 80% emissions reduction by 2050. In 2009, the UK Low Carbon Transition Plan set out a range of measures and strategies to reach these new ambitious targets, confirming the central role of the three prioritised technological options for power generation. The Renewable Energy Strategy (RES) announced a target of 15% renewable sources in the energy mix by 2020.

In relation to these new priorities, the main policy emphasis concerned 1) markets for carbon, and 2) the role of low-carbon energy technologies.

Firstly, UK energy policy remained highly committed to the role of markets for the efficient allocation of choice in the energy domain. This market however had to be regulated to take into account externalities such as climate change. The UK was one of the early countries to experiment with carbon trading. In 2005, the EU ETS was created as a cap-and-trade system for carbon emissions from large industrial combustion. However, this system has been criticised for its low level of ambition due to implementation details such as the free allocation of allowances,[52] and numerous exemptions and loopholes bare the imprint of powerful interests in high-emissions sectors such as power generation:

> " 'Internalizing' market failure such as CO2 emissions has proved to be highly contentious however and governments have been so far unwilling to set a price on carbon that can be agreed upon." (Fudge *et al.* 2008:43)

Ideally, the EU ETS should be unfavourable to coal as compared to other sources of power. Implementation details reduced this threat in practice:

> "In theory, carbon pricing should deter investment in new coal plants. However, so far the EU ETS has not been effective in driving down emissions, let alone influencing investment decisions. This is mainly because allowances have been too generous, and the time frame of each phase of the scheme has been too short." (Lockwood 2008:30)

Secondly, in terms of technological choice, the joint challenge of energy security and climate change was framed as calling for secure, diverse and low-carbon energy sources. In terms of technology policy, this meant that future energy systems would rely on a portfolio of technological options, and that support should be given for the development and deployment of a range of low-carbon alternatives. The 2007 White Paper on energy policy (DTI 2007) emphasised Government support to three main technological options in the electricity sector: renewables, CCS for fossil fuels, and nuclear power. Support to CCS was further signalled through a number of provisions in the 2008 Energy Act.

In the context of technology strategies to deliver the UK low-carbon energy transition, *coal-fired generation has received a mixture of pressure and support*. Indeed, as coal-fired generation is the most energy-intensive source of electricity and a substantial source of acidification, stricter targets tend to discourage coal, and encourage its decommissioning. For instance, the implementation of the EU LCPD required coal-fired generators to install abatement equipment or opt out of the scheme and plan to shut down by 2015:

> "The [EU LCP] Directive is expected to result in the closure of about half of the UK's remaining coal powered electricity generating capacity by 2015." (Shackley and Green 2007:230)

However, 2005-6 can also be seen as a *turning point* in the recognition that coal *will* play a substantial role in energy supply in the future, not least because of disruptions in

---

[52] Criticism about free allocation of allowances has led to a reform that should enable the auctioning of over half of the allowances from 2013 (http://ec.europa.eu/clima/policies/ets/index_en.htm, accessed September 15, 2011).

gas supplies, the recognition of an emerging capacity gap, and increasing momentum in the support for CCS technology (Farley 2007). So, *coal-fired generation found itself at a crossroads between decline and renewal*. A coal future in the UK became increasingly likely, but dependent on the materialisation of the CCS technological trajectory.

The official position on the future of coal has emerged as a form of conditional support to coal-fired generation. Jointly addressing concerns about the environmental consequences of coal-fired generation, and the energy security challenge, regulators in Europe moved towards the inclusion of CCS as a pre-requisite for new coal-fired power plants. The Office of Carbon Capture and Storage (OCCS) was created to facilitate the development and deployment of CCS technology.

Financial support was provided for technology demonstration. The 2007 White Paper confirmed Government support to CCS through a demonstration programme, to be implemented in stages of increasing capacity. A national competition for project proposals was launched. The pre-qualification for Demo 1 retained the applications of four consortia led by Peel Energy, BP, E.On and Scottish Power in June 2008. The 2010 Spending Review included a £1bn commitment by the Treasury for a post-combustion capture plant to be completed by 2014-15, seemingly confirming the UK's commitment to a specific technological design choice.

In parallel, the European Commission launched the NER 300 programme, to fund projects for innovative renewable energy technology and CCS. It committed to make the proceeds of the auctioning of 300 million EU ETS allowances (roughly £2-3bn, depending on the price of carbon) available for such projects. A first call for proposals was launched in 2010, to be considered by the European Investment Bank by 2012.

#### 7.3.2.4 Anti-coal mobilisation

The political support for coal also attracted protest groups. At a time when the Stern Review was being publicly celebrated, campaigns led by environmental activists targeted coal-fired generation as the symbol of Government and industry inaction on climate change. Arguments against new coal investments were produced and disseminated by environmental NGOs (Greenpeace 2008a, Greenpeace 2008b, WWF 2008). Such groups saw the alarming possibility of a *coal renewal in the UK*, and argued that such long-lasting investments must be ruled out for the sake of climate mitigation:

> "The decision over whether to approve the Kingsnorth plant is likely to be the most important climate decision of Brown's premiership. Opening the flood gates to new coal stations now would *lock Britain into* high levels of emissions for decades to come and signal Brown's surrender on meeting his own climate targets." (Greenpeace 2008a:2, original emphasis)

New coal investments were seen as perpetuating long-standing logics in power generation, and a major obstacle to the development of renewable energy:

> "The government's system [policy framework for energy] is designed to accommodate for large, inefficient and remote power stations owned by large companies like the coal and nuclear utilities such as E.ON. In other words, nuclear and coal power stand like two bouncers at the door blocking the way for renewables and efficiency - and perpetuating our outdated, inefficient and centralised energy system." (Greenpeace 2008a:12)

Renown scientists joined the ranks, publicly calling for the caution of policymakers against irreversible decision on new coal investment. In a public letter to the then Prime Minister Gordon Brown, James Hansen, director of the NASA Goddard Institute for Space Studies argued against new coal investment without carbon capture:

> "A firm choice to halt building of coal-fired power plants that do not capture the CO2 would be a major step toward solution of the global warming problem" (Hansen, 2007:2)

These discursive and political strategies were supplemented by direct action. The Drax climate camp was set up in an attempt to temporarily shut down Britain's largest source of carbon dioxide, emblematic of the country's reliance on coal for power generation (*The Times*, September 1, 2006). The occupation of the Didcot power station by Greenpeace protesters a month later was more successful, as it achieved a halt to generation (*The Guardian*, November 3, 2006). Between 2008 and 2010, a number of targeted actions were set up to protest against E.On's plans to replace and expand its Kingsnorth coal-fired power plant. Subsequently, the company announced its withdrawal from the CCS competition,[53] effectively shelving the replacement of Kingsnorth power station. These developments paved the way to Government pledges not to allow new coal-fired generation projects to go forwards without CCS plans.

---

[53] http://pressreleases.eon-uk.com/blogs/eonukpressreleases/archive/2010/10/20/1628.aspx, accessed March, 7, 2011.

### 7.3.3 Industry strategies – economic environment

#### 7.3.3.1 Economic positioning strategy

Energy companies, facing high present and future market uncertainties, privileged *diversification strategies* into multiple fuels and generation technology. In this context, coal raised its profile from a position of gradual phase-out to a guarantor of diversity in the domestic energy mix.

Coal-fired generation's market position has benefitted from changes in energy prices:

> "since 2000, oil and gas prices have increased significantly (…) which has led to a resurgence of the use of coal for power generation" (Lockwood 2008:13)

So, economic *prospects for coal were stabilising* again. The fluctuations in the shares of gas-fired and nuclear power were interpreted as a long-term pattern improving the relative attractiveness of the coal industry. The expected stabilisation of coal-burn, in a climate of growing energy security anxieties, channelled *hope and renewed expectations* about the possibility to maintain a stronghold on future energy choices. Such expectations indeed materialised (interview Brewer).

In 2011, five of the Big Six power generators in the UK operated a similar capacity of coal-fired generation, around 4,000 MW (Figure 7.8). The contribution of coal to power generation is expected to change with the planned decommissioning of ageing plants, and plants opting out of the LCPD. E.On and RWE are the most affected by these changes, and should see their coal-fired capacities shrink by 60% and 80 % respectively (based on data in Jess 2006), which are thus likely to push for new coal capacity in order to maintain a diverse portfolio:

> "In the next fifteen years, companies like E.On, EDF, and British Energy would like to build large new coal or nuclear stations. Other companies suggest marine renewables (wind, wave, tidal) and gas fired CHP as alternatives. In 2006, E.On applied to build the first UK coal plant in 20 years." (Parliamentary Office of Science and Technology, postnote February 2007 Number 280, UK Electricity Infrastructure, p.2)

In the context of replacing a substantial proportion of the ageing British power generation stock, and because of the new economic and strategic arguments to retain a substantial capacity of coal-fired generation, we can expect to see new investments in the coming years:

> "Interest in new coal plants has been sparked by relatively low coal prices over the last five years, making them more profitable than gas plants. However, the strongest driver for new coal is the desire by companies to maintain a portfolio of generating capacity that includes a range of fuels, to

hedge against market, security of supply or policy risk. As some companies are losing a significant amount of coal capacity from 2015 onwards, they are very keen to replace it." (Lockwood 2008:6)

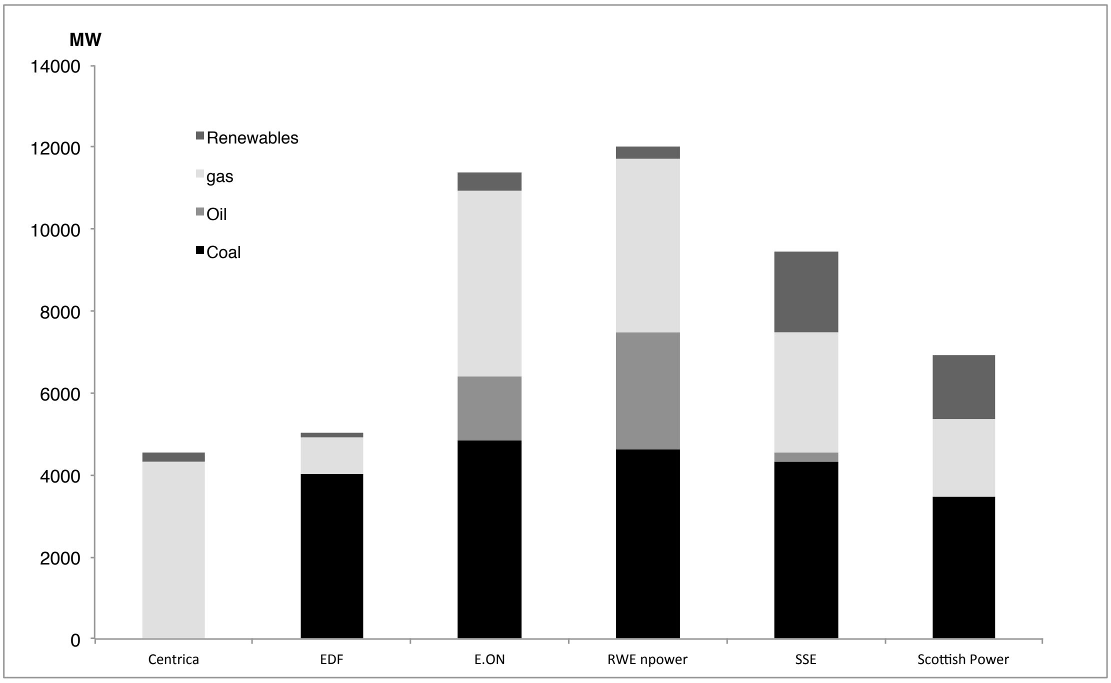


**Figure 7.8: Portfolio of major energy company capacity, MW, Source: DECC 2011c)**

### 7.3.3.2 Innovation strategies

The industry recognised the need to adapt to increased concerns about climate change, and engaged in substantial innovation efforts:

> "focus is increasingly being placed on the introduction of clean coal technologies to mitigate carbon emissions associated with coal fired power generation." (Coal Authority Annual report and accounts 2007-2008:4)

In the medium-term, efficiency improvements (advanced and supercritical coal combustion) became the main innovation objectives. Projects abounded:

> "During 2006, six major clean coal power station projects were announced (2 GW of IGCC and 3.6 GW of advanced supercritical)" (Farley 2007:16)

> "Powergen, the energy supplier owned by E.ON of Germany, unveiled plans yesterday to invest £1bn in the UK's first "super" coal-fired power station to try to curb carbon emissions. The company expects to apply for formal consent next month to build two new 800 megawatt units at its Kingsnorth station in Kent using "super-critical" technology. They would replace the station's four existing units from 2015, enabling Kingsnorth to operate at much higher levels of efficiency while producing fewer carbon emissions." (*The Independent*, 12 October 2006, p.44)

However, by 2011, progress was still relatively slow.

In the long-term, the industry was seeking the development and commercial use of CCS for coal generation in order to comply with increasing environmental constraints:

> "The UK power industry is keen to invest in coal fired generation and understands that CCS will be necessary if this is to have a future in countries with commitments to cutting greenhouse gas emissions." (Sussex Energy Group 2009:4)

Indeed, the CCS technological promise offers an attractive development trajectory to fossil fuel interests. It can be seen as:

> "a technology that allows companies to build on existing technologies by providing an add-on element to existing practices (…), popular amongst oil, coal and electricity companies. CCS gives carbon-intensive companies the opportunity to show proactivity on climate change, while concurrently continuing their core business activities – this has also been a source of criticism." (Kolk and Pinkse 2010:48)

From a destabilisation perspective, CCS, the main technological proposition put forward by industry actors involved with coal-fired generation, is a technological option that would allow established actors to maintain their core activities unchanged. In this respect, it can be seen as a 'sustaining' technology (Bowen 2011), which explains why it is being pushed by actors with vested interests in maintaining the importance of fossil fuels in the energy system.

As the Government became interested in this technological promise, and decided to further investigate its potential, increasing support became available. The Department of Trade and Industry (2005) issued a strategy for CCS development and thereby contributed to legitimise this future technological option. Public funding was made available for CCS research:

> "Ministers pledged £25m yesterday to develop technology that captures greenhouse gas pollution from power stations and dumps it under the North Sea. The funds for carbon capture and storage are part of a £40m package to help tackle climate change announced by the energy minister, Malcolm Wicks. Experts think the technique, known as carbon sequestration, could dispose of decades worth of pollution in depleted oil and gas fields while allowing us still to burn fossil fuels - emissions from which contribute to global warming." (*Guardian*, 15 June 2005, p.7)

However, this was deemed insufficient by industry to support technology demonstration:

> "Iain Miller, chief operating officer of Mitsui Babcock, an engineering company that makes technology that can be fitted to existing power stations, believes research funds of £100 million to £120 million are needed to convert a power station producing 500 megawatts of electricity." (*The Times*, May 16, 2005:36)

Subsequently, £1bn was made available to assist the funding of a full scale demonstration plant in the UK. The competition first retained two projects (at Kingsnorth and at Longannet) as likely candidates, but they were dropped for technical and financial reasons. The £1bn public funding still remains to be attributed to a credible candidate.

While a number of projects of gradually increasing scale have been developed worldwide, the largest carbon capture pilot plant in the UK was opened in November 2011 at Ferrybridge, with a capacity equivalent to a 5MW plant. It was developed by a consortium bringing together Doosan Babcock, SSE and Vattenfall, and benefitted from a £6.3m contribution from DECC.

Within CCS innovation, three main technological design options co-exist for capture: pre-combustion technology, oxyfuel firing and post-combustion technology. Additionally, CCS could be fitted to thermal plants firing any kind of fuel, and may also be coupled to downstream processes such as enhanced oil recovery (EOR) to enhance its economic viability (interview Paxman). The British Government initially favoured post-combustion technologies, for reasons such as its claimed flexibility and retrofitting potential in emerging markets such as China and India. This position has recently been challenged. Following the decision not to go ahead with the Longannet project, UK demonstration has become more flexible as to the design option it is likely to support, which is seen as a satisfying development from industry actors pushing for alternative designs (interview Paxman).

While coal combustion with greatly improved thermal efficiencies is already feasible today, the development of CCS technology is much less certain. The technical feasibility of CCS technologies has already been proven, but it is not clear whether and when such technologies will be commercially viable. This will depend on a number of conditions, among which the price of carbon (Mills 2010) and the emergence of a dominant design that would allow economies of scale required for a breakthrough (Shackley and Green 2007). There is also substantial concern that CCS is a technological promise that will never materialise and is used as as an argument to further delay carbon abatement. There is currently no agreement on a possible date for the first full scale CCS project to come on stream in the UK.

At any rate, most of the options in a low-carbon energy portfolio require substantial capital investments in plant and infrastructure, which the current liberalised energy markets do little to support. Because of the major investments involved, the technological uncertainties, and the substantial uncertainties as to the policy framework for low-carbon energies that will materialise in the coming years, it remains uncertain whether CCS technology will develop as it may be wished by advocates of coal-fired generation. So far, most of the corporate activity on CCS "has been focused on basic scientific research and lobbying governments for subsidies and support rather than investments needed to deploy the technology on a commercial scale" (Bowen 2011:2256). Such strategies are however unlikely to lead to the kind of technological breakthrough that is currently being held as the main assumption of CCS enthusiasts:

> "even an accelerated timetable could not see large-scale deployment of CCS in the UK much before 2020. This is consistent with other projections at the EU level" (Lockwood 2008:47)

The route currently being put forward by industry actors relies heavily on the involvement of public funders for demonstration programmes. While there is substantial enthusiasm for developing CCS in the UK and become a leader on future global markets, its advocates are concerned about the climate for investment, e.g. the absence of stable carbon prices and the obstruction by climate activists. Indeed, current (low) carbon prices are seen as discouraging CCS or other low-carbon alternatives

> "The main [policy] question is, though, is how soon carbon prices will be high enough to support CCS projects, and whether – given the high volatility seen on carbon markets so far – project developers will have enough confidence to go ahead with costly, long-lived and inflexible investments. Research and development is also promoted by stable prices." (Mills 2010:231)

Accordingly, CCS advocates are pushing for tax incentives, loan guarantees for demonstration and deployment projects (CIAB 2008).

However, pursuing the CCS option would require the rapid scaling up of incentives for technological development (Bowen 2011). Additionally, because of "public hostility to new coal plants, demonstrations, regulatory challenges, lawsuits" in the UK, it might "be better for the power industry to sidestep such opposition, by having clear legal mandates for CCS that at least put all the companies on a level playing field" (Mills 2010:231).

Industry actors have enthusiastically engaged in debates and negotiations to put forward CCS in the UK between 2006 and 2009. Lobbying efforts were rewarded by the announcement of Government support, and a flurry of company projects entered the race for demonstration (CPS 2007). However, from 2009, with lack of a stable investment framework in perspective, individual companies have started pulling out of the technological race for the deployment of CCS in the UK. Today, a few projects remain in the race for the UK and European demonstration programmes. At any rate, the difficulties to maintain a stable framework for long-term investment in CCS seems to suggest that the UK is less likely to take the lead on large-scale deployment than other parts of the world such as the USA (interview Brewer).

### 7.3.4 Industry strategies – socio-political environment

#### 7.3.4.1 Political strategies

Companies and interest groups related to coal engaged in *lobbying strategies* to secure support for energy policies compatible with the continued burning of fossil fuels. Given the increasing momentum of climate change considerations in energy policies, efforts had to be made to *legitimise* coal's role as an energy source for the future. So, lobbying efforts shifted from obstructing climate change policies to influencing their direction. Two main political strategies prevailed: 1) ensuring that the energy gap can be seized for new coal-fired investments, and 2) building support for innovation in CCS technology.

It was crucial for some energy companies to get new coal-fired generation on stream by 2015. By 2008, various coal-fired projects totalling just over 11GW were being planned or pending approval (Lockwood 2008:13). However, planning permissions were complicated and delayed by environmental activism.

At the EU level, groups such as EURACOAL, which represent coal interests, argued for new investment in coal-fired generation, and the establishment of a protected framework for CCS:

> "Since the beginning of 2010, EURACOAL continues to repeat that new coal-fired power plants are necessary in addition to replacing old power plants, in order to greatly reduce emissions thanks to modern technology improving power plant efficiency (…) Carbon Capture and Storage also remains a very important option for the period after 2020, particularly if industrialised countries must reduce their emissions of greenhouse gases by 80 % or more by 2050. In order to reach the objectives related to CCS, EU Member States together with industry, must overcome obstacles of legal, financial, infrastructural nature and also, probably more difficultly, public acceptance. An initial case will be the construction of 10 to 12 pilot plants throughout the EU by 2015." (EURACOAL 2010:29)

British coal-related interests pursued similar strategies, arguing for the necessity of strong Government involvement:

> "The success of carbon capture and storage demonstration plant fitted to coal fired power stations being sponsored by Government is fundamental to the long term future success of the industry." (Coal Authority Annual report and accounts 2009-2010:8)

The UK Coal Forum, set up by Government in 2006 and attended by representatives of Government and industry, regularly argued in favour of strong support for coal, in the name of meeting climate targets, maintaining energy security through diversity, and contributing to employment in coalfields communities.

Companies with intentions to develop new coal-fired projects sought to obtain Government approval and planning permission. External expressions of support, such as that of environmental NGOs, were seen as greatly improving the chances of successful applications. The Hatfield IGCC project, initially led by Powerfuel, for instance, crucially acquired the support of Friends of the Earth (Lodge 2007:13).

This seemingly ‘pro-active’ position on future technological promises allowed companies with interests in coal-fired generation to argue for new coal-fired investments on the basis of a future retrofit when CCS technology would become available. This influenced the official position requirements for new coal-fired generation, enshrined in the national policy statements, according to which new-built should be constructed according to the criterion of ‘capture-readiness’:

> “All commercial scale fossil fuelled generating stations have to be carbon capture ready […]. In addition […] new coal-fired generating stations, or significant extensions to existing stations, in England or Wales must have CCS on at least 300 MW net of the proposed generating capacity and secure arrangements for the transport and permanent storage of carbon dioxide.” (DECC 2011a:54)

#### 7.3.4.2 Framing strategies

After the 1990s, coal interests in the UK in general admitted that they were no longer in a position to contest climate change publicly, given the high degree of public and policy support that it had attracted in recent years (interview Brewer). This situation was significantly different in the US, where climate scepticism was much deeper rooted in the political, media and industrial domains (Antonio and Brulle 2011).

However, companies and interest groups sought to influence the core rationales of energy policy to be favourable to the continued burning of coal and to discredit alternative goals and technologies. The emphasis was set on three main aspects: 1) the pressing importance of energy security, 2) the ability of free market institutions to address the climate problem as opposed to picking technological winners, and 3) constructing enthusiasm for clean coal technologies. Via these strategies, interests pushing for the continued development of coal-fired generation in the UK sought to position coal as a viable option and to obstruct the development of alternatives such as renewable technologies.

Firstly, rising energy prices and the threat of supply disruptions were mobilised as arguments to re-state and insist on coal's relevance for the future of energy mixes and regain a respective degree of *legitimacy*. The main argument consisted in framing coal's potential contribution to a diverse fuel portfolio, and insisting on the domestic availability of resources. This framing allowed the continuation of coal-fired generation as a strategic imperative:

> "The Coal Authority (Authority) believes that coal will continue to make an important contribution to the medium term energy requirements of the nation as part of a diverse energy mix, underpinning security of supply, with indigenous coal being particularly significant in reducing the dependence on imports (…) Coal can have a major role in ensuring security and diversity of supply to enable the nation to determine and develop alternative long term energy solutions that meet 21st century requirements." (Coal Authority Annual report and accounts 2004-2005:1)

Coal was thus increasingly framed as one key to energy security, in the face of the risks presented by overreliance on gas. Additionally, coal enthusiasts regularly emphasised the problems of renewable energy. The intermittent nature of renewable energy was mobilised to emphasise the need for load-following energy sources such as coal-fired generation. Coal-fired generation with CCS was also argued to be cheaper than renewables (interview Paxman):[54]

> "Fitting clean coal technology to the UK's 16 power plant would cost an estimated £6 bn. In comparison, 2,000 wind turbines are being put up in the UK over the next six years at a cost of £9bn." (CPS 2007:10, mobilising claims by Doosan Babcock Energy)

Secondly, *framing strategies* consisted in insisting on a central role for market allocation, thereby preventing the debate on energy policy to engage with questions of strategic technological choice. Given that market mechanisms had been developed to include carbon constrains – be them largely captured by powerful industries' ability to dilute them – a marked preference for the status quo prevailed. In this context, and in order to avoid future requirements for mandatory CCS for coal-fired generation, the Confederation of British Industries (CBI) argued that the EU ETS was enough to ensure low-carbon energy systems:

> "Introducing alternative measures, such as emissions performance standards or mandating for CCS, which limit or ban new coal-fired power stations will send out the signal that government does not have confidence in the EU ETS" (CBI 2008:6)

---

[54] Such favourable price estimates relied on strong assumptions such as the technological feasibility of CCS.

Furthermore, it was argued by coal interests that the offsetting mechanisms inscribed in the EU ETS made the debate on the relative rise of UK emissions irrelevant (WWF 2008), which meant that the UK could continue burning coal as long as it was offsetting its emissions elsewhere. Coal-related industries also tried to discredit renewable energies and policy instruments supporting their diffusion, such as the Renewable Obligation, and called for similar schemes to support clean coal technologies:

> "Doosan Babcock has lobbied the Government to introduce a form of incentive, similar to the Renewable Obligation Certificate, for power generators to invest in clean-coal technology." (CPS 2007:11)

According to this strategy, caps and emission limits were seen as incompatible with liberalised markets (including carbon trading), since emitters should be allowed to choose fuel and technology. 'Enabling' incentives structures were thus preferred over 'limiting' regulation.

Thirdly, industry actors sought to *construct positive framings* of coal-fired generation technologies. 'Clean coal' is an oxymoron that has been constructed by the coal lobby in order to suggest that coal can be reconciled with environmental objectives. It has been used to signify various technological options and promises throughout the years, and remains ambiguous. Today, the emphasis is set on CCS.

With respect to the acceptability of CCS, industry actors believe that more needs to be done to improve the public's perception of the technology:

> "Much more needs to be done to raise public awareness. Policy makers and opinion leaders must be more forthcoming in explaining to their constituencies the significance of CCS technology and its potential ability to contain the much-feared affects of global climate change." (CIAB 2008:36)

However, they also recognize that in constituencies dependent on coal mining and coal-fired generation, the technology is much more accepted – as would any option that could ensure future survival of existing industries (interview Paxman).

Another element of coal advocates' *technological framing strategies* has consisted in constructing promises that new-built coal can be designed to be 'capture-ready'. This relatively vague rhetorical device (Markusson and Haszeldine 2009) is meant to safeguard and reassure as to the industry's willingness to abate carbon emissions in the future. In practice, the commitment doesn't imply much besides more uncertainty:

> "When building power plants, the space to extend them must be foreseen so that they are "capture-ready" as soon as this technology is perfectly mastered." (EURACOAL 2010:29)

Crucially, the 'clean coal' promise tied together emerging energy security concerns with a promise to tackle climate change within the coal regime. New coal investment plans re-surfaced in 2005-6, signaling the possibility of a serious re-birth of coal-fired generation in the UK. This renewed *enthusiasm*, backed by policy support, was related to *framings* of a new generation of 'clean coal' technologies that could jointly contribute to address climate change and reduce energy security:

> "The government yesterday gave its clearest signal yet that King Coal is ready for a comeback as it emphasised that clean technology could help the fuel play a new role in future energy needs. Alan Johnson, the trade and industry secretary, said the UK should make sure its "eggs aren't in one basket," both in terms of power sources and their countries of origin. "If a new, cleaner coal generation is viable, then I think it could have an important part to play in making sure we have diverse generation in the future. Coal is easy to store and it comes from a variety of well-established sources around the world," " (*The Guardian*, 21 February 2006)

In 2006, E.On and RWE announced their intentions to build 'clean coal' power plants in order to compensate the closure of capacity under the LCPD (E.On Annual Report 2006, RWE Annual Report 2006).

So, thanks to successful *framing strategies*, it increasingly looked like coal would make a comeback in British electricity production:

> "**Old King Coal is back** (...) Coal was supposed to be the forgotten fuel, the dirty man of Europe, fit only for meeting the electricity needs of the developing world, where the stuff is plentiful and economic self-improvement still takes precedence over the trashing of the environment. (…) **Coal is cheap and in abundant supply compared with gas** (…) So, in the short- term at least, **making maximum use of coal-fired capacity is a no-brainer**." (*The Independent*, 23 December 2005, p.49, my emphasis)

Coal-fired generation achieved to create a discursive space for itself by emphasising the joint imperatives of energy security and climate goals.

> "It can be stated with confidence that the UK's dependence on fossil fuels will continue far into the future (…) It is true that CO2 emissions from coal are higher than alternative fuels. However, this presents an opportunity to capture the greatest amount of CO2 captured per unit of electricity." (Foreword by Richard Budge, CPS 2007:1)

> "New clean coal technologies can allow the UK, the US and other coal rich countries to develop new technologies which harness Carbon Capture and Storage (CCS). They can thereby demonstrate to the developing world the practical importance of embracing the cleaner and more efficient use of coal." (CPS 2007:4)

Coal was once more considered as a serious contender in a future energy mix, which testifies of the success of framing strategies.

## *7.4 The future?*

With grand challenges ahead, and only limited recent change, the urgency of accelerating a shift to low-carbon and secure energy sources is become increasingly urgent:

> "In the UK, environmental restrictions on coal-fired power, the need to decommission most of the existing nuclear reactor stock and the probable need to cater for even modest demand growth means that investment in new capacity of at least 20,000 megawatts (MW) will be needed by 2020 (…) The choice of fuel for these new power stations will heavily condition electricity sector carbon emissions until mid-century – the time by which the UK aims for an absolute carbon emission cut of 60 per cent. To have any hope of getting near such an aspiration, new electricity generating capacity must be very low carbon." (Scrase and MacKerron 2009:96)

The UK Government is showing signs of stepping up its commitments to a low-carbon transition. Most recently, the Electricity Market Reform (EMR) was introduced by a White Paper in 2011 (DECC 2011b). It aimed at clarifying and stabilising the market framework to encourage investment in low-carbon power capacity. It confirmed the Government's commitment to the 'trinity' of low-carbon power technologies, and suggested the implementation a set of policy instruments, notably, 1) a feed-in tariff enabling long-term contracts for low-carbon energy, 2) the introduction of a carbon price floor, 3) an emission performance standard of 450gCO2/kWh to prevent new high-carbon investments, 4) a mechanism to ensure the adequacy of future capacity.
So, this new policy framework might improve the context for investment in low-carbon technologies. However, it tends to confirm commitment to a neo-liberal approach to energy markets. It seeks to correct market failures by the introduction of mostly market-based instruments (Newbery 2011). While such incremental 'corrections' are welcome, it remains to be seen whether they will be enough to enable the radical changes that are necessary for a transition to low-carbon energy systems.
With respect to coal's position, the new framework has confirmed its support to coal with CCS. The WP could mark the beginning of the acceleration of a shift from 'traditional' coal-fired generation to a new generation of ambitious low-carbon options. In that sense, incentives for CCS are greater than ever in the UK. However, a number of policy implementation concerns remain.
Coal-related industries are worried about the carbon price support that would ensure a floor carbon price to prevent investment in coal without CCS (interview Brewer). The fact that coal generators are opposing the application of such measures is quite revealing

of the double discourse that is currently being held: 1) CCS should be encouraged, but 2) measures to discourage coal new-built without CCS should be opposed. The outcome of such lobbying activity on detailed policy implementation remains to be seen. Furthermore, the Government has recently considered the delivery of up to 10GW CCS capacity by 2020 in its Carbon Plan (DECC 2011d). CCS lobby groups still judge this target as being too low. Indeed, CCSA continues to argue for the need to reach a CCS capacity of 20 to 30 GW by 2030 if emission reduction targets are to be met (CCSA 2011).

On a global level, coal is continuing to expand, and CCS technology is attracting major interests, notably from the oil and coal industries. A number of pilot plants are already in operation.[55] Large-scale CCS projects are multiplying throughout the world, mostly to come on stream from 2015. The main countries involved are the US, Canada and Northern European countries. The American context is seen as comparatively more favourable to CCS for two main reasons: 1) a long history of R&D funding, and 2) the positive association of CCS with Enhanced Oil Recovery, which makes the technology commercially viable in the absence of a carbon constraint (interview Paxman). Critically, major international institutions have recently endorsed the future role of CCS in tackling climate change. Indeed, the IEA attributed a major role to CCS technology in its most world energy outlook (IEA 2011). Following intense lobbying from the World Coal Association (WCA), CCS has been included as an option in the Clean Development Mechanism at the Durban climate negotiations in Durban (Dec. 2011), further reflecting its raised international acceptability.

The 'capture-readiness' requirements potentially open the door for at least fifty more years of commitment to coal-fired generation by delaying the necessity of assessing CCS viability and societal acceptability. Furthermore, there are serious concerns that 'capture ready' plants will never retrofit CCS because of the high costs involved (WWF 2008). As such, it can be seen as an empty promise that allows going ahead with capacity replacement and avoiding mandatory CCS retrofits, which are not favoured by industry:

> "We may expect resistance to regulation making capture retrofitting mandatory" (WWF 2008:5)

---

[55] The status of CCS projects worldwide can be consulted at http://sequestration.mit.edu

There is an evident risk that this form of strategy will further delay drastic cutbacks in carbon emissions and contribute to make future efforts more costly. A consultation on CCS and what was meant by 'capture ready' was set up in 2008, confirming concerns:

> "[Some stakeholders] saw the concept as at best a distraction and at worst a smokescreen to get unabated coal capacity built in advance of CCS being available" (Scrase and Watson 2009:179)

Semantic considerations were amplified, given the low degree of technical specifications of the term, and the low prospects of seeing CCS materialise anytime before 2020. In light of this controversy, the UK demonstration programme can be seen as disappointing, slow, as its terms "legitimised a 'build now, capture later' mindset in the UK power industry" (WWF 2008:7).[56] "There are real risks that a policy intended to accelerate development and learning of CCS technology is being used to legitimise much larger, investments in unabated (if 'capture ready') coal capacity" (WWF 2008:7).

## *7.5 Analysis*

This case study is incomplete in nature, and ends at a crossroads with regards to the industry's future. Coal-fired generation's future prospects have been greatly improved in recent years, which suggests that the industry is unlikely to fully contract as could have been predicted a decade ago. Notably, the industry has proved resourceful in positioning itself positively in relation to the great challenges facing current energy systems: energy security and climate change.

The industry was initially weakened and deprived of long-term survival prospects in a context that favoured other energy sources. Especially, the issue of climate change, which gained prominence from 2000, contributed to *de-legitimise* coal-fired generation in the UK, which was deemed to decline as its production units were put off stream. However, the industry managed to contest this highly negative industry outlook. The re-emergence of energy security concerns from 2005 provided an opportunity to position coal as an attractive fuel option for the future. 'Clean coal' technologies (and notably CCS) promised to jointly address the problems of climate change and energy security. While investments projects have not yet fully materialised, the enthusiasm around CCS suggests that industry actors with an interest in coal-fired generation have succeeded in constructing support and regaining some degree of *political legitimacy*. While coal-fired

[56] This perception is further justified by the choice of funding post-combustion technology, over other technological alternatives.

generation remains controversial, it has regained a part to play in the energy picture of tomorrow.

### 7.5.1 External pressures

The case study shows that coal-fired generation in Britain experienced multiple pressures in its economic and socio-political environments. Table 7.2 summarises the main pressures, and indicates how they have evolved in the various periods.

**Table 7.2: External pressures for change exerted on the British coal industry, as located in economic and socio-political environments (the sign (+/-) indicates whether pressures are challenging/enhancing industry stability, the value (+, ++) provides an indication of the importance of the pressure)**

| | Essential supply-side resources | Shrinking markets | Changing markets and preferences | Technological competition | New entrants | Normative contestation | Public opinion and discourse | Political pressure |
|---|---|---|---|---|---|---|---|---|
| **1990-1997** | (++) Removal of support; negative investment climate; very low R&D | (++) Market collapse | (+) Liberalised ESI; less capital-intensive options favoured | (++) Dash for gas | (+) Low barriers to entry | (+) Climate change science and activism | (0/+) Growing climate awareness | (+) Interest in acid rain and climate change policies |
| **1997-2005** | (0/-) Negative investment climate & ageing capital stock, but coal cheap | (0/-) stable market | (0/+) environmental constraints as investment criteria | (--) Dash for gas weans but interest in low-carbon technology | (+/-) Foreign investors | (++) Climate change gathers momentum | (++) Climate change established; negative framing of coal | (+) Moratorium on gas, but climate change enters energy policy |
| **2005-2011** | (+/-) Worsening investment climate, but coal abundant & cheap | (-) Opportunities as energy gap to be filled | (+/-) Rising energy prices & fuel diversity requirements | (+) Renewables, nuclear but also 'clean coal' to fill the gap | | (+) Climate change urgency but energy security concerns | (+/-) Climate change highly mediatised but 'clean coal' future becomes accepted | (-) Climate change policies (20-20-20, CCA 2008, etc.), but also CCS support |

Some pressures existed almost continuously throughout the case (e.g. growing environmental concerns about climate change). Other pressures were less ongoing, e.g. energy security concerns that only surfaced in the last period. Coal-fired generation was under major pressure (economic and socio-political), and faced declining prospects. However, the rise of energy concerns and changing fuel prices in the last period provided an opportunity to re-frame coal as a potential future option – thus restoring a degree of political legitimacy, and a case for future investment.

The most important pressures on the industry were related to 1) *technological competition*, 2) *societal pressure*, and 3) *political pressure* for the inclusion of environmental issues.

1) substantial competition from alternatives better aligned with the changing context led to the rapid replacement of coal-fired generation by gas in the 1990s. In the longer-term, coal-fired generation has had to compete with the enthusiasm generated for cleaner and low-carbon technologies (gas, nuclear and renewables). Rising oil and gas prices attenuated this challenge in the last period.

2) The energy sector was characterised by substantial societal concerns. Environmental concerns have been relatively high since the late twentieth century, first focussing on acid rain and then on climate change. Both problems saw coal-fired generation as the main offender, which led to substantial pressure in the form of environmental policies. In the medium-term, acid rain policies required coal-fired generators to invest in expensive abatement technologies or decommission. In the longer-term, increasing carbon abatement policies threatened the future viability of coal and thus prevented new investments. With rising energy prices, energy-related issues made their way to the public debate. Energy security concerns, however, played in favour of coal-fired generation, as an opportunity to halt its decline.

3) Growing environmental concerns have led to the implementation of more stringent *policies*, first related to acid rain, and then related to climate change. Raised climate targets, the introduction of carbon pricing, and incentives for low-carbon technologies put substantial pressure on traditional coal-fired generation. Since the future of coal-fired generation depended on the industry's ability to secure long-term investments in an adverse climate, energy policy and support to technological development became crucial to secure long-term prospects for coal.

Contrastingly, *resource problems* were less salient. Indeed, while the rush from coal of the 1990s led to the removal support structures and funding sources for capital-intensive projects, the abundance of coal reserves worldwide at relatively cheap prices has rather played in favour of coal-fired generation, especially in recent years.

The case also displays the important influence of *landscape trends and shocks*:

- the climate problem was linked to the emergence of an international pressure coalition driven by scientists and environmental NGOs, but British policy advances also reflected a willingness to take the lead internationally. Indeed, domestic measures to mitigate climate change are highly dependent on international efforts.

- Global upward trends in coal consumption have influenced the framing of coal, and the perception of future opportunities
- The global nature of fossil fuel trades has increased fluctuations, and has notably led to increasing energy security concerns from 2003.
- The 2008 financial crisis was an extreme event with lasting consequences that has been driving policy, business and media attention since its eruption, to the detriment of issues that had recently acquired a high status, such as climate change. It has led to the slowdown of economic activity, the re-ordering of economies worldwide, the introduction of austerity measures, and considerably increased the uncertainty of long-term investments in energy ventures.

### 7.5.2 Interaction between pressures

The industry faced a highly adverse environment at the beginning of the period, characterised by *radical market change* and the vanishing of *political support*. The industry was set on a trajectory to "hollow out", declining gradually in the absence of support structures and the inevitabilities of old age. Environmental pressures added to this adverse context, in which pressures became *aligned* towards the decline of coal-fired generation – although the technological pressure was temporarily relieved. In the last period, however, the emergence of energy security concerns provided a *window of opportunity* for coal-fired generation to position itself as both *secure* and *low-carbon*, via the technological promise of CCS.

So, the case started with a high degree of *pressure interaction* pointing clearly towards the long-term decline of coal-fired generation, but ended with disjoined pressures, namely as a result of deliberate industry strategies to create space for itself on the basis of new energy policy priorities.

***1990-1997.*** The liberalisation and privatisation of the electricity sector led to a re-configuration of the rules governing investments and decision-making in the industry. Coal-fired generation was hard hit by these changes. The inflow of *new entrants*, opportunities for investment, and new rules favoured *technological alternatives* to coal that were comparatively less capital-intensive and entailed lower acid emissions. The dash for gas marked the rush from coal, the instalment of a consensus about the benefits from economic liberalism and its *coupling* with greater interest in *environmental issues* (acid rain and climate change). The problem of climate change made its way on the public and political agenda. So, strong pressures were *aligned* against coal-fired generation.

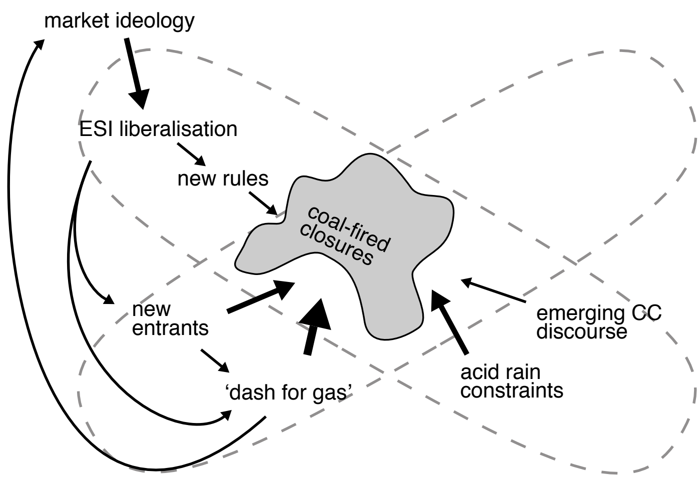


**Figure 7.9: Pressure interactions 1990-97**

***1997-2005.*** The negative effects of privatisation were assessed and led to adjustments. Coal-fired generation was temporarily relieved and protected from the intense market pressures: the penetration of *technological alternatives* (gas) was halted, market rules were adjusted and reinstated coal's position in the merit order. Public concerns about climate change gained significant momentum, catalysed by the advancement of international scientific consensus and mobilisation. Climate change advocates called for the definitive end of coal, while (less salient) energy security arguments emerging towards the end of the period suggested that low-risk fuel sources (such as coal) should be preferred. The decommissioning of coal-fired capacity was due to accelerate to comply with acid rain policies.

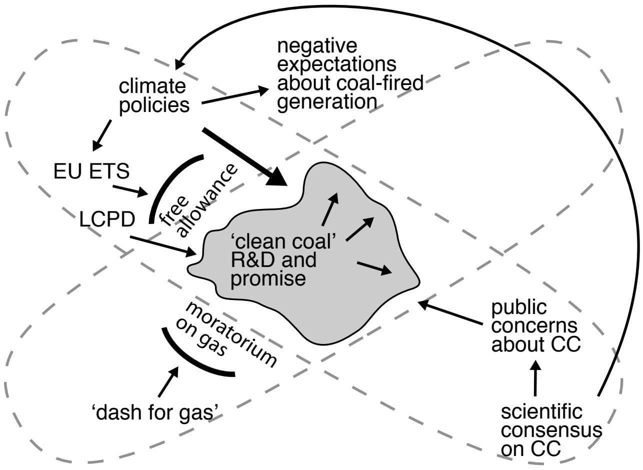


**Figure 7.10: Pressure interactions 1997-2005**

***2005-2011.*** Fluctuations on international fuel markets were taken up in the policy environment, casting doubts over the reliance on gas. Energy security and climate change confirmed their raised status. Aspirations to a transition to low-carbon energy justified more stringent policy action to enable this change: low-carbon targets and commitments were raised, carbon markets were introduced, and greater attention to issues of strategic technological choice was sought. *Technological alternatives* (renewables, nuclear power) were increasingly considered, *coupling* climate change concerns with increasing anxieties about an upcoming energy gap. This context favoured a mix of technological options that could address both issues. Power generators renewed their interest in (relatively cheaper) coal as an option to hedge against fuel price fluctuations. The 'trinity' of low-carbon energy supply options (renewables, nuclear, CCS) emerged in this context. So, while societal opposition to coal persisted (and was alarmed about the international growth of coal-burn), it became increasingly accepted that coal was to play a role in future energy systems. These expectations were bundled around the technological promise of CCS, which received innovation support and shaped future opportunities for coal-fired generation. Meanwhile, the financial crisis and the deadlock of international climate negotiations reduced confidence about transitions to low-carbon energy systems, and investment in general.

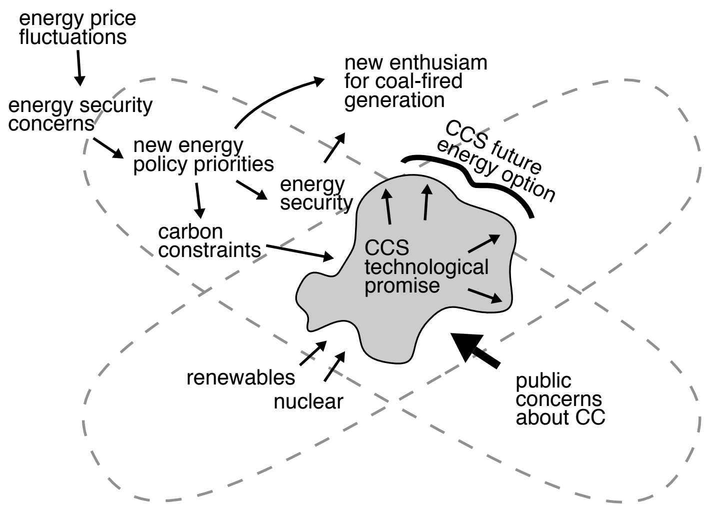


**Figure 7.11: Pressure interactions 2005-11**

So, the industry environments was initially characterised by pressures on multiple fronts (markets, technological competition, policies, environmental problems), pointing towards the long-term *decline* of coal. This coherent front was swept away by the instalment of divergent demands on energy systems: energy security *and* carbon constraints. The pressures, exerted in parallel, provided diverging signals to energy industries, which faced an increasingly uncertain future. An attempt to constructively reconcile these concerns was then operated via the build-up of technological expectations around a possible coal future. Presently, coal-fired generation in the UK finds itself at crossroads between its gloomy past and potential future opportunities.

The most important issues have been climate change and energy security concerns. They thus provide an opportunity for the analysis of issue build-up and interaction:
The **climate change issue** was initially raised by scientists and activists and attracted public attention. It first entered policy circles in international arenas. British politicians were eager to take the lead internationally, and contributed to raise the issue's public profile. Early policies sought to establish emission reduction targets and a price for carbon. Although too weak to be effective, such measures ensured that the issue penetrated the economic environment of energy industries, attracting the interest, concern and involvement of industry actors. The recognition of the ineffectiveness of current policies, combined with a raised urgency about the climate problem, led to more ambitious policies, resulting in greater stress on industry actors. Currently, it remains to

be seen how effectively such energy and climate policies will be implemented, but carbon abatement seems to have remained stuck at the discursive and prospective level, and lacks strong economic drivers and motivations. This gives me reasons to doubt a further decline of coal-fired generation in the UK.

**Energy security concerns** have repeatedly made their way on the energy policy agenda. They have been related to swings in commodity prices, or disruptions to the continuous supply of fuels. In this case, the combination of past technological choices (dash for gas), rising oil and gas prices, and concerns about over-dependence on imports from unstable countries, have led such resource problems to enter the political agenda as energy security concerns, influenced by industry framing strategies to strengthen the position of coal in relation to this emerging issue. These concerns led to the questioning of the market model for energy industries, greater pressure for regulations and state intervention in strategic technological choice. The rise of energy security concerns in decision-making in the electricity sector provided opportunities for the voicing of specific fuel-related interests.

**Likely future pressure evolution**

While the future evolution of the UK's energy system, and coal-fired generation in particular, is difficult to predict, a number of trends, upcoming contradictions and crucial opportunities can be outlined.

Overall, it seems that environmental and energy security concerns have firmly established themselves as important criteria shaping the future of energy systems, although mobilisation around climate change may be declining. Because they relate to market failures, these concerns are inherently conflicting with the operation of free markets and the instalment of the neo-liberal doctrine since the 1980s; their influence on energy systems will be mediated by the introduction of new rules and regulations. However, efficient market allocation is likely to remain the underlying principle driving policy formulation in this sector. So far, it is not clear that the conflict between these societal goals framed as market failures and the underlying commitment to market allocation will be overcome by the gradual introduction of piecemeal regulation, such as the EMR package (DECC 2011b). Addressing the major challenges related to environmental problems, anxieties about economic prosperity, and the strategic need for reliable energy sources is unlikely to go forward with incremental changes alone.

Increasing technological competition can be expected as alternative technologies jockey for position to gain market shares in the energy system of tomorrow. Such options, if coupled with strong societal demands (e.g. around climate change, energy security, or both), ambitious policies, and stable investment conditions could in turn contribute to shape the (upcoming?) transition and its underlying framework. However, in the absence of a clear technological leader, and given the established assumption that no single technological option can solve the climate problem, the upcoming transition path is likely to be more complex than it has been in past substitution patterns. It will continue to be prone to the strong influence of heterogeneous actors, of which coal-related interests will be part. Difficulties of managing this technological diversity is a strong obstacle to the destabilisation of established industries and the breakthrough of new ones.

The elaboration of a new governance framework addressing these problems jointly could be crucial to the establishment of long-term commitments that have the ability to send out clear signals to industry actors to profoundly alter their strategies. Such signals will only have a structuring effect if they shift from the discursive level to strong constraints. In this perspective, we are likely to see the role of the state and industrial policy make a comeback, enabling *interactions* from societal concerns to economic frame conditions. Furthermore, a stable high carbon price is seen by many as the key to the acceleration of commitments and the internationalisation of the climate problem. The recent policy makes shy steps in this direction.

### 7.5.3 Endogenous enactment

I now turn to regime changes and strategy developments from an industry perspective. These are summarised in Table 7.3 and analysed below.

**Table 7.3: The development of industry strategies**

| | Socio-cultural framing strategies | Political strategies | Economic positioning strategies | Innovation strategies |
|---|---|---|---|---|
| **1990-1997** | Contest climate change claims; Focus on uncertainties | Seek support against dash for gas; Lobbying against the 'Pool' | International companies and supply chains; Cost reductions; Closure of coal-fired plants | Underfunded 'clean coal' research |
| **1997-2005** | Worries about climate developments; 'Clean coal' framing | Delaying acid rain policies; Lobbying to create support for 'clean coal' R&D | Concentration; Renewed confidence in maintaining coal; Diverse fuel portfolios | 3 'clean coal' promises:<br>- short-term: flue gases<br>- mid-term: efficiency<br>- long-term: CCS |
| **2005-2011** | Inflate energy security worries & insistence on coal's role; 'Clean coal'; 'Capture-ready' | Secure commitments:<br>- new coal for energy security<br>- CCS for climate change | Maintain fuel diversity with coal; Seek new coal replacement | Plans for supercritical plants; CCS projects |

***1990-1997.*** In response to the liberalisation of the ESI, coal-fired generators developed *lobbying strategies* to acquire support to weather the dash for gas and contest the market mechanisms in place. Firms adapted to the new economic framework with *restructuring strategies* and international *positioning*. *Counter-framing strategies* sought to limit the influence of the climate problem by focussing on uncertainties.

***1997-2005.*** In the face of increasing concerns about climate change, the industry worried about its ability to further halt its decline. The development of the 'clean coal' *framing* sought to conciliate energy security and climate change, in order to *create market opportunities* for a *renewed* coal-fired generation industry. This technological promise thus constructed the image of an industry embracing a new *mission, identity, values* and *strategy*. This new prospective *technological strategy* gathered interest and funding for *innovation*.

***2005-2011.*** The industry sought further commitment to the deployment of CCS in order to materialise its promised *re-orientation*. Future developments will depend on the success of this *innovation strategy*, without which coal-fired generation is likely to *decline* in the UK. Positive price signals and investments in R&D are pointing towards a new sense of optimism for a coal renewal.

### 7.5.4 Destabilisation pattern

In this case, the diagnosis of destabilisation is less straightforward, for two main reasons: 1) the transition in which it is inscribed has not fully materialised, and 2) coal-fired generation's positioning has tended to improve over the period.

Coal-fired generation was hard hit by the liberalisation of the ESI and growing environmental concerns. It engaged in the last stages of industry decline and dissolution in the face of highly adverse conditions. However, it managed to subsequently halt its decline, through the successful lobbying for support, and the opportune rise of energy security concerns and price signals favouring coal. This context allowed the industry to frame itself as a necessary part of current and future energy systems. Furthermore, it actively participated in the conciliation of energy security and climate change concerns via a technological proposition and its accompanying framing, thereby ensuring itself a central role in official low-carbon discourse and consolidating the commitment of Government support.

Coal managed to inflate its position to become an integral part of discourses (and commitments) about future energy mixes (especially for power generation) internationally, and in Britain in particular. This development is particularly interesting when considering that coal-fired generation's attractiveness had been declining from the mid-1980s in most Western countries.

However, this technological trajectory, although likely to materialise because of economic and political support, still has the characteristics of a technological promise, with its flurry of uncertainties and likelihood of failure. Industry actors, although highly interested in this technological trajectory, are still in the phase of constructing its future commercial viability and socio-political legitimacy. Furthermore, it is remarkable that the technological option that promises to sustain a market for coal-fired generation does not require a fundamental departure from current industry activities, but rather the incorporation of additional technologies and skills downstream. In this way, it represents a deeper entrenchment in historical lock-in, rather than radical technological regime change.

In terms of pattern matching, the industry seems to have found a way to *halt its historical decline*. It has engaged in a partial *re-orientation* in a future niche that it has carved for itself at the junction of energy security and climate concerns. If this scenario materialises, we might be able to see this development as active *environmental shaping*. Given the length of investment times in power generation, the industry's influence on the shape and direction of a 'low-carbon' transition will bear consequences for many decades.

Coal was practically buried dead in the UK in the early 1990s. There was an insignificant domestic mining industry, and no planned replacement of the ageing coal-fired capacity to come off stream by the turn of the century.

This situation was a result of the previous destabilisation phases, which had made coal a relic of the industrial past, largely replaced by other fuels in power generation. The increased societal momentum of environmental concerns such as acid rain and climate change further downgraded the enfeebled position of coal in British power generation. Indeed, coal symbolically represented the dirtiest of fuels, and coal-fired power generation rapidly became the focal point for dramatic emission reductions.

Building on concerns about security of fuel supply and changing relative prices of fuels in the present energy configuration, the industry managed to turn this context into an opportunity, generating enthusiasm for CCS, and a gradual integration of the notion that coal will play a part in a future energy mix.

If Vaclav Smil was writing in 2003 that

> "Coal's future is not (…) fundamentally a matter of resource availability or production cost but one of environmental acceptability" (Smill 2003:232)

British coal-fired generators have geared efforts towards legitimising coal's ability to play a central role in low-carbon transitions.

# 8 Conclusions

This thesis aimed at answering the following main research question:

*How can we understand the unfolding industry destabilisation processes?*

Because I adopt a *process* epistemology (see chapter 4), I seek to answer this question by searching for relevant patterns and causal mechanisms involved in the unfolding of real world industry destabilisation processes.

In chapter 3, I have developed an integrative understanding of industry destabilisation, building on five existing theoretical views, and addressing three main research challenges. Taking stock of empirical insights, I here elaborate conclusions that generalise on fundamental aspects of destabilisation processes uncovered by this research.

## *8.1 Destabilisation: three explanatory processes*

In chapter 3, I suggested that industry destabilisation is a process leading up to substantial changes in established ways of being, thinking, and doing things (industry regime rules). Furthermore, the explanation is organised around three interacting explanatory processes:

1) the accumulation of external pressures,
2) industry responses to low performance (economic and legitimacy challenges),
3) weakening commitment to established regime rules.

While these explanatory processes can be analytically isolated (as has been done at the end of each empirical chapter), they are typically mutually complementary and interactive. Furthermore, the cases suggest that the processes follow an ordered sequence: a) pressures tend to build up before industry actors experience challenging performance levels, b) themselves preceding the serious questioning of regime rules characterising destabilisation. This sequence relates to two time lags, which can be explained as follows:

a) Initially, external problems tend to be overlooked and downplayed by incumbent actors, who have a strong tendency to resist change. If pressures increase, industry actors may face decreasing performance (in economic and/or legitimacy terms), as a result of which they may no longer be able to leave pressures unattended. Low performance levels translate into an increasing mismatch between industry actors and their environments that may be curbed with appropriate response strategies to identified problems. Industry destabilisation thus involves related processes of external pressure build-up and strategic responses to weakening industry performance.

b) However, initial response strategies to performance challenges tend to remain within the frame of existing industry trajectories. Indeed, industry actors routinely draw on established regime rules, which reproduce industry trajectories. Early response strategies thus seek to re-establish a degree of fit between industry actors and their environments, and tend to be incremental corrective action. When faced with disruptive challenges or overwhelming environmental change, drawing on existing regime rules may only lead to limited results. When this point is reached, the erosion of regime commitment is manifested by a loss of faith in the ability to adapt. Destabilisation thus results from demands for changes in established regime rules. But regime rules are deeply engrained habits that are difficult to change. Destabilisation is thus a process whereby external pressures and problems become such challenges for established industry actors that industry regimes can no longer be re-produced.

My cases provide credit to this generic explanation, although there are some differences in the particular ways in which these three processes lead to industry destabilisation. These differences point to time lags concerning a) the interpretation of pressures as industry challenges and b) the enactment of regime changes.

In case 1:

Overall, the industry faced *mounting pressures* on a number of dimensions throughout the period (shrinking markets, stagnant productivity, policy dissatisfaction, alternative technologies, smoke problem, etc.), as shown in Table 5.5, although government interventions *interrupted the gradual increase of pressures*.

Economic problems (related to shrinking markets and new entrants) and legitimacy pressures (about coal smoke and miner conditions) were *downplayed* in the first period (1914-1930), and led to minor regime-reinforcing adjustments (wage cuts, piecemeal mechanisation).

Only *when economic pressures became more serious* (in the 1930s), with visible consequences on *economic performance* (bankruptcies) and *political legitimacy* (early policy concerns about industry's viability), did *the industry recognise its problems*. However, these problems led to *incremental response strategies* (piecemeal mechanisation) and market protection (cartelisation and import restrictions) that ensured short-term survival within the bounds of the existing regime.

WWII and the post-war reconstruction period *temporarily halted* (and concealed) *the further progression of economic and legitimacy problems*, and brought incentives for the industry to modernise and innovate. *Commitment to core regime rules* (beliefs, mission, and identity) *was reinforced*, *diversification strategies were pursued*, but the industry's economic *performance stagnated* (slow productivity improvements, dependence on government funding). Furthermore, the Great London Smog (1952) led to regulations that favoured alternatives.

When strong economic and socio-political *pressures re-surfaced* from the mid-1950s (shrinking markets, penetration of alternatives, etc.), the industry's *economic performance* (finance and profits) and *legitimacy* (political frustration, negative cultural discourse) were heavily *eroded*. Response strategies were not in tune with the extent of pressures: markets were shrinking as alternatives diffused, policy enthusiasm waned and shifted to alternatives, the industry adapted only sparsely to the smoke pressure. However, *industry hopes lived on* despite increasing doubts. It is only from 1959 that the industry really lost faith in its ability to survive unchanged. The industry *declined* in most markets, but also successfully *re-oriented* itself by concentrating on its only remaining growth market (steam coal for power generation) for which it had acquired commercial and policy protection.

In case 2:

Pressure evolution followed an 'up-and-down' pattern. The case started with a *moderate amount of pressure*: market growth levelled off in the late 1960s, while *legitimacy* levels were relatively low (dissatisfaction, concerns about financial viability and nationalised status, etc.). However, the industry was pursuing new strategies: specialisation in the power segment and restructuring.

With the oil crisis, *pressures were reversed*: coal regained *economic prospects*, *legitimacy* and acquired substantial power (over its main customer). *Industry hope and commitment to regime rules were higher than ever*, despite the continuity of background frustration and dissatisfaction (of main customer and policymakers), which became more pressing towards the late 1970s.

Political change (Thatcher's election) brought a new ideological frame for economic and industrial policy. The breakthrough of neo-liberal ideology led to the discursive *coupling of many accumulated problems*, and greater industry exposure to these as protective barriers were dismantled. In practice, central Government imposed new values and beliefs to nationalised industries (imposed regime change). The British coal industry was to become competitive, restructure drastically ahead of its own privatisation. *Initial resistance* to such new imperatives (e.g. Great Strike) was crushed; the industry was forcefully downscaled, modernised and restructured (*re-creation*). However, cutbacks on financial slack and diversification attempts, as well as the industry's inherited overspecialisation limited its long-term economic prospects.

The liberalisation of the ESI in 1990 provoked a radical environmental change, opened the market for alternative power generation technologies (CCGT) and coal imports that led to a rapid collapse of the market for British deep-mined coal and overwhelmed the industry. The industry regime change did not prevent its near-terminal contraction.

In case 3:

Pressure on coal-fired generation has been relatively high throughout the case, although the industry seems to have found a way of diverting these pressures, by positioning itself as indispensable to the emerging energy agenda in a context of rising energy security concerns – and thus halting destabilisation to some extent.

In the first period (1990-97), the industry faced *substantial pressures* (radical market change led to technological competition, exerted by new entrants and emerging environmental constraints) that threatened its *economic viability* and *legitimacy*. The industry was hard hit by economic challenges and was *restructured*, but *contested* socio-political pressures (climate counter-framing).

In the second period (1997-2005), the industry tried to respond to the climate problem, which was gaining momentum, by developing the 'clean coal' *framing*. It thus *recognised* socio-political challenges and sought to face the new constraints through *diversification strategies*, whilst slowing down the further decline of coal-fired generation.

In the third period (2005-2011), the rise of energy security concerns provided *less adverse economic conditions* for coal-fired generation, which compared much better on cost with alternatives. By *framing* itself as indispensable, the industry regained some degree of *political legitimacy* and created positive expectations about the role of CCS in the transition to low-carbon and secure energy systems. The projected *re-orientation*, based on a technological promise, provided financial resources for innovation strategies. The future of these projects (and thus the materialisation of the projected *re-orientation*) is yet uncertain, but the prospect for the survival of coal-fired capacity in the UK is improved. If materialised, this *re-orientation* strategy, although based on the integration of the climate challenge, is unlikely to disrupt core regime rules (mission, beliefs, identity).

The cases thus confirm the usefulness of conceptualising industry destabilisation according to three basic complementary processes. However, in each case, time lags have been observed 1) between mounting external pressures and the recognition of serious challenges, and 2) between early responses to problems and the serious questioning of regime rules. I illustrate the second form of time lag below:

In the first case, the second time lag was relatively long (1930-1959), because the industry was deeply embedded in society (basic energy needs, multiple markets, employment, etc.) and benefitted from state intervention (market protection and financial assistance), which ensured the continuity of operations and reinforced commitment to core industry regime rules, thereby enhancing industry inertia. The erosion of political legitimacy and the penetration of alternatives in a context of worsening performance problems overwhelmed the (over)confident industry, which lost faith in most markets but was able to re-orient in the power generation market.

In the second case, the second time lag was shorter, because the industry's restructuring was performed under strong political impulse: industry resistance to change (management and miners) was forcefully broken over a short period (1983-1990), involving the imposition of new managers, new regime rules (revision of social role, competitiveness criteria, automated operations, etc.), and drastic cuts preventing diversification attempts.

In the third case, while problems have been increasingly recognised until 2005, we have not yet seen a loss of faith, because energy security questions and technological expectations have provided the basis for current renewed hope in the industry's future.

So, the three processes played out differently in each case. Considering destabilisation as a multi-level unfolding process, as suggested in chapter 3 (3.3.2), provides further explanations for the materialisation of the observed time lags and differences across cases. Furthermore, the resulting understanding of industry destabilisation reaches out to a number of essential mechanisms influencing the overall process.

The conclusions are structured in relation to categories developed in chapter 3. I first discuss the unfolding of destabilisation at different levels, then multi-dimensional co-evolution, before turning to the role of environmental challenges in destabilisation processes. The conclusion ends with insights on sustainability transitions and a discussion of the scope of findings and suggestions for further research.

## *8.2 Unfolding at different levels*

In chapter 3 (3.3.2), I suggested that destabilisation is a multi-level unfolding process. I here conclude on each of the following levels of unfolding: 1) industries, 2) industry environments, and 3) broader landscapes.

### 8.2.1 Endogenous enactment of destabilsaition

In chapter 3 (3.3.2.1), I elaborated an ideal-typical model of industry destabilisation enactment. I have suggested that at industry level, the enactment of destabilisation by industry actors can be conceptualised as following five phases, from denial to dissolution:

1) Blindness and denial
2) Early small changes
3) Doubts and diversification
4) Destabilisation and decline
    a. *Re-orientation*, or
    b. *Re-creation*
5) Dissolution

I first assess the overall match of each case with the phase-model. Deviations are then explained in relation to the different levels of unfolding and related conceptual categories.

## Case 1: The destabilisation of the British coal industry (1914-1967)

The first two periods (1914-1946) fit well with the model, with the industry first downplaying structural problems and then introducing piecemeal and incremental innovations. The third period (1946-1956) deviates from the model, because expanding post-war markets created optimism instead of increasing doubts and some blindness regarding structural problems. The industry innovated and modernised to meet the new opportunities, not because of despair. It also diversified (somewhat) into smokeless fuels to address the smoke problem, which caused some concern for the industry. The fourth period (1956-1967) deviates from the model, because it encompasses both the fourth and fifth phase. The reason was that the industry followed two tracks. There was decline (fifth model phase) in many market segments, which caused major performance problems (financial problems, loss of cultural legitimacy and political support). But there was also strategic *re-creation* (fourth phase) towards the growing electricity market, which sets the stage for the second case.

So, the coal industry, while *dissolving* many of its activities, did not *fully destabilise*, because new market opportunities revitalised hopes and a certain degree of *legitimacy*, and thereby prevented a complete loss of faith.

Furthermore, the industry followed a shock-wise destabilisation pattern, clinging on to hopes until it was too late and multiple markets had to be abandoned.

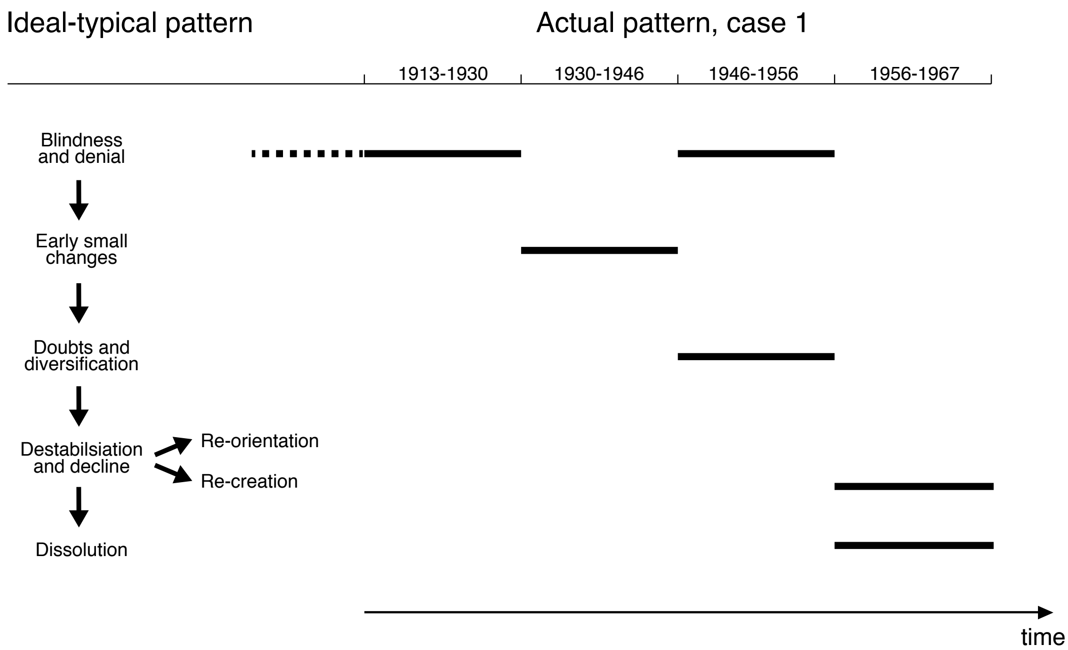


**Figure 8.1: Destabilisation enactment pattern, case 1**

## Case 2: The destabilisation and decline of the British deep coal mining (1967-1997)

The first period (1967-1973) fits well with the model, with the industry clinging on to an expanding market (following its *re-orientation* in power generation) and restructuring to match the new situation. The second period (1973-1981) deviates from the model because the oil crisis created new enthusiasm and positive expectations despite structural problems, but also made resources available for diversification strategies. The third period (1981-1990) followed two tracks. Increasing pressures (negative government attitude and policies, competition from nuclear and gas, price threats from foreign coal) led to the early recognition of problems regarding the industry's future viability and the implementation of small changes enhancing productivity locally. However, under strong political influence, the industry was abruptly restructured, seeking to *re-create* itself on the basis of newly imposed competitiveness criteria. More forward-looking innovation attempts were halted because the government imposed tighter managerial rules and cut innovation programs. Overall, industry strategy was increasingly reduced to 'fire-fighting' and short-term responses to imminent threats ('living in a permanent crisis'). The fourth period (1990-1997) deviates from the model in the sense that the destabilisation process skipped the fourth phase (*re-orientation*) and immediately moved to the fifth phase (dissolution). Smooth *re-orientation* was difficult because government policies had eroded slack and (financial and technical) capabilities. The industry therefore had limited possibility to respond to the unleashed competition that followed ESI privatisation. Collapsing markets forced the rapid shrinking of the industry.

So, the deep mining industry experienced *full destabilisation*, because declining markets, in the absence of material slack and political legitimacy, led to a complete loss of faith regarding future opportunities.[57] The industry destabilised rapidly in a shock-wise pattern.

[57] While the deep mining of coal reached near-terminal contraction, coal-fired generation capacity based on imported coal retained a place in Britain, which justifies the third case.

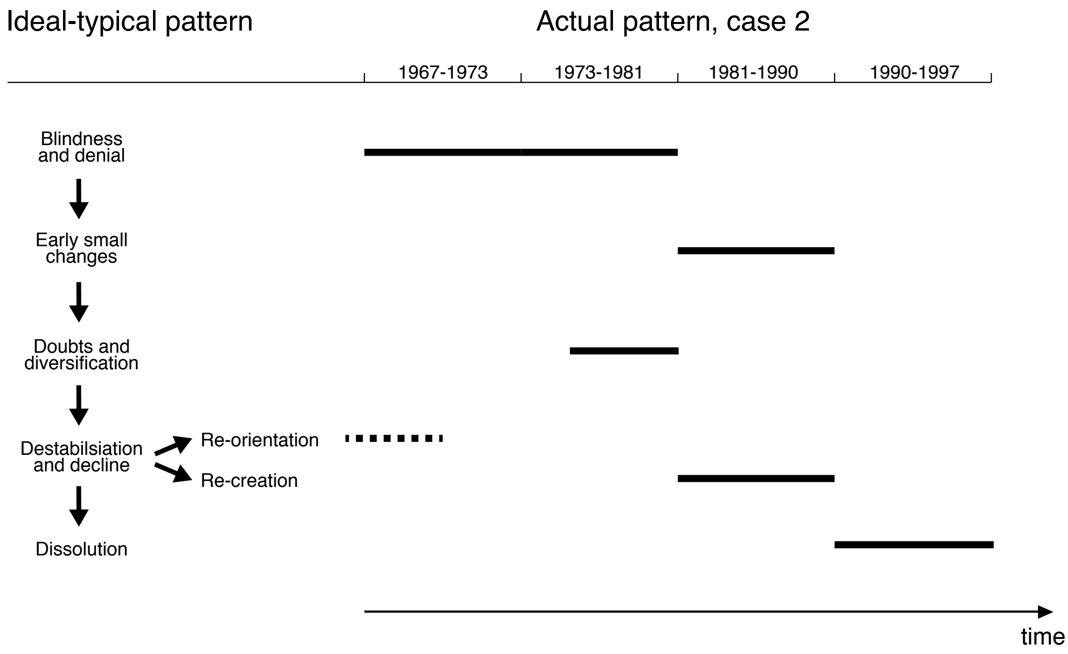


**Figure 8.2: Destabilisation enactment pattern, case 2**

## Case 3: The destabilisation of coal use in the British power industry 1997-today. Possible revival?

For the contemporary case, the overall diagnosis of destabilisation is complicated by two main features: 1) the case is not fully realised, and 2) the case begins with the electricity industry's commitment to coal in serious jeopardy.

The first period (1990-1997) partly matches the model. It doesn't fit it, because the industry was under acute pressure and was collapsing. However, the small remaining industry downplayed and contested problems such as climate change. The second period (1997-2005) fits relatively well, because the industry started to worry about its ability to cope with incoming challenges. But it also started to engage with longer-term diversification strategies. The third period (2005-2011) also fits partly, as diversification attempts became more concrete. Furthermore, the industry was clinging on to its only chance of survival: embarking on a technological re-orientation trajectory for which it could make itself indispensable. The future remains open, and the industry may manage to gather lasting commitment to its renewal, or else will face inevitable decline.

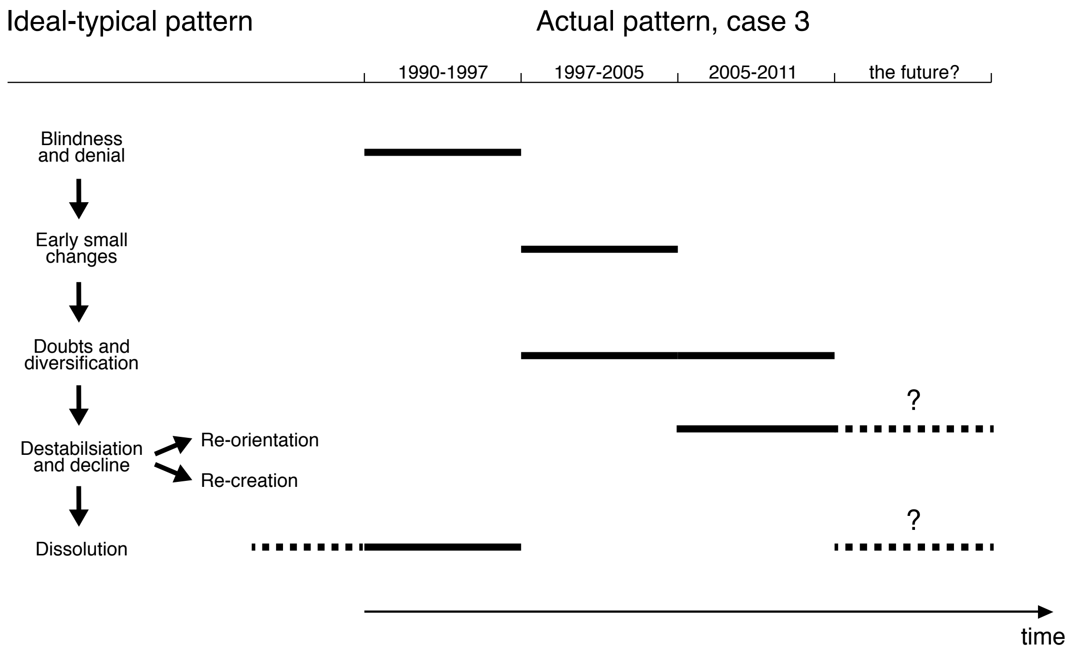


**Figure 8.3: Destabilisation enactment pattern, case 3**

So, while it is too early to conclude with regards to the third case, both historical cases broadly match the five-phase model of destabilisation, thus confirming its overall plausibility. This allows me to reach the following conclusion:

*<u>Conclusion 1</u>: The five-phase model provides a useful framework to understand the endogenous enactment of destabilisation: early destabilisation is about emerging doubts, while full destabilisation is about losing faith in the ability of the existing regime to cope with changes in the external environments.*

However, destabilisation is more complicated, as shown from the deviations from the ideal model. The deviations confirm the usefulness of mobilising an ideal-type as a heuristic that allows the identification of more subtle patterns. This underlines that the phase-model should be used flexibly, and not as a mould into which historical data are to be forced. Furthermore, the identification of deviations allows further conceptual refinements on particular aspects of destabilisation unfolding.

Four types of deviations can be explained in relation to multi-level aspects of unfolding:

1. Full industry dissolution (fifth phase) can be avoided by industry renewal activities (e.g. move to power generation market in the first case). The ability for

industry renewal requires the availability of material and institutional slack (see 8.2.1) and opportunities in industry environments (see 8.2.2)

2. The build-up of pressures is not as gradual as assumed in the model. Deviations (accelerations, reversal, etc.) can be explained in relation to external aspects of destabilisation: the multi-dimensionality of industry environments (see 8.2.2), the role of landscape developments (see 8.2.3), and interactions between the different levels of unfolding (see 8.2.4)
3. The abrupt nature of destabilisation patterns observed (rapid loss of faith in later stages instead of the more gradual questioning of regime rules predicted by the model) can be explained in relation to industry inertia (see 8.2.1), but also to the intervention of external actors (see 8.2.2)
4. Differences in the timing of destabilisation enactment (skipping through phases, overlaps, varying length of phases) can be explained in relation to different forms of inertia and the endogenous enactment of transformational regime change (see 8.2.1), and the multiplicity of simultaneous pressures (see 8.2.2).

*<u>Conclusion 2</u>: Industry destabilisation is a process by which industry actors abandon prevailing forms of inertia (institutional and material commitments) in an effort to address disruptive changes in the external environment.*

In the two historical cases, destabilisation has involved a discernable rupture with established trajectories as industry actors recognised the outdated nature of the associated frames of reference.

> In the first case, destabilisation involved the industry's 'last minute' adaptation to the breakthrough of technological alternatives (the 'four fuel economy') that questioned the legitimacy of coal's inherited monopoly over fuel industries. In the second case, destabilisation involved the industry's powerless conformation to the pervasive 'market logic' that swept away long-standing assumptions about the legitimacy of maintaining a strategic domestic coal industry and its associated social contribution.

Furthermore, the cases show that the 'moment' in which the abandonment of institutional logics is enacted is relatively short in relation to the more long-term resistance to ongoing problems, denoting the acceleration of destabilisation dynamics in the later phases and more shock-wise patterns of enactment. In the first case, over forty years of relative regime commitment (1880-1946) were followed by over a decade of increasing doubts (1946-1959), and a rapid loss of faith (1959-1967). In the second case, destabilisation also accelerated as new logics were swiftly imposed to the industry from the mid-1980s, following twenty years of growing dissatisfactions. Conclusion 3 generalises from this observation:

*Conclusion 3: Full industry destabilisation, arising from and overcoming a structural tension between industry inertia and changing external realities, may involve abrupt patterns of enactment.*

This conclusion diverges from the initial assumption according to which destabilisation is a gradual phased process (see 3.3.2.1). This divergence can be further explained in relation to specific mechanisms at play that tend to delay the enactment of regime change: a) different sources of industry inertia, b) associated difficulties of enacting transformational change, c) the attractiveness of short-term opportunities, and d) the availability of various forms of slack.

*Conclusion 3a: Industry destabilisation is delayed by the persistence of industry commitment to different kinds of regime rules.*

Indeed, industry actors will hang on to established regime rules as long as it is possible for them to do so. The cases show that industry responses to pressing external problems have appeared to be systematically slowed down by regime commitment, with industry actors finding it difficult to adapt to changing circumstances. This observation is in line with theoretical predictions, that established industry actors have an inherent tendency to resist change. Furthermore, the *industry regime* construct (see 3.2.3) has provided a valuable conceptualisation of the sources of inertia that explain the time lag between external pressures and endogenous responses. The cases suggest that industry actors were unable to overcome the inertia of industry regimes in a timely fashion, despite substantial pressure accumulation. Lasting commitment to established ways of being, interpreting, and doing things has prevented industry actors from foreseeing or engaging with the kind of structural transformations required from disruptive destabilisation contexts. Furthermore, building on the cases, I can provide further depth to this conclusion by suggesting a hierarchy between regime elements:

*<u>Conclusion 3b</u>: Core beliefs are more difficult to abandon than technical and regulatory regime elements.*

Cultural-cognitive and normative regime rules are more fundamental because they are constitutive rules that shape ‘ways of being’. *Beliefs* about how to see and interpret the world (cultural-cognitive regime elements) have led industry actors to underestimate (or fail to perceive) new threats to their activities. *Beliefs* about who you are and what is the right thing to do (normative regime elements) prevented industry actors from adapting their normative view of the world to changing external values and expectations.

> In the first case, the British coal industry failed to interpret the threats posed by the emergence of alternative energy industries and the collapse of markets, because of their taken-for-granted, but outdated, beliefs that the coal industry was the cornerstone of the British economy, thus making its decline inconceivable. In the 1930s, market problems and successive warnings by Government for the need to change its structure were downplayed and a cartel structure where business could continue as usual was preferred. Even in the 1950s, amidst multiple market and legitimacy problems, the coal industry clung on to images of a glorious past and created visions of a glorious future, which prevented it from engaging with more structural problems. Only when the battle was already ‘lost’ did industry beliefs change, recognising the threat from alternatives and accepting that coal was only one fuel amongst others, that it could not take customers for granted, and that the electricity industry increasingly formed its lifeline.
>
> In the second case, prevailing beliefs were about the everlasting relationship with the electricity industry, the nature and types of competition, but also the industry’s inherited social and strategic function in society. The coal industry failed to perceive and adapt to the upcoming structural market reforms (liberalised markets) that challenged these assumptions and led to the penetration of new entrants (international coal) and new technologies (the dash for gas). Even when these problems became more imminent and foreseeable (in the late 1980s), it focussed its adaptive response on productivity improvements and commercial deals, rather than taking stock of structural changes in energy markets and the delegitimisation of its social and strategic mission.
>
> In the third case, there are some signals that coal-fired generators in the UK have started to integrate the notion that new values about environmental concerns (namely about climate change) will become a necessary condition of future success. This apparent change in beliefs seems to provide a strong opportunity to be perceived as a legitimate industry. Long-term stability will depend, among other things, on the materialisation of this (for now mainly rhetorical) promise.

Technological and regulatory regime rules relate to *ways of doing things* (the world of action), and are comparatively easier to change. Indeed, introducing new technologies, production practices, forms of knowledge, and regulations need not entail changing commitments to existing beliefs and values. They may even contribute to the reinforcement of existing industry beliefs and values.

> In the first case, the industry responded to market problems by introducing important changes in mining techniques and technologies in successive waves (piecemeal technology diffusion in the interwar period and more integrated technology in the 1950s) without fundamentally questioning the legitimacy of the industry's belief systems. Similarly, technological responses to the smoke problem were sought within the bounds of established value commitments to coal: first concerning the downstream uses of coal (through improvements in combustion technology and techniques in the interwar period), and later concerning innovation in smokeless coals in the 1950s. The introduction of new far-reaching industry regulations (Coal Mines Act in 1930 and nationalisation in 1946) tended to confirm established values and beliefs rather than displace them. The industry's re-orientation and specialisation in the power generation market in the 1950s entailed technological and regulatory changes, but not a fundamental change in values and beliefs (to the industry's strategic and social importance, and hopes of long-lived renewal).
>
> In the second case, the pattern is slightly different, because both forms of regime rules were changed in the 1980s. This can however be explained by the strong and precipitating influence of political power in the enactment of industry destabilisation (see 8.2.2).

So, except under exceptional circumstances, cultural-cognitive and normative rules tend to be more fundamental and more difficult to question than technological and regulatory forms of commitment. Furthermore, the more deeply entrenched cultural-cognitive limitations of incumbent industry actors prevent them from seeing and interpreting long-term changes that are out-of-tune with routinised industry activities and preoccupations.

*<u>Conclusion 3c</u>: Under adverse circumstances, industry actors have a tendency to seek short-term protection and external support.*

In both historical cases, amidst adverse external conditions, industry actors have preferred to seek external support and protection against problems (see also 8.2.2) rather than implement transformational change.

> In the 1930s, efforts to regulate the industry's structure in order to improve its economic performance were rapidly turned down in favour of a protective cartel that encouraged the status quo. From the 1960s and onwards, the coal industry based its commercial strategy on politically negotiated contracts with the electricity industry and import restrictions.

Such strategies, while providing important relief in the short term, tend to *artificially* inflate morale and hope, reinforce commitment to outdated regime rules, and thus reduce long-term adaptability to external changes.

> In the 1950s and 1970s, coal industry actors seized the new opportunities and articulated new promises about a bright future, which temporarily led to greater external support. This new enthusiasm may, however, have led industry actors to pay insufficient attention to deeper structural problems, which came back with a vengeance when macro-economic pressures changed again (inflation and budgetary problems in late 1950s, and oil price collapse after 1986).

So, the temporary availability of external support despite ongoing structural problems tends to further delay industry preparation and response to disruptive change, and contributes to explain why industry destabilisation has a tendency to be 'too little, too late'. This is particularly the case with capital-intensive industries, for which the restructuring of operations may take decades.

However, the availability of various forms of slack also mediates the influence of negative external conditions, and thereby influences the unfolding of destabilisation processes.

<u>Conclusion 3d</u>: *The availability of various forms of slack influences the timing and scope of destabilisation processes.*

Industry slack can be related to material resources (e.g. access to finance and capital) and external sources of legitimacy (e.g. political support). The cases show that both forms of slack can crucially influence the destabilisation process:

- industry actors may mobilise accumulated slack to halt the progression or prevent the need to face destabilising conditions
- low levels of slack hinders industry ability to exploit new (technological, market, etc.) opportunities
- the availability of slack is necessary for industry *re-orientation* and *re-creation* efforts that may avoid full destabilisation (*dissolution*)
- full industry destabilisation is more likely when sustained weak performance has eroded material slack and political capital

So, while the availability of slack can slow down destabilisation processes and may allow the mitigation of adverse conditions by enabling the development of new activities, the loss of slack can accelerate industry destabilisation and lead to greater vulnerability to external challenges.

Overdependence on accumulated slack may contribute to more shock-wise and cliff-edge patterns when rapidly lost.

> The protective barriers raised in the interwar period reinforced the industry's tendency for minimal structural improvements, and thereby contributed to the scope of the supply-side challenges facing the nationalised industry in the post-war years. In the early 1960s, the availability of residual material resources and some degree of political support provided the possibility for industry renewal.
>
> In the second case, the rapid degradation of financial slack and the loss of political support in the 1980s – which had been so crucial to maintain the industry alive – contributed to a more violent destabilisation pattern with greater despair and virtually absent prospects.

So, industry destabilisation is influenced by a number of mechanisms that mediate the degree of fit between industry actors and their environments. However, the 'relatively independent development' of change in various dimensions of industry environments (Freeman and Louça 2001) justifies a closer look at dynamics at play within them.

### 8.2.2 Multi-dimensional pressures from industry environments

In chapter 3, I have suggested that unfolding at the level of industry environments is crucial to understanding industry destabilisation processes. I here mobilise insights from cases to explain how the multi-dimensional nature of industry environments influences industry destabilisation.

Destabilisation processes involve changes in economic *and* socio-political environments, for which a number of sources of change can be identified (see Figure 3.2). In chapters 5 to 7, I have assessed the evolution of different kinds of pressures (see Table 5.5, Table 6.4, Table 7.2), as well as their role in explaining destabilisation. It results from this analysis that all forms of change are not equal when it comes to industry destabilisation, which allows the following conclusion:

Conclusion 4*: Economic pressures tend to be the direct drivers of destabilisation, while socio-political pressures have a mediating influence*

> In the first case, crucial destabilising pressures came from: new entrants in export markets (1920s-1930s), changing user preferences (1950s-1960s), technological competition (1950s-1960s), and shrinking markets (1950s-1960s). These pressures undermined the financial performance of the coal industry. Policy makers propped up the industry in the 1930s and 1950s. Decreasing legitimacy

eroded this support in the late 1950s, and enhanced the vulnerability of the coal industry to economic pressures after the 1965 White Paper.

In the second case, core economic pressures came from cheap international coal, nuclear power and gas. These pressures were mediated and unleashed by neo-liberal Conservative policies in the 1980s and early 1990s.

These illustrations however allow to further clarify what is meant by 'direct driver' and 'mediating', as well as to qualify the importance of economic *and* legitimacy criteria in destabilisation processes (see Figure 8.4). Indeed, in both historical cases, economic problems initiated the destabilisation sequence by creating challenges for industry. Relatively high levels of political legitimacy allowed the development of protection measures to moderate the influence of economic problems through the creation of protective buffers. However, when political legitimacy was eroded along with the narrowing scope of economic opportunities, the industry was faced with overwhelming economic challenges and experienced full destabilisation.

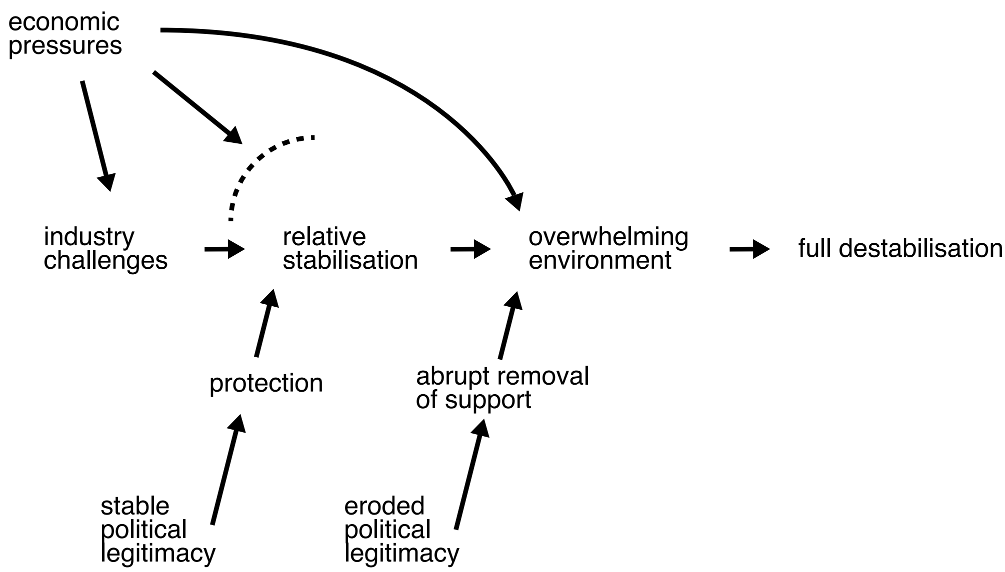


**Figure 8.4: Schematic representation of the respective roles of economic pressures and political legitimacy in industry destabilisation processes (direct drivers above, mediating factors below, dotted line signifies impermeability to pressure).**

This schematic representation is also relevant for less visible or obvious socio-political processes, such as the evolution of societal issues that involves challenges of cultural legitimacy (see also 8.4).

Indeed, in the first case, the smoke problem has had a mediating influence over changes on economic dimensions, rather than a direct effect on industry destabilisation: the anti-smoke pressure had no substantial *direct* effect on the industry's trajectory until the passing of tough regulations in 1956. However, it contributed to the long-term erosion of cultural and political legitimacy, and provided directionality to changes in markets, customer preferences and technological alternatives, which eventually overwhelmed the industry.

This latter illustration further justifies the need to focus on the role of interaction between and co-evolution of pressures, which I address in 8.3.

Industry actors face ongoing, and sometimes conflicting, changes on multiple dimensions in their environments (see 3.2.1 and 3.3.3), which may vary independently *as well as* in conjunction. As a result, industry actors are constantly engaged in multiple games that may stretch their ability to navigate coherently through troubled contexts, and further complicates destabilisation dynamics.

*Conclusion 5: Industry destabilisation becomes more likely when the number, intensity and alignment of multiple pressures in industry environments increase.*

The historical cases show that industry destabilisation has involved situations in which industry actors became overwhelmed by the sheer *number* and *intensity* of the pressures they were facing, but also their degree of *alignment*. I thus suggest consolidating these categories in order to characterise destabilisation contexts.[58] The *intensity* of a given pressure can be defined in terms of the *mismatch* between external change and industry performance (e.g. mismatch between supply and demand, or external expectations and industry goals, etc.) and thus allows identifying 'ups-and-downs' for individual problems. The *number* of pressures simply accounts for the multiplicity of sources of change exerting significant pressure on industry. Pressure *alignment* accounts for the coherence and compatibility between pressures and thus influences the overall *direction* of change adverse to established trajectories.[59]

A typology of destabilisation contexts can be suggested on the basis of these dimensions (Figure 8.5):

[58] This approach bears resemblance to that of Suarez and Oliva (2005), further elaborated by Geels and Schot (2007). See also the related discussion in 2.2.1.3.

[59] The notion of *alignment* will be further elaborated when discussing pressure interaction in 8.3.

| Number | Intensity | Alignment | Destabilisation context |
| --- | --- | --- | --- |
| High | Low | Low | Ongoing noise |
| High | Low | High | Minor pressure front |
| High | High | Low | Strong turbulence |
| Low | High | N/A | Strong directed pressure |
| High | High | High | Major pressure front |

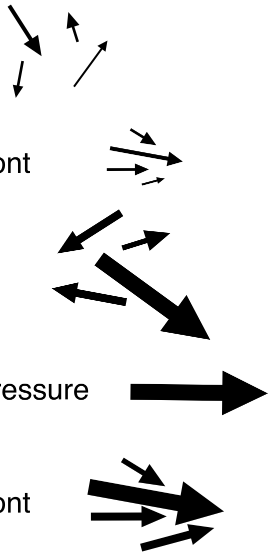

**Figure 8.5: A Typology of destabilisation contexts**

On the basis of this typology, I will discuss which kind of context is more challenging, and more likely to lead to industry destabilisation.

The first two contexts (*ongoing noise* and *minor pressure front*) are unlikely to lead to destabilisation, because the overall amount of pressure is not significant enough to create major challenges that cannot be addressed within existing regimes. The three last contexts are worth discussing in more detail. A *strong directed pressure* and a *major pressure front* are likely to lead to industry destabilisation, because overall pressure is high (and thus challenging to the established regime), and because the degree of alignment is high, which means that there is a clear direction of change away from established trajectories. In both historical cases, industry destabilisation has occurred in the context of a major pressure front, in which many substantial pressures were aligned and rapidly overwhelmed the industry (see pressure interaction figures in chapters 5 to 7):

> In the first case, a 'perfect storm' of strong pressures overwhelmed the industry, including declining markets, changing customer preferences, the breakthrough of alternatives, increasing policy enthusiasm for alternatives and scrutiny of financial performance, negative cultural framings of coal, and anti-smoke regulations.
>
> In the second case, multiple pressures became increasingly aligned as the market reform agenda went forward, leading to market collapse. These pressures included: cheaper imports, customer

dissatisfaction, new entrants and new investment criteria, favoured technological alternative (CCGTs), and a newly embraced environmental agenda around acid rain.

So, the alignment of pressures appears as crucial to the formation of destabilisation contexts, and will be further discussed in 8.2.4 and 8.3.

The third type of context (*strong turbulence*) remains ambiguous. Since my cases do not provide much compelling evidence about it, I can only provide a qualified theoretical discussion of its possible consequences. My hypothesis is that *strong turbulence* leads to major industry challenges, but is not likely to lead to destabilisation. Indeed, I suggest that in such cases environmental signals are too conflicting for tensions and uncertainties to be resolved, and are more likely to lead to 'wait-and-see' patterns in the absence of clear directed choices – thus delaying the unfolding of destabilisation. However, I also recognise that ongoing tensions and crises may bring major opportunities. *Strong turbulence* may rapidly turn into a *major pressure front* if powerful or daring actors are able to seize the opportunities generated by the climate of uncertainty and set re-configurations in motion. This discussion suggests that pressure interaction and alignment are important determinants of industry destabilisation. Patterns and mechanisms of pressure alignment will be further discussed in 8.3.

### 8.2.3 Landscape developments

In chapter 3, I suggested that the long-term unfolding of industry destabilisation is also influenced by deep structural trends and events playing out at the level of landscape dynamics (see 3.3.2.3). The cases confirm the influence of such higher-order change on industry destabilisation.

<u>Conclusion 6</u>*: Destabilisation is influenced by secular landscape developments, particularly a) gradual landscape trends and b) extreme events, because they influence the alignment and precipitation of pressures.*

**a) The role of gradual landscape trends**

Destabilisation conditions can worsen in relation to higher order change in landscapes. Deep-structural and slow-paced landscape trends bear distal forms of causation on industry trajectories. Because they affect entire societies, they are powerful sources of pressure alignment, carving 'avenues of environmental change', and thus increasing the likelihood of concurring societal dynamics by deep structural alignment.

Significant changes in mentalities and broad cultural repertoires engaged in the 1930s (about modernity, cleanliness, etc.) had a structural influence on consumer behaviours that led to changed kinds of demand that contributed to framings of coal as outdated and emerging enthusiasm about alternatives. These dynamics, in the long run, led to the penetration of the conceptualisation and materialisation of the 'four-fuel economy'.

The emergence of the neo-liberal view of the world in the late 1970s, building on accumulated dissatisfaction with state intervention, gained momentum and installed itself from the 1980s and onwards, providing the ideological background for profound economic reforms. This paradigm shift fundamentally re-configured the environment of the coal industry, thereby accelerating and intensifying its destabilisation. Indeed, coal-fired generation was no longer perceived as an attractive proposition in the context of de-industrialisation and 'free' markets, favouring less capital-intensive investments with shorter payback time, and disregarding of long-term strategic planning.

It has been suggested that aspirations for greener societies, economies and lifestyles may provide the background for the next economic paradigm shift. While the materialisation of this change remains questionable to this date, if it were to be confirmed, we should be prepared to experience a major transition in energy systems with the potential to fundamentally re-configure established energy regimes and industries.

The cases thus suggest that broad macro-economic, socio-cultural and socio-political changes are more than the background in which destabilisation in played out: they can provide the macro-tensions according to which the break between the old and the new is formulated (by actors at different levels).

**b) The role of shocks and extreme events**

Destabilisation can be accelerated or halted by shocks and extreme events. The effect of extreme events is however mediated by contexts and preceding articulation processes. *Punctual crises* can raise the sense of urgency regarding problems, and increase public and political pressure.

The London Smog (1952), for example, caused public outrage and led to the CAA (1956). But smog events with many casualties had happened in previous decades without similar effects. So, public outrage in the 1950s was not only due to the smog event, but also to the delegitimisation of coal in preceding decades (through smoke activism, a cultural discourse of cleanliness and health, and new visions of the household), and the legitimisation of alternative technologies.

*Macro-economic events* affect industry destabilisation by influencing market demand, competitive positions and/or future expectations. This influence may enhance existing destabilisation pressures, or instead contribute to the alleviation of pressures, and thus contribute to explain observed delays

The Great Depression weakened markets for coal, causing economic problems for the industry.

The 1973 oil crisis was a disruptive event in the macro-political landscape that created new enthusiasm for coal, because it positively influenced the competitive position of coal compared to oil. It led to increased availability of financial resources and political legitimacy that created the lasting illusion of a possible industry renewal. It was actively mobilised by the coal industry.

The recent financial crisis has slowed down previous enthusiasm for low-carbon transitions, major capital investments, and energy research. This situation is likely to benefit established systems and favour the status quo, as it diverts attention away from societal problems.

### 8.2.4 Multi-level interactions

In chapter 3 (3.3.2), I have suggested that destabilisation results from the interaction of mechanisms at play in and between these different levels. I have so far discussed the unfolding of industry destabilisation in relation to different levels independently, with passing references to how these different levels are linked together.

The cases confirm that the progression of destabilisation processes is associated with self-reinforcing interactions between changes at multiple levels.

The emergence of new cultural repertoires at *landscape level* from the 1930s contributed to changes at *environmental level*: the consolidation of markets for technological alternatives to coal, via the expression of new forms of demand, and the articulation of framings according to which coal became seen as outdated and alternatives attracted enthusiasm. The new framings gained momentum and a wider public as markets developed, allowing greater customer and public exposure to these technologies. New entrants also actively mobilised these linkages to market their products in contradistinction to coal, thereby contributing to widen the gap between the old and the new, and creating important challenges at *industry level*.

The restructuring and liberalisation of the coal industry in the 1980s-1990s materialised at the conjunction of accumulated problems at *industry level* (financial problems, lagging productivity, etc.), at *environmental level* (customer frustration, political dissatisfaction, etc.) and *landscape level* (difficult economic times, de-industrialisation, neo-liberal ideology). Although the implemented solution resulted from a highly politicised process, it was crucially framed in relation to these accumulated tensions.

These empirical illustrations suggest that the observed acceleration of destabilisation processes towards the later phases can be explained by the multiplication and strengthening of multi-level linkages:

- Incumbent industry actors become increasingly dissociated from their environments and broader landscapes (increasing mismatch)

- New actors in industry environments actively mobilise landscape changes as new frames that amplify their distinction from established regimes
- Conversely, actors in industry environments participate in the construction of landscape changes through the elaboration of visions and expectations about the future
- As landscape changes gain momentum, new actors, interests, values and ideas become increasingly interlinked and contribute to the elaboration and actualisation of new regimes, in contradistinction to established regimes
- Industry actors lose their ability to shape and adapt to environmental changes as environmental change becomes highly embedded in landscape dynamics

These observations can be further elaborated into more generalisable conclusions about destabilisation dynamics:

*<u>Conclusion 7a</u>: Linkages between change at environmental and landscape levels may build up marginally over extended periods of time without creating insurmountable challenges to established industries.*

*<u>Conclusion 7b</u>: While industry actors can resist isolated forms of change, it becomes increasingly difficult for them to do so when multiple levels of change become interlinked.*

*<u>Conclusion 7c</u>: Critical destabilisation moments arise from the synchronisation of multiple forces of change playing out on different levels and temporal dimensions.*

*<u>Conclusion 7d</u>: The confluence of multi-level pressures on established industries becomes critical to destabilisation when environmental actors are able to seize the resulting opportunities to articulate the shift away established patterns of inertia.*

## *8.3 Co-evolution*

In Chapters 2 and 3 (2.2.2 and 3.3.3), I have suggested that a co-evolutionary perspective can enhance the understanding of industry destabilisation by reaching out to the mechanisms and processes participating in the articulation and acceleration of destabilisation contexts leading up to regime transformation.

The discussion so far has confirmed the importance of multi-dimensional interactions and pressure alignment in destabilisation processes. Indeed, industry destabilisation does not proceed from individual or conflicting pressures, but from the co-evolution of multiple forces of change that jointly challenge the viability of established regimes and create opportunities for more constructive dynamics to be put forward. Furthermore, the mutual reinforcement of environmental pressures through processes of interaction accelerates and amplifies destabilisation dynamics (see figures at the end of empirical chapters for illustrations).

<u>*Conclusion 8*</u>*: The destabilisation of existing industries becomes more likely when multiple external pressures become aligned in a clear direction.*

In both historical cases, full destabilisation involved the simultaneous articulation and alignment of multiple pressures:

> In the first case, destabilisation followed a 'perfect storm' pattern, in which multiple pressures increased and overwhelmed the coal industry between 1956 and 1965: competition from technical alternatives, negative cultural discourse about coal, the Clean Air Act, and the downscaling of government support.
>
> In the second case, the crucial alignment was between competitive pressures (cheap foreign coal, gas, nuclear power) and a macro-level ('landscape') political ideology (neo-liberalism), which was translated into radical policy reforms, causing a coal market collapse.

Leading up to these relatively dramatic points of rupture, more pressure interactions build up over extended periods of time, and can be analytically isolated. Linking back to Figure 3.2, Figure 8.6 maps six specific forms of interaction between pressures with a strong potential for mutual reinforcement in destabilisation processes, for which I provide illustrations. I first focus on selected examples of interaction before reflecting on longer pressure interaction chains and their contribution to industry destabilisation.

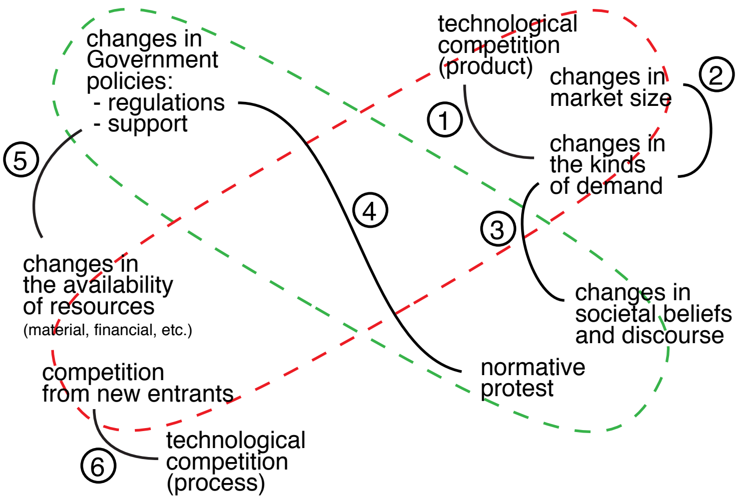


**Figure 8.6: Selected local pressure interactions in industry environments**

1. Alternative technologies and kinds of demand

The early development of gas and electricity in niches before the 1930s, although not perceived as a direct challenge by the coal industry, contributed to altering consumer preferences, in turn stimulating the diffusion of these more 'convenient' alternatives in contradistinction to coal.

In the second case, changes in the determinants of demand for power generation options (towards more competitive and short-term paybacks) contributed to the breakthrough of CCGT technologies, the success of which was associated with the benefits of liberalised energy markets.

2. Changing kinds of demand and shrinking markets

The diffusion of new modes of energy consumption from the 1930s gradually eroded the attractiveness of solid fuels and led to a decline in coal use in multiple sectors throughout the first case, with the exception of power generation, and thereby confirmed qualitative market changes.

3. Societal beliefs and new kinds of demand

The long-term progression of new collective framings and discourses about energy (smokelessness, convenience, etc.) shaped emerging customer demands for new energy services in the 1930s that provided additional momentum to these new discourses, and thereby contributed to outdate coal and favour alternatives.

4. Environmental pressure groups and policies

In all cases, pressure groups and activists have sought to influence policymakers towards the regulation of industry activities. Furthermore, they have been crucial in introducing new issues previously unattended to by industry or considered beyond the state's core functions, such as environmental issues. From the 1880s to the 1950s, normative activists have repeatedly challenged policymakers and pressed for stringent coal smoke policies. Similarly, acid rain and climate change have been brought to the attention of policymakers by engaged scientists and environmental activists.

So, not only is civil society important to policies on new issues, the cases seem to suggest that a buoyant civil society is necessary for the emergence of such issue to the attention of the public and policymakers.

5. Government support and the availability of external resources

Because economic and industrial policy is one of the core functions of modern states (Dryzek *et al.* 2003), governments are routinely engaged in the design and regulation of markets and resource distribution patterns. With respect to destabilisation, this form of interaction can 1) stimulate industry re-orientation (via public support and funding of development programmes), and 2) buffering/amplification effects (by altering the rules of the economic game in favour of or against established regimes).

Major industry development programmes have provided resources to support re-orientation attempts: in the early years of nationalisation (Plan for Coal in 1950), during the oil crisis (Plan for Coal 1973), but also the Wheeler plan (1986).

The economic framework has been significantly altered during a) both world wars (through state control), b) with the 1930 Coal Mines Act (introducing restrictions on competition and pricing mechanisms), c) with nationalisation (creating a vertically integrated industry), d) with the institutionalisation of the four-fuel economy (WP 1967), and e) with liberalisations in the 1990s (fundamentally overturning long-term stable demand patterns). While a), b), and c) have been crucial to provide breathing space in troubled times, d) and e) have disrupted to established market relationships and thereby accelerated destabilisation.

6. New entrants and technological competition

This relationship is relatively trivial. What is more interesting is how this relationship has been mediated.

In the first case, technological threats (from modern mining techniques mastered by foreign industries) were long kept at bay by the protection of domestic markets from these new entrants.

In the second case, because markets were long protected from new entrants, the opening up of markets following liberalisation led to the rapid diffusion of new technologies (CCGT) that outcompeted coal-fired generation.

While the above selection of illustrations from cases is not exhaustive, it provides a substantial amount of evidence to substantiate the following conclusion:

*Conclusion 8a: Interactions between forces of change in industry environments can lead to mutually reinforcing dynamics that contribute to pressure alignment and generate momentum for change.*

However, such analytically isolated interactions, while crucial to long-term pressure alignment, fail to fully explain industry destabilisation processes and their timing if considered in isolation. Indeed, the cases show that destabilisation has proceeded from the cascading dynamics resulting from the articulation of multiple such forms of interaction in long sequences (see respective figures in empirical chapters). So, multiple forms of pressure interactions provide the hinge points for longer interaction chains that provide storylines for destabilisation processes.

*Conclusion 8b: The multiplication of interactions (between different types of change) can lead to the emergence of longer interaction chains and coherent pressure fronts through cascading dynamics.*

Furthermore, in each historical case, a specific 'master' alignment process can be identified as having significantly shaped the articulation of destabilisation pressures, harnessing these emergent forces in a coherent direction away from the established regime:

> In the first case, the breakthrough of alternatives to coal has greatly enhanced the coherence and coupling of multiple accumulated problems, thereby providing the definitive overwhelming challenge to the coal industry that led to the collapse of multiple markets. The breakthrough of alternatives provided a credible gradient for change, which allowed the articulation of multiple pressures (political dissatisfaction with economic performance, changing customer preferences and markets, cultural discourse on energy, changing cultural repertoires, the smoke problem, etc.) in a clear direction in contradistinction to coal.
>
> In the second case, the neo-liberal ideology and the implementation of radical economic policy reforms reshaped the industry's environment through the coherent articulation of multiple problems (poor financial performance and related subsidies, customer captivity, outdatedness, 'better' alternatives, obstruction to imports, emerging environmental concerns, etc.) in discourse and practice, leading to industry collapse.

Building on the notion of 'gradients for action' as higher-order constraints on the articulation of change (Geels 2004, see 3.3.2.3), these illustrations allow me to formulate the following conclusion:

*<u>Conclusion 8c</u>: Far-ranging landscape dynamics, when articulating the break between the 'old' and the 'new' (across different levels), can provide emergent gradients for multi-dimensional pressure alignment.*

Furthermore, this conclusion allows me to look back and reflect on a starting motivation of this thesis, which consisted in counterbalancing a common assumption according to which industry destabilisation is the result of technological challenges. I suggested that *industry destabilisation fulfils a productive role in transitions as it may open up opportunities for novelty to emerge*.

The empirical cases show that the relationship between established systems and novelty is less unidirectional than expected:

- industry destabilisation opens up opportunities for alternatives to break through
- as (technological or aspirational) alternatives gain momentum, they crucially contribute to the destabilisation of existing industries.

This leads me to formulate the following conclusion:

*<u>Conclusion 9</u>: The causal relationship between industry destabilisation and the breakthrough of novelty in transitions is bi-directional.*

Both processes are not only causally linked; they exist (in theoretical and material form) only with reference to each other in the frame of transitions.

## *8.4 Societal problems*

In chapter 3, I suggested ways in which societal challenges may influence industry trajectories in destabilisation processes (see 3.3.4). The empirical evidence, based on environmental problems, confirms that the direct influence of such problems may be limited.

*<u>Conclusion 10</u>: Societal problems alone are unlikely to lead to industry destabilisation*

While societal problems can play an important role in destabilisation processes, the empirical evidence suggests that they are unlikely to be the main cause of destabilisation.

> In the historical cases, social movements exerted pressures relating to environmental problems (smoke, acid rain). The direct effects on destabilisation long remained limited, because policy makers shielded the industry, because public opinion was limitedly concerned (in the first case), and because industries used political and framing strategies to defend themselves.
>
> In the second case, the problem of acid rain had virtually no influence on the destabilisation process, because it was kept off the political agenda until the late 1980s, at which time it was opportunistically tied to the liberalisation agenda as an ex-post justification of alternative technological preferences.

Societal concerns about climate change are thus unlikely to destabilise existing industries on their own. However, the cases also show that environmental issues can gain traction when they are expressed *in conjunction with* economic factors (e.g. alternative technologies, changing customer demands, accumulated dissatisfaction, shrinking markets), or broader cultural trends (e.g. cleanliness).

Furthermore, the cases show that the evolution of societal issues is a slow process, as suggested by the issue life cycle literature (see 2.2.3.1). The early stages are likely to be characterised by strong industry resistance and avoidance who tend to 'wait and see' before major regulation or policy is developed.

> The coal smoke problem took many decades, from early framings in the late nineteenth century to serious legislation in the 1950s. Crucial steps bringing the issue forward included the education of the public, the professionalisation of the anti-smoke movement and the refinement of its claims, trial-and-error with poorly enforced regulatory attempts, the development of credible technological alternatives, the opportunistic mobilisation of a major crisis.
>
> In the second and third cases, while the issue of acid rain progressed in relation to the evolution of scientific framings and political and public mobilisation, industry actors first responded with denial and counter-framing, re-directing attention on the natural occurrence of the environmental damage, the natural resilience/tolerance of natural systems, and uncertainties in monitoring proxies. Later on, as consensus began to emerge, they adopted 'wait and see' strategies, delaying responses and obstructing action before major regulation or policy is implemented.

The cases thus confirm that industry actors are unlikely to address normative problems spontaneously, as long as they are not perceived as challenges to established trajectories. The existence of a vibrant and politically determined civil society is crucial for societal problems to be considered by industry actors.

## *8.5 Lessons for sustainability transitions*

This thesis has also sought to address a second research question related to contemporary challenges:

*What lessons for current sustainability transition challenges can be derived from an understanding of destabilisation and the insights from the historical cases?*

This research has suggested that the destabilisation of established industries is crucial to socio-technical transitions. Furthermore, my cases have shown that industry destabilisation is a long-term process, unfolding over decades and involving many concomitant forms of change. In light of my historical examples and findings, I aim to formulate qualified lessons for current sustainability transitions.

Transitions to low-carbon energy systems cannot be assumed to materialise in the near future, and are likely to take many decades. Indeed, the climate problem, although it has achieved major steps in building scientific consensus, mobilising the attention of the public and policymakers, and has aligned aspirations towards visions of low-carbon societies, faces numerous challenges:

a) the alternative technologies put forward are still judged unviable by many,
b) it faces considerable resistance from fossil-fuel industries and fossil-fuel rich countries,
c) policy implementation is still at its early steps and is filled with loopholes, exemptions and fragile half-hearted commitments,
d) public awareness has not yet materialised in serious behaviour change towards low-carbon lifestyles or mainstream consumer preference changes
e) macro-economic and energy consumption patterns point in the wrong direction (economic crisis drives attention away, and globally more energy-intensive lifestyles complicate the challenge)
f) macro-political trends seem to disengage with the trend towards greater global cooperation.

Difficult as they may be, transitions to environmentally cleaner energy systems have however occurred in the past (Fouquet 2010). My cases have confirmed that the destabilisation of established energy industries is inherent to such transitions. Contestation and challenges (cultural, political, economic) are as important as the development and breakthrough of alternatives in transitions. Destabilisation is thus a relevant focus for advocates of low-carbon transitions. Low-carbon transitions can be accelerated if both the build-up of alternative systems *and* the destabilisation of established regimes are tackled simultaneously.

Furthermore, the following more detailed points can be derived from historical cases in order to inform current challenges:

1. Established industries are likely to resist change and long remain committed to regime rules

This means that substantial pressure over the climate problem or against centralised energy systems will not be enough to destabilise fossil fuel based industries. Instead, we can expect these industries to resist such pressures and fight back in order to keep a stronghold in their core businesses. As seen from the third case, it can be suggested that many energy-related industries have moved beyond the initial phase of problem denial, and may be between the second and third phase of the enactment model. Indeed, coal-fired generation in the UK is still committed to its inherited regime, but has acknowledged serious problems and is demonstrating efforts to devise technological solutions (e.g. CCS). However, it remains to be seen whether and how these will be developed. Furthermore, the proposed solutions do not entail a fundamental change in core beliefs and are not expected to displace existing competences. On the contrary, the development and up-scaling of CCS technology as a low-carbon option is likely to stabilise the existing (fossil fuel based) regime through the introduction of new forms of commitment.

2. Societal pressure around climate change is not assured to remain at the top of public and political concerns

Indeed, the historical cases show that the salience of societal problems may follow more irregular patterns ('ups-and-downs', interruptions, etc.), as other problems come to the fore of public and political attention, or industry actors mobilise successful counter-framing strategies. More specifically, I suggest that scientific and political consensus about the causes of climate change has been reached in the international arena, despite remaining pockets of resistance. However, societal demand for low-carbon economies is still in its infancy, as a better-informed public is finding it hard to engage with and commit to low-carbon lifestyles (and abandon high-carbon habits). Similarly, but perhaps more critically, economic growth – a major obsession of governments and societies for decades – is showing no signs of decoupling from carbon emissions. Furthermore, the financial crisis and the following recession have reshuffled political and private priorities towards the more traditional functions of the state to provide protection and the conditions for prosperity, and comparatively lower degrees of priority for such grand societal challenges as climate change. However, as shown in the third case, industry actors seem to have taken up the issue on a rhetorical level, which is already a hopeful step away from its denial.

3. Climate change aspirations alone are unlikely to destabilise existing high-carbon industries.

The historical cases show that economic pressures tend to prevail over socio-political pressures in destabilisation processes. However, societal problems can gain traction if formulated *in conjunction with* economic forces. So, it is likely that the destabilisation of fossil fuel industries will involve pressures in the economic environment (e.g. resource exhaustion, new kinds of demand, alternative technologies, customer dissatisfaction, weakened profitability, etc.). The influence of climate change over the destabilisation of high-carbon industries will thus depend on the development of positive interactions with such economic problems.

This means that proponents of low-carbon transitions have to find creative ways of linking societal aspirations to economic processes such as the creation of new markets, improved services, new customer demands, etc. Some of the economic attributes of renewable energy options have so far failed to gain mainstream traction (e.g. self-sufficiency, price/performance, long-term savings, etc.). Public support for societal transitions is not only related to public awareness about the issue, but also to the perceived attractiveness of the proposed alternatives. Indeed, while public opinion was long aware of the smoke problem, the issue only gathered significant momentum when it was associated with hopeful aspirations and visions of the future. This means that for low-carbon transitions to materialise, the associated visions needs to become culturally integrated and socially desirable (e.g. linked to improved status). So the attractiveness of low-carbon lifestyles should be attended to and actively constructed.

4. The role of government support is a double-edged sword in destabilisation processes.

While a certain amount of protection might be desirable to weather difficult economic circumstances, the cases show that industry actors tend to take advantage and remain dependent on external sources of support, even when these have lost their initial relevance (e.g. necessity or desirability). In both cases, governments have found it difficult to step away from commitments to support established industries. Increasing policy frustration with industry attitudes have however led to decreased legitimacy and political capital. The resulting removal of government protection has been found to accelerate destabilisation and contribute to shock-wise destabilisation patterns in which industry actors are precipitously confronted with adverse environments. Lifting subsidies for the consumption and production of fossil fuels – estimated to an annual US$ 650bn worldwide (UNEP 2011) would therefore greatly contribute to their destabilisation, but also pose difficult social challenges (related to industry collapse and resulting unemployment). However, because fossil-based business is currently profitable, it is not sure how much of a destabilising effect such a removal of subsidies would have. Designing more conditional and temporally limited forms of support in difficult times may prevent this form of political lock-in in the future, provided new industries can curtail the associated negative socio-economic effects of industry decline by allowing the conversion and re-deployment of workers and competences. Furthermore, while policymakers have a responsibility for the pervasiveness of established industries and vested interests, they may also have the power to abolish such privileges provided a legitimate mandate, determination, and coherence in implementation.

5. Political determination can lead to major normatively guided structural reforms, even in the presence of strong industry resistance.

The implementation of ideologically motivated market reforms in the 1980s and 1990s shows that industries can be *deliberately* destabilised. This provides credit to the possibility for economic conditions to be radically altered in relation to specific aspirations, effectively shifting the balance between incumbents and contenders. Working on the articulation of ongoing problems and prospective solutions (proposals), (political) entrepreneurs can thus become central actors for the introduction of radical changes in framework conditions that may precipitate destabilisation processes and lead to the alignment of existing pressures.

In the second case, determinant aspects of the introduction of substantial change in frame conditions included:

a) The pre-existence of problems and dissatisfaction with the established industry
b) The mobilisation of latent disappointment for the critique of the established regimes
c) A discursive framing that contributes to making the proposed reform more acceptable to public perception
d) The articulation of visions of change and hopeful expectations for large-scale industrial transition
e) The build-up of authority and legitimacy for the implementation of difficult transition reforms
f) The availability of alternatives and new entrants to introduce them.

The simultaneous existence of these or parts of these conditions provided substantial windows of opportunity for the introduction of change. Such windows are however short-lived (Kingdon 1984).
In the case of low-carbon transitions, it is doubtful whether changes in economic frame conditions – however radical – would be enough to lead to systemic change in low-carbon directions. Furthermore, efforts at setting a high price for carbon have so far stalled upon the resistance and lobbying power of energy-intensive industries. This problem is further complicated by the globalised nature of energy industries.

6. A related point concerns the changing pattern of state-economy relationships over the long-term.

Indeed, the acceptability of state intervention has varied through the cases: state intervention is by definition difficult to argue for in a country attached to liberal values such as Britain, but has nevertheless been found acceptable in exceptional times and beyond (e.g. WWI, Great Depression, WWII, post-war reconstruction), and can be considered to have been relatively high for British standards between 1920 and 1970. It is thus not unthinkable that stronger government intervention, and the resulting greater coordination of strategic industrial policy choices could make a comeback in Britain some day. In this case, providing clear normative direction (such as low-carbon imperatives) for the development of energy markets, infrastructures and industries would be less difficult.

7. The elaboration of credible alternatives and the destabilisation of established industries mutually reinforce each other in transition processes.

The cases show that cultural criticisms, political contestations and technical challenges to existing systems are equally important as the elaboration of desirable alternatives. Without the accumulation of problems with existing industries, and the positioning of alternatives in contradistinction to these, neither destabilisation nor breakthrough would have occurred. This suggests that advocates to low-carbon transitions, already involved with the development of alternative technological options (e.g. renewables, energy efficiency, etc.), should equally attend to means and strategies to destabilise established industries. Weakening the cultural, political, economic and technological dimensions of fossil fuel related industries is just as important as stimulating green options.

## 8.6 Discussion: Research goals, contributions, limitations and areas for future research

### 8.6.1 Nature of the theoretical goals

In this thesis, I have sought to make an original theoretical contribution to the transitions literature. I have considered 'big' questions, related to socio-technical transitions, destabilisation processes and the role of societal problems in transitions. Such 'big' questions can be defined as follows:

> "questions about large-scale outcomes that are regarded as substantively and normatively important by both specialists and nonspecialists." (Mahoney and Rueschemeyer 2003:7)

I recognise that this is an ambitious and hazardous undertaking, with serious implications and limitations for theoretical claims.

This research has explorative and conceptual aims. Because of the limited comprehensive body of work on destabilisation within the transitions literature, substantial conceptual elaboration was required, and represents a substantial original contribution of this thesis. Various literatures have provided valuable insights on economic decline and de-institutionalisation processes, providing represent substantial bodies of work for theoretical elaboration.

Furthermore, I have aimed to address three major aspects of destabilisation jointly (long-term unfolding, multi-dimensional co-evolution, and the role of environmental problems). These crosscutting research challenges relate to classic problems and common struggles in the social sciences. I have mobilised them as three 'transverse' scopes for contribution. Because, to my knowledge, no existing perspective on destabilisation addresses these challenges jointly, I developed a new perspective, which enabled me to address new questions of relevance to current societal and academic concerns.

However, theory-building was not done from scratch, as a number of aspects relevant to destabilisation processes can be found in a wide array of literatures. For this reason, I mobilised insights from a number of different approaches, using them as 'building blocks' for theoretical elaboration. Chapter 2 thus served the purpose of identifying and collecting such 'building blocks'. I then combined them to formulate an integrative conceptual perspective on destabilisation processes (in chapter 3).

I am aware that such an integrative and multi-disciplinary approach to theory-building also potentially raises a number of criticisms:

1. A first criticism relates to addressing fundamental problems in social science, which tend to be seen as endless debates between and within disciplines.

My strategy was not to search for a definitive answer to the three 'transverse' issues taken up, but rather to develop a perspective that puts these fundamental problems at the core of theoretical elaboration. I thus mobilised such theoretical tensions as the 'glue' to assemble different theoretical building blocks together.

2. A second criticism relates to disciplinary stretching: by mobilising too many forms of explanation one takes the risk of sacrificing depth for breadth.

Theory-building always involves trade-offs between depth and breadth. In this respect, my approach leans towards greater breadth, which is justified by the kind of question I ask. I developed a more 'transverse' approach that identifies linkages (common research problems and analytical shortcomings) between existing views. In practice, I took a combinatorial approach to theory-building, based on (fragmentary) building blocks from various literatures and suggested their combination in a synthetic perspective. In order to do this, I have identified potential linkages and anchoring points between different perspectives that allowed me to put the emphasis on *connections* between various disciplines, rather than disagreement.

### 8.6.2 My contributions

In this thesis, I have made a number of contributions:

- I have elaborated an original perspective on industry destabilisation that is attentive to unfolding at multiple levels, co-evolutionary processes, and the role of environmental problems. I have done so by building on extant literature and combining 'building blocks' from different existing views.
- I have undertaken three case studies of destabilisation in coal-related industries in Britain, constructing analytical narratives on the basis of theoretical categories.
- I have generated a number of conclusions that reach out to core mechanisms of industry destabilisation.
- I have generated insightful lessons for current societal challenges on the basis of historical cases.

### 8.6.3 Qualifying the scope of the conclusions

I have generalised from a small number of cases that present geographical, historical and sectorial specificities. The findings thus have to be qualified, so that they can be mobilised in further research in full knowledge of their limitations. How do the specificities of my cases affect the scope of my conclusions?

Firstly, the cases are limited to the *specific geographical scope* of the United Kingdom. Although international developments have been considered as they affected the British industry (e.g. international competition, foreign capital injection, global policy considerations, etc.), the findings are mostly relevant to *national* systems. Furthermore, the British geographical context may display unique particularities that may have affected the unfolding of destabilisation.

a) The British coal industry has been characterised by strong embeddedness (especially in the first case with multiple markets), owing to Britain's early involvement in historical industrialisation phases (based on coal) and its long-lived commitment to coal. This means that the resulting patterns of inertia observed are likely to be particularly strong. Other, less extreme, destabilisation cases may thus display less resistance to change and be comparatively more rapid.

b) The British context is also one in which specific notions of political economy have prevailed throughout history. Indeed, the first case has revealed the importance of *laissez faire* in determining government's ability to interfere with industrial activities, reminiscent of 'liberal market economies' (LMEs) (Hall and Soskice 2001). This might be very different in contexts like France, which has a longer tradition of strong state involvement in economic affairs. Furthermore, the UK has been central to the long-term instalment of the neo-liberal doctrine from the 1970s, which had such a strong influence on industry development in the second case. Countries more temperate in the introduction of market reforms may have allowed the smoother decline of their coal industries in the 1980s. Comparing destabilisation cases across varieties of capitalism may lead to different conclusions.

c) Britain has long been among the most developed and powerful economies in the world. The conclusions drawn from British cases are thus more directly relevant to countries with similar development patterns. I have made only passing comments on the rapid development of coal-fired generation in other countries (e.g. India and China). Major recent investments in coal in these countries may result in long-term stability rather than upcoming destabilisation.

Secondly, the empirical material has been restricted to three historical periods, although spanning over a century. The *historical context* has had a strong influence on the mechanisms at play. This has been evidenced through variations in the relative influence of societal mechanisms across cases. To give but a few important examples:

a) The role of *civil society* has changed significantly across cases. Mostly local and constituted of influential individuals until the early 1900s, civil society became better organised (first as 'societies' and later as 'organisations'), consequently more resourceful, growing in influence on national decision-making, and leading to greater involvement of the general public. These changes have allowed the success of the anti-smoke mobilisation in the 1950s, but are also crucial for the advancement of environmental problems in more contemporary settings. The relative infancy of civil society mobilisation around problems related to the natural environment at the beginning of the twentieth century may explain the difficulties of putting the smoke issue on the political agenda. Furthermore, the role of civil society is likely to be more important in determining current industry development patterns, which may explain the comparatively rapid rise of public and political attention to the climate change issue in the third case.
b) However, *industry actors have become more powerful and organised* with the rise of multinational corporations, which means that the inertia of established industries may also be comparatively stronger. Large firms today are highly resourceful, heavily engaged in lobby politics and influencing public debates. The resulting power and informational asymmetries (between firms and civil society, between firms and governments) may contribute to stall the progression of societal contestation of industry activities and thus make industry destabilisation comparatively more challenging.
c) The *relationship between the state and the economy*, and the resulting influence of market forces has also differed between cases. During world wars, and during the nationalisation period, the influence of *market forces* on industry development was tempered by strategic imperatives and the search for the greater good. Comparatively, *market forces* can be seen as being relatively influential today, and especially acute in economic recession, which suggests that the internationalisation of common goods in current economies may be comparatively more difficult.

A more general point raised by these illustrations is that the relative strength of environmental pressures (and their role in industry destabilisation) is bound to change over time (as well as between specific cases): *the environmental dimensions put forward in the conceptual framework and their interactions are not a-historical*. However, mobilising cases from different historical periods and engaging with historical embeddedness has allowed me to reach a deeper level of generalisation about industry destabilisation that balances the time-bound nature of the dynamics unveiled in each case.

Thirdly, the empirical material covered in this thesis concerned a *specific type of industry*. Indeed, the cases are related to energy industries, and more specifically coal. The coal-mining and coal-using industries covered have important characteristics.

a) They are large, capital-intensive industries. This means that they require substantial investments, with relatively long payback periods (10-20 years), and capital renewal periods (30-50 years). A major consequence is that long-term planning is an inherent part of activities in such industries, and that responsiveness to short-term market changes is very difficult. This condition might lead to above-average degrees of industry inertia. Furthermore, we can expect an important role for government intervention to correct or protect from more volatile market conditions for such industries. So, other types of industries may destabilise more rapidly (because of lower inertia) and experience less governmental mediation.
b) They are related to a bulky natural resource. Fossil fuels are natural resources that are limited, and have to be extracted. Such industries are exposed to structural constraints: reserves are bound to diminish and become increasingly difficult and costly to extract. This has been a fundamental problem of coal mining in the UK. Production problems (resource-related, process competition, etc.) are likely to be more prominent in extractive industries more generally.
c) They relate to the strategic societal function of energy provision. Indeed, energy is an essential human need, and is thus relatively inelastic. This means that demand for energy can be expected to be relatively stable over time, and major changes to be related to the introduction of substitutes. Furthermore, because energy is an essential need, ensuring the continuity of energy supply over time appears to be a highly strategic issue, one that governments have been willing to

> take on. It results that this kind of industry is likely to receive substantial support in times of crisis. Industries with similar features include agri-food businesses, water supply, housing, and banking (under current socio-economic circumstances).

The above limitations thus qualify the generalisability of findings, and suggest additional criteria for case selection in future industry destabilisation research.

### 8.6.4 Qualifying the kinds of conclusions

Taking a process approach to explanation has allowed me to explain *how* industries change over time in destabilisation dynamics. I have gained access to developmental patterns, provided insights on a number of basic mechanisms, and have suggested crucial processes that allow retrospectively explaining how destabilisation has unfolded. I have done so by elaborating a basic understanding of the sources of industry stability, and an ideal model of industry destabilisation as a heuristic against which to evaluate real-world cases. The longitudinal case narratives have provided empirical evidence that broadly matched this model, but also pointed to significant deviations. The analysis and cross-comparison of these deviations has allowed theoretical refinements and reaching out to core mechanisms.

Rather than searching for specific factors and causes, I have privileged another kind of explanation that is attentive to *processes of unfolding*. My purpose was not to establish the superiority of this approach over others, but rather to enhance the understanding of destabilisation from this particular perspective. It has allowed me to gain privileged access to the *hows* of change, but also to a specific kind of *whys* of change by looking into the motivations, beliefs and interests of actors. Furthermore, this research has sought to explore the phenomenon rather than test specific hypotheses.

While the conclusions do not allow me to forecast the specific timing of destabilisation processes, uncovering the interaction dynamics at play in historical destabilisation processes across societal domains, levels of process, and temporality has allowed me to generate a number of lessons of theoretical relevance for transition studies and of more practical relevance for current and future transition efforts.

Destabilisation appears as both the point of rupture when regime commitment is abandoned (related to significant events that can be identified within a relatively short timeframe) *and* the long-term process leading up to this breaking point. Critical destabilisation *turning points* arise amidst the long-term accumulation of tensions between industries and their environments, thereby producing historical breaking points between the 'old' and the 'new'. The research has confirmed that such critical ruptures can be understood by looking back in time to unveil the proximate and more distant causes of industry destabilisation, as well as understanding significant events as the time-critical outcomes of co-evolutionary processes. Adopting long time horizons for the study of change allows reaching out to important processes of cumulative change and causal chains (Pierson 2004, Burke 2005, Sewell 2005) – and thus transcending the search for 'immediate causes'. By attending to the co-evolution of processes unfolding at multiple levels, I have thus reached conclusions that other approaches would have overlooked. While the destabilisation of carbon-intensive industries might eventually materialise as an *immediate* consequence of radical policy initiatives (or the breakthrough of a technological solution) the exact form of which we cannot predict, the possibility for such a rupture to materialise will necessarily be the result of longer-term processes of change in multiple dimensions (markets, policy, technology, culture, etc.) and their articulation – possibly in the form of a crisis.

In terms of societal relevance, I have argued that advocates of low-carbon transitions can enhance the effectiveness of their efforts by adopting an interest in the destabilisation of specific industries. Indeed, the inertia of established high-carbon industries may be the single most powerful barrier to transitions to a low-carbon economy today, stalling innovative efforts, the momentum of socio-cultural change and political determination.

### 8.6.5 Underexposed themes and areas for future research

In this thesis, I have only begun to address what I have identified as a research neglect. A new research agenda could emerge in transition studies from this initial exploration. A number of important aspects of destabilisation processes have emerged from this research. While they go beyond the scope of this thesis, they are worthwhile mentioning, as they could provide fruitful ground for future research.

A first requirement to consolidate the claims put forward in this thesis concerns the *increase of the evidence base* and the exploration of different kinds of cases. Indeed, the conclusions of this thesis could be further exposed, refined and modulated on the basis of a greater number of cases and their comparison. This could potentially lead to the elaboration of more detailed patterns, destabilisation typologies and generally finer grained analyses.

Another point for future improvement concerns the *refinement of concepts* put forward in this thesis. Indeed, the exploratory nature of the research has led me to make use of loosely defined notions. I have mobilised the notion of *commitment* to refer to the coherence of industry actions with prevailing institutional logics, and have assumed that changes in industry commitment (to a set of rules) can be traced over time. The notion of *alignment* has been mobilised to refer to the degree to which particular pressures evolve in a similar direction (away from established regimes), and has been applied across environmental dimensions as well as across levels of unfolding. I have suggested that alignment is crucial in destabilisation processes but have not systematically elaborated on different forms of alignment, which can be a) coincidental, b) the result of collaborative interaction (e.g. coalition), c) via expectations and visions, d) because of shocks and crises, e) through constraining landscape changes, etc. How can the multi-level aspect of these two central notions (*commitment* and *alignment*) be more investigated more systematically?

The mutual influence of *destabilisation and the breakthrough of novelty* has appeared to be crucial in transition processes. Transitions research should thus attend to the co-evolutionary nature of this relationship, so as to improve the intelligibility of both processes in relation to each other. Research questions that could be pursued include: How can the long-term unfolding of destabilisation *and* novelty creation be analysed jointly over transitions processes? How does the co-evolution of destabilisation and novelty play out in different transitions pathways?

I have repeatedly referred to *the importance of political intervention* in mediating the influence of destabilisation pressures and industry responses. Furthermore, the introduction of new economic policy frameworks is crucial in the context of purposive transitions, when normative ideals are at the root of transformative activities. My findings concerning the role of policy in destabilisation processes remain anecdotal and could benefit from more systematic research. Research questions that could be pursued include: How can destabilisation processes be fostered, or accelerated, and under which conditions? How can policy actively facilitate destabilisation processes? Are some forms of support more useful than others in specific destabilisation contexts? A more practice-oriented set of questions relates to the rationales and justification of policy support in destabilisation contexts: How can policymakers know when to support, and when to drop support? What forms of conditional support can best contribute to long-term industry stability?

In this thesis, I have shed some light on relationships between multiple levels of unfolding in destabilisation processes. Multi-level embedding has appeared as an important determinant of destabilisation dynamics, especially as it influences the acceleration and alignment of pressures. However, the integration and consideration of multi-level embeddedness by industry actors has been barely touched upon, and provides a fruitful area for future research. Indeed, industry actors experience difficulties to conciliate long-term outlooks with short-term imperatives. This inability is however crucial for adaptation to adverse contexts. Research questions that could be pursued include: How effective have foresight activities and long-term strategies in industry for industry re-creation (a side observation from the case is that industry actors are relatively bad at this, and tend to be overoptimistic)? What types of organisational structures and activities may increase the ability of industry actors of coping with long-term change?

# 9 References


Abbott, A., 1992. From causes to events: Notes on narrative positivism, *Sociological Methods and Research* **20**:428-455.

Abernathy, W.J., and Clark, K.B., 1985. Innovation: Mapping the winds of creative destruction, *Research Policy* **14**(1):3-22.

Abernathy, W.J. and Utterback, J.M., 1978. Patterns of innovation in technology, *Technology Review* **80**(7):40-47.

Aldrich, H.E., Fiol, M.C., 1994. Fools rush in? The institutional context of industry creation, *Academy of Management Review*, **19**(4):645-670.

Allen, G. C., 1970. *British Industries and their Organization*, 5th edition, Longmans: London.

Aminzade, R. 1992. Historical sociology and time, *Sociological Methods Research* **20**:456-480.

Ansoff, I., 1987. *Corporate Strategy*, revised edition, Penguin Books: Harmondsworth.

Antonio, R.J., Brulle, R.J., 2011. The unbearable lightness of politics: Climate change denial and political polarization, *The Sociological Quarterly* **52**:195-202.

Archer, M. S., 1982. Morphogenesis versus structuration: On combining structure and action, *British Journal of Sociology* **33**:455-483.

Argyris, C., 1976. Singe-loop and double loop models in research on decision-making, *Administrative Science Quarterly* **21**(3):363-375

Arrowsmith, J., 2003. Post-privatisation industrial relations in the UK rail and electricity industries, *Industrial Relations Journal* **34**(2):150-163.

Arthur, W.B., 1989. Competing technologies, increasing returns, and lock-in by historical events, *Economic Journal* **99**(394):116-131

Ashby, E., Anderson, M., 1981. *The politics of clean air*, Monographs on Science, Technology, and Society, Clarendon Press: Oxford.

Ashworth, W., 1986. *The history of the British coal industry, vol. 5, 1946–1982: The nationalized industry*, Clarendon Press: Oxford.

Bailey, R., 1974. The UK coal industry – Recent past and future, *Energy Policy* **2**(2):152-158.

Barber, B., 1995. All economies are 'embedded': The career of a concept, and beyond, *Social Research*, **62**:387-413.

Barley, S.R., Tolbert, P.S., 1997. Institutionalization and structuration: Studying the links between action and institution, *Organization Studies* **18**(1):93-117

Barr, P.S., 1998. Adapting to unfamiliar environmental events: A look at the evolution of interpretation and its role in strategic change, *Organization Science* **9**(6):644-669.

Barr, P.S., Stimpert, J.L., Huff, A.S., 1992. Cognitive change, strategic action, and organizational renewal, *Strategic Management Journal* **13**:15-36.

Barty-King, H., 1984. *New Flame. How Gas Changed the Commercial and Industrial Life of Britain between 1813 and 1984*. Graphmitre Limited: Devon.

Benford, R.D., Snow, D.A., 2000. Framing processes and social movements: An overview and assessment, *Annual Review of Sociology* **26**:611-639.

Bennett, A., Elman, C., 2006. Qualitative Research: Recent Developments in Case Study Methods, *Annual Review of Political Science* **9**:455-476.

Berkhout, F., 2002. Technological regimes, path dependency and the environment, *Global Environmental Change* **12**(1): 1-4.

Bertels, K., 1973. *Geschiedenis tussen struktuur en evenement: Een methodologies en wijsgerig onderzoek*. ('History Between Structure and Event: A Methodological and Philosophical Investigation'). Wetenschappelijke Uitgeverij BV: Amsterdam.

Beynon, H., Cox, A., Hudson, R., 1999. The decline of King Coal. The Coalfields Research Programme: Discussion Paper No.1

Beynon, H., Cox, A., Hudson, R., 2000. *Digging up trouble: Opencast coal-mining and environmental protest*, Rivers Oram: London.

Bigelow, B., Fahey, L. and Mahon, J.F., 1993. A typology of issue evolution, *Business & Society* **32**(1):18-29.

Blyth, M., 2002. *Great transformations. Economic ideas and institutional change in the twentieth century*. Cambridge University Press: Cambridge.

Boehmer-Christiansen, S. and Skea, J., 1991. *Acid politics*, Belhaven Press: London.

Bourgeois, L. J., Eisenhardt, K. M., 1988. Strategic decision processes in high velocity environments: Four cases in the microcomputer industry, *Management Science* **34**:816-835.

Bowden, S., Higgins, D.M., 2004. British industry in the interwar years, in: Floud, R., Johnson, P. (eds.), *The Cambridge economic history of modern Britain. Volume II: Economic maturity, 1860-1939*, Cambridge University Press: Cambridge.

Bowen, F., 2011. Carbon capture and storage as a corporate technology strategy challenge, *Energy Policy* **39**:2256–2264.

Boyer, G., 2004. Living standards, 1860-1939, in: Floud, R., Johnson, P. (eds.), *The Cambridge economic history of modern Britain. Volume II: Economic maturity, 1860-1939*, Cambridge University Press: Cambridge.

Boykoff, M.T., 2008. The cultural politics of climate change discourse in UK tabloids, *Political Geography* **27**: 549-569.

Braudel, F., 1958. Histoire et sciences sociales: La longue durée, *Annales. Économies, Sociétés, Civilisations* **13**(4):725-753.

Brown, W., 2004. Industrial relations and the economy, in: Floud, R., Johnson, P. (eds.), *The Cambridge economic history of modern Britain. Volume III: Structural change and growth, 1939-2000,* Cambridge University Press: Cambridge.

Burke, P., 2005. *History and social theory*, Polity Press: Cambridge.

Burns, A., Newby, A., Winterton, J., 1985. The Restructuring of the British Coal Industry, *Cambridge Journal of Economics* **9**:93-110.

Burstein, P., 2003. The impact of public opinion on public policy: A review and an agenda, *Political Research Quarterly* **56**(1):29-40.

Burt, G., 2009. Researching the Organization-environment relationship, in Costanzo, L.A. and MacKay R.B., *Handbook of Research on Strategy and Foresight*, Edward Elgar, Cheltenham.

Buxton, N.K., 1970. Entrepreneurial efficiency in the British coal industry between the wars, *Economic History Review* **23**:476-497.

Buxton, N.K., 1979. Coalmining, in: Buxton, N.K. and Aldcroft, D.H. (eds.), *British industry between the wars: Instability and industrial development 1919-1939*, Scholar Press: London.

Callon, M., Laredo, P., Rabeharisoa, V., 1992. The management and evaluation of technological programs and the dynamics of techno-economic networks: the case of the AFME, *Research Policy* **21**(3):215-236.

Cameron, K., Kim, M.U., Whetten, D.A., 1987. Organizational effects of decline and turbulence, *Administrative Science Quarterly* **32**:222-240.

Carbon Capture and Storage Association, 2011. UK Carbon Plan - Not far enough on CCS, available online at http://www.ccsassociation.org/press-centre/ccsa-press-releases, accessed December 13, 2011.

Carvalho, A. and Burgess, J., 2005. Cultural Circuits of Climate Change in U.K. Broadsheet Newspapers, 1985–2003, *Risk Analysis* **25**(6):1457-1469.

Cass, L.R., 2007. Measuring the domestic salience of international environmental norms: Climate change norms in American, German, and British climate policy debates, in Pettenger, M.E. (ed.), *The social construction of climate change: power, knowledge, norms, discourses*, Ashgate Publishing: Aldershot.

Centre for Policy Studies, 2007. *Clean coal: A clean, secure and affordable alternative*, Centre for Policy Studies: London.

Chapman, J.H., 1999. *The policy processes and the decline of the British deep-mined coal industry from the mid-1960s to 1995*, PhD Dissertation, University of Sheffield.

Chesshire, J., 1991. British coal: transition and uncertainty, in Pearson, P. (ed,), *Prospects for British Coal*, Macmillan: London.

Chesshire, J. and Skea, J., 1989. *The UK energy market*, Report prepared for James Capel & Company.

Chick, M., 1998. *Industrial Policy in Britain, 1945-51*, Cambridge University Press: Cambridge.

Child, J., 1972. Organization, structure, environment and performance: The role of strategic choice, *Sociology* **6**(1):1-22.

Child, J., 1997. Strategic choice in the analysis of action, structure, organizations and environment: Retrospect and prospect, *Organization Studies* **18**(1):43-76.

Christensen, C., 1997. *The innovator's dilemma: When new technologies cause great firms to fail*, Harvard Business School Press: Boston.

Church, R., 1986. *The history of the British coal industry, Vol. 3, 1830-1913: Victorian pre-eminence*, Clarendon Press: Oxford.

Church, R.A., 1995. *The rise and decline of the British motor car industry*, Cambridge University Press: Cambridge.

Churchill, R., Kutting, G.,Warren, L., 1995, The 1994 UN ECE Sulphur Protocol, *Journal of Environmental Law* **7**(2):169-197.

Clemens, E.S., 2007. Toward a historicized sociology: theorizing events, processes, and emergence, *Annual review of sociology* **33**:527-549.

Coal Industry Advisory Board, 2008. *Clean coal technologies: Accelerating commercial and policy drivers for deployment*, IEA Publications: Paris.

Cohen, M.D., March, J.G., Olsen, J.P., 1972. A Garbage Can Model of Organizational Choice, *Administrative Science Quarterly* **17**(1):1-25.

Collier, U., 1998. Liberalisation in the energy sector: Environmental threat or opportunity?, in Collier, U., ed., *Deregulation in the European Union. Environmental perspectives*, Routledge: London

Colling, T., Clark, I., 2006. What happened when the Americans took over Britain's electricity industry? Exploring trans-national sector effects on employment relations, *International Journal of Human Resource Management* **17**(9):1625-44

Collins, J., 2009, *How the mighty fall, and why some companies never give in*, Random House: London.

Cooper, A.C., Schendel, D., 1976. Strategic responses to technological threats, *Business Horizons* **19**(1):61-69.

Corley, T. A. B., 1966. *Domestic electrical appliances*, Random House: London.

Court, W. H. B., 1945. Problems of the British coal industry between the wars, *The Economic History Review*, **15**(1-2):1-24.

Cyert, R.M. and March, J.G., 1963. *A behavioral theory of the firm*, Prentice Hall: Englewood Cliffs, NJ.

Dacin, M.T., Beal, B.S., Ventresca, M.J., 1999. The embeddedness of organizations: Dialogue & directions, *Journal of Management* **25**(3):317-356.

Dacin, M.T., Goodstein, J., Scott, W.R., 2002. Institutional theory and institutional change: introduction to the special research forum, *Academy of Management Journal* **45**(1):45-57.

Daft, R. and Weick, K., 1984. Toward a model of organizations as interpretation systems, *Academy of Management Review* **9**(2):284-295

Damanpour, F. and Gopalakrishnan, S., 1998. Theories of organizational structure and innovation adoption: the role of environmental change, Journal of Engineering and Technology Management **15**:1–24.

David, P. A., 1985. Clio and the economics of QWERTY, *American Economic Review*, **76**: 332-337.

Davis, G. F., Diekmann, K. A., Tinsley, C.H., 1994. The decline and fall of the conglomerate firm in the 1980s: The deinstitutionalization of an organizational form, *American Sociological Review*, **59**(4):547-70.

Davis, G.F., Morrill, C., Rao, H., Soule, S.A., 2008. Introduction: Social movements in organizations and markets, *Administrative Science Quarterly* **53**:389–394.

Demers, C., 2007. *Organisational change theories: A synthesis*, Sage Publications: London.

Department for Business, Enterprise and Regulatory Reform, 2008. *Meeting the energy challenge: A White Paper on nuclear power*, Cm 7296, TSO: London.

Department of Energy (1974), *Coal industry examination: Final report*, HMSO: London.

Department of Energy and Climate Change, 2008a. *Historical Coal Data: Coal Production, Availability and Consumption 1853 to 2008*, data available online.

Department of Energy and Climate Change, 2008b. *UK Energy Sector Indicators 2008*. DECC: London.

Department of Energy and Climate Change, 2010. Quarterly energy prices, December 2010, available online at http://www.decc.gov.uk/assets/decc/Statistics/publications/prices/1085-qepdec10.pdf, accessed August 14, 2011.

Department of Energy and Climate Change, 2011a. *Overarching National Policy Statement for Energy (EN-1)*, TSO: London.

Department of Energy and Climate Change, 2011b. *Planning our electric future: a White Paper for secure, affordable and low-carbon electricity*, Cm 8099, TSO: Norwich.

Department of Energy and Climate Change, 2011c. Statistical table dukes 5.11, available online at http://www.decc.gov.uk/assets/decc/Statistics/source/electricity/dukes5_11.xls, accessed August 14, 2011.

Department of Energy and Climate Change, 2011d. *The Carbon Plan: Delivering our low carbon future*, available online at www.decc.gov.uk

Department of Energy and Climate Change, 2011e. *UK Renewable energy roadmap*, July 2011, available online at www.decc.gov.uk, accessed September 22, 2011.

Department of the Environment, 1990. *This Common Inheritance: Britain's Environmental Strategy*, TSO Books, Cm.1200.

Department of Trade and Industry, 1993. *The prospects for coal: Conclusions of the Government's coal review*, Cm 2235, HMSO: London.

Department of Trade and Industry, 1998. *Conclusions of the review of energy sources for power generation and Government response to fourth and fifth reports of the trade and industry committee*, Cm 4071, HMSO: London.

Department of Trade and Industry, 1999. *Cleaner Coal Technologies*, Energy Paper 67, TSO: London.

Department of Trade and Industry, 2002. *Energy trends*, 6th Edition, DTI: London.

Department of Trade and Industry, 2003. *Our energy future-creating a low carbon economy*, Cm 5761.

Department of Trade and Industry, 2004. *UK Coal production outlook 2004-16*, Victoria House: London.

Department of Trade and Industry, 2005. *A strategy for developing carbon abatement technologies for fossil fuel use*, DTI/Pub URN 05/844.

Department of Trade and Industry, 2007. *Meeting the energy challenge: A White Paper on energy*, Cm 7124, TSO: Norwich.

Den Hond, F. and De Bakker, F.G.A., 2007. Ideologically motivated activism: How activist groups influence corporate social change activities, *Academy of Management Review* **32**(3):901-924.

DiMaggio, P.J, Powell, W.W., 1983. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. *American Sociological Review* **48**:147-60.

Dintenfass, M., 1992, *Managing industrial decline: British coal industry between the wars*, Ohio State University Press.

Dosi, G., Nelson, R.R., 1994. An introduction to evolutionary theories in economics, Journal of Evolutionary Economics **8**(3):153-172.

Downs, A., 1972. Up and down with ecology – The 'issue-attention' cycle, *Public Interest* **28**:38-50.

Doyle, J., 2007. Picturing the clima(c)tic: Greenpeace and the representational politics of climate change communication, *Science as culture* **16**(2):129-150.

Dryzek, J. S., Downs, D., Hernes, H. K. and Schlosberg. D., 2003. *Green states and social movements: Environmentalism in the United States, United Kingdom, Germany, and Norway*, Oxford University Press: Oxford.

Dudley, N., Barrett, M. and Baldock, D., 1985. *The acid rain controversy*, Earth Resources Research: London.

Dunlap, R.E., McCright, A.M., 2010. Climate change denial: Sources, actors and strategies, in Lever-Tracy, C. (ed.), *Routledge Handbook of Climate Change and Society*, 240-259.

Durucan, S., Jozefowicz, R., Brenkley, D., 2010. Coal mining research in the United Kingdom: A historical review, in Brune, J. (ed.), *Extracting the science: A century of mining research*, SME: Littleton, Colorado.

Dutton, J.E., Dukerich, J.M., 1991, Keeping an eye on the mirror: Image and identity in organizational adaptation, *Academy of Management Journal* **34**(3):517-554.

D'Aunno, T., Succi, M. and Alexander, J.A., 2000. The role of institutional and market forces in divergent organizational change, *Administrative Science Quarterly* **45**(4):679-703.

D'Aveni, R.A., 1989. The aftermath of organizational decline: A longitudinal study of the strategic and managerial characteristics of declining firms, *Academy of Management Journal* **32**(3):577-605.

Eames, M., 2000. The Large Combustion Plant Directive (88/609/EEC): An Effective Instrument For Pollution Abatement?, 24 July 2000, SPRU working paper

Edgerton, D., 1996, *Science, technology and the British industrial 'decline'*, Cambridge University Press: Cambridge.

Eisenhardt, K.M., 1989. Building theories from case study research, *The Academy of Management Review*, **14**(4):532-550.

Eisenhardt, K.M., Graebner, M.E., 2007. Theory building from cases: Opportunities and challenges, *Academy of Management Journal* **50**(1):25-32

Elbaum, B. and Lazonick, W., 1984. The decline of the British economy: An institutional perspective, *Journal of Economic History* **44**(2):567-583.

Elbaum, B. and Lazonick, W. (eds.), 1986. *The decline of the British economy*, Clarendon Press: Oxford.

Elzen, B.,Geels, F.W., Green, K., 2004. *System innovation and the transition to sustainability: Theory, evidence and policy*. Edward Elgar: Cheltenham.

Elzen, B.,Geels, F.W., Leeuwis, C., van Mierlo, B., 2011. Normative contestation in transitions 'in the making': Animal welfare concerns and system innovation in pig husbandry, *Research Policy* **40**:263-275.

Etzion , D., 2007. Research on organizations and the natural environment, 1992-present: A review, *Journal of Management* **33**:637-664.

EURACOAL, 2007. *The long-term perspectives for coal in the electricity sector in the EU*, September 2007.

EURACOAL, 2010. *60 years of voicing coal interests in Europe*, June 2010, available online at:

http://www.euracoal.org/componenten/download.php?filedata=1277811927.pdf&filename=EURACOAL%20HISTORY.pdf&mimetype=application/pdf, accessed August 11, 2011.

European Commission, 2000. *Towards a European strategy for the security of energy supply*, COM(2000) 769, Commission of the European communities, Brussels.

Fagerberg, J., 2003. Schumpeter and the revival of evolutionary economics: an appraisal of the literature, *Journal of Evolutionary Economics* **13**(2):125-159.

Farley, J.M., 2007. Clean coal technologies for power generation, Proceedings of the Institution of Civil Engineers Energy 160:15–20

Fisher, B., N. Nakicenovic, K. Alfsen, J. Corfee Morlot, F. de la Chesnaye, J.-Ch. Hourcade, K. Jiang, M. Kainuma, E. La Rovere, A. Matysek, A. Rana, K. Riahi, R. Richels, S. Rose, D. van Vuuren, Warren, R., 2007. Issues related to mitigation in the long term context. In: Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., Meyer, L.A. (eds.), *Climate change 2007: Mitigation of climate change. Contribution of Working Group III to the fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, pp. 169- 250.

Fligstein, N., 1996. Markets as politics: A political-cultural approach to market institutions, *American Sociological Review* **61**(4):656-673

Flyvbjerg, B., 2006, Five misunderstandings about case-study research, *Qualitative Inquiry* **12**(2):219-245.

Forsyth, T., 2003. *Critical Political Ecology: The Politics of Environmental Science*, Routledge: New York.

Fouquet, R., Pearson, P.J.G., 1998. A thousand years of energy use in the United Kingdom, *The Energy Journal* **19**(4):1-41.

Fouquet, R., 2008. *Heat, power and light: Revolutions in energy services*, Edward Elgar: Cheltenham

Fouquet, R., 2010. The slow search for solutions: Lessons from historical energy transitions by sector and service, *Energy Policy* **38**:6586-6596.

Fouquet, R., 2011. Divergences in long run trends in the prices of energy and energy services, *Review of Environmental Economics and Policy*, 5(2), 196-218.

Freeman, C., 1994. The economics of technical change, *Cambridge Journal of Economics* **18**:463-514.

Freeman, C., Louça, F., 2001. *As time goes by: From the industrial revolutions to the information revolution*, Oxford University Press: Oxford.

Freeman, J., Cameron, K.S., 1993. Organizational downsizing: A convergence and reorientation framework, *Organization Science* **4**(1):10-29

Freeman, C., Perez, C., 1988. Structural crisis of adjustment, business cycles and investment behaviour, in: G. Dosi, C. Freeman, R. Nelson, G. Silverberg & L. Soete (eds.), *Technical Change and Economic Theory*, London: Pinter, 38-66.

Freeman, C., Soete, L., 1997. *The economics of industrial innovation*, 3rd Edition, MIT Press.

Fudge, S., Hunt, L., Jackson, T., Mulugetta, Y., Peters, M., 2008. The political economy of energy regulation in the UK 1945-2007: Paradigms and policy, *RESOLVE Working Paper*, 02-08.

Furrer, O., Thomas, H., Goussevskaia, A., 2008. The structure and evolution of the strategic management field: A content analysis of 26 years of strategic management research, *International Journal of Management Reviews* **10**(1):1-23.

Gaddis, J.L., 2002. *The Landscape of History. How Historians Map the Past*, Oxford.

Garud, R., Karnøe, P., 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship, *Research Policy* **32**:277-300.

Gavetti, G., Rivkin, J.W., 2007. On the origin of strategy: Action and cognition over time, *Organization Science* **18**(3):420-439.

Geels, F.W., 2002a. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study, *Research Policy* **31**(8-9):1257-1274.

Geels, F.W., 2002b. *Understanding the dynamics of technological transitions*, PhD thesis, Universiteit Twente: Enschede.

Geels, F.W., 2004. From sectorial systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory, *Research Policy* **33**(6-7):897-920.

Geels, F.W., 2005a. *Technological Transitions and System Innovations: a Co-Evolutionary and Sociotechnical Analysis*, Edward Elgar, Cheltenham.

Geels, F.W., 2005b. Co-evolution of Technology and Society: the Multi-level Perspective and a Case Study, the Transition in Water Supply and Personal Hygiene in the Netherlands (1850–1930), *Technology in Society* **27**(3):363-397.

Geels, F.W., 2010. Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective, *Research Policy* **39**:495-510.

Geels, F.W., 2011. A triple embeddedness framework of industrial change: Understanding the co-evolution of industry with markets, civil society and politics, submitted to *Research Policy*

Geels, F.W., Schot, J.W., 2007. Typology of sociotechnical transition pathways, *Research Policy*, **36**(3):399-417.

Geels, F.W. and Schot, J.W., 2010. The Dynamics of Transitions: A Socio-Technical Perspective, in: Grin, J., Rotmans, J. and Schot, J. (eds.), *Transitions to sustainable development: New directions in the study of long term transformative change*, Routledge: London.

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**(6):910-30.

George, A.L. and Bennett, A., 2004. *Case studies and theory development in the social sciences*, MIT Press: Cambridge, Massachusetts.

Gibbon, P., Bromley, S., 1990. 'From an institution to a business'? Changes in the British coal industry 1985-9, *Economy and Society* **19**(1):56-94.

Giddens, A., 1984. *The Constitution of Society: Outline of the Theory of Structuration*, University of California press: Berkeley.

Gilbert, C.G., 2005. Unbundling the structure of inertia: Resource versus routine rigidity, *The Academy of Management Journal* **48**(5):741-763.

Giugni, M. and Passy, F., 1998. Social Movements and Policy Change: Direct, Mediated, or Joint Effect?, *American Sociological Association Section on Collective Behavior and Social Movements Working Paper Series*, vol. 1, no. 4 (http://www.nd.edu/~dmyers/cbsm).

Glasson, J., Chadwick, A., 2000. Gas, coal and gas from coal: A strategic socio-economic appraisal of the UK energy policy, *Journal of Environmental Assessment Policy and Management* **2**(2):225–247.

Glyn, A. and Machin, S., 1997. Colliery closures and the decline of the UK coal industry, *British Journal of Industrial Relations* **35**(2):197-214.

Godwin, G., 1854. *London shadows: A glance at the "homes" of the thousands*, Routledge: London.

Gopinath, C., 2005. Recognizing decline: The role of triggers, *Mid-American Journal of Business* **20**(1):21-27.

Gough, C., Shackley, S., 2001. The respectable politics of climate change: the epistemic communities and NGOs, *International Affairs* **77**(2):329-345.

Grainger, L. and Gibson, J., 1981. *Coal utilisation: Technology, economics and policy*, Graham and Trotman: London.

Granovetter, M., 1985. Economic action and social structure: The problem of embeddedness, *American Journal of Sociology* **91**(3):481-510.

Green, R., 1999. Draining the Pool: the reform of electricity trading in England and Wales, *Energy Policy* **27**:515-525.

Greenpeace, 2008a. *The Greenpeace case against coal-fired power generation*, available online: http://www.greenpeace.org.uk/files/pdfs/climate/caseagainstcoal0808.pdf, accessed on 3/02/2009.

Greenpeace, 2008b. *The true cost of coal*, Greenpeace International, Amsterdam.

Greenwood, R. and Hinings, C.R., 1996. Understanding radical organizational change: Bringing together the old and the new institutionalism, *Academy of Management Review* **21**(4):1022-1054.

Griffin, L.J., 1993. Narrative, event-structure, and causal interpretation in historical sociology, *American Journal of Sociology* **98**(5):1094-1133

Grinyer, P.H., Spender, J.-C., 1979. Recipes, crises, and adaptation in mature businesses, *International Studies of Management and Organization* **9**(3):113-133.

Grübler, A., 1990. Technology diffusion in a long-wave context: The case of the steel and coal industries, in Vasko, T., Ayres, R., Fontvieille, L., (Eds.), *Life cycles and long waves* (T. Vasko, *et al.*, Eds.), Springer-Verlag: Berlin.

Hakim, C., 1987. *Research design: Strategies and choices in the design of social research*, Allen and Unwin: London.

Hall, P. A., 1993. Policy paradigms, social learning, and the state: The case of economic policymaking in Britain, *Comparative Politics* **25**(3):275-296.

Hall, P.A., Soskice, D., (Eds.) 2001. *Varieties of capitalism: the institutional foundations of comparative advantage*, Oxford University Press: Oxford.

Hall, T. 1981. *King Coal: Miners, coal and Britain's industrial future*. Penguin: Harmondsworth.

Hambrick, D.C. and D'Aveni, R.A., 1988. Large corporate failures as downward spirals, *Administrative Science Quarterly* **33**(1):1-23.

Hannah, L., 1982. *Engineers, managers and politicians*, Macmillan and Johns Hopkins.

Hannah, L., 2004. A failed experiment: The state ownership of industry, in: Floud, R. and Johnson, P. (eds.), *The Cambridge economic history of modern Britain. Volume III: Structural change and growth, 1939-2000*, Cambridge University Press: Cambridge, pp. 84-111

Hannan, M. and Freeman, J., 1977. The population ecology of organizations. *American Journal of Sociology* **82**:929-964.

Hansen, J., 2007. Public letter to Prime Minister Gordon Brown, December 19 2007, available online at: http://www.columbia.edu/~jeh1/mailings/2007/20071219_DearPrimeMinister.pdf, accessed February 6, 2009.

Haveman, H.A. and Rao, H., 1997. Structuring a theory of moral sentiments: Institutional and organizational coevolution in the early thrift industry, *American Journal of Sociology* **102**(6):1606-1651.

Harrigan, K.R., 1980. Strategy formulation in declining industries, *Academy of Management Review*, **5**(4):599-604.

Haveman, H.A. and Rao, H., 1997, Structuring a theory of moral sentiments: Institutional and organizational coevolution in the early thrift industry, *American Journal of Sociology*, **102**(6): 1606-1651

Haydu, J., 1998. Making use of the past: time periods as cases to compare and as sequences of problem-solving. *American Journal of Sociology* **104**(2):339-371.

Haydu, J., 2010. Reversals of fortune: path dependency, problem solving, and temporal cases, *Theory and Society* **39**:25-48.

Heald, D., 1980. The Economic and Financial Control of U.K. Nationalised Industries, *The Economic Journal* **90**(358):243-265.

Heald, D. and Steel, D., 1981, Nationalised Industries: The search for Control, *Public Money & Management* June, 3-19.

Helm, D., 2003. *Energy, the state, and the market*, Revised Edition, Oxford University Press: Oxford.

Helm, D., 2008. Climate-change policy: Why has so little been achieved?, *Oxford Review of Economic Policy* **24**(2):211-238.

Helm, D., 2010. Government failure, rent-seeking, and capture: the design of climate change policy, *Oxford Review of Economic Policy* **26**(2):182-196.

Henney, A., 1994. Energy Markets and Energy Policies after the White Paper, *Energy Policy* **22**(1):5-14.

Hess, D.J., 2005. Technology- and product-oriented movements: Approximating social movement studies and science and technology studies, *Science Technology Human Values* **30**:515-535.

Hicks, J. and Allen, G., 1999. *A century of change: Trends in UK statistics since 1900*, House of Commons, Research Paper 99/111.

Hilgartner, S. and Bosk, C.L., 1988. The rise and fall of social problems: A public arenas model, *American Journal of Sociology* **94**(1):53-78.

Hill, C.W.L., Rothaermel, F.T., 2003. The performance of incumbent firms in the face of radical technological innovation, *The academy of management review* **28**(2):257-274.

Hillman, A. and Hitt, M., 1999. Corporate political strategy formulation: A model of approach, participation, and strategy decisions, *Academy of Management Review* **24**(4):825-842.

Hoffman, A.J., 1999. Institutional evolution and change: Environmentalism and the US chemical industry, *Academy of Management Journal* 42(4):351-371.

Hoffman, A.J., 2001. Linking organizational and field-level analyses: The diffusion of corporate environmental practice, *Organization & Environment* **14**(2):133-156

Hoffman, A.J. and Ocasio, W., 2001. Not all events are attended equally: Toward a middle-range theory of industry attention to external events, *Organization Science* **12**(4):414-434.

House of Commons, 1984. *Acid rain.* Fourth report from the Environment Committee, vol. 1, HMSO: London.

House of Lords, 1984. *Air pollution.* 22nd report from the Select Committee on the European Communities, HMSO: London.

House of Commons, 1990. *Flue Gas Desulphurisation Programme*, Third Report of the Energy Committee, Session 1989-90, HMSO: London.

House of Commons, 1998. *Coal.* 4$^{th}$ Report from the Trade and Industry Committee, vol.2, HMSO: London.

Hudson, R., 2002. The changing geography of the British coal industry: Nationalization, privatization and the political economy of energy supply, 1947–97, *Mining Technology* **111**(3):180-186.

Hudson, R., Sadler, D., 1990. State policies and the changing geography of the coal industry in the United Kingdom in the 1980s and 1990s, *Transactions of the Institute of British Geographers* **15**(4):435-454.

Huff, J.O., Huff, A.S. and Thomas, H.T., 1992. Strategic renewal and interaction of cumulative stress and inertia, *Strategic Management Journal* **13**:55-75.

Hughes, T.P., 1987. The evolution of large technological systems, in: W.E. Bijker, T.P. Hughes & T. Pinch (eds.), *The social construction of technological systems: New directions in the sociology and history of technology*, MIT Press: Cambridge, Massachusetts, 51-82.

Intergovernmental Panel on Climate Change, 2001. *Climate change 2001: Synthesis report* (TAR), Cambridge University Press: Cambridge.

Intergovernmental Panel on Climate Change, 2005. Intergovernmental Panel on Climate Change Special Report on Carbon Capture and Storage. Cambridge University Press: Cambridge, UK.

Intergovernmental Panel on Climate Change, 2007. *Climate change 2007: Synthesis report*, Available online at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf, accessed April 12, 2009.

International Energy Agency, 2010. *World Energy Outlook 2010*, International Energy Agency: Paris.

International Energy Agency, 2011. *World Energy Outlook 2011*, OECD/IEA: Paris.

Jefferson, M., 2008. Accelerating the transition to sustainable energy systems, *Energy Policy* **36**:4116-4125.

Johnson, C., Dowd, T.J., Ridgeway C.L., 2006. Legitimacy as a social process, *Annual Review of Sociology* **32**:53-78.

Jordan, A., Lorenzoni, I., 2007. Is there now a political climate for policy change? Policy and politics after the Stern review, *The Political Quarterly* **78**(2):310-319.

Judge, W.Q. and Miller, A., 1991. Antecedents and outcomes of decision speed in different environmental contexts, *The Academy of Management Journal* **34**(2):449-463.

Kaplan, S. 2008. Framing contests: Strategy making under uncertainty, *Organization Science* **19**(5):729-752.

Kaplan, S., Murray, F. and Henderson, R., 2003. Discontinuities and senior management: Assessing the role of recognition in pharmaceutical firm response to biotechnology, *Industrial and Corporate Change* **12**(2):203-233.

Kelly, D., Amburgey, T.L., 1991. Organizational inertia and momentum: A dynamic model of strategic change, *Academy of Management Journal* **34**(3):591-612.

Kemp, R., Soete, L., 1992. The greening of technological progress: an evolutionary perspective, *Futures* 437-457.

Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management, *Technology Analysis and Strategic Management* **10**:175-196.

Kemp, R., Rip, A., Schot, J.W., 2001. Constructing transition paths through the management of niches. In: Garud, R., Karnoe, P. (Eds.), *Path dependence and creation*. Lawrence Erlbaum: Mahwah, NJ, pp. 269–299.

Kemp, R., Geels, F.W., Dudley, G., 2012. Introduction: Sustainability transitions in the automobility regime and the need for a new perspective, in: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (eds.), 2012, *Automobility in transition? A socio-technical analysis of sustainable transport*, Routledge, pp. 3-28

King, B.G., 2008. A political mediation model of corporate response to social movement activism, *Administrative Science Quarterly* **53**:395-421.

Kingdon, J.W., 1984. *Agendas, alternatives and public policies*, HarperCollins College Publishers.

Kirby, M.W., 1992. Institutional rigidities and economic decline: Reflections on the British experience, *Economic History Review* **45**(4):637-660.

Kline, S., Rosenberg, N., 1986. An overview of innovation, in Landau. R, Rosenberg, N. (eds), *The positive sum strategy: Harnessing technology for economic growth*, National Academy Press: Washington DC. pp 275-305.

Koerner, R., Rutledge, I., Wright, P., 1995. The impact of oil company investment on the world coal industry. Overcapacity and price destabilization 1973-92, *Energy Policy* **23**(8):659-667.

Kolk, A., Pinkse, J., 2010. Business and climate change: Key strategic and policy challenges, *Amsterdam Law Forum* **2**(2):41-50.

Krippner, G. R., 2001. The elusive market: Embeddedness and the paradigm of economic sociology, *Theory and Society* **30**(6):775-810.

Lamertz, K., Martens, M.L. and Heugens, P.P.M.A.R., 2003. Issue evolution: A symbolic interactionist perspective, *Corporate Reputation Review* **6**(1):82-93.

Langley, A., 1999. Strategies for theorizing from process data, *Academy of Management Review* **24**(4):691-710.

Lazonick, W., 1983, 'Industrial organization and technology change: The decline of the British cotton industry', *Business History Review*, **57**(2), 491-516

Leblebici, H., Salancik, G.R., Copay, A. and King, T., 1991. Institutional change and the transformation of interorganizational fields: An organizational history of the U.S. radio broadcasting industry, *Administrative Science Quarterly* **36**(3):333-363.

Lehtonen, M. and Nye, S., 2009. History of electricity network control and distributed generation in the UK and western Denmark, *Energy Policy* **37**: 2338-2345.

Leman, S. and Winterton, J., 1991. New technology and the restructuring of pit-level industrial relations in the British coal industry, *New Technology, Work and Employment*.

Leonard-Barton, D., 1992. Core capabilities and core rigidities: A paradox in managing new product development, *Strategic Management Journal* **13**:111-125.

Levinthal, D.A., 1998. The slow pace of rapid technological change: Gradualism and punctuation in technological change, *Industrial and Corporate Change* **7**(2):217-247.

Lewin, A.Y and Volberba, H.W., 2003. Preface: Beyond adaptation versus selection research: Organizing self-renewal in co-evolving environments, *Journal of Management Studies* **40**(8):2109-10.

Ling, K.A., Ashmore, M.R., Macrory, R.B., 2000. The use of word-based models to describe the development of UK acid rain policy in the 1980s, *Environmental Science and Policy* **3**:249-262.

Lodge, T., 2007. *Clean coal. A clean, secure and affordable alternative*, Centre for Policy Studies, May 2007.

Longhurst, J.W.S., 1988. Some observations on the environmental impact of the UK flue gas desulphurisation programme, *The Environmentalist* **8**(2):115-121.

Longhurst, J., Bantock, J, Hare, S., Conlan, D., 1995. Changing public interest in, and awareness of, acid deposition: Some evidence from the UK, *Water, Air and Soil Pollution* **85**:2631-1636.

Loorbach, D., 2007. *Transition management: New mode of governance for sustainable development*, PhD Dissertation, Erasmus Universiteit Rotterdam.

Lorenz, E.H., 1991, *Economic decline in Britain: The shipbuilding industry, 1890-1970*, Clarendon Press: Oxford.

Lorenz, E., 1994. Organizational inertia and competitive decline: The British cotton, shipbuilding and car industries, 1945–1975**,** *Industrial and Corporate Change* **3**(2):379-403.

Lounsbury, M. 2001. Institutional sources of practice variation: Staffing college and university recycling programs, *Administrative Science Quarterly* **46**:29-56.

Lounsbury, M., Glynn, M.A., 2001. Cultural entrepreneurship: Stories, legitimacy, and the acquisition of resources, *Strategic Management Journal* **22**(6-7):545-564.

Lounsbury, M., Ventresca, M., and Hirsch, P.M., 2003. Social movements, field frames and industry emergence: A cultural-political perspective on US recycling, *Socio-Economic Review* **1**(1):71-104.

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.

MacGregor, I.K, Tyler, R., 1986. *The Enemies Within: The Story of the Miners' Strike, 1984-5*, Collins:London.

Macher, J.T., Richman, B.D., 2004. Organisational responses to discontinuous innovation: A case study approach, *International journal of innovation management* **8**(1):87-114.

MacKerron, G., 1999. Historical overview, in Hester, R.E. and Harrison, R.M., Eds, *Environmental impact of power generation*, Issues in Environmental Science and Technology No. 11, The Royal Society of Chemistry.

MacKerron, G., 2001.Organisation and regulation of the electricity supply industry in the United Kingdom, in De Paoli, L. (ed.), *The electricity industry in transition: Organization, regulation and ownership in EU Member States*, FrancoAngeli: Milan, 529-585.

MacKerron, G., 2009, Lessons from the UK on urgency and legitimacy in energy policy-making, in Scrase and MacKerron (Eds.), *Energy for the future: A new agenda*, Palgrave Macmillan: New York.

Mahon, J.F., 2002. Corporate reputation: Research agenda using strategy and stakeholder literature, *Business & Society* **41**(4):415-445.

Mahon, J. and Waddock, S.A., 1992. Strategic issues management: An integration of issue life cycle perspectives, *Business & Society* **31**:19-32

Mahoney, J., 2000. Path dependence in historical sociology, *Theory and Society* **29**:507-548.

Mahoney, J., Rueschemeyer D., eds., 2003. *Comparative historical analysis in the social sciences*, Cambridge University Press: New York.

Malerba F, Orsenigo L., 1996. The dynamics and evolution of industries. *Industrial and Corporate Change* **5**(1):51–87

March, J.G., 1991. Exploration and exploitation in organizational learning, *Organization Science* **2**(1):71-87

Margolis, R.M., Kammen, D.M., 1999. The energy technology and R&D policy challenge, *Science* **285**(5428):690-692.

Markusson, N., Haszeldine, S., 2009. 'Capture readiness' – lock-in problems for CCS governance, *Energy Procedia* **1**(1):4625-32.

McCarthy, I.P., Lawrence, T.B., Wixted, B., Gordon, B.R., 2010. A multidimensional conceptualization of environmental velocity, *Academy of Management Review* **35**(4):604-626.

McCormick, J., 1991. *British politics and the environment*, London: Earthscan.

McCormick, J., 1997. *Acid earth: The politics of acid pollution*, 3rd Edition, London: Earthscan.

McKinley, W. 1993. Organizational decline and adaptation: Theoretical controversies, *Organization science* **4**(1):1-9.

Meadowcroft, J., 2009. What about the politics? Sustainable development, transition management, and long term energy transitions, *Policy Sciences* **42**:323-340.

Meyer, A.D., 1982, Adapting to environmental jolts, *Administrative Science Quarterly* **27**(4):515-537.

Meyer, A.D., Brooks, G.R., and Goes, J.B., 1990, Environmental jolts and industry revolutions: Organizational responses to discontinuous change, *Strategic Management Journal* **11**:93-110.

Meyer, J.W. and Rowan, B., 1977. Institutionalized organizations: Formal structure as myth and ceremony, *American Journal of Sociology* **83**(2):340-363.

Miles, R. H. and Cameron, K.S., 1982. Coffin nail and corporate strategies. Prentice-Hall: Englewood Cliffs, N.J.

Miller, D., 1990. *The Icarus Paradox: How Exceptional Companies Bring About Their Own Downfall*, Harper: New York.

Mills, R., 2010. *Capturing Carbon: The New Weapon in the War Against Climate Change*, Columbia University Press: New York.

Miner, A. Amburgey, T., Stearns, T. 1990. Interorganizational linkages and population dynamics: Buffering and transformational shields, *Administrative Science Quarterly* **35**(4):689-713.

Ministry of Fuel and Power, 1946. *Domestic fuel policy*, Report by the Fuel and Power Advisory Council, Cmd 6762, HMSO: London.

Ministry of Power, 1967. *White Paper on fuel policy*, Cm3438, HMSO, London.

Mintzberg, H., 1979. *The structuring of organizations*. Prentice-Hall: Englewood Cliffs, NJ.

Mintzberg, H., Ahlstrand, B., Lampel, J., 1998, *Strategy safari: A guided tour through the wilds of strategic management*, The Free Press: New York

Mitchell, C., 2008. *The political economy of sustainable energy*, Palgrave MacMillan: Basingstoke.

Mitchell, C., Connor, P., 2004. Renewable energy policy in the UK 1990-2003, *Energy Policy* **32**:1935-47.

Mitchell, R.K., Agle, B.R., Wood, D.J., 1997. Toward a theory of stakeholder identification and salience: Defining the principles of who really counts, *The Academy of Management* Review 22(4):853-886.

Mokyr, J., 1990. *The lever of riches*. Oxford University Press: New York.

Mone, M.A., McKinley, W., Barker, V.L., 1998. Organizational decline and innovation: A contingency framework, *The Academy of Management Review* **23**(1):115-132.

Monopolies and Mergers Commission, 1983. *National Coal Board*, Cmnd 8920, HMSO: London.

Morlacchi, P., Martin, B., 2009. Emerging challenges for science, technology and innovation policy research: A reflexive overview, *Research Policy* **38**:571-582.

Moses, K., 1986. New mines in the United Kingdom, *The Mining Engineer*.

Munslow, A., 2006. *The Routledge companion to historical studies*, Second edition, Routledge: London.

National Coal Board / British Coal, 1946-1994. Annual Reports and Account. London, HMSO [dated of the year ending in December for 1946-1962, dated of the year ending in March from 1964, British Coal from 1986]

National Coal Board, 1957b. *British coal. The rebirth of an industry*, Hobart House: London

Nelson, R.R. and S.G. Winter, 1982, *An evolutionary theory of economic change*, Belknap Press: Cambridge (Mass.).

Newbery, D.M., 1993. The impact of EC environmental policy on British Coal, *Oxford Review of Economic Policy* **9**(4):66-95.

Newbery, D. 2011. Reforming Competitive Electricity Markets to Meet Environmental Targets, *Electricity Policy Research Group Working Paper 1126*, available online at www.eprg.group.cam.ac.uk, accessed October 26, 2011.

Newbery, D.M. and Pollitt, M.G., 1997. The restructuring and privatisation of Britain's CEGB - was it worth it?, *The Journal of Industrial Economics* **45**(3):269-303.

North, P., 2011. *The politics of climate activism in the UK: a social movement analysis*, Environment and Planning A **43**:1581-1598.

Nuttall, W.J., Holweg, M., Leybovich, M.E., 2011. Too big to fail – Lessons for today and the future from British industrial policy, 1960-1990, *Technological forecasting and social change* **78**(8):1286-1298.

Nye, D. E., 1999. Path Insistence: Comparing European and American Attitudes Toward Energy, *Journal of International Affairs* **53**:129-48.

Nystrom, P.C. and Starbuck, W.H., 1984. To avoid organizational crisis, unlearn, *Organizational Dynamics* **12**(4):53-65

O'Donnell, K., 1988. Pit closures in the British coal industry: a comparison of the 1960s and 1980s, *International Review of Applied Economics* **2**(1):62-77.

O'Rand, A.M. and Krecker, M.L., 1990. Concepts of the Life Cycle: Their History, Meanings, and Uses in the Social Sciences, *Annual Review of Sociology* **16**:241-262.

Office for Nuclear Regulation, 2011. *Japanese earthquake and tsunami: Implications for the UK nuclear industry*, Final Report, available online at www.hse.gov.uk

Organisation for Economic Cooperation and Development, 1977. *The OECD programme on long-range transport of air pollutants*. Measurements and Findings, OECD: Paris.

Organisation for Economic Cooperation and Development, 2011. *Inventory of estimated budgetary support and tax expenditures for fossil fuels*, OECD: Paris.

Oliver, C., 1991. Strategic responses to institutional processes, *Academy of Management Review* **16**(1):145-179.

Oliver, C., 1992. The antecedents of deinstitutionalization, *Organization Studies* **13**(4):563-588.

Oliver, T., 2008. Clean fossil-fuelled power generation, *Energy Policy* **36**:4310-4316.

Pardo del Val, M. and Martinez Fuentes, C. 2003. Resistance to change: A literature review and empirical study, *Management Decision* **41**:148-155.

Park, C.C., 1987. *Acid rain: rhetoric and reality*, Methuen & Co.: London.

Parker, M., 1994. *The politics of coal's decline. The industry in Western Europe.* The Royal Institute of International Affairs: London.

Parker, M., 2000. *Thatcherism and the fall of coal*. Oxford: Oxford University Press.

Parker, M., Surrey, J., 1993. The October 1992 coal crisis and UK energy policy, *The Political Quarterly* **64**(4):396-409.

Patterson, W., 2000. Energy company? What energy company?, *Chatham House Paper*, November 2000.

Patterson, W., Grubb, M., 1996. Liberalizing European Electricity: Impacts on Generation and Environment, *Chatham House Briefing Paper* **34**, November 1996.

Pearce, M. and Stewart, G., 2002 (1992). *British political history, 1867-2001: Democracy and decline*, third edition, Routledge: London.

Pearson, P., Watson, J., 2012. *UK Energy Policy 1980-2010: A history and lessons to be learnt*, The Parliamentary Group for Energy Studies: London.

Pettigrew, A.M., 1987. Context and action in the transformation of the firm, *Journal of Management Studies* **24**:649-670.

Pettigrew, A.M., 1990. Longitudinal field research on change: Theory and practice, *Organization Science* **1**(3):267-292.

Pettigrew, A.M., 1992. The character and significance of strategy process research, *Strategic Management Journal* **13**:5-16.

Pettigrew, A.M., 1997. What is processual research?, *Scandinavian Journal of Management* **13**(4):337-348.

Phillips, M.E., 1994. Industry mindsets: Exploring the cultures of two macro-organizational settings, *Organization Science* **5**(3):384-402

Pierson, P., 2004. *Politics in Time: History, Institutions, and Social Analysis*, Princeton University Press: Princeton.

Pinch, T.J. and W.E. Bijker, 1987. The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other', in: W.E. Bijker, T.P. Hughes & T.J. Pinch (eds.): *The social construction* *of technological systems: new directions in the sociology and history of technology*. MIT Press: Cambridge, Massachusetts, 17-50.

Pollard, S., 1989. *Britain's Prime and Britain's Decline. The British Economy 1870-1914*, Edward Arnold: London.

Poole, M. A., Van de Ven, A. H., Dooley, K., & Holmes, M. E., 2000. *Organizational Change and Innovation Processes: Theory and Methods for Research*. Oxford University Press: New York.

Porter, M., 1980, *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, Free Press: New York.

Porter, M., 1991. Towards a dynamic theory of strategy, *Strategic Management Journal*, Winter Special Issue **12**:95-117

Porter, M. E., van der Linde, C., 1995, Toward a new conception of the environment-competitiveness relationship, *Journal of Economic Perspectives* **9**:97-118.

Posner (1993), Electricity and the primary fuels – technology, market structure and prices, *National Institute Economic Review* **145**:64-86.

Ragin, C.C., 1987. *The comparative method: Moving beyond qualitative and quantitative strategies*, University of California Press: Berkeley, CA.

Ragin, C.C., 1997, Turning the tables: How case-oriented research challenges variables-oriented research, *Comparative Social Research* **16**:27-42.

Rajagopalan, N. and Spreitzer, G., 1997. Toward a theory of strategic change: A multi-lens perspective and integrative framework, *Academy of Management Review* **22**(1):48-79

Ramsbottom, E. C. 1935. The course of wage rates in the United Kingdom, 1921–1934, *Journal of the Royal Statistical Society* **98**:639–94.

Ramsbottom, E.C., 1939. Wage rates in the United Kingdom in 1938, *Journal of the Royal Statistical Society* **102**:289-91.

Ridley, N., 1977. *Nationalised Industries Policy Group Report*, PG/10/77/38, The Conservative Research Department: London.

Riemer, P., 1996. Greenhouse Gas Mitigation Technologies, an Overview of the C02 Capture, Storage and Future Activities of the IEA Greenhouse Gas R&D Programme, *Energy Conversion and Management* 37(6-8):665-670.

Rip, A., Kemp, R., 1998. Technological change. In: Rayner, S., Malone, E.L. (Eds.), *Human choice and climate change*. Battelle Press: Columbus, OH, 327-399.

Rivoli, P., Waddock, S., 2011. "First they ignore you...": The time-context dynamic and corporate responsibility, *California Management Review* **53**(2):87-104.

RJB Mining, 2000. Annual Report and Accounts

Robens, Lord, 1972, *Ten year stint*, Cassell: London

Robinson, P.W., 1988. Economic background to the coal dispute. In Cooper, D., Hopper, T. (Eds.), 1988. *Debating coal closures: Economic calculation in the coal dispute 1984-5*, Cambridge University Press: Cambridge, 195-224.

Robertson, P.L., Langlois, R.N., 1994. Institutions, inertia and changing industrial leadership, *Industrial and Corporate Change* **3**(2):359-378.

Rogers, E. M., 1983. *Diffusion of innovations*. Free Press: New York.

Roques, F.A., Newbery, D.M., Nuttall, W.J., 2005. Investment incentives and electricity market design: The British experience, *Review of Network Economics* **4**(2):93-128.

Rose, C., 1990. *The dirty man of Europe: The great British pollution scandal*. Simon & Schuster: London.

Rosenberg, N., 1976, *Perspectives on technology*, Cambridge University Press: Cambridge.

Rosenkopf, L., Tushman, M., 1994. The coevolution of technology and organization, in: J. Baum, Singh, J. (eds.), *Evolutionary Dynamics of Organizations*, Oxford University Press: Oxford, 403-424.

Rotmans, J., Kemp, R., van Asselt, M., 2001. More evolution than revolution: transition management in public policy, *Foresight* **3**(1):15-31.

Rutledge, I., Wright, P., 1985. Coal Worldwide: The International Context of the British Miners' Strike, *Cambridge Journal of Economics* **9**:303-326.

Sadler, D., 2001. The political economy and regional implications of energy policy in Britain in the 1990s, *Environment and Planning C: Government and Policy* **19**:3-18.

Sandén, B., Jonasson, K. M.. 2005. Variety creation, growth and selection dynamics in the early phase of a technological transition: The development of alternative transport fuels in Sweden 1974-2004. ESA-report 2005:13, Chalmers University of Technology: Göteborg.

Sanderson, J.B., 1961. The National Smoke Abatement Society and the Clean Air Act (1956), *Political Studies* **9**:236-253.

Scarrow, H.A., 1972. The impact of British domestic air pollution legislation, *British Journal of Political Science* **2**(3):261-8.

Schot, J., Elzen, B., Hoogma, R., 1994. Strategies for shifting technological systems. The case of the automobile system. *Futures* **26**(10):1060-1076.

Schumpeter, J.A., 1939. *Business cycles: A theoretical, historical and statistical analysis of the capitalist process*. McGraw-Hill Book Company: New York.

Scott, W.R., 2000. The structuration and destruction of organizations and organizational fields, *Advances in Strategic Management: A Research Annual* **17**:181-185.

Scott, W.R., 2001, *Institutions and organizations*, 2nd edition, Sage publications: Thousand Oaks, CA.

Scott, W.R., 2008, Approaching adulthood: The maturing of institutional theory, *Theory and Society* **37**:427-442.

Scrase, I. and MacKerron, G., 2009. (Eds.), *Energy for the future: A new agenda*, Palgrave Macmillan: New York.

Scrase, I., MacKerron, G., 2009. Lock-in, in Scrase and MacKerron (Eds.), *Energy for the Future: A New Agenda*, Palgrave Macmillan: New York.

Scrase, I., Watson, J., 2009. CCS in the UK: squaring coal use with climate change?, in Meadowcorft, J., Langhelle, O., (eds.), Caching the carbon: The politics and policy of carbon capture and storage, Edward Elgar: Cheltenham.

Sewell, W.H.Jr., 1996. Three temporalities, in: McDonald, T.J. (ed.), *The historic turn in the human sciences*, University of Michigan Press.

Sewell, W.H.Jr., 2005. *Logics of History. Social Theory and Social Transformation*, University of Chicago Press: Chicago.

Sheail, J., 1997. Business and the environment: An inter-war perspective on the federation of British industries, *Contemporary British History* **11**(4):21-41.

Shove, E., Walker, G., 2007. CAUTION! Transitions ahead: politics, practice, and sustainable transition management, *Environment and Planning A* **39**:763-770.

Siggelkow, N., 2007. Persuasion with case studies, *Academy of Management Journal* **50**(1):20-24

Simmonds, G., 2002. *Regulation of the UK electricity industry*, 2002 edition, CRI Industry Brief: Bath.

Sine, W.D., David, R.J., 2003. Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry, *Research Policy* **32**:185-207.

Smil, V., 2003. *Energy at the crossroads: Global perspectives and uncertainties*, MIT Press: London.

Sminia, H. 2009. Process research in strategy formation: Theory, methodology and relevance, *International Journal of Management Reviews* **11**(1):97-125.

Smith, A., 2005. The alternative technology movement: An analysis of its framing and negotiation of technology development, *Human Ecology Review* **12**(2):106-119.

Smith, A., Stirling, A, Berkhout, F., 2005. The governance of sustainable socio-technical transitions, *Research Policy* **34**:1491-1510.

Stern, N., 2007. *The economics of climate change. The Stern Review*, Cambridge university Press: Cambridge.

Stradling, D., Thorsheim, P., 1999. The Smoke of great cities: British and American efforts to control air pollution, 1860-1914, *Environmental History* **4**(1):6-31.

Suchman, M., 1995. Managing legitimacy: strategic and institutional approaches, *Academy of Management Review* **20**:571-610.

Suarez, F.F., Oliva, R., 2005. Environmental change and organizational transformation, *Industrial and Corporate Change* **14**(6):1017-1041.

Summerton, J., 1994. Introductory essay: The systems approach to technological change, in: Summerton, J. (Ed.), *Changing large technical systems*. Westview Press: Boulder.

Sundqvist, G., Letell, M., Lidskog, R., 2002. Science and policy in air pollution abatement strategies, *Environmental Science & Policy* **5**:147-156.

Supple, B. 1987. *The History of the British coal industry, Vol. 4, 1913-1946: The political economy of decline*, Clarendon Press: Oxford.

Supple, B. 1988. The Political economy of demoralization: The tate and the coalmining industry in America and Britain between the wars, *The Economic History Review* **41**(4):566-591.

Surrey, J. and Walker, W., 1975. Energy R&D: A UK perspective, *Energy Policy* **3**(2):90-115.

Sussex Energy Group, 2009. Response to the Department for Energy and Climate Change: ‘A Framework for the development of clean coal: consultation document’, September 9, 2009.

Stenzel, T., Frenzel, A., 2008. Regulating technological change—The strategic reactions of utility companies towards subsidy policies in the German, Spanish and UK electricity markets, *Energy Policy* **36**:2645-2657.

Stern, N., 2007. *The economics of climate change. The Stern Review*, Cambridge university Press: Cambridge.

Sydow, J., Schreyögg, Koch, J., 2009. Organisational path dependence: Opening the black box, *Academy of management review* **34**(4):689-709.

Tarrow, S., 1994. *Power in Movement*, Cambridge University Press: Cambridge.

Taylor, J., 1937. *The smoke menace*, 14 min., black & white, J. Grierson, Realist Film Unit (http://www.screenonline.org.uk/film/id/1290752/)

Taylor, A.J., 1961. Labour productivity and technological innovation in the British coal industry, 1850-1914, *The Economic History Review*, New Series **14**(1):48-70.

Teece, D., Pisano, G. and Shuen, A., 1997. Dynamic capabilities and strategic management, *Strategic Management Journal* **18**(7):509-533.

The Coal Research Forum, 2005. *Coal research and engineering needs in the UK*, A report of the Coal Research Forum and the Coal Utilisation Subject Group of the IChemE.

Thomas, S., 1997. The British market reform: A centralist capitalist approach, in Midttun, A., (ed.), *European electricity systems in transition: A comparative analysis of policy and regulation in Western Europe*, Elsevier.

Thompson, J.K.J., 1998. *Decline in history*, Polity Press.

Thorsheim, P., 2002. The paradox of smokeless fuels: Gas, coke and the environment in Britain, 1813–1949, *Environment and History* **8**:381-401.

Thorsheim, P., 2006. *Inventing pollution: Coal smoke and culture in Britain since 1800*, Ohio University Press: Athens.

Tidd, J., Bessant, J. and Pavitt, K., 2005, *Managing innovation: Integrating technological, market and organizational change*, 3rd edition, John Wiley & Sons Ltd: Chichester.

Tombs, F., 1983. Electricity, in: Ezra, D. (Ed.), *The energy debate*, Benn Technical Books: Croydon

Treasury, 1978. *The nationalised industries*. Cmnd 7131. HMSO: London.

Tripsas, M. and Gavetti, G., 2000. Capabilities, cognition and inertia: Evidence from digital imaging, *Strategic Management Journal* **21**:1147-1161.

True, J.L., Jones, B.D. and Baumgartner, F.R., 1999. Punctuated-equilibrium theory: Explaining stability and change in American policymaking, in: Sabatier, P.A. (ed.), *Theories of the policy process*, Westview Press: Boulder, 97-115

Tsoukas, H., 1989. The validity of idiographic research explanations, *Academy of Management Review* **14**(4):551-561.

Turner, R.L., 1989. *The politics of industry*, Christopher Helm: London.

Turnheim, B., Geels, F., 2011. The destabilisation of existing regimes in socio-technical transitions: Confronting a multi-dimensional framework with a case study of the British coal industry (1914-1970), submitted to *Research Policy*.

Turnheim, B., Tezcan, M., 2010. Complex Governance to Cope with Global Environmental Risk: An Assessment of the United Nations Framework Convention on Climate Change, *Science and Engineering Ethics* **16**:517-533.

Tushman, M. and Anderson, P., 1986. Technological discontinuities and organization environments, *Administrative Science Quarterly* **31**(3):439-465.

Tushman, M.L and E. Romanelli, 1985. Organizational evolution: A metamorphosis model of convergence and reorientation, in: L.L. Cummings & B.M. Staw (eds.), *Research in Organizational Behavior*, Vol. 7, JAI Press: Greenwich, CT, 171-222

UNFCCC, 2011. *Fact sheet: The need for strong global action on climate change*, http://unfccc.int/files/press/backgrounders/application/pdf/fact_sheet_the_need_for_strong_action_on_climate_change.pdf, accessed on 25 May 2011.

Ungar, S., 1992. The rise and (relative) decline of global warming as a social problem, *The sociological quarterly* **33**(4):483-501

Unruh, G.C., 2000. Understanding carbon lock-in, *Energy Policy* **28**(12):817-830.

Unruh, G.C., 2002. Escaping carbon lock-in, *Energy Policy* **30**:317-325.

UNEP, 2011, *Towards a green economy: Pathways to sustainable development and poverty eradication – A synthesis for policy makers*

UN Global Compact, 2010. *Caring for climate: The business leadership platform, a statement by the business leaders in the UN Global Compact*, http://www.unglobalcompact.org/docs/issues_doc/Environment/climate/CARING_FOR_CLIMATE_STATEMENT_2010.pdf, accessed on 23 June 2010.

Utterback, J.M., Acee, H.J., 2005. Disruptive technologies: An expanded view, *International Journal of Innovation Management* **19**(1):1-17.

Utterback, J.M. and Suarez, F.F., 1993. Innovation, competition and industry structure, *Research Policy* **22**(1):1-21.

Van de Ven, A. H., 1992. Suggestions for studying strategy process: A research note, *Strategic Management Journal* **13**:169-188.

Van de Ven, A.H., 1993. A community perspective on the emergence of innovations, *Journal of Engineering and Technology Management* **10**:23-51.

Van de Ven, A.H., 2007. *Engaged scholarship: A guide for organizational and social research*, OUP: New York.

Van de Ven, A.H., Garud, R., 1994. The coevolution of technical and institutional events in the development of an innovation, in: J.A. Baum, Singh, J.V., *Evolutionary Dynamics of Organizations*, Oxford University Press: New York, 425-443.

Van de Ven, A.H. and Poole, M.S., 1995. Explaining development and change in organizations, *Academy of Management Review* **20**(3):510-540.

Van de Ven, A.H. and Poole, M.S., 2005. Alternative approaches for studying organizational change, *Organization Studies* **26**(9):1377-1404.

Van Driel, H., Schot, J., 2005. Radical innovation as a multi-level process: introducing floating grain elevators in the port of Rotterdam, *Technology and Culture* **46**(1):51-76.

Verhees, B., 2012. *Cultural legitimacy and innovation journeys: A new perspective applied to Dutch and British nuclear power.* PhD thesis. Eindhoven University of Technology: Eindhoven.

Volberda, H.W. and Lewin, A.Y., 2003. Co-evolutionary dynamics within and between firms: From evolution to co-evolution, *Journal of Management Studies* **40**(8):2111-2136.

Walker, W., 2000. Entrapment in large technology systems: Institutional commitments and power relations, *Research Policy* **29**(7-8):833-846.

Wartick, S.L., Heugens, P.P.M.A.R, 2003. Future directions for issues management, *Corporate Reputation Review* **6**(1):7-18.

Watson, J., 1997. *Constructing success in the electric power industry: Combined cycle gas turbines and fluidised beds*, DPhil dissertation, SPRU, University of Sussex.

Watson, J., 2005. Advanced Cleaner Coal Technologies for Power Generation: Can they deliver?, Paper for the 2005 BIEE Academic Conference, 22-23 September 2005

Weick, K.E., 1995, *Sensemaking in organizations*, Sage Publications: Thousand Oaks, CA.

Weick, K.E., 2007. The generative properties of richness, *Academy of management journal* **50**(1):14-19.

Weitzel, W. and Jonsson, E., 1989. Decline in organizations: A literature integration and extension, *Administrative Science Quarterly* **34**(1):91-109.

Wheeler, A., 1986. Frontiers and forward – Colliery production and productivity, *The Mining Engineer*.

Whetten, D.A., 1987. Organizational growth and decline processes, *Annual Review of Sociology* **13**:335-358.

Whittington, H.W. and Bellhouse, G.M., 2000. Coal-fired generation in a privatised electricity supply industry, *Electrical Power and Energy Systems* **22**:205-212.

Wiener, M.J., 1982, *English culture and the decline of industrial spirit*, Cambridge University Press: New York.

Williams, T.I., 1981. *A history of the British gas industry*, Oxford University Press: Oxford.

Winskel, M., 2002. When systems are overthrown: The 'dash for gas' in the British electricity supply industry, *Social Studies of Science* **32**(4):563-598.

Winterton, J., 1994. Social and technological characteristics of coal-face work: A temporal and spatial analysis, *Human Relations* **47**(1):89-118.

World Coal Study (Robert P. Greene, J. Michael Gallagher, Carroll L. Wilson), 1980. *Future coal prospects: Country and regional assessments,* Vol. 2, Ballinger Pub. Co.: Cambridge, Massachusetts.

World Wildlife Fund, 2008. Evading Capture. Is the UK power sector ready for carbon capture and storage?, Briefing Paper.

Yin, R. K., 1994. *Case study research: Design and methods*, Thousand Oaks Sage

Zahariadis, N., 1999. Ambiguity, time and multiple streams, in : Sabatier, P.A. (ed.), *Theories of the Policy Process*, Westview Press: Boulder, 73-93.

Zammuto, R.F., 1985. Managing decline: Lessons from the U.S. auto industry', *Administration & Society* **17**(1):71-95.

Zammuto, R.F. and Cameron, K.S., 1985. Environmental decline and organizational response, in: Cummings, L.L. and Staw, B.M. (eds.), *Research in Organizational Behavior*, Vol. 7, JAI Press: Greenwich, CT.

Zyglidopoulos, S.C., 2003. The issue life-cycle: Implications for reputation for social performance and organizational legitimacy, *Corporate Reputation Review* **6**(1):70-81.