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The Destabilisation of the German Electricity Industry (1998-2015)

Application and Extension of a Multi-dimensional Framework

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Abstract

This article aims to explain the rapid destabilisation of the German electricity industry between 1998 and 2015. The longitudinal case study uses analytical categories from a multi-dimensional framework, which emphasises the importance of external pressures on the industry (both techno-economic and socio-political) and firm-level response strategies (technical innovation, economic positioning, cultural framing, corporate political strategies). We also extend the framework by investigating the effects of different kinds and temporal sequence of external pressures, and the role of industry heterogeneity in shaping response strategies. The case study uses a wide range of primary sources (interviews with high-level managers, press releases, annual reports, newspapers) and secondary sources (quantitative statistics, academic articles, books) to develop a comprehensive, multi-dimensional explanation of the destabilisation process.

Zusammenfassung

Dieser Artikel will die rapide Destabilisierung der deutschen Elektrizitätsindustrie im Zeitraum zwischen 1998 und 2015 erklären. Hierfür wird eine multidimensionale Forschungsheuristik – das Triple Embeddedness Framework (Geels 2014) – angelegt, welches die Bedeutung von externen (sozio-politischen und ökonomischen) Veränderungen sowie von Anpassungsstrategien der Unternehmen (technologische Innovationen, Öffentlichkeitsarbeit oder politische Strategien) gleichermaßen in Rechnung stellt. Wir erweitern dieses Framework, indem wir die Rolle verschiedener Arten von externen Veränderungen sowie deren temporale Sequenzen berücksichtigen und außerdem die Rolle von Heterogenität innerhalb einer Industrie untersuchen. Die Fallstudie greift auf einen breiten Fundus an primären Datenquellen (Interviews mit Managern, Pressemitteilungen, Geschäftsberichte, Zeitungsartikel) sowie Sekundärquellen (quantitative Statistiken, wissenschaftliche Artikel und Bücher) zurück, um so eine umfassende, multi-dimensionale Analyse des Destabilisierungsprozesses zu bieten.

Contents

1 Introduction

The German electricity industry experienced major changes in fortune in a short period of time. After liberalisation in 1998, the industry consolidated (resulting in the Big-4: E.ON, RWE, EnBW, Vattenfall), increased its percentage of electricity generation (from 71% in 1998 to 90% in 2004), became a "national champion" in Chancellor Schröder's industrial strategy (expanding on European electricity markets), and saw major share prices increases, between 100 and 200% between 2001 and 2008. Subsequently, however, net profits of the Big-4 nosedived (Figure 1), share prices collapsed (Figure 2), and the Big-4 percentage of electricity generation decreased to 73% in 2014 (Bundesnetzagentur & Bundeskartellamt 2015). These problems led utilities to question their strategy and business models. For instance, EnBW's CEO stated in its 2012 annual report: "I see a paradigm shift in the energy sector that questions the traditional business model of many power supply companies".

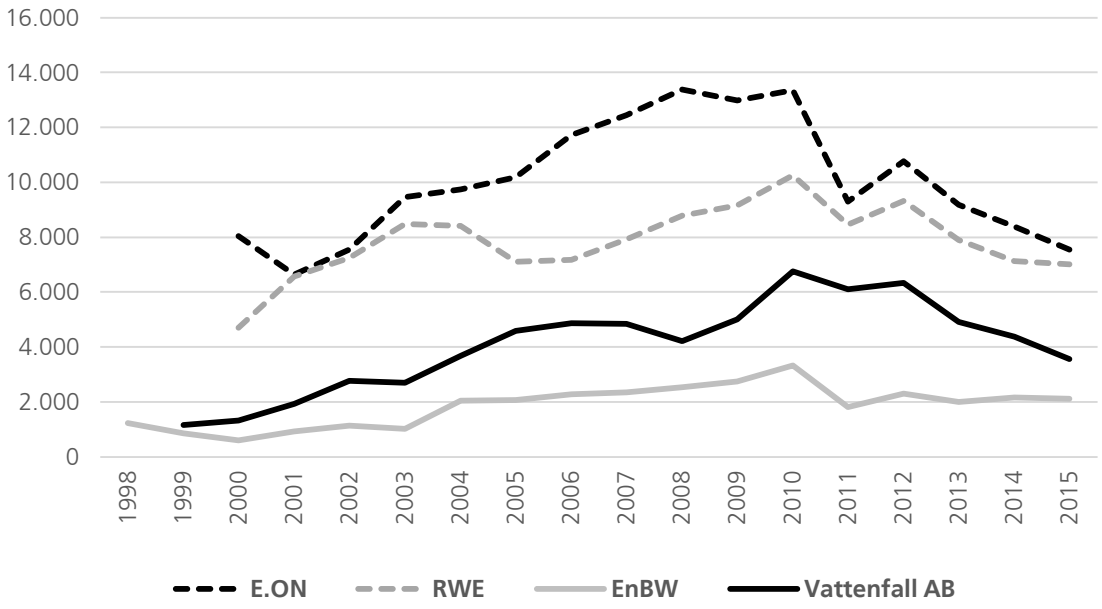

Figure 1: Development of the earnings before interest, taxes, depreciation and amortisation (EBITDA) of the Big-4 utilities, in million euros (Source: Annual reports)[1]

This paper aims to explain this rapid change in fortune and the destabilisation of the 'industry regime', which consists not only of technical knowledge and capabilities, but also of shared mindsets, identity, business models and regulations (Geels 2014). External pressures on the German electricity industry are clearly part of this explanation, e.g. the rise of renewable electricity technologies from 4.7% of electricity gen-

[1] Due to different reporting standards and adjustments over time data is partly incomparable.

eration in 1998 to 30.1% in 2015, the financial-economic crisis in 2008 and 2009, public protests and negative discourses, the Fukushima nuclear accident in 2011 and the German government's decision to phase out nuclear power by 2022.

Figure 2: Share price performance of German electricity companies, normalised by starting date (Source: Finanzen.net)[2]

But endogenous responses to external pressures are also likely to be part of the explanation. These responses include both (mis)interpretations (e.g. underestimation of the threat of renewables and declining reputations) and flawed strategic choices (e.g. expensive European take-overs in the mid-2000s and decisions to build many new coal-fired power plants).

The empirical challenge is to investigate how the interactions between external pressures and endogenous responses resulted in destabilisation of a previously very powerful industry. To guide the empirical analysis, we adopt a multi-dimensional analytical perspective developed by Turnheim and Geels (2012, 2013) to understand the destabilisation of industry regimes. This perspective builds on the Triple Embeddedness Framework, TEF (Geels 2014), which distinguishes not only *techno-economic* pressures on industries (e.g. new entrants, new technologies, market developments), which are commonly distinguished in industrial and evolutionary economics (Porter 1980; Nelson & Winter 1982), but also *socio-political* pressures (from policymakers, civil society, social movements), which are commonly used in neo-institutional theo-

[2] Vattenfall is not included because it is a Swedish state-owned company.

ries (Powell & DiMaggio 1991; Scott 1995). The Triple Embeddedness Framework also suggests that firms-in-industries use multiple strategies to respond to environmental pressures, including economic positioning strategies, innovation strategies, corporate political strategies, and framing strategies. These strategies are shaped by a broader industry regime which enables and constrains firm-level activities (Figure 3).

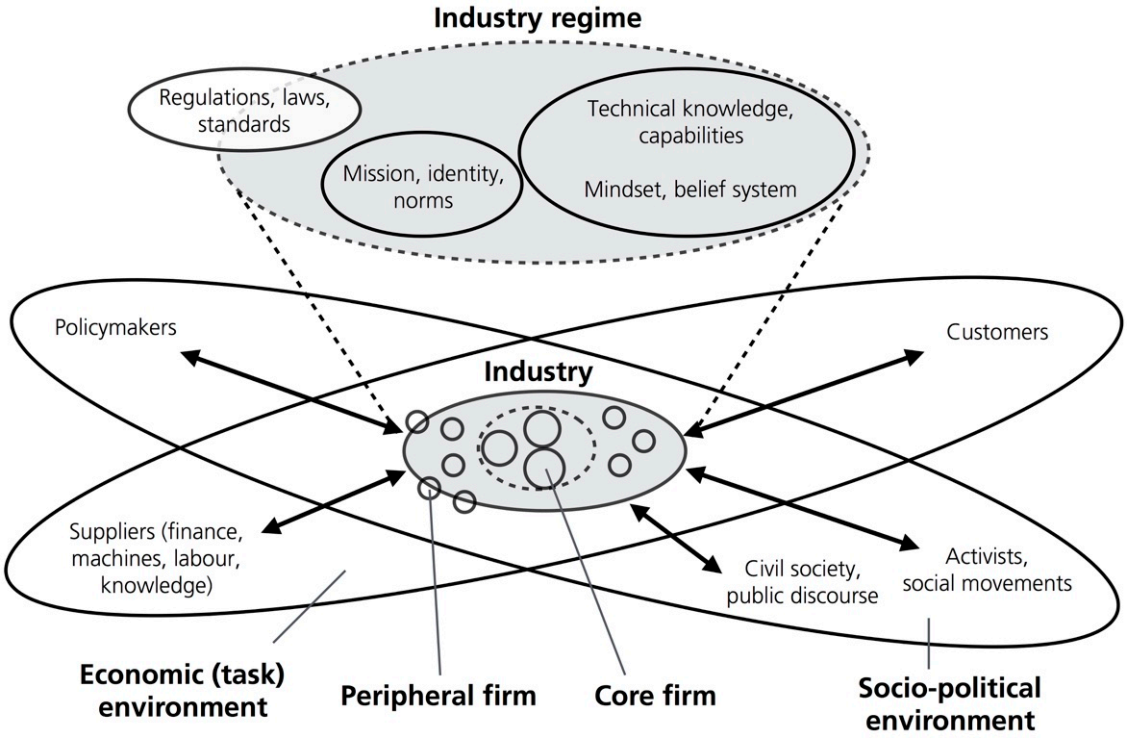

Figure 3: Triple embeddedness framework of firms-in-industries (Geels 2014, 266)

Building on the TEF, Turnheim and Geels (2013) suggested that destabilisation of industry regimes entails interactions between three processes:

1) Increase of external (techno-economic and/or socio-political) pressures, which cause economic and/or legitimacy problems for firms-in-an-industry.
2) The implementation of defensive strategic responses to stem the problems and moderate external pressures.
3) Weakening commitment of firms to industry regimes and reorientation towards alternative technologies, business models, mission and mindsets. This reorientation is often stimulated by exacerbating performance problems if earlier responses prove to be flawed or insufficient to address increasing external pressures. Reorientation may be 'too little, too late', in which case firms-in-an-industry decline further.

This industry destabilisation framework has only been illustrated with two historical case studies of the UK coal industry between 1913 and 1967 (Turnheim & Geels 2013) and between 1967 and 1997 (Turnheim & Geels 2012). One contribution of this paper is therefore to confront the framework with a more contemporary case study. We also use the specificities of the case to elaborate the framework in three ways. First, building on Suarez and Oliva (2005), we will address the roles of *different kinds* of external pressures in destabilisation processes, focusing on 'specific shocks' and gradually building 'disruptive pressures'. Second, we propose that the *temporal sequence* of external pressures is important and may lead to different destabilisation patterns. Third, we pay more attention to the *heterogeneity* between firms-in-an-industry, which may lead to (somewhat) different response strategies.

The paper is structured as follows. *Section 2* briefly discusses extant literatures on industry destabilisation and their integration in a multi-dimensional framework. This section also elaborates the three extensions mentioned above. *Section 3* discusses methods, data-sources and the demarcation of case study periods. *Section 4* presents a longitudinal case study of the German electricity industry, which is guided by the analytical categories from the conceptual framework. *Section 5* analyses the case and section 6 concludes the paper.

2 Conceptual framework and elaborations

The Turnheim and Geels (2013) framework accommodates three views on destabilisation from different literatures. The first view, which can be found in economic history, evolutionary and industrial economics (Lazonick 1983; Hoerr 1988; Lorenz 1994), focuses on industrial decline in the economic (task) environment. Much of this literature highlights the role of economic pressures (e.g. shrinking markets, changing consumer preferences, new entrants, technical substitutes) and the difficulty of industries to adapt, because of various lock-in mechanisms (e.g. organisational inertia, technical capabilities). Some scholars also mention the role of political institutions, which protected an industry for too long, thus delaying adjustment until it was too late (Brainard & Verdier 1997).

The second view, which can be found in sociological and neo-institutional literatures, focuses on de-legitimation and de-institutionalisation of industries in socio-political environments. These literatures highlight pressures from activists and social movements (Hiatt et al. 2009), public debates and discourses (Maguire & Hardy 2009) and policymakers (Lehrman 1994; Sine & David 2003), which may lead industry actors to question elements of industry regimes and shift to new missions and mind-sets.

The third view, which can be found in management and organisation theories, focuses on the decline of organisations resulting from unsuccessful adaptation to external pressures. This literature makes several points. First, it understands decline as a longitudinal process, consisting of several stages. Weitzel and Jonsson (1989), for instance, distinguish five stages: 'blinded', 'inaction', 'faulty action', 'crisis', and 'dissolution'. Hambrick and D'Aveni (1988) distinguish three phases: early weaknesses in slack and performance, extreme and vacillating strategic actions, and abrupt environmental decline. Collins (2009) proposes five stages (Figure 4) and suggests that earlier phases sow the seeds for later failure (e.g. via hubris and complacency).

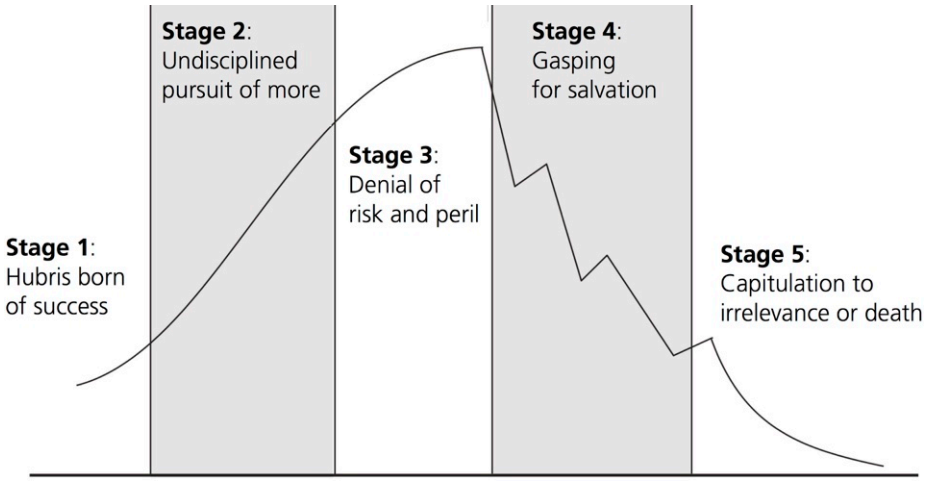

Figure 4: The five stages of decline (Collins 2009, 20)

Second, firms often postpone adaptation of core organisational elements for too long. This reluctance to change is due to path dependence and lock-in effects: core capabilities may become core rigidities (Leonard-Barton 1992); established mind-sets may hinder firms in their interpretation of external developments (Ocasio 1997); norms and identities may leads to strong views about what is appropriate (Dutton & Dukerich 1991). Third, organisations often require an external shock or crisis to overcome the lock-in mechanism. Shocks or crises may stimulate managers to recognise the seriousness of the problems and "help management break out of its response routines" (Gopinath 2005, 23). Fourth, there is unlikely to be one pattern of decline. Based on several company studies, Collins (2009, 19) concludes that "there are more ways to fail than to become great". So, instead of focusing on the precise number of phases, it seems better to use a versatile framework with multiple processes and causal mechanisms that can combine in various ways to produce different destabilisation patterns.

The Turnheim/Geels perspective offers such a versatile framework, which accommodates core aspects from the three views discussed above: techno-economic or socio-political pressures from industry environments and firm-level responses to these pressures. With regard to the former, it is important to recognise that firms-in-an-industry face *multiple* external pressures at the same time, which may point in different directions and increase or decrease at different rates. Based on their case study, Turnheim and Geels (2013, 1765) therefore recommend that: "one should analyse the ebb and flow of external pressures rather than assuming linear increase". With regard to responses, Geels (2014) suggests these can be divided into:

- externally-oriented responses towards environments ('horizontal' responses in Figure 3); examples are economic positioning strategies, corporate political strategies, and framing strategies.
- internally-oriented actions to change core organisational characteristics and regime elements ('vertical' responses in Figure 3); examples are the development of new technical capabilities and changes in beliefs and identities through second-order learning (Argris 1976).

Turnheim and Geels (2013) suggest that firms-in-industries initially tend to respond to external pressures with *externally-oriented* strategies that aim to defend existing industry regimes; these responses do not entail changes in core characteristics. It often takes mounting external pressures, and sometimes a crisis, for firms to seriously implement *internally-oriented* changes in technology, marketing strategies, beliefs and mission, which means abandoning the established industry regime. To capture the gradual shift from externally-oriented (defensive) strategies to internally-oriented reorientation, Turnheim and Geels (2013) distinguish four specific phases in response strategies: a) initial retrenchment (cost cutting, tighter control), b) local search and incremental innovation, c) more distant search and exploration of technical alternatives, d) questioning of core beliefs, mission and business models. This phase-model, like the proposals above, implicitly assumes that there is *one* increasing external pressure to which firms respond with increasingly comprehensive changes in core characteristics. This assumption may be incorrect for destabilisation processes, especially when firms-in-an-industry face *multiple* external pressures that increase or decrease at different rates. In that case, one would expect firms to enact multiple strategic responses which may not all move synchronously through a simple phase-model. This reinforces the point, made above, that there may be different patterns (and phases) in the ways firms respond to external pressures.

We will apply this multi-dimensional framework to analyse the developments in the German electricity industry. But we also aim to use the case to explore three elaborations. The first elaboration concerns the role of *different kinds* of external pressures

in destabilisation. Suarez and Oliva (2005) distinguish five kinds of environmental change, based on different combinations of four dimensions: 1) frequency: number of environmental disturbances per unit of time, 2) amplitude: magnitude of deviation from initial conditions caused by a disturbance, 3) speed: rate of change of disturbance, 4) scope: number of environmental dimensions that are affected by simultaneous disturbances. They combine these four attributes into five types of environmental change (Table 1).

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**

Table 1: Attributes of change and resulting typology (Suarez & Oliva 2005, 1022)

The last three environmental changes in table 1 seem most relevant for destabilisation, because of their 'amplitude'. *Specific shock* corresponds to environmental changes that are rapid and high in intensity, and are relatively narrow in scope. *Disruptive change* corresponds to changes that occur infrequently, develop gradually, but have a high-intensity effect in one dimension. *Avalanche change* occurs very infrequently, but is of high intensity, of high speed, and simultaneously affects multiple dimensions of the environment. Our specific proposition is that 'specific shocks' and 'avalanche change' will attract more attention from industry actors than 'disruptive change', because of their high speed and immediately noticeable effect. This means that industry actors are more likely to mis-interpret or underestimate the latter, which creates special vulnerabilities.

The second elaboration concerns the *temporal sequence* of external pressures. Most of the literature on environmental jolts and radical environmental change (Meyer et al. 1990; Keister 2002; Sine & David 2003) focuses on *single* pressures. In the TEF, however, firms-in-industries may face *multiple* environmental pressures. Turnheim and Geels (2013) already emphasised the importance of *alignments* between external pressures. We here propose that particular *sequences* of pressures may also be important for destabilisation processes. Our intuition is that the Fukushima accident may have acted as a 'killer blow' because preceding pressures (e.g. financial crisis, renew-

ables competition, declining public image) had already eroded the German electricity industry.

The third elaboration concerns heterogeneity within industries. While the concept of 'industry regime' focuses on high-level similarities and shared characteristics, this does not mean that firms-in-an-industry are entirely similar and implement the same strategies. We propose that differences between firms (e.g. in assets, ownership structures, specific capabilities, and economic positions) may influence response strategies to external pressures and, consequently, destabilisation processes.

3 Methods and data sources

We will analyse the destabilisation of the German electricity industry, using the framework described above. Since most phase-models suggest that seeds for destabilisation are sown early on, we use a longitudinal case study design, starting in 1998 when liberalisation of the electricity sector heralded the start of a new period. We have divided the case into four sub-periods, based on qualitative considerations (important policies and external shocks) and quantitative time series trends (especially EBITDA, averaged stock price performance, and wholesale electricity price), represented in Figure 5. For the first period (1998-2005) all proxies (beside stock price performance) indicate an upward trend. Upwards trends (in share price, electricity price, EBITDA) continue in the second period (2005-2008), but several policies indicate a shift (emission trading and cartel restrictions in 2005). Starting with the economic crisis, from phase three on (2008-2011) these trends reverse: electricity prices decrease, demand fluctuates and share prices collapses. Phase four (2011-2015), which starts with the nuclear disaster of Fukushima is characterised by a further downward trend at all levels.

Our case study offers an in-depth description of these four periods, which is guided by the analytical categories of the conceptual framework. For each period we first describe pressures in task and institutional environments (policy; social movement and protests; public attention; markets; new entrants; technical alternatives) and then industry response strategies (economic positioning, technical innovation strategies, political and framing strategies). We end each period with a brief summary and a 'spillover figure', which is a representational technique we borrow from Turnheim and Geels (2013, 1765) to synthetically represent how "technical, economic, political and cultural pressures influence each other in longer interaction chains and cascading dynamics."

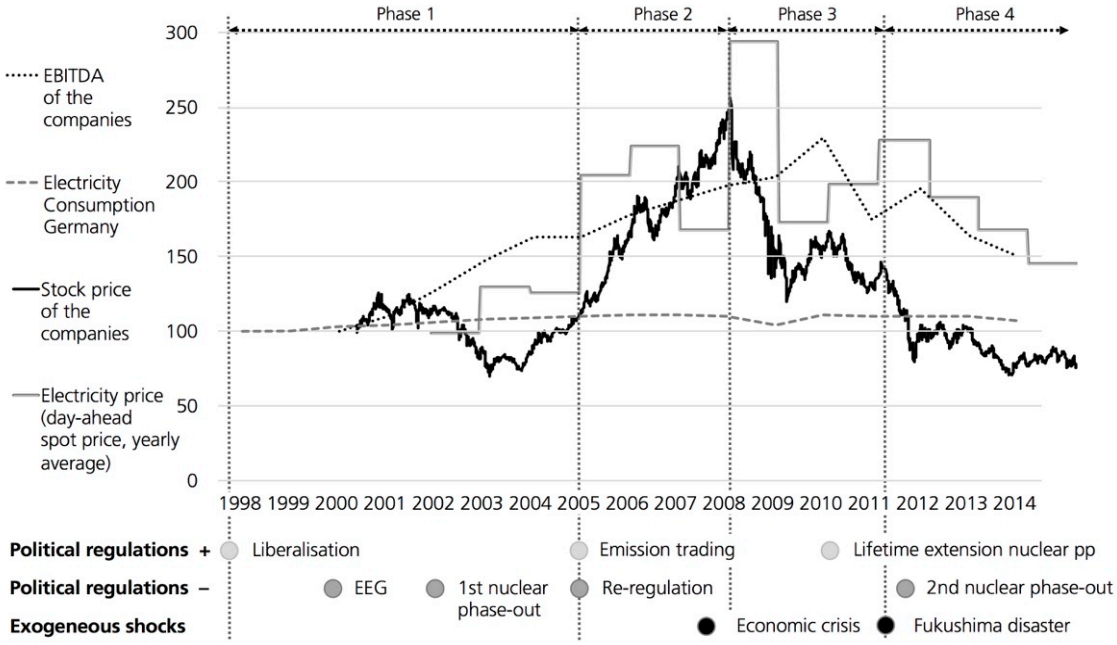

Figure 5: Phases of decline based on proxy variables. Quantitative data normalised by starting date (Sources: Reports by the companies, BDEW, finanzen.net, energinet.dk).

The case description of external pressures is largely based on secondary sources (academic books, articles). The description of industry responses draws on a wide range of primary sources: annual reports, company press reports, reports from business journals and a variety of daily newspapers (to ensure coverage of different political positions).[3] Documents were collected from online archives, searching for the companies' names, and analysed with the qualitative content analysis method by Gläser and Laudel (2009). The documents were coded along a category system which was derived from the theoretical framework and was subject to constant adjustment. For coding, we used the data analysis software MAXQDA. Extracted data were processed using Excel. The final data sheets organise the data by source, category, company and date, which enabled quick search for any issue. We analysed 2548 documents with this procedure: 365 company reports, 715 newspaper articles, and 1468 documents from business journals.

The description of response strategies also draws on information from 22 expert interviews, conducted between August 2013 and August 2015. Twenty interviews were with managers from the respective companies and two with representatives of companies' shareholders. Fourteen interviews were conducted face-to-face, eight via tel-

[3] The selected daily newspapers were: Süddeutsche Zeitung, Westdeutsche Allgemeine, Frankfurter Allgemeine, Die Zeit, Der Spiegel, Die Welt. Additionally we used the biggest economic newspaper in Germany: Handelsblatt. We also gathered articles via the newspaper search machine Paperball.

ephone. All interviews, except four, were recorded. Interviewees were selected to span different companies and a range of areas: corporate development, trade, sales, market analysis, transmission grids, distribution grids, research and development, generation, public affairs, public relations and municipal relations. We interviewed both present and former employees, who had worked at the companies for a long time. The appendix provides anonymised information about the interviewees.

4 Case study

4.1 Politically supported concentration, expansion and growth (1998-2005)

Pressures in task and institutional environment

Policy

The 1998 election of a Red-Green government coalition heralded several fundamental policy changes in the German electricity supply system. These changes resulted from compromises between the Social Democrats (SPD), which traditionally supported the power industry (and coal interests), and the Green Party, which wanted to phase-out nuclear power and support renewable energy technologies (RETs).

First, following an EU market directive, the electricity supply industry was liberalised in 1998. This policy disbanded the former regional monopolies, and scrapped state control over investments and electricity prices. However, the law abstained from regulating third party grid access and implementing strict unbundling rules. The big utilities thus continued to operate the transmission grids and controlled the largest parts of the distribution grid. This gave the utilities a complete overview of the market, because grid operators had to be informed on any new power plant constructions. As it a former E.ON manager put it: "In Germany nothing happened without the company knowing about it" (E.ON interview 4). So, although market was legally open, competition remained limited due to the incumbents' strategies and historic ownership interlocks (Becker 2011). The increasing market power of the big utilities (including mergers) was politically supported because of Chancellor Schröder's goal to create "national champions" that could compete on European electricity markets (Lobo 2011).

Second, the federal government and the utilities reached an agreement on the future of nuclear power (the 2000 "Atomkonsens"), which was institutionalised in the revised Nuclear Energy Act 2002. This policy banned the construction of new nuclear power plants and limited the running time of existing plants to 32 years on average from the date of commissioning.

Third, the Red-Green government published a climate protection program in 2000, which aimed for 25% CO2-reduction by 2005 (compared to 1990) and 10% renewable electricity in 2010. In 2002, the climate change target was confirmed, while the renewable electricity target was increased to 12.5% by 2010 and 60% in 2050 (Jacobsson & Lauber 2006). Even optimistic experts thought this target was rather ambitious (Lobo 2011). The Renewable Energy Sources Act (EEG), introduced in 2000, was a crucial policy instrument, which obliged grid operators to prioritise renewable energy on the grid and provided attractive, long-term (20 years), technology-specific remuneration rates for electricity generated from renewable sources (Jacobsson & Lauber 2006).

Social movements and protests

The anti-nuclear movement, which was quite strong in Germany, especially since the 1986 Chernobyl accident, expressed concerns about the long-term character of the 2002 nuclear phase-out policy: they feared that the decision could be reversed by future governments before nuclear plants would be switched off (Roose 2010).

Public attention

In the 1980s, the German anti-nuclear movement articulated a discourse of nuclear power as a potentially catastrophic threat (Hermwille 2016). This discourse co-existed with the dominant policy discourse, which framed nuclear power as a reliable base-load power source. The 1998 election of the Red-Green government and the negotiations about nuclear phase-out reignited public attention for nuclear power (Bohn & Walgenbach 2016).

Markets

Electricity demand in most sectors steadily increased during this period (Figure 6).

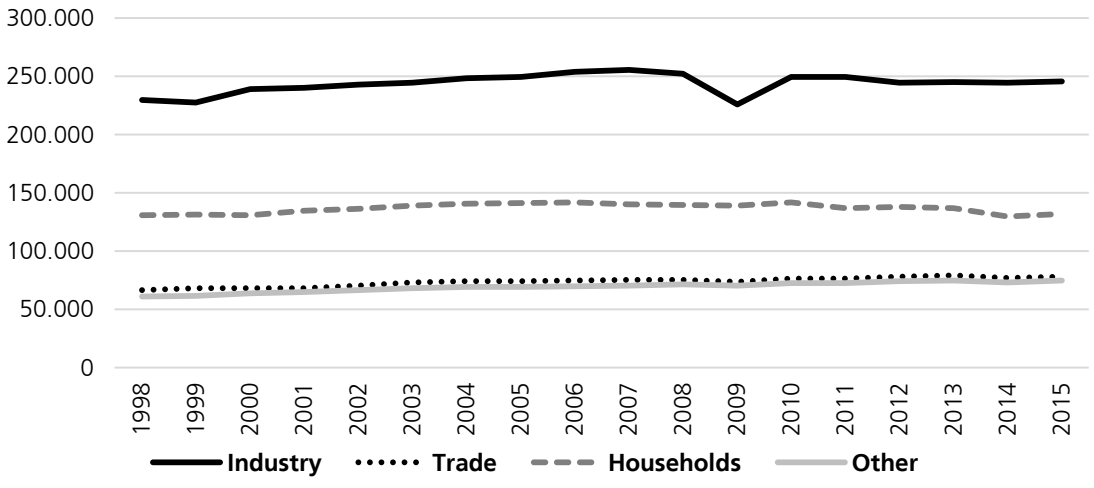

Figure 6: Net electricity consumption (in GWh) in Germany (Source: BDEW)

New entrants and technical alternatives

The EEG improved grid access for new entrants (e.g. farmers, activists), which enabled a 'social opening up' of the electricity sector, including the creation of new associations that helped professionalise the renewables sector (Mautz et al. 2008). The EEG also stimulated renewable electricity production, which increased from 26.3 TWh in 1998 to 56.6 TWh in 2004. The expansion mainly came from onshore wind (which rose from 4.5 TWh to 25.5 TWh) and biomass (which rose from 1.1 TWh to 8.2 TWh). These developments were initially underestimated by the utilities as an interviewee regretfully expressed: "we realised much too late what kind of momentum it had behind it" (RWE interview 5).

Industry response strategies

Economic positioning strategies

Before 1998, the German electricity sector had a three-layered structure: 1) Eight vertically integrated *utilities* (RWE, VEW, Preussenelektra, HEW, EnBW, Bayernwerk, VEAG and Bewag), which produced the bulk of the German electricity, owned transmission grids, and controlled several regional and municipal utilities; 2) About 70 *regional suppliers*, which mainly served as distributors, although some also produced electricity (about 9%); 3) A heterogeneous block of about 900 *municipal utilities*, which mainly acted as distributors, although some also produced power (about 11%) (Latkovic 2000). Liberalisation created many economic opportunities for the utilities, which they exploited with the following strategies:

- *Mergers and take-overs* led the creation of the Big-4 utilities. E.ON and RWE became the biggest companies with the largest sales (Figure 7). Although competition between the companies initially led to decreasing electricity prices for end-consumers, this trend reversed by the end of this period (Becker 2011).

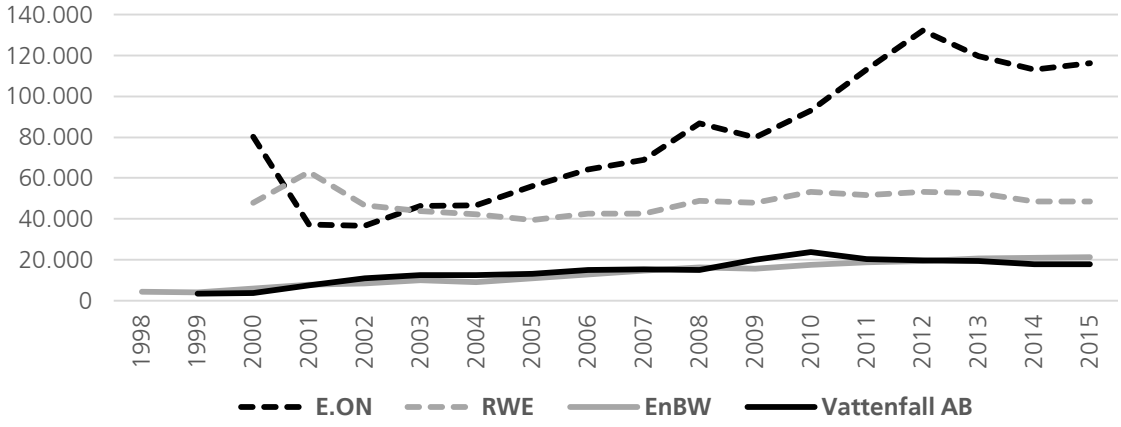

Figure 7: External sales (in million euro) of the Big-4 utilities (Source: Annual reports)

- Utilities (except Vattenfall) also *expanded regionally* via take-overs and purchasing majority shares in municipal utilities. Cartel authorities stopped these regional strategies of RWE and E.ON, because of market power concerns. Cartel authorities focused less on EnBW, however, which continued its regional expansion strategy (Becker 2011).
- Because RWE and E.ON faced domestic cartel restrictions, they pursued *European and global expansion strategies*. EnBW remained focused on Germany, because of smaller financial scope for large take-overs and because Electricité de France, which owned a significant part of EnBW shares (34% in 2002), hindered EnBW expansion into markets they were themselves interested in.
- The German utilities also *expanded in other energy markets* such as gas (Bontrup & Marquardt 2011). Vattenfall engaged in heat supply, while RWE expanded into global water supply (a market they later abandoned).
- Companies also divested non-energy activities, which generated resources to finance the other expansion strategies. Especially, RWE and E.ON, which were multi-industry concerns before liberalisation, sold activities in areas like chemicals, telecommunication and logistics.

Technical innovation strategies

Companies significantly decreased R&D expenditures because they sold R&D intensive units (e.g. chemicals, print). Between 2000 and 2004 RWE reduced R&D expenditures from 505 to 114 million euro; E.ON reduced expenditures from 661 to 55 million euro (based on data from annual reports). Energy-related R&D mainly consisted of applied research (pilot projects, test plants), focused on efficiency improvement of conventional power plants. Utilities also dedicated smaller research efforts to fuel cells, CO2-reduction, and 'smart home' technologies.

Corporate political strategies

The utilities negotiated with the government about the specifics of the nuclear phase-out decision, exploiting dissent between the SPD and Greens (Lobo 2011). The result (average running time of 32 years before shut-down) was closer to the utility demands (40 years) than to Green Party's demands (below 20 years) (Mez 2001).

While utilities oriented most efforts towards the nuclear phase-out, they also dedicated some political activity to opposing the EEG. For example, the industry association VDEW called for limitations to the feed-in priority for renewable energies. It also demanded that back-up capacity, which was needed to mitigate the volatility of wind power, would be financed through the EEG (VDEW et al. 2003). The utilities were unable, however, to create an entirely closed industry front. The utility PreussenElektra, for instance, supported the EEG, before it became part of E.ON. And EnBW

expressed some support for the 2004 EEG-adjustments as they hoped to receive remuneration for large scale hydro power plants (Hirschl 2008).

Framing strategies

The utilities strongly engaged in public debates, arguing that a nuclear phase-out was not realistic, would create energy security risks and job losses, and contradicted the goals of the Energy Industry Act to provide secure, cheap and environmentally friendly energy (Bohn & Walgenbach 2016).

With regard to the EEG, utilities emphasised high costs and contradictions with liberal market policies. RWE, for instance, argued in their 2000 annual report that the EEG would "lead to the construction of new capacities in a stagnating market. Additionally a significant part of the liberalised market is again decoupled from competition."

Summary

Politically-supported liberalisation created economic opportunities for utilities, which consolidated, increased their market power, and expanded on the European level. The utilities used most of their political capital to negotiate the design of the nuclear phase-out. They paid somewhat less attention to opposing the EEG, which created entry points for renewable energy technologies (RETs) and new entrants. Figure 8 schematically summarises the main developments.

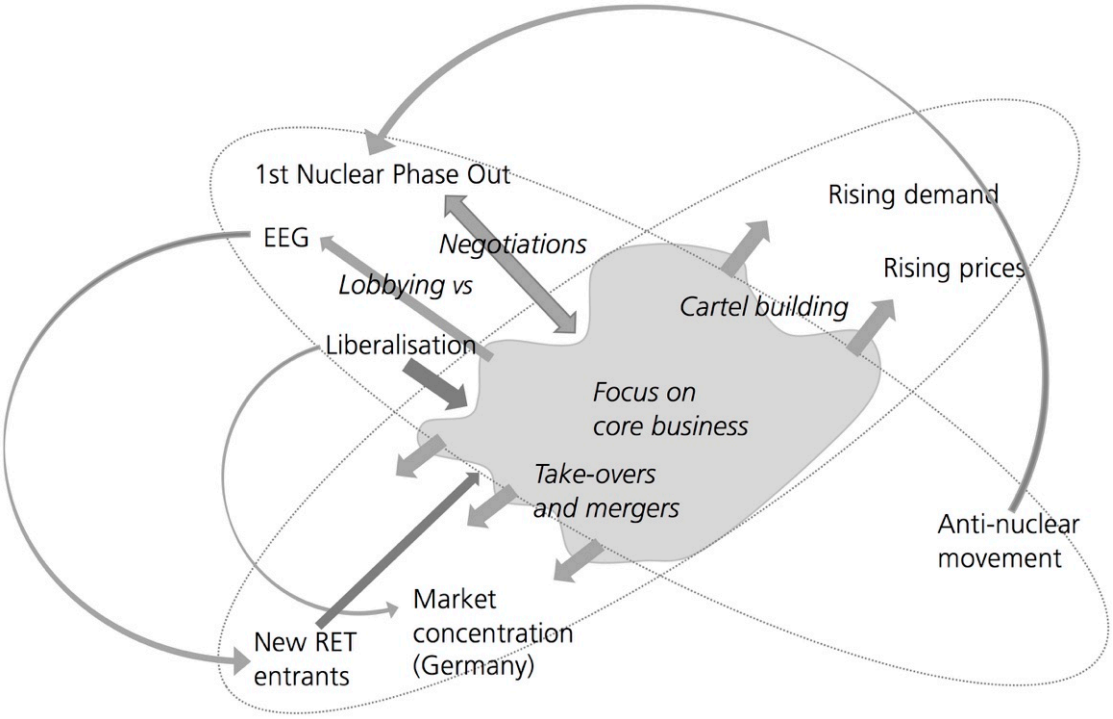

Figure 8: Multi-dimensional pressures, responses and spillovers (1998-2005)

4.2 Positive economic developments and windfall profits despite rising restrictions (2005-2008)

Pressures in task and institutional environment

Policy

The 2005 elections replaced the Red-Green government with a grand coalition of Social Democrats and Conservatives, headed by Chancellor Merkel. Despite some dissent within the Conservative Party, the government coalition continued the previous policies on the EEG and nuclear phase-out (Lauber & Jacobsson 2016).

One new policy was the second amendment to the Energy Industry Act (EnWG), which, in 2005, tightened the unbundling rules for transmission and distribution businesses and regulated third party grid access to facilitate competition (Bontrup & Marquardt 2011).

Another new policy was the national implementation of the European emission trading scheme. In the first trading period (2005-2007), 95% of emission certificates were given to power plant operators for free (Lobo 2011). The companies priced these certificates in as opportunity costs, which led to increasing electricity prices and windfall profits for the companies (see below).

The two biggest utilities (RWE and E.ON) faced increasing criticisms (e.g. from cartel authorities) about excessive market power and market manipulation. In 2007, the European Commission to mandate a sector inquiry, because of suspicions that E.ON, between 2002 and 2007, had manipulated prices at the stock exchange by holding back production capacity. The commission seized documents from E.ON's offices and also investigated market manipulation by the Big-4. Investigations were halted in 2009 when the commission reached a compromise with the utilities[4] (Becker 2011).

Social movements and protests

Local protests erupted in response to company plans to build a raft of new coal-fired power plants (see below). These protests did not gain huge public traction, however, because of comparatively high acceptance of coal in Germany (European Commission 2007) and strong economic dependence of certain regions.

Public attention

The public image of electricity utilities, compared to other economic sectors, decreased considerably in this period (Figure 9). This was due to negative public debates about cartels, abuse of market power and accusations that energy suppliers over-charged consumers.

[4] To stop the investigations (which could lead to penalties of billions of euros), E.ON agreed to sell its transmission grid and about 5.000 MW of production capacities in Germany.

Public attention to climate change and renewables increased in this period. The German public strongly supported renewables, as indicated by successive surveys by the environmental ministry (BMU 2002; 2004; 2006; 2008; 2010). Nuclear power also returned to public debates, because the utilities increased their lobbying activities to influence the new government (Bohn & Walgenbach 2016).

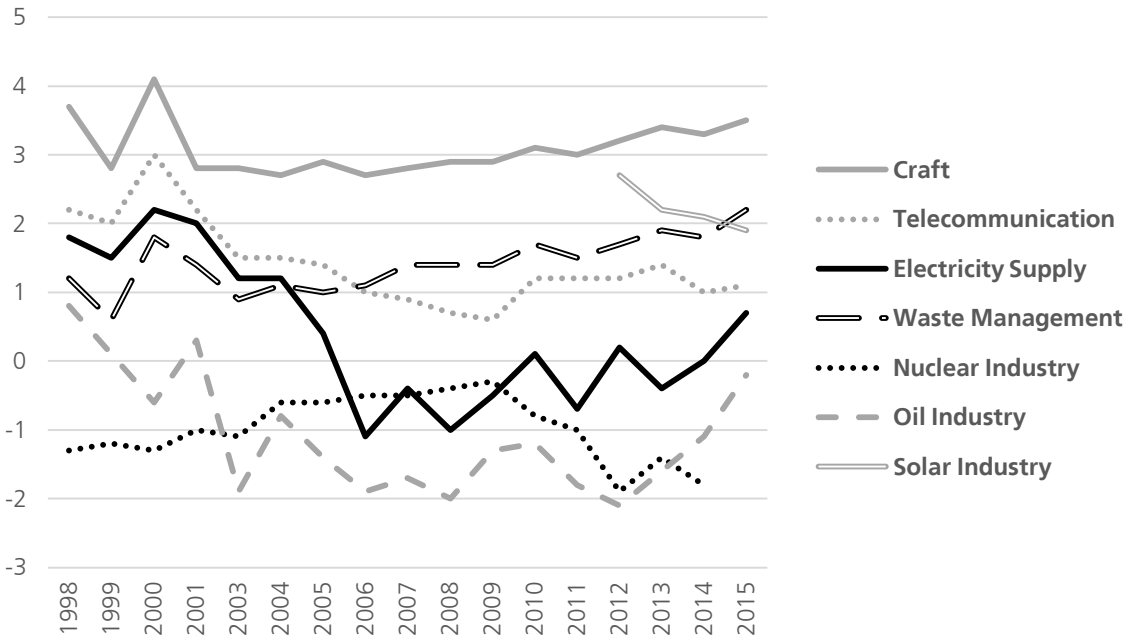

Figure 9: Development of the public image of different industries: From -3 (very bad) to +5 (very good) (Source: BDEW 2015)

Technical alternatives and new entrants

Renewable electricity rapidly increased from 56.6 TWh in 2004 to 88.3 TWh in 2007. The 2002 target of 12.5% renewable electricity by 2010 was already met in 2007 (Figure 10). So, RETs not only expanded faster than initially anticipated, but also took market shares from existing technologies (Figure 10).

Financial support from the 2004 EEG amendment attracted more new entrants such as farmers (which engaged in biogas production and installed wind turbines), households (which installed small rooftop solar-PV) and project developers, which installed large solar-PV installations (Mautz et al. 2008).

Markets

Electricity demand continued to increase gradually in this period (Figure 6). Electricity prices also increased (Figure 11), because of possible rigging, priced-in emission certificates, and rising commodity prices (Figure 12).

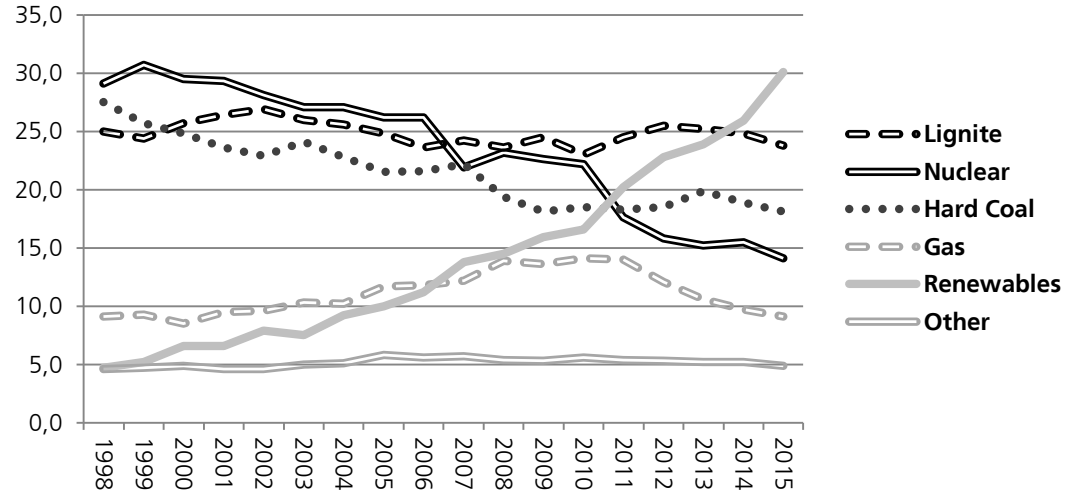

Figure 10: Relative fuel contributions (in %) to German electricity production (Data: AG Energiebilanzen)

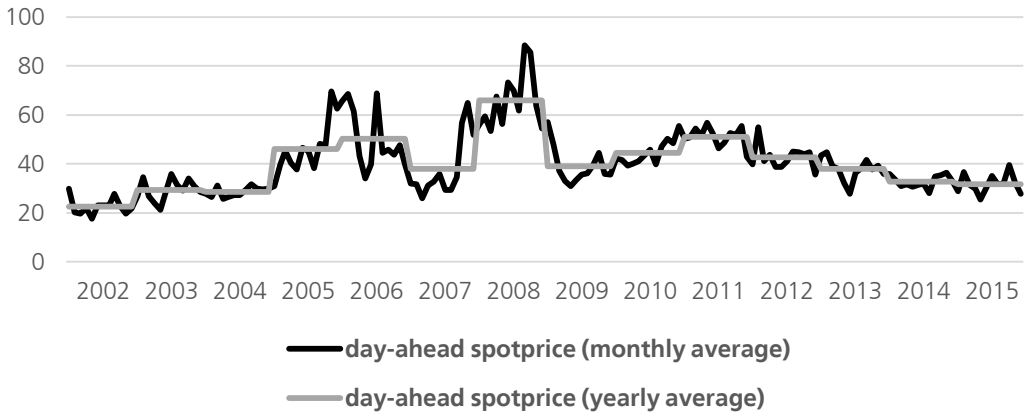

Figure 11: Development of day-ahead spot price for electricity (EUR/MWh). DE European power exchange (Source: Energinet.dk)

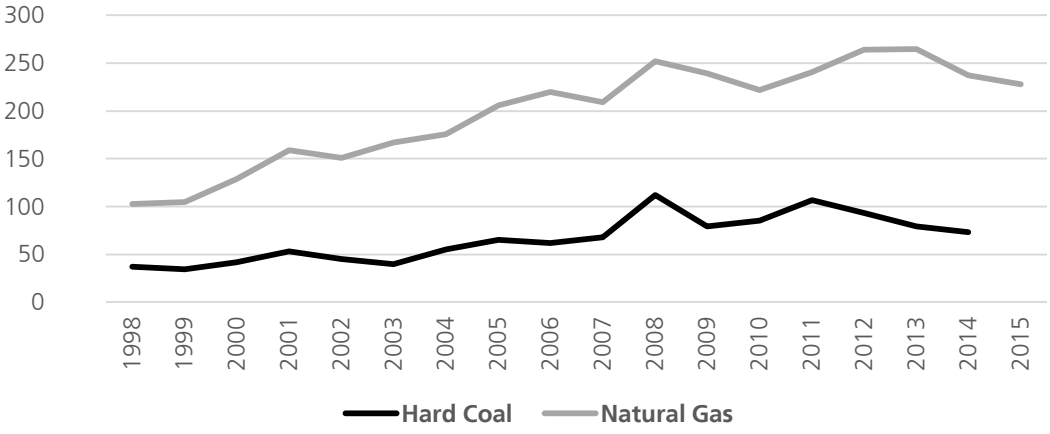

Figure 12: Development of import prices (in Euro/t SKE) (Data: Kohlewirtschaft e.V.)

Industry response strategies

Corporate political strategies

Utilities initially opposed the emissions trading scheme. They changed tack, however, when they realised the scheme offered commercial opportunities, as an interviewee noted: "At one point during internal discussion someone suggested: 'Think about it: this could very well become an extremely interesting business model, because we will just pass this on to the customers by adjusting the electricity prices'" (E.ON interview 4). There were differences in company strategies, however. RWE and Vattenfall, which had many lignite power plants, lobbied aggressively for the highest possible allocation of free emission certificates. EnBW and E.ON, which had less CO2 intensive power plants, tried to reduce the benefits of their competitors (Lobo 2011). The windfall profits could be large. Cludius and Hermann (2014) estimate the value of the free certificates for the first ETS-phase (2005-2007) at over nine billion Euro. This led one RWE manager to state that: "Then the golden era began, namely the era of emissions trading" (RWE interview 4).

The utilities, except EnBW, also oriented political strategies towards the 2005 EnWG amendment. The opposition, however, had limited effects because the SPD (which had often supported the utilities) was weakened after the 2005 elections, because anti-trust litigations eroded their reputation and credibility, and because lack of competition (see above) showed that legally binding rules were necessary (Lobo 2011).

Political strategies also targeted renewable energy, but this was not a priority issue. The industry association (VDEW 2005) proposed an "integration model" of renewable energies that would replace feed-in tariffs with a quota model, which would offer greater predictability of RET-expansion and better integration with regard to existing plants.

Framing strategies

Utilities started to acknowledge climate change as an important issue. But they argued that renewables were not the best mitigation option, because of high costs and the inability to provide base-load power. Instead, they claimed that nuclear power was crucial for reaching climate targets cheaply and reliably (Bohn & Walgenbach 2016). They also pointed to efficiency improvements in fossil fuel plants and flagged the possibility of carbon capture and storage (CCS).

Economic positioning strategies

Rising electricity prices (Figure 11) boosted the profitability of power plants with low marginal costs such as lignite and nuclear power (RWE interview 4). Combined with windfall profits from emissions trading, utilities experienced substantial growth

in net profits (Figure 1) in this period. "So, one had tailwind in all areas, in all operational areas" (E.ON interview 4).

These positive financial developments trumped concerns about renewable electricity or declining public reputations. They also stimulated a search for further expansion. Growth at the European level offered less opportunities, however, as Vattenfall noted in their 2006s annual report: "Opportunities to make major acquisitions have decreased in pace with a declining number of possible takeover candidates in relevant markets in Europe, which is driving up prices." Despite the limited opportunities and high prices, shareholders exerted pressure on managers to use the surplus money for take-overs (especially at E.ON and RWE). In 2006, E.ON made a take-over bid on the Spanish utility Endesa (for roughly 40 billion Euro), which was impeded by the Spanish government. To please institutional investors an agreement was reached that E.ON would take over parts of Endesa, especially assets in France, Italy and Spain, which a former manager later referred to as being "anything but high performers" (E.ON interview 4). Another former manager referred to this period as "expansion at highest prices" (E.ON interview 5).

Utilities also pursued an organic growth strategy, investing in new assets such as fossil power plants. This strategy was underpinned by expectations of future demand growth and a need for new production capacities, as well as the availability of financial surpluses. They were also optimistic about the feasibility of CCS and underestimated the growth of renewables, as an interviewee admitted: "In 2007 the entire board – myself included – was convinced that it would take a long, long, long time before the era of renewables would arrive. We thought there would definitely be another generation of large power stations before renewables got off the ground" (RWE interview 5). So, between 2005 and 2008, companies decided to build several new power plants (Table 2), which (for different reasons) were not all realised.

Towards the end of this period, utilities also explored renewable energy as a possible business area. "I think the real breakthrough for the large companies came with offshore wind farms, where you could also do a few megawatts. But that also has to do with financial considerations. We were large energy suppliers and tended to think big; we didn't deal in small projects" (RWE interview 2). In 2007 and 2008, utilities founded separate business units for renewable energies, which offered some protection from normal performance criteria: "I decided to build up a renewables division which was sheltered from the influence of sceptics, myself included", E.ON's chairman later said to a German newspaper (Spiegel, 7 June 2012). The first big wind parks were all built outside Germany, partly because return rates seemed more promising in other countries, partly because they wanted to protect their sunk investments in conventional power plants: "we don't cannibalise our own power plants" (E.ON interview 5).

Company	Decided	Status	Location	Fuel Type	Capacity	Note
E.ON	2005	Commissioned 2010/2011	Irsching	Gas	845 MW + 550 MW	
E.ON	2005	Delayed	Datteln	Hard Coal	1100 MW	Ongoing litigations
EnBW	2006	Commissioned 2014	Karlsruhe	Hard Coal	912 MW	
EnBW	2007	Commissioned 2015	Mannheim	Hard Coal	900 MW	
EnBW	2007	Cancelled 2009	Dörpen	Hard Coal	900 MW	Stopped by local protests
RWE	2005	Commissioned 2012	Grevenbroich-Neurath	Lignite	2 x 1100 MW	
RWE	2005	Delayed	Hamm	Hard Coal	1530 MW	Problems in construction
RWE	2007	Commissioned 2010	Lingen	Gas	875 MW	
RWE	2006	Cancelled 2007	Ensdorf	Hard Coal	1600 MW	Stopped by local protests
Vattenfall	2006	Commissioned 2012	Boxberg	Lignite	675 MW	
Vattenfall	2006	Commissioned 2015	Moorburg	Hard Coal	2 x 827 MW	
Vattenfall	2007	Cancelled 2009	Klingenberg	Hard Coal	800 MW	Stopped by local protests
Vattenfall	2008	Commissioned 2009	Tiefstack	Gas	321 MW	

Table 2: Mid-2000s power plant projects by the Big-4 in Germany (Source: Annual reports and press reports)

Technical innovation strategies

While most R&D efforts focused on efficiency improvements in conventional power plants, utilities also seriously investigated CCS. In their 2006 annual report RWE designated CCS as its medium- to long-term R&D focus. RWE, E.ON and Vattenfall joined German and European CCS programmes like “COORETEC”, “ENCAP”, “CASTOR” or “CO2SINK”. EnBW marginally invested in CCS, because the company had the lowest CO2-emissions of the Big-4. Companies also dedicated some resources to exploratory research in geothermal, fuel cells, smart technologies and compressed air storage.

Summary

Utilities faced some negative pressures from stricter regulations, cartel restrictions, RET-expansion, restricted European expansion opportunities, and declining public views. They paid relatively limited attention to these developments, which did not affect their bottom line. In fact, windfall profits from emission trading and rising electricity prices created substantial financial surpluses and optimism, which led to decisions to build new fossil fuel plants and engage in (expensive) take-overs. Both decisions would turn sour in the next period. Figure 13 schematically summarises the main developments.

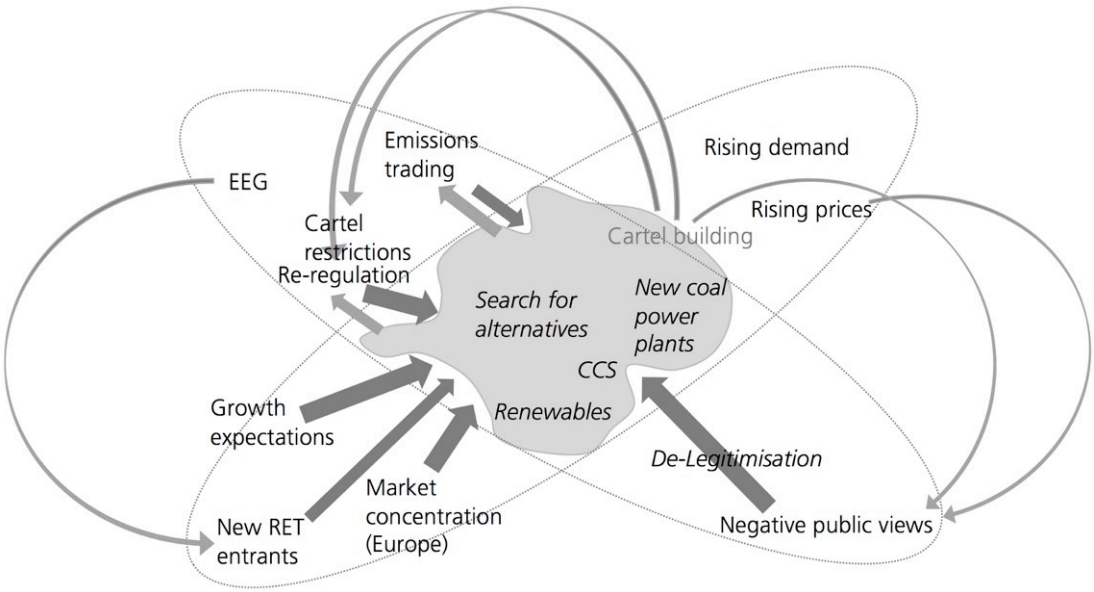

Figure 13: Multi-dimensional pressures, responses and spillovers (2005-2008)

4.3 Gathering storm clouds but incremental responses (2008-2011)

Pressures in task and institutional environment

Policy

The 2009 elections resulted in a Conservative-Liberal government coalition, which was favourable to the utilities. The new government wanted to slow down RET-expansion, especially solar-PV, and reduce EEG-related costs (Hoppmann et al. 2014). The government also stated nuclear power could act as a 'bridge' until renewables were 'affordable'. In 2010 the government overturned the earlier phase-out policy and implemented a lifetime extension of nuclear power plants (by twelve years on average). To siphon off parts of the profits the government also introduced a nuclear fuel tax, starting in 2011. This tax, which would expire after six years, would

initially negate the profits of the lifetime extension; only after its expiration, the utilities would financially benefit, which thus introduced a temporal risk (Handelsblatt, 10 September 2010). The government also implemented an 'Energy Concept' with high renewables targets (35% by 2020; 80% by 2050), which the opposition branded as a tactic to legitimate the new nuclear policy (Lauber & Jacobsson 2016).

Another political debate concerned carbon capture and storage (CCS) technologies, which the utilities were trying to develop. The European Commission stipulated that CCS should be embedded in a legal framework. This led to vivid political debates, which proved difficult to resolve because of three factors (Fischer 2012): a) disagreement between coalition parties, b) public opposition (see below), c) the fact that the most suitable carbon storage sites were located in federal states with few emission-intensive power plants. Consequently a first draft CCS-law was blocked by the federal states in 2009. CCS was then postponed to the next legislation period.

During the second phase of the European emission trading scheme (2008-2012), 90% of the certificates were still given to utilities for free (Lobo 2011). Although windfall profits were still substantial, they were smaller than in the first ETS-phase (Cludius & Hermann 2014).

Social movement and public protest

Civil society pressure increased substantially in this period. In several regions public protests were held against the plans to build new coal fired power plants. In some occasions these protests led to project cancellations (Table 2).

Although the public was hardly aware of CCS before 2008, the search for potential storage sites triggered many local protests. In the affected federal states public sentiments against underground storage were strong because past experiences with underground nuclear repositories (Fischer 2012).

Public attention

Pressure from public debates also increased in this period. The government's nuclear lifetime extension decision was very unpopular with the German public, leading to heated debates. A survey by a German newspaper showed that 49% of the population was against any lifetime extension and another 29% supported an extension by a maximum of ten years (Die Zeit, 22 July 2010).

Meanwhile, the public's view of renewable energy remained very positive, despite claims by the governments and utilities about high costs. In 2006, 2008 and 2010 respectively, 87%, 86% and 85% of the population agreed with the statement that "we need a consistent change towards renewable energies" (BMU 2006, 2008, 2010).

The public debate on CCS became increasingly negative, as companies searched for potential storage sites and the government debated possible laws (Fischer 2012).

Technical alternatives and new entrants

Power production from renewables increased from 88.3 TWh in 2007 to 104.8 Twh in 2010, which amounted to 16.6% of total electricity (Figure 10). Much of this increase came from biomass and solar-PV. The latter, in particular, experienced rapidly decreasing prices (due to learning curves, low-cost imports from China, overcapacities and price dumping). As PV-costs dropped faster than EEG remuneration rates, record amounts of solar-PV were installed in 2010, 2011 and 2012 (Hoppmann et al. 2014).

Renewable electricity technologies were still mainly deployed by new entrants such as households and farmers (Geels et al. 2016). Another new entrant were newly founded municipal utilities, which increased from 13 between 2005-2008 to 59 between 2009-2012 (Berlo & Wagner 2013b). When long-term concession agreements between municipalities and grid operators came to an end, many municipalities took the opportunity to re-municipalise local distribution grids, which gave them more independence from the big utilities (Berlo & Wagner 2013a).

Markets

German utilities faced substantial pressure from three market developments: a) the financial-economic crisis decreased demand for electricity (Figure 6), b) the expansion of renewable electricity (see below) reduced market shares of the utilities, c) electricity prices decreased (Figure 11), because of sinking hard coal prices (Figure 12) and the merit order effect of renewables, which had priority access.[5] These developments did not immediately affect the net incomes of the utilities (which did not decline until 2011, as indicated in Figure 1), because they routinely hedged against the risk of decreasing prices (see below) (EnBW interview 1).

Industry response strategies

Corporate political strategies

After 2009, the utilities intensively lobbied the new government for a lifetime extension of nuclear power plants. “We were all aware that a change in government in Berlin would mean the opportunity to renegotiate the schedule for the nuclear phase-out” (E.ON interview 3). This issue was the main focus of their political activities. “We were

[5] The merit order refers to the ranking of sources of electrical generation, in ascending order of short-run marginal production costs. Electricity sources with the lowest marginal costs (i.e. renewable electricity in this period) are first brought online to meet demand.

heavily engaged in it. We were among those that worked towards prolonging nuclear energy" (EnBW interview 2). The companies disliked the nuclear fuel tax idea and threatened to file lawsuits during the negotiations (Handelsblatt, 11 November 2010).

With regard to renewable energy, the companies argued for European 'harmonisation' of support policies, which meant abolishing the EEG. These demands were backed up by a supposedly neutral study from the industry-friendly research institute EWI (BDEW press release, 23 April 2010).

Framing strategies

To support their nuclear lifetime extension lobby, the utilities deployed media campaigns highlighting the benefits of nuclear power, e.g. offering climate protection, diminishing the threat of energy shortages, and offering benefits for the national economy. They also claimed that they needed the money from nuclear power plants to finance the change towards renewable energies (Bohn & Walgenbach 2016).

Economic positioning strategies

As the companies were still doing well financially, they initially underestimated the impact of the financial-economic crisis and thought it would not affect them. RWE for example communicated that: "We are hell-bent to utilise the current crisis for further growth" (Handelsblatt, 16 December 2008). In 2009, RWE took over the Dutch company Essent, while Vattenfall bought the Dutch company Nuon. With hindsight, managers qualified both investments as overpriced (RWE interview 5, Vattenfall interview 2).

Companies not only faced problems from take-overs turning sour, but also from their power plant investments in the previous period (Table 2). These investments were based on the assumption of growing electricity demand and stable market shares (i.e. limited renewables) which turned out to be wrong.

The utilities finally started to take serious the expansion of renewable energies. "Among those in the conventional business the first signs of hesitation came around mid-2009, and the final straw was Fukushima!" (Vattenfall interview 1) The threat from renewables was not recognised earlier "because they had blinders on. You could have seen it if you had dealt with the subject proactively and openly. But it was the old energy economists that had the say in the companies and it was them who tried to prevent all this. Their old way of thinking was: What we do not want, does not happen in the market, ok?" (E.ON interview 4). Towards the end of this period, most companies started cost-cutting and efficiency measures to address worsening market developments. One month before the Fukushima accident RWE's CEO qualified the fifth year of rising profits (Figure 1) with this caution: "But now we are on the summit, and from there it goes downhill in all directions" (Handelsblatt, 25 February 2011).

Technical innovation strategies

Besides efficiency improvements of conventional power plants, innovation strategies focused on CCS-testing. EON, for instance, stated that: "We work intensely to make CCS economically feasible by 2020" (Handelsblatt, 29 August 2008). German CCS development strategies were hindered, however, by local protests and the inability of policymakers to develop a legal framework. The resulting deadlock was particularly problematic for Vattenfall, which in their 2008 annual report presented CCS as the main pillar to a low-carbon future by 2050. Utilities also researched alternative technologies like e-mobility and smart technologies.

Summary

In this period, the utilities achieved political success with nuclear lifetime extension. Their net profits also increased (Figure 1), which created confidence that they could weather the financial-economic crisis (and even engage in take-overs). But the utilities also faced negative market developments, e.g. shrinking markets, decreasing electricity prices, competition from RETs (Figure 14). These developments were initially (mis)interpreted as temporary, although perceptions changed by the end of the period. Civil society pressures also increased (e.g. coal protests, CCS protests, disapproval of nuclear lifetime extension), which undermined the industry's legitimacy and reputation. Despite mounting pressures, the companies did not engage in substantial reorientation efforts.

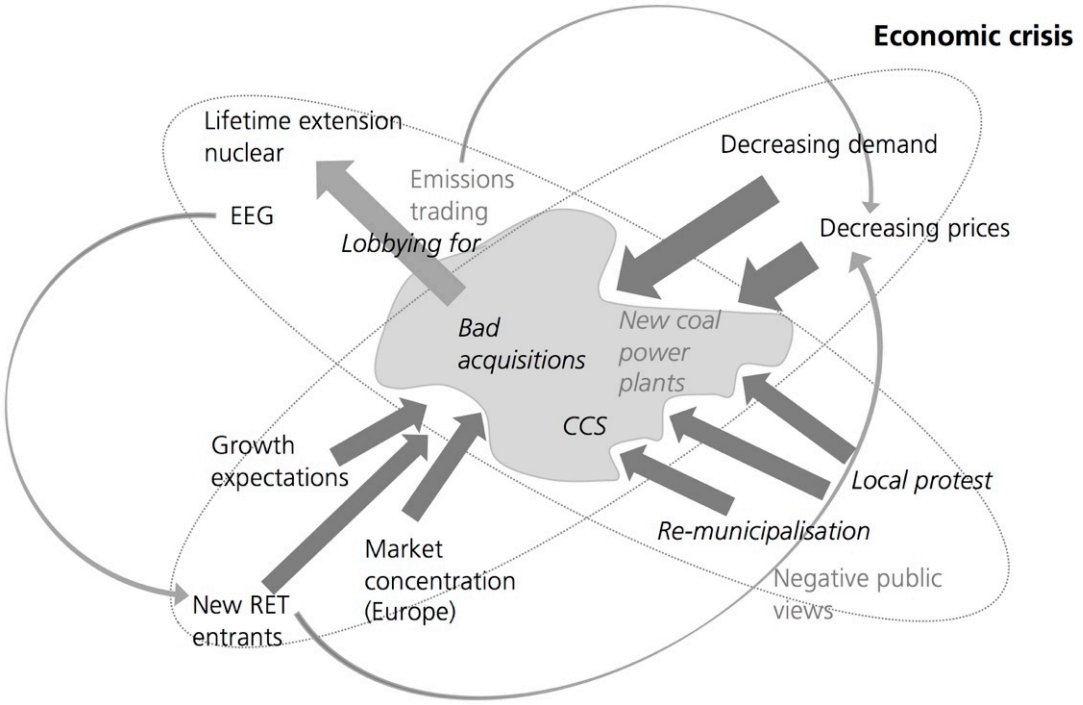

Figure 14: Multi-dimensional pressures, strategies and spillovers (2008-2011)

4.4 Crisis and reorientation (2011-2015)

Pressures in task and institutional environment

Policy

The Fukushima accident on March 12, 2011 was a major shock, which placed the previous nuclear lifetime extensions in a bad light (Hermwille 2016). In response to a public outcry (see below) and with an eye to upcoming state level elections later that month (in Saxony-Anhalt, Baden-Wuerttemberg and Rhineland-Palatinate), Chancellor Merkel implemented for a moratorium on nuclear power and a security assessment of all nuclear power plants. In June 2011, the government decided to shut down the eight oldest reactors and phase-out the remainder by 2022.

The nuclear phase-out also gave rise to the *Energiewende,* an explicit energy transition policy that formally adopted the renewable electricity targets from the 'Energy Concept'. Nevertheless, the government tried to reduce the EEG support for renewable electricity technologies, which gave rise to intense debates within Parliament and with federal states, especially those with renewable energy industries or generation (Lauber & Jacobsson, 2016). When, in December 2013, the European Commission opened state aid infringement procedures against Germany (because of industry exemptions to paying the EEG surcharge), this provided the government with opportunities to scale down renewables support (Tews 2015). A hasty EEG-amendment was pushed through Parliament, coming into force in August 2014. The amendment, which was harmonised with EU state-aid guidelines, contained various restraints for renewable energies and saw the replacement of the feed-in-tariff system by a bidding system by 2017. Although these policy changes favoured the incumbents (Lauber & Jacobsson, 2016), they came too late to stop RET-expansion.

The government also introduced CCS-legislation in 2012. The bill had been watered down to a law for CCS-demonstration plants, which capped the volume of storage sites and gave federal states veto rights against storage sites. The law thus failed to provide a stable basis for the commercial use of CCS (Fischer 2012).

Social movement and protests

The utilities and government faced huge anti-nuclear protests after Fukushima (Hermwille 2016), which contributed to the nuclear phase-out decision.

Public attention

Fukushima caused a public outcry, because the accident seemed to validate the preexisting framing of nuclear power as a potentially catastrophic threat (Hermwille 2016)

and because it underlined the government's folly to overturn the phase-out a year earlier. The public widely supported the 2011 phase-out decision and also continued to support RET-expansion. A majority of people thought that the energy transition benefitted the German economy. They also attributed rising electricity prices more to the profit-seeking behaviour from the utilities than to the energy transition (BDEW 2013).

Markets

Market developments also continued to exert pressure on utilities. Although demand bounced back from the sharp drop following the economic crisis, the overall demand trend was downward (Figure 6). Other negative developments also continued: electricity prices decreased (Figure 11) and RET-expansion continued (Figure 10). RWE's CEO characterised developments as the "worst structural crisis in the history of energy supply" (Handelsblatt, 21 January 2014). Future forecasts became increasingly gloomy as an interviewee explained: "The hardest year will probably be 2016. That has to do with the fact that we sell our electricity years in advance. And so the current catastrophically low energy prices will really take effect in 2016. And that will put the company in an extremely difficult situation" (EnBW interview 3).

Technical alternatives and new entrants

Renewable electricity production increased from 104.8 TWh in 2010 to 160.6 TWh in 2014, which accounts for 26.2% of total electricity generation (Figure 10). This growth was driven mainly by solar-PV, onshore wind and biomass. Installation rates slowed down, however, as political debates and reduced EEG-tariffs created uncertainties that scared off investors (Lauber & Jacobsson 2016). Table 3 shows that RETs were mostly deployed by new entrants to the electricity sector. Citizen cooperatives became a more widespread organisational form (Geels et al. 2016). The Big-4 had some presence in biomass, but were generally limitedly involved in new renewables.

	House-holds, citizens	Farmers	Banks, funds	Project developers	Municipal utilities	Industry	Four major utilities	others
Wind	51.5	1.8	15.5	21.3	3.4	2.3	2.1	2.2
Biogas	0.1	71.5	6.2	13.1	3.1	0.1	0.1	5.7
Biomass	2.0	0	3.0	6.9	24.3	41.5	9.6	12.7
PV	39.3	21.2	8.1	8.3	2.6	19.2	0.2	1.1

Table 3: German ownership structure (%) of installed capacity of different renewable electricity technologies in 2010 (Source: trend:research 2011)

Industry response strategies

Corporate political strategies

The government's nuclear phase-out decision was a major shock for the utilities, especially since they were not consulted beforehand (Handelsblatt, 25 March 2011). The immediate shut-down of eight reactors, and the accelerated closure of the remainder, implied major financial losses. Furthermore, the nuclear fuel tax was upheld, which caused extra losses since the policy was designed to become profitable after six years (see above).

The utilities initially responded cautiously, taking account of the sensitive context. But when the situation calmed down, they started various litigations and lawsuits against the phase-out policy and the nuclear fuel tax. The companies suggested they might drop their lawsuits if the government would create a public foundation with responsibilities for waste disposal and the decommissioning of nuclear power plants. The various struggles about the nuclear phase-out implementation continue at the time of writing.

Another battlefront was the unprofitability of many conventional power plants (because of low electricity prices and RET-competition). Because wind and solar-PV are intermittent power sources, the utilities argued that conventional power plants should be paid for providing back-up capacity (even when they generated no power) since this created grid stability and security of supply. EnBW's CEO stated in a newspaper interview: "There is a product "security of supply" which the market needs and which we have to provide and which has a price" (Frankfurter Rundschau, 3 March 2014). The demands and interests of the companies, however, differ depending on locations and energy mixes of their assets (Table 4 below). Some companies (e.g. EnBW, Vattenfall) demand specific attention for 'system relevant' power plants (in strategic locations which are threatened by electricity shortages); other companies (E.ON, RWE) demand generic 'market-based' mechanisms that do not discriminate certain power plants (data from company reports). These debates are ongoing at the time of writing.

Framing strategies

The utilities complemented their political strategies with media performances, arguing that a nuclear phase-out would pose threats for supply security, cause job losses, raise energy prices, and conflict with German climate targets (Bohn & Walgenbach 2016). Utilities also claimed that the government had historical responsibility for their engagement with nuclear power and therefore should bear some of the phase-out costs. RWE's CEO, for instance, stated that: "We will have to bear our responsibility for it. But it is not only and not solely our responsibility […]. The energy branch has been driven into nuclear energy by the policy back then" (Handelsblatt, 21 May 2014).

Company criticisms of the EEG also increased sharply in this period, as the threat from renewables increased. Prior to the 2012 EEG-amendment, they demanded that support schemes were harmonised on a European level (which implied removal of the feed-in-tariff). After 2012, they directly attacked the EEG, demanding more fundamental changes. For instance, E.ON's chairman stated: "We finally need a general revision of the energy transition, cosmetic fixes are not enough" (Die Welt, 17 October 2013). And the boss of RWE's renewables division said: "(the EEG) in its present form is not tenable, neither economically nor politically" (Finanzen.net, 10 January 2013).

Economic positioning strategies

All companies saw major decreases in net profits in 2011, followed by some rebound in 2012, and further decreases afterwards (Figure 1). The companies were differentially affected, however, by the nuclear phase-out and market developments, because of varying energy production assets (Table 4). E.ON and EnBW were hit hardest by the nuclear phase-out, because of larger nuclear assets. Companies with much gas-fired power plants (e.g. E.ON, RWE) suffered from low electricity prices and solar-PV competition (which pushed gas plants out of the grid at mid-day). Lignite-fired plants could still operate at relatively favourable production margins because of low fuel costs (which benefitted RWE and Vattenfall).

	E.ON		RWE		EnBW		Vattenfall	
	in MW	*in %*	*in MW*	*in %*	*in MW*	*in %*	*in MW*	*in %*
Nuclear Power	5.403	26,0	3.901	12,5	3.333	25,0	0	0,0
Hard Coal	6.016	29,0	9.555	30,5	3.953	29,6	1.318	9,4
Lignite	852	4,1	9.799	31,3	1.034	7,7	7.123	50,8
Gas	4.599	22,1	5.228	16,7	1.210	9,1	1.777	12,7
Hydro	2.437	11,7	n/a	n/a	2.704	20,3	2.880	20,5
Wind	198	1,0	n/a	n/a	194	1,5	13	0,1
Other	1.258	6,1	2.802	9,0	922	6,9	911	6,5
Total	20.763	100,0	31.285	100,0	13.350	100,0	14.022	100,0

Table 4: German power plant capacities of companies by fuel type by the end of 2011 (Source: Annual reports)[6]

[6] For RWE, country specific data on renewables are not available. Their renewables division operated 2.357 MW of renewables worldwide in 2011. Category "other" differs widely and may include renewables. For EnBW, exclusive data for Germany are not available; their data thus include power plants outside Germany. However, the bulk of EnBW's power plants are sited in Germany: 86% of sales and 92% of employees were attributed to Germany in 2011.

The Fukushima accident and subsequent phase-out not only affected the companies financially, but also culturally led to a change in mind-sets and perceptions, as an interviewee indicated: "After Fukushima… that was when colleagues across-the-board started to rethink" (Vattenfall interview 1). RWE's CEO described the developments in the energy business as "a profound structural disruption which destroys our business model of a centralised power supply" (Westdeutsche Allgemeine, 5 October 2014).

In response to the economic difficulties, the utilities implemented job-cuts, cost cutting programs and major divestments (Kungl 2015). They also started reorientation strategies that aimed to expand in new areas such as decentralised service activities, smart energy solutions and renewable energies. They also searched for new business models, for instance in renewable energy, where the utilities explored a 'less capital - more value' business model. This model, which focused less on long-term *operation* and more on building, selling and servicing new power plants, would enable them to gain expertise in new technical domains and earn money more quickly, which created flexibility for new projects (see for example, E.ON press release, 13 November 2013).

In this volatile and uncertain context, the companies explored different strategic paths:

- In 2014, E.ON announced it would split its business into two separate companies: a) E.ON would focus on renewables, distribution grids and service activities, b) the spin-off 'Uniper' would hold conventional business in large-scale electricity production and trading activities. In their 2014 annual report E.ON explained this strategy as follows: "This strategy is founded on our assessment that over the past few years two energy worlds have emerged: a conventional and a new energy world. They're not separate. On the contrary, they depend on one another. But they place completely different demands on energy companies."[7]
- EnBW aimed to reorient towards the energy transition with its new CEO proclaiming: "we will rethink energy and we will rethink EnBW" (Handelsblatt, 1 October 2012). EnBW streamlined their organisational structure and called their new motto: "Energiewende. Safe. Hands on". A leading manager stated: "we want the Energiewende to continue. We rely on it to continue if the German market is to remain relevant for us. […] If the energy transition does not continue […] that means I will lose money in the generation of conventional energy regardless, but that I won't be able to do anything new. And that's the worst part of it" (EnBW interview 4). Press reports also related the re-orientation of EnBW to the influence of the Red-Green government of Baden-Wuerttemberg which held 45% of the company's shares in 2011 (Handelsblatt, 26 September 2012).

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[7] In 2015, however, E.ON announced it might abstain from separating their nuclear power plants (Berliner Zeitung, 14 October 2015).

- The failure of German CSS deployment was a major setback for Vattenfall, which was facing increasing pressure from its owner (the Swedish government) over the link between lignite and climate change (Der Spiegel, 3 October 2014). "With that (CSS) we tried to develop lignite in line with the objectives of Vattenfall's portfolio. But that has obviously failed now unfortunately due to public opposition" (Vattenfall interview 4). In 2015, Vattenfall decided to offer its German lignite activities for sale, which represented a major retreat from the German market, given the relative size of its lignite assets (Table 4).
- RWE abstained from substantial reorganisation until the end of 2015, which press reports related to the strong influence of RWE's municipal shareholders, which demanded stable dividends and aimed to protect their regional interests, including coal mining (e.g. Die Welt, 23 April 2015). In December 2015, however, RWE adopted a similar restructuration strategy as E.ON, although the other way around: RWE announced to separate its renewables, grid and retail business in a new subcompany which was meant to be stock listed and sold stepwise (RWE press release, 1 December 2015).

Technical innovation strategies

To accompany reorientation strategies, utilities created internal innovation teams such as E.ONs ':agile' project and EnBW's 'innovation campus'. The direction of innovation strategies changed substantially with greater attention for radical innovations. Many CCS-projects were cancelled (e.g. Vattenfall's projects at Jänschwalde, Altmark and Schwarze Pumpe). Research on conventional power plants (e.g. RWE and Vattenfall on lignite) focused on ways to improve flexibility, which acknowledged the need to adapt to increasing shares of intermittent renewables (e.g. Vattenfall press release, 14 November 2014). Companies also focused more on renewables, smart technologies (e.g. smart meters, smart grids) and Power-to-Gas (where electricity is used to create gas, e.g. hydrogen via electrolysis of water), for which they set up large-scale test facilities (E.ON at Falkenhagen and RWE at Niederaußem).

Summary

Fukushima and the nuclear phase-out decision were a financial and cultural shock, which came on top of ongoing negative developments (decreasing prices, RET-expansion, eroding cultural legitimacy). The shock changed industry mind-sets and created awareness of structural problems, which led to cost-cutting and reorientation programs, which addressed both technologies and business models. Because utilities were differentially affected by the problems, their response and reorientation strategies diverged. The utilities contested the government's nuclear phase-out implementation (asking for financial compensation or transfer of liabilities), but also asked the government for support for conventional power plants. Policymakers changed some

policies in favour of the utilities (e.g. EEG-2014, bidding system), but have hesitated to make major concessions (e.g. capacity markets, transfer of nuclear liabilities). Figure 15 summarises the main developments in this period.

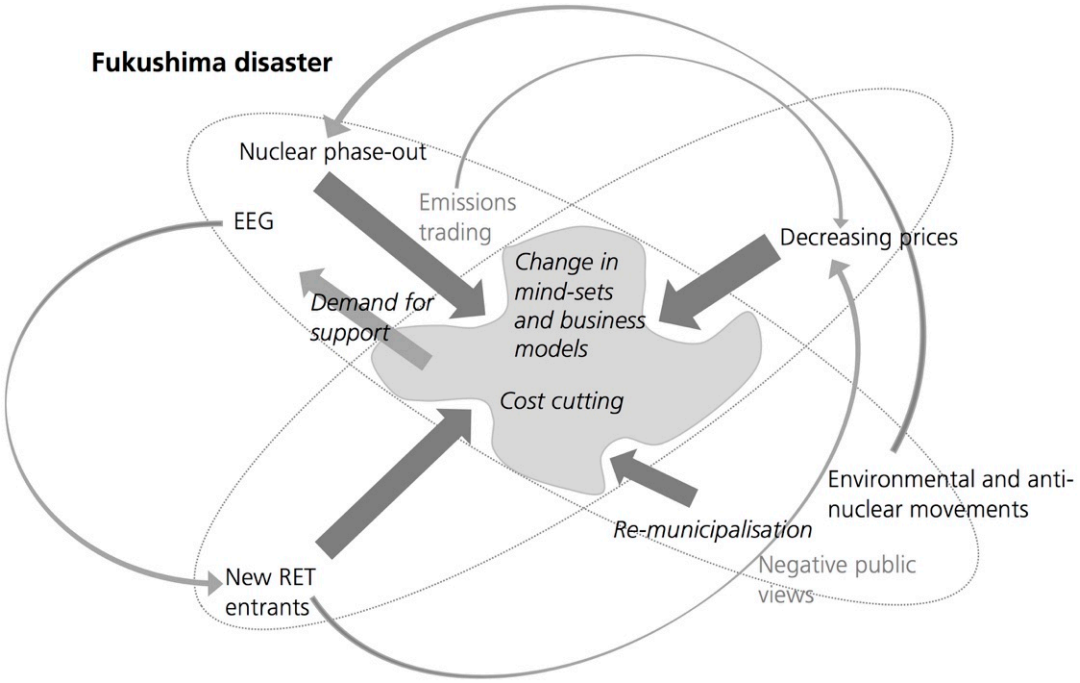

Figure 15: Multi-dimensional pressures, strategies and spillovers (2011-2015)

5 Analysis

Applying the conceptual model

The case study showed that the German electricity industry experienced a roller coaster ride, which ended with destabilisation of the industry regime and a search for new business models, technologies, mission and mind-sets. To explain why this de-stabilisation processes happened so quickly, we first apply the conceptual model and then revisit the three elaborations to offer further nuance.

The first part of the conceptual model concerns the development of external pressures from economic and socio-political environments. For each period, Table 5 summarises the main pressures. Based on this summary, we draw the following conclusions:

- The industry faced multiple pressures, which changed in strength and direction. Some pressures were continuously negative (social movements, new entrants, new technologies), although their strength varied (especially RETs). Other pressures (market developments, political pressure, public discourse) changed from positive

to negative, although at different speeds. This reinforces the importance of analysing the 'ebb and flow' of multiple pressures in destabilisation processes.

- The industry destabilised because an increasing number of pressures turned negative. In the second period (2005-2008), there was some negative pressure from renewables, decreasing public image, debates on rising prices, attention for climate change, and anti-trust investigations. But economic conditions remained favourable, leading to windfall profits. In the third period (2008-2011) most pressures turned negative, except for political pressure, where nuclear lifetime extension offered positive support. These pressures did not lead to destabilisation, however, because the firms still had positive financial performance and interpreted the problems (economic crisis, shrinking markets) as temporary rather than structural. It was not until the fourth phase, when the Fukushima accident and nuclear phase-out decision came on top of continuing negative pressures, that the industry was overwhelmed and realised the structural nature of their problems.
- Some of the pressures also interacted as the various spillover figures showed (Figures 8, 13, 14, 15). Strong interactions occurred between: a) industry consolidation, anti-trust investigations, debates about rising prices (second period) decreasing public image, b) anti-nuclear movement, nuclear phase-out, public discourse and public image, c) RET-expansion and decreasing electricity prices (third and fourth period), d) attention for climate change, RET-expansion, 2011 nuclear phase-out (because the phase-out was accompanied by the Energiewende strategy based on renewables).

The second part of the conceptual model concerns firm responses to external pressures. As indicated in Table 5, the electricity industry faced a wide range of economic, technical, socio-cultural and political issues, which created difficulties for interpretation and prioritisation of responses. Based on the case description, we conclude that five decisions in particular contributed to industry problems (Table 6). All these decisions were based on wrong interpretations and assessments. Some of these misinterpretations related to established mind-sets (e.g. underestimating renewable energies, technology-push approach with CCS); others turned out to be wrong in retrospect and could not have been anticipated (e.g. the assumption of continued demand growth was disrupted by the financial-economic crisis; the nuclear fuel tax deal turned sour after the Fukushima accident).

At a deeper level, the misinterpretations can be related to hubris and complacency, stemming from positive financial performance until 2011. This positive performance masked the increasing negative pressures in the third period. So, the temporality of utilities' response strategies has a fairly good match with the four phases suggested by Collins (2009): 1) hubris born of success (1998-2005), 2) undisciplined pursuit of more (2005-2008), 3) denial of risk and peril (2008-2011), 4) grasping for salvation (2011-2015).

	Political pressure	Social movement pressure	Public discourse and legitimacy	Market developments	New entrants and technologies
1998 - 2005	**++** Market Liberalisation	**-** Anti-nuclear movement	**+** Decreasing nuclear debates after "nuclear consensus"	**+** Rising demand	**-** Renewable energy producers
	- RET support		**+** Positive image of utilities	**-+** Decreasing electricity prices (recovered by end of period)	**-** RET expansion (mainly wind onshore and biomass)
	- Nuclear phase out				
2005 - 2008	**--** Re-regulation	**-+** Protests against coal power plants	**-** Increasing attention for climate change	**+** Slightly rising demand	**-** Professionalisation of RET branch. Expansion of actor variety
	++ Emissions trading		**-** Return of nuclear debates	**++** Rising electricity prices	**-** RET expansion (photovoltaics, onshore wind and biomass)
	-- Anti-trust investigations and cartel restrictions		**-** Debates on rising prices		
			- Image of utilities decreased considerably		
2008 - 2011	**+** Lifetime-extension of nuclear power plants	**-+** Protests against coal power plants	**-** Critique on lifetime-extension of nuclear power plants	**--** Decreasing demand	**-** Further expansion of RET branch.
	- Nuclear fuel tax	**-** Protests against CO2 storage	**-** Image of utilities remains negative	**-** Decreasing prices (recover in parts until end of phase)	**-** Foundation of new municipal utilities
		-- Increased re-municipalisation			**--** Photovoltaic boom
2011 - 2015	**--** Nuclear phase-out, but maintained nuclear fuel tax	**-** Protests against nuclear	**-** Public support of nuclear phase-out	**-** Slightly dropping demand	**--** Ongoing RET expansion
	+ Cut in RET support	**-** Re-municipalisation	**-** Public support of RET	**--** Decreasing prices	
	- Implementation of CCS law		**-+** Slight improvement in image of utilities		

Table 5: External pressures for change in economic and socio-political environment (- is negative developments for utilities, + favourable. -- resp. ++ refers to the intensity of the effect. +- or -+ means that the direction of an effect changed over time)

The case also confirms the proposition from section 2 that firms initially tend to respond to external pressures with externally-oriented strategies (corporate political, socio-cultural framing, economic strategies). Only in the last period did firms seriously implement internally-oriented strategies in business models, mind-sets, beliefs and radical innovation. It remains to be seen if this reorientation of the German electricity industry will be sufficient, or if the industry will continue to Collins's fifth phase 'capitulation to irrelevance or death'. The German case resonates with two findings in an earlier study of the UK coal industry, namely that mind-sets, mission and business models are often the hardest regime elements to change, and that these reorientations often have "characteristics of a crash programme when the damage had already been done in terms of cultural legitimacy, competitiveness and political support" (Turnheim & Geels 2013, 1765).

Period	Strategic mistakes	Wrong interpretations and assessments
2000-2009	Underestimation of renewable energies	The expansion of renewables and their market impact were long underestimated because of established mind-sets. This prevented timely reorientation (or more dedicated fightback).
2005-2007	Decision to build new coal-fired power plants	These investment decisions soon became unprofitable, because electricity demand did not increase as expected, because of the financial crisis and because RETs expanded faster than anticipated.
2007-2009	Overpriced take-overs	Acquisitions of Nuon (by Vattenfall), Essent (by RWE) and parts of Endesa (by E.ON) were too expensive and rapidly turned sour in when macro-economic conditions turned negative. Take-over decisions were based on too much optimism (and full coffers), shareholder pressure and mis-interpretation of structural trends.
2005-2010	Fighting for life-time extension of nuclear power	Utilities succeeded in nuclear life-time extension, but this had two unintended effects: 1) decreasing public image, 2) the nuclear fuel tax (which was agreed as part of a package deal) came back to haunt them after 2011 nuclear phase-out decision.
2004-2012	Betting on CCS	Utilities placed high hopes on CCS-development (to reduce carbon emissions of conventional power plants). They underestimated issues of public acceptance and political feasibility.

Table 6: Strategic mistakes that contributed to destabilisation

Discussing three elaborations

Using the case study, we revisit the three elaborations of the conceptual framework, discussed in section 2. The first elaboration was that different kinds of pressures, distinguished by Suarez and Oliva (2005), are likely to have different effects on industry destabilisation. The case confirmed the proposition that industries may be espe-

cially vulnerable to 'disruptive' change, which develops gradually and has high-intensity effects in one dimension. The increase of renewable electricity, which started small, but gathered pace in the third and fourth period, is an excellent illustration of this pattern. Industry actors long underestimated its disruptive effects for regime technologies and business models. The case partly confirmed the proposition that 'specific shocks' attract more attention from industry actors because of high speed and immediately noticeable effects. The Fukushima accident confirms this proposition. The financial-economic crisis, however, does not confirm the proposition because it did not lead to strong responses. In fact, we suggest that the crisis masked the threat of renewables, because industry actors interpreted market problems as conjunctural instead of structural. So, we conclude that the distinction between different kinds of pressures is important and relevant, but also that empirical application requires contextual sensitivity.

The second elaboration concerns the importance of the temporal sequence of external pressures. Table 5 shows how the domestic, sector-specific pressures on German utilities became increasingly negative in the third and fourth period. On top of that, German utilities experienced two exogenous (international) shocks: the financial-economic crisis and the Fukushima accident. These shocks affected and accelerated the destabilisation process, although in different ways. The financial-economic crisis depressed electricity demand, which undermined the viability of coal plant investments in the mid-2000s and the European take-overs. But the crisis also masked the threat of renewables, as we noted above. In fact, industry actors thought they could 'weather the storm' in the third period because of continued positive financial performance (due to windfall profits from emissions trading). The Fukushima accident, in contrast, was a 'killer blow' which destabilised the industry, not only because of direct financial effects of the subsequent nuclear phase-out decision, but also because of its symbolic effect since it represented the abolishment of the traditional electricity system based on large scale power plants. The utilities lost their previous confidence and started questioning their core beliefs and business models. The Fukushima accident also had much impact because it happened after a range of external pressures had already eroded the industry, weakening its economic positions, public reputation, and political capital. So, the effect of the shock depended on its place in an event chain, knock-on effects and contexts.[8]

[8] Hermwille (2016) argues that Fukushima was influential in Germany because it seemed to offer empirical evidence for the pre-existing discourse that nuclear power was a potentially catastrophic threat. In countries like the UK, where this discourse had much less traction, Fukushima had limited political and socio-cultural effects. So, the effects of shocks also depends on cultural contexts and interpretations.

The third elaboration concerns industry heterogeneity and variety in response strategies. Based on the case study, we highlight two instances of industry heterogeneity. Firstly, differences in asset structures (particularly the kinds of power plants) affected the ease or difficulty in creating 'closed industry fronts' in political strategies towards specific policy issues (Geels & Penna 2015). Table 7 shows that utilities were able to create a closed industry front with regard to nuclear policy, because they all had nuclear plants. With regard to renewables support policy (EEG) and re-regulation ('grid unbundling'), utilities created almost closed industry fronts (except for one). But for emissions trading and capacity markets, the industry was not able to present a closed front, because companies were differentially affected, based on generation mixes.

Issue	Response to issue	Closed industry front?	Explanation
EEG policy	Opposition	All but […]	Utilities mounted strong opposition, although the industry front was not entirely closed (in each period at least one company did not join the coalition against the EEG).
Nuclear policy	Compromise	Yes	All companies were affected by nuclear policy changes and created coalitions to shape these changes.
Emissions trading	Initial opposition, then accommodation	Medium to no	Utilities did not create a closed industry front, because emissions trading affected them differently based on generation mixes: RWE and Vattenfall (with more lignite) were more affected than E.ON and EnBW.
Re-regulation (EnWG 2005)	Opposition	All but […]	All utilities, except EnBW, opposed the 2005 re-regulation policy.
Crisis of conventional power plants	Demand for political support	No	Utilities did not create a closed front, because differences in generation mixes and site locations led to different demands.

Table 7: Homogeneity or heterogeneity of companies' responses to specific issues

Secondly, ownership structures influenced the growth and reorientation strategies.

- For E.ON and RWE, institutional shareholders exerted growth pressures in the second and third period, which led to some flawed take-overs.
- For RWE, municipal shareholders (from North Rhine-Westphalia) hindered strategic reorientation in the fourth period, because they wanted to protect regional coal interests and needed stable dividends (and therefore resisted strategic investments).

- EnBW were (from 2011 on) controlled by two shareholders: The federal state of Baden-Wuerttemberg and OEW (a network of municipalities from Baden-Württemberg). The former (which had a green governor after the 2011 elections) supported the company's re-orientation. The latter did not hinder strategic reorientation, because they did not have regional coal interests.
- Vattenfalls shareholders (Swedish State) did not have regional interests in Germany. They were mainly interested in milking the (lignite) assets until this created legitimacy problems in Sweden (because of climate change concerns).

These two instances demonstrate that two company differences (asset structures and ownership structures) were relevant for aspects of the destabilisation processes in our case. We suggest that future research may fruitfully investigate the effects of other differences, e.g. company cultures, size, regional diversification, skill profiles, innovation strategies, managerial styles.

6 Conclusions

This article has explained the speed of the destabilisation of the German electricity industry, by applying a multi-dimensional conceptual framework. One part of the analysis was the increase of domestic, sector-specific negative external pressures on the industry (increasing renewables competition, anti-trust investigations, nuclear debates, declining public image, coal and CCS protests, decreasing demand and electricity prices, grid re-municipalisation). On top of that, the industry was destabilised by two exogenous shocks: the financial-economic crisis and Fukushima accident. The second part of the analysis showed that destabilisation was due to strategic mistakes (underestimation of renewables, overpriced take-overs, betting on CCS, fighting for nuclear lifetime extension, building new power plants), which, in turn, depended on misinterpretations and a sense of complacency. Utilities underestimated the structural nature of their problems and engaged too late in strategic reorientation activities.

The article replicated the Turnheim/Geels conceptual model with a new case study, demonstrating its versatility. We also elaborated the framework in three ways, highlighting: 1) the effects of different *kinds* of pressures ('shocks' and 'disruptive' trends), 2) the importance of the *sequence* of external pressures, and 3) industry *heterogeneity* and differences in firm response strategies.

More generally, the article illustrates the importance of multi-dimensional approaches to industry destabilisation. While new technology was obviously important, something that evolutionary economists and innovation management scholars have previously emphasised, the case study also clearly demonstrated the relevance of political, socio-

cultural, economic, and business dimensions. Our article thus heeds a recent warning from Richard Nelson (2013, 188) who suggested that: "scholars in our camp [i.e. evolutionary economics GK, FWG] may have a tendency to exaggerate the role that innovation plays in influencing what happens in an economy". To overcome that tendency, we suggest that innovation should be analysed within broader socio-political and techno-economic contexts, as this article as attempted to do for industry destabilisation.

Appendix: List of interviewees

Interview	Position	Still in position?	Interview situation	Date
E.ON-1	Operational business	Y	Telephone	August 2013
E.ON-2	Operational business	Y	Telephone	July 2014
E.ON-3	High management	N	Telephone	May 2015
E.ON-4	High management	N	Face-to-face	May 2015
E.ON-5	High management	N	Telephone	May 2015
RWE-1	Operational business	Y	Telephone	March 2014
RWE-2	High management	Y	Face-to-face	March 2014
RWE-3	High management	Y	Face-to-face	April 2014
RWE-4	Operational business	Y	Telephone	May 2015
RWE-5	High management	Y	Face-to-face	August 2015
EnBW-1	Mid management	Y	Face-to-face	August 2013
EnBW-2	Operational business	Y	Face-to-face	April 2014
EnBW-3	High management	Y	Face-to-face	June 2014
EnBW-4	High management	Y	Face-to-face	July 2014
EnBW-5	High management	Y	Face-to-face	July 2014
EnBW-6	High management	Y	Face-to-face	June 2015
Vattenfall-1	High management	N	Face-to-face	August 2014
Vattenfall-2	High management	N	Telephone	June 2015
Vattenfall-3	High management	N	Face-to-face	June 2015
Vattenfall-4	High management	Y	Telephone	July 2015
VKA-1	High position	Y	Face-to-face	May 2015
OEW-1	High position	Y	Face-to-face	July 2015

Table 8: Anonymised information about interviewees[9]

[9] VKA is the association of RWE's municipal shareholders. OEW represents the municipal shareholders of EnBW (which held 46.75% of shares in 2015).

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