



## Analysis

## Corporate strategy in the Anthropocene: German electricity utilities and the nuclear sudden stop

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## ABSTRACT

In 2011, the major German electricity-producing utilities faced an existential crisis: a sudden and unexpected volte-face on nuclear power regulation together with greatly increased competition from renewables and severe economic downturn in their core markets. The situation approximates, on a small scale, fears around what has been called “transition risk”: the danger to economies and financial systems posed by an abrupt transition away from fossil fuel energy production. This article takes a business history approach to consider what one case of a “sudden stop” looked like on the ground. How did the four major German electrical utilities react to a situation in which their operations, strategies, and balance sheets were suddenly thrown into disrepair? In the end, the utilities adopted widely varying strategies in attempts to adapt to changing circumstances. The reasons for and ways in which companies chose differing paths in response to similar external shocks can be instructive for thinking about cases where deep and rapid transformation is necessary and how scenarios with potential for transition risk might unfold at the firm level.

## 1. Introduction

In the summer of 2011, shocked over the March nuclear disaster in Fukushima, the German parliament voted overwhelmingly to permanently close eight of the country’s nuclear power stations effective immediately and scheduled the remaining nine to be shuttered by 2022 at the latest. The decision amounted to a complete about-face from a deal negotiated less than a year earlier that had prolonged the life of of these same nuclear power plants, implying operations well into the 2030s for the newest stations. Nuclear represented a sizeable portion of the fuel mix of major German electrical utilities – up to nearly 50% for one company and between 16% and 23% for the others. At the same time the utilities were hit with unexpectedly strong competition from renewable energy and were suffering from the effects of a major economic slowdown in their European markets. The crisis pushed them to the brink of insolvency as earnings slumped, debt went through the roof, holes in their balance sheets appeared almost overnight, and credit ratings deteriorated.

The plight of the four largest German electricity utilities in 2011 resembles in miniature fears regarding the possible outcome of swift, unexpected regulatory changes proscribing burning of fossil fuels, what former Bank of England head Mark Carney (2015) has famously called

“transition risk”. In Carney’s framework, transition risk is one of three risks posed by climate change that could potentially threaten financial systems as a whole, thus making such risk a cause for central bank concern in accordance with mandates for ensuring financial stability. Transition risk might crop up if rapid and unexpected changes in policy, technology, or physical risk lead to abrupt shifts in asset values, which in turn could cause waves of losses, fire sales, write downs, and corporate defaults – in a word, a “climate Minsky moment” (Carney, 2018; Batten et al., 2016). Building on ideas of “carbon bubbles” resulting from unburnable fossil fuels already on corporate balance sheets (Leaton, 2011), a number of scholars have taken up the topic. An expanding stream of research has gone into assessing, modeling, and suggesting policy to mitigate such risk at the systemic and macroprudential level (van der Ploeg and Rezai, 2020; Battiston et al., 2021; Dafermos and Nikolaidi, 2021; D’Orazio and Popoyan, 2019).

Carney and ensuing authors have focused on the systemic risks posed by unexpected policy change, understandably given central banks’ mandate and the scale of the potential risk. They have thus modeled global systems and examined possible impacts on highly stylized models of the real world. What, however, might a “disorderly transition scenario” (Batten et al., 2016) look like on the ground, at the individual firm or national sectoral level? This article analyzes the German state’s

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sudden decision on nuclear power phase-out in 2011 as a real world case study of an unexpected “sudden stop” in energy production. What were the threatened firms’ immediate responses, how and how quickly were they able to reformulate new business strategies, and how might the characteristics of the firms, structure of the German and European electricity market, and the German political economy in general have conditioned their decision making? Such empirical and historical examples of situations similar to sudden-stop fossil fuel transitions can compliment, and perhaps inform, higher level systemic modeling exercises in attempts to estimate the risk stemming from rapid transitions and design policy to ameliorate such dangers.

The analysis below also builds on and engages with several existing lines of inquiry from energy transitions research. Growing numbers of energy transitions researchers have begun to explore the politics not just of new technologies and infrastructures but phase-out of the old. Within this lacuna attention is increasingly paid to the lobbying power of incumbents and social and economic implications of dismantling fossil fuel sectors (Bretz et al., 2018; Jewell et al., 2019; Oei et al., 2020). Another line of inquiry in transitions research is the politics and character of the German energy transition, known as the *Energiewende* – its causes, characteristics, and ultimate effects (Strunz, 2014; Morris and Jungjohann, 2016; Renn and Marshall, 2016; Jacobsson and Lauber, 2006; Moore and Gustafson, 2018). One major question regarding the German case is why the large German electricity utilities were so slow to begin decarbonization of electricity production. One explanation is groupthink and conceptual lock-in. The incumbents earned windfall profits for most of the 2000s, which made them less willing to think innovatively while relying on risk evaluations that assumed a slow and incremental phase out of both nuclear and coal. An alternative explanation has pointed to a “perfect storm” of both endogenous and exogenous factors – expansion of renewable energy production in the 2000s, increasing alarm at climate change, the Fukushima accident and global financial crisis – whose coincidence would have been difficult to predict (Kungl, 2015; Kungl and Geels, 2018).

This article builds on the analyses cited above but rather than asking how or why the state ended up enacting its nuclear policy or why the big utilities were seemingly so unprepared for such a scenario, it seeks instead to understand how these firms reacted and sought to adapt to the most unique element of the German energy transition: the abrupt and unexpected nuclear phase-out begun in 2011. Thus, the methodological approach here entails a firm-level analysis of the four major utilities – investment decisions, firm structure, strategies, and approaches to risk mitigation – and how they struggled for survival subsequently. While the plight of the four was broadly similar, they adopted widely varying strategies after the Fukushima crisis. One has left the German electricity market completely, one has sold off its production capacity and limited itself to infrastructure, while the other two face enormous challenges in the goal of transforming themselves into carbon-free electricity producers. How and why did the four major utilities develop long-term strategies that differed so markedly from one another?

To this end this article takes a business history approach to transition risk where the firm is the central unit of analysis (Chandler, 1992). It builds on growing interest within business history in issues of climate change and environment, where scholars have begun analyzing how corporations have sought to transform themselves into environmental stewards, ways they have gauged and handled risk, and how enterprises have sought to identify new opportunities within this changing environment (Rome, 2019; Bergquist, 2017; Berghoff and Rome, 2017). The approach of business history is also particularly well suited to examining the decline of industries given historians’ well-developed aversion to ‘Whiggish’ narratives and attention to possibilities of historical contingency (Lamoreaux et al., 2004). Furthermore, the small-scale, firm-centered approach of business history is more fine grained than much of the current literature in energy transitions studies. As this article implicitly argues, there is significant potential for greater interaction and cross-fertilization between scholars of energy transitions and

business historians and historians of capitalism.

## 2. The German electricity sector before 2011

### 2.1. Deregulation

The highly-regulated post-1945 German electricity sector was comprised of three levels. At the local level, some 900 city works (*Stadtwerke*) acted as end supplier to consumers. At the regional level were some 80 suppliers operating transmission networks of high- and medium-voltage and some limited production capacity, which supplied both *Stadtwerke* and end consumers. At the highest level were nine major producers generating 80% of the Federal Republic’s electricity and managing a high-voltage distribution network (Brückmann, 2004).

In the 1950s, amidst postwar optimism that nuclear energy could provide clean, nearly unlimited amounts of electricity, the German state began to push nuclear. A Ministry of Atomic Affairs was formed in 1956, and federal law on atomic energy passed in 1959 followed by extensive state-funded research into nuclear power leading to the opening of the country’s first nuclear energy station in 1961. Large utilities, however, remained initially skeptical, citing risks regarding the costs of nuclear power, technical uncertainty, and the possibility nuclear would render their investments in coal-fired power plants unprofitable. By the late 1960s, however, major utilities such as Rheinisch-Westfälisches Elektrizitätswerk (RWE) had become proponents of nuclear together with major German industrial firms including Siemens and Allgemeine Elektrizitäts-Gesellschaft (AEG) that had a significant stake in construction of nuclear power plants. Popular support buttressed expansion of nuclear energy (Krichhof and Trischler, 2020; Radkau, 1983). Public opinion, however, fundamentally shifted over the course of the 1970s in the wake of major demonstrations against further construction of atomic power plants and nuclear storage facilities. The country’s experience with and proximity to the Chernobyl disaster further pressed public opinion against nuclear – the German Green Party, itself an outgrowth of nuclear protests, began advocating for an immediate stop to nuclear power generation while the social-democratic party (SPD) shifted its policy preference to a phase-out of nuclear energy (Jahn and Korolczuk, 2012; Krichhof and Trischler, 2020; Radkau, 1983; Lauber and Jacobsson, 2016). At the same time, oil crises of the 1970s reinforced the position of nuclear energy as the sector continued to benefit from state support and strongly entrenched interests. By the end of the century the country had 19 nuclear power plants producing some 30% of the country’s total generated electricity (Mez and Piening, 2002).

In April 1998 the government passed landmark legislation deregulating large parts of the sector. It kept transmission a natural monopoly but required production, transmission, and distribution within a single enterprise be separated (at least for accounting purposes) and demanded network access for third parties. The majority of the German electricity industry had been starkly against any moves toward deregulation and doggedly defended the status quo that provided them limited but protected market access. Opposition slowly broke down in the course of negotiations and with particular pressure from the European Union (Eising, 2000). Just months later, in September 1998, a red-green coalition government came to power in Berlin, passing renewable energy legislation that in some ways worked at cross-purposes to deregulation. It required electricity-heating coupling to increase energy efficiency and articulating a consensus for abandoning nuclear production, which also threatened cost increases, a factor cited by the utilities in their opposition to the legislation (Brückmann, 2004; Bechberger, 2000).

The coalition government of social democrats and the Green party immediately launched negotiations to secure a plan for nuclear power phase-out. These so-called “consensus talks”, were focused on finding a consensual agreement through which the utilities would agree to shut down nuclear power without demanding state subsidies. The government’s desire for consensus gave the industry a strong negotiating position and in the end it secured an agreement that nuclear reactors be

allowed total lifetimes of some 32 years, calculated in energy output, that could be transferred from one plant to another. Thus, a rough phase-out date of the early part of the 2020s was secured. Other issues, including taxation of “provisions” that utilities were required to keep for eventual clean-up following decommissioning, were also decided significantly in favor of the industry. These provisions, in what some analysts called an “open secret”, allowed the utilities to finance a good deal of their business activities and gave them obvious incentive to delay phase-out and clean-up for as long as possible (Mez, 2001).

Deregulated electricity markets coincided with a new, more free-wheeling German capitalism that had also been significantly liberalized. Banks had traditionally played an oversized role in Germany serving not just as a principle source for firm financing through loans but also via long-term equity holding, thereby shielding firms from short-term market pressures (Hall and Soskice, 2001; Deeg, 2010). Though significant, high levels of retained earnings meant that lending was not the sole or perhaps even primary source of bank influence over firms. Banks’ influence came as much from participation on supervisory boards, dense interbank networks between firms, as organizers and influential members of consortia, and shareholders in their own right (Höpner and Krempel, 2004; Jackson et al., 2004). These networks started to unwind in the late 1990s – also the time period of electricity deregulation – though some have suggested that changes began already in the 1970s to varying degrees (Höpner and Krempel, 2004; Marx, 2019).

2.2. Expansion and profit in a deregulated world

The confluence of rapid change in the German political economy with Europe-wide deregulation quickly led to major restructuring as larger companies gobbled up smaller utilities and municipal distribution

companies. Although the anti-monopoly authority (*Bundeskartellamt*), threatened to intervene, and in time did, in 1999 its president saw the merger trend as sign of increased competition and lower prices for consumers, arguing “we need big firms” (Jung and Schäfer, 1999). By the time the dust had settled eight major national electrical utilities had become four. By 2003 some 90% of the electricity produced in Germany originated in the facilities of one of these massive enterprises (Brückmann, 2004). Two utilities, RWE and E.ON, controlled over 50% of electricity production, 43% of high-voltage transmission wires, and held stakes in some 75% of all regional and municipal utilities (Morris and Jungjohann, 2016).

The largest was E.ON, the product of a ‘mammoth wedding’ of two of the largest utilities in Bavaria and North-Rhine Westphalia in what was at the time the largest German corporate merger ever. E.ON now had over 200,000 employees and included daughter companies in everything from logistics, heavy industry, silicon, real estate, electronics, retail, telecommunications, and chemicals. Plans were immediately announced to sell up to one-third of the business to fund the costs of the merger. Like the other German utilities, it had entered the deregulated era reliant more on bank loans rather than credit markets. In 2002, however, it issued over €11 billion in bonds (Fig. 1) and then spent much of the 2000s reducing it’s debt load that resulted from its rapid growth at the start of the millennium (Der Spiegel, 1999). It also expanded quickly into world markets outside Germany, as well as into natural gas. E.ON was, as a result, in some ways the most ‘Americanized’ of the Big 4 – a highly leveraged company, funded primarily via capital markets, and with the great majority (over 90%) of its stock in free-float with no controlling or significant concentration of shares.

The rest of the decade saw the company consolidate these assets across Europe, as well as spread to other electricity markets in Russia, Spain, Italy, and Eastern Europe. By 2010 generation capacity outside of

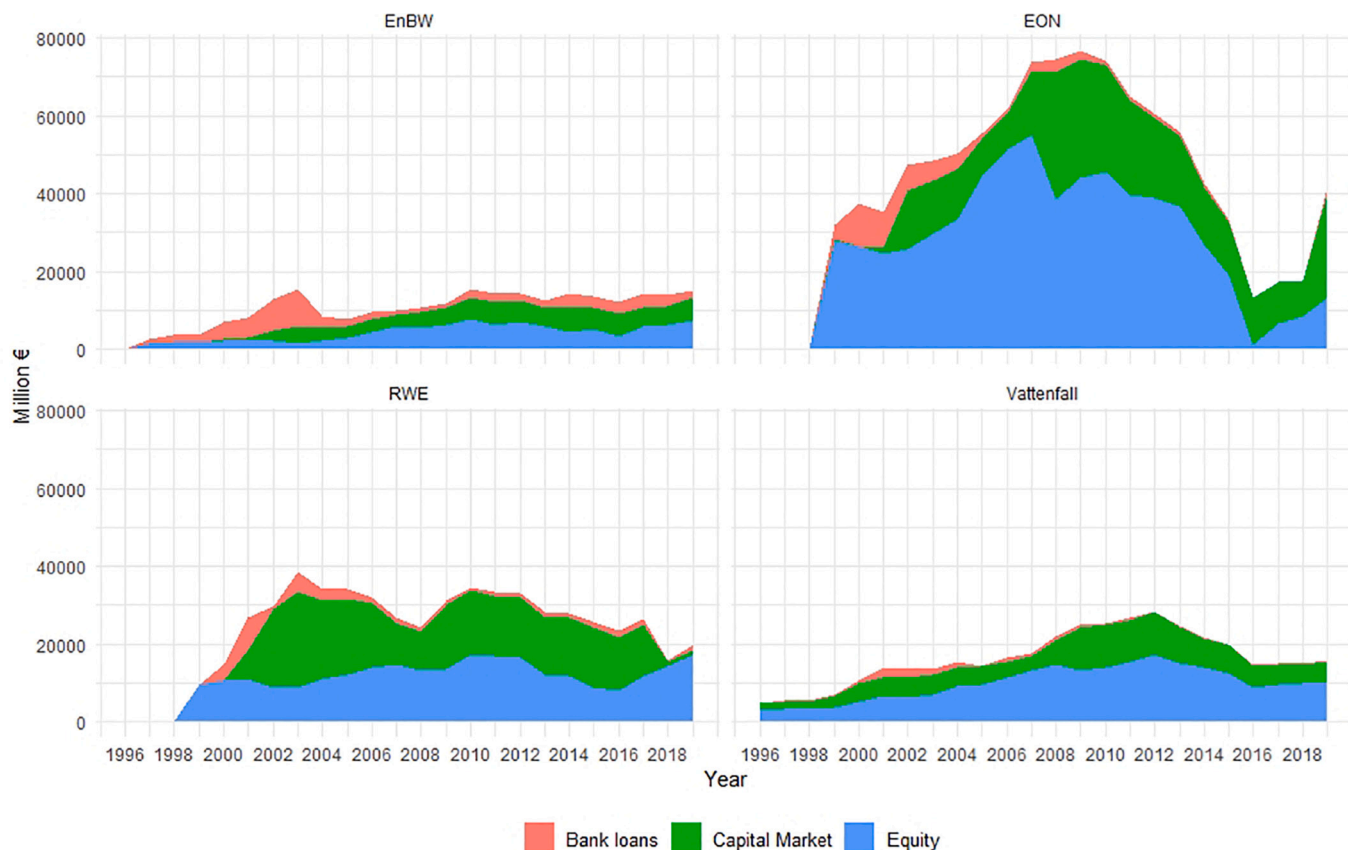


Fig. 1. Capital structure of the four big German electrical utilities. Here and below, figures compiled from corporate year-end reports to investors and author’s calculations.

Germany represented over 48% of its total. Like the rest of the Big 4, E.ON enjoyed growth and large profits for the bulk of the decade, with earnings before interest, taxes, depreciation, and amortization (EBITDA, a frequently-used industry indicator) topping €13 billion with some 85,000 employees worldwide (58% outside Germany) in 2010 (E.ON AG 2011). Germany represented slightly under half of E.ON's total sales, with European-wide gas under one-third, UK electricity some one-sixth and Nordic and other markets the remainder. This was roughly the strategy going forward: E.ON's new investment plan in 2007 for the following seven years were dominated by coal-fired plants to enter service between 2011 and 2014, followed by gas-driven facilities ('combined-cycle gas turbines'). Renewables made up just 15% of total planned investment spending (E.ON AG 2008; E.ON AG, 2010).

Nevertheless, the tone of E.ON's corporate reports shifted in 2008 and 2009 with significantly increased coverage and attention given to renewables, as the corporation advertised its goal to achieve an energy mix consisting of 24% renewables by 2030. The company stated it had been willing to cut back CO<sub>2</sub> emissions significantly more under the Copenhagen climate talks. The climate summit's failure, reported E.ON, meant that it also scrapped its more daring plans. E.ON was committed to a more serious climate strategy only if its competitors would be forced to adhere to one as well. Similar conditionality is also part of transition plans among large oil producers (Christophers, 2022). In 2010, the corporation moved (and deprioritized) its renewable energy business unit into a more general 'Emerging markets' group and attention devoted to renewables in annual reports, which had spiked in 2008 and 2009, dissipated (Fig. 2).

RWE had expanded too and was now the second-largest German utility and eighth-largest corporation overall, boasting some 132,000 employees in 2002, mostly concentrated still in its native North-Rhine Westphalia (Fig. 3). Founded in the late nineteenth century, the first three-person board of directors of RWE had included the mayor of the utility's headquarters Essen. By 1905 not only were municipalities represented on the board, Essen, Gelsenkirchen, and Mülheim municipalities held significant shares in the company; the strategy of co-opting and incorporating municipalities was key to RWE's initial expansion (Eising, 2000; Schweer and Thieme, 1998). This pattern remained. Roughly 40% of the shares of the new, post-merger RWE were retained

by municipalities. Many commentators found this to be a deep weakness. An article in the weekly Der Spiegel argued that the corporation lacked initiative and its management resembled a government agency, bereft of creativity and zeal. "In the Essen conglomerate, the public sector has the last word" (Spiegel, 1999).

The question of the firm's identity was in play in the struggle to name a new CEO in 2003 with implications for how the corporation would be run – for its workers and, theoretically, in close coordination with the municipalities, or with an eye toward financial indicators and shareholder value. The big shareholders eventually prevailed and a CEO from outside the company, outside the electricity sector, and even outside the country was named in the person of a long-time Shell executive and native of the Netherlands. For a company so deeply integrated with both local and federal levels of state, having a CEO who did not even speak solid German was a major shift of both material and symbolic importance (Spiegel, 2002a). While unions and the municipalities often had overlapping interests and local governments were also deeply concerned about employment, at the end of the day the municipalities relied on stable dividend payments to supplement their tight budgets. Thus it was hoped that a *Sparkurs* that drove down debt and overhead – up to and including reducing employment – would lead to continued dividends. This was, at the end of the day, the priority for municipalities (Spiegel, 2002b).

Like its chief rival E.ON, RWE expanded geographically over the decade, stretching across Europe, Turkey, Russia, and the United States. In 2010, Germany was the origin of 66% of RWE's EBITDA and home to 58% of its 71,000 strong workforce (RWE AG, 2011). So, too, did the company's CO<sub>2</sub> emissions grow. RWE's production mix had traditionally been based on the coal of the Ruhr valley along with nuclear built in the regulated era. By 2007 it was Europe's single largest corporate carbon emitter. Like the others, the strategy seemed to be to stay the course and plot out a gradual increase in renewables over the next several decades. Thus, RWE had a large amount in common with E.ON – not only were they clearly the two dominant players on the German market, they were highly leveraged and funded almost exclusively on the capital market, and both with American-style executive compensation to boot (Fig. 3). RWE, however, had deep and historical ties with its region and local municipalities of the German rust belt.

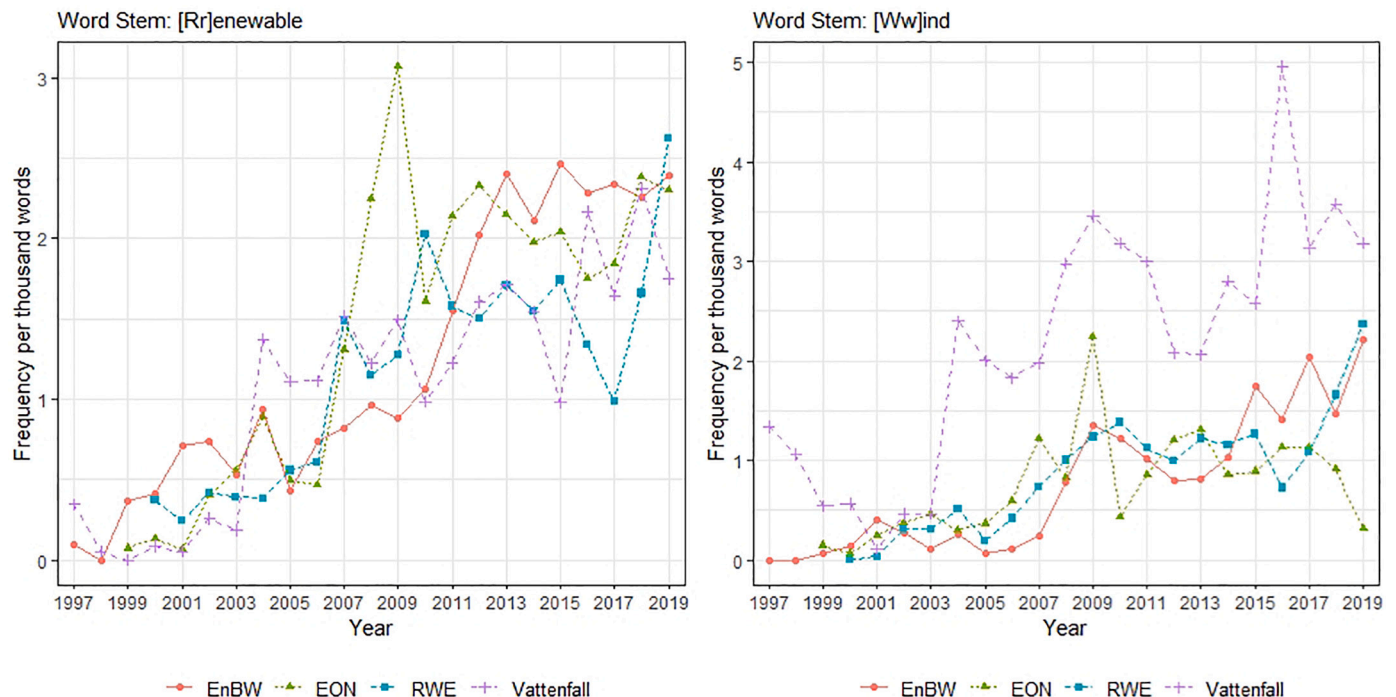


Fig. 2. Word frequencies in year-end reports to investors.



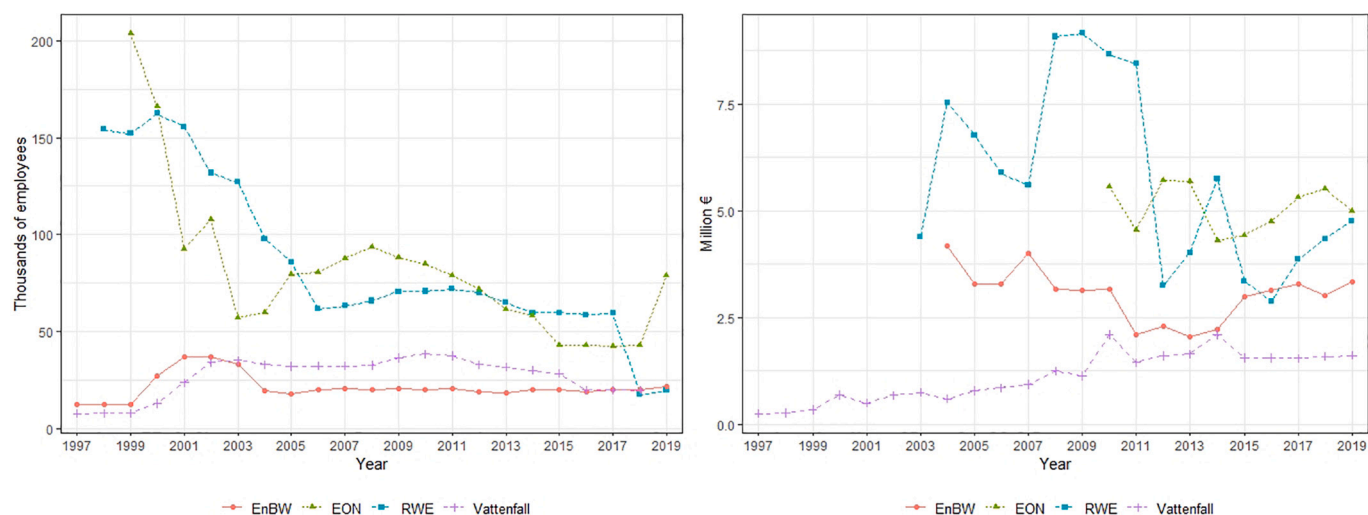


Fig. 3. Total number of employees (left) and CEO compensation (right), including salary, stock, and other incentives as reported on year-end balance sheets.

RWE was subject to severe criticism from environmental groups. Its reaction was sharp. In the company's year-end report for 2006 the CEO wrote to stockholders that "unfortunately, the discussion [on climate] – especially in Germany – is frequently conducted in a manner lacking objectivity." He agreed, on behalf of RWE, that the need for renewables was clear and that all resources available should be put toward replacing coal and nuclear energy, "but with some sense of proportion and, please, without dogma," he chided (RWE AG, 2007). Indeed, the company put much more emphasis on "clean coal" and nuclear technologies as an "innovative path toward climate-friendly electricity production" than on renewables (RWE AG, 2008). Thus, much of the increased word frequency of 'renewables' (Fig. 2) or 'climate' was in the context of arguing against them. Digging its heels in, the company entitled its 2010 annual report 'Straight talk' directly confronting and contesting the many allegations against it that had sullied its image, insisting that it was "improving our CO<sub>2</sub> balance", continuing "clean, safe, and affordable" nuclear production while blaming state regulations for high consumer electricity prices (RWE AG, 2011).

Energie Baden-Württemberg (EnBW), a product of a 1997 merger between two regional companies, was jointly held by municipalities and the southern federal province of Baden-Württemberg. In the late 1990s more than one-third of its shares had been on the auction block, both the province and city of Stuttgart looking to divest. RWE, among others, bid. The shares, however, ended up going to the French state-owned giant EDF, Europe's largest electricity producer. EnBW was the smallest of the Big 4 and had the characteristics of a regional, less-internationalized firm such as lower executive compensation, greater proportion of bank funding of its financial liabilities, and more local base of operations. In 2010 just 7% of its 21,000 person workforce was located outside of Germany, largely in the neighboring Czech Republic. However, over the course of the 2000s EnBW, too, shifted from bank-based to capital market-based financing (Fig. 1). As the group drew progressively more from bonds and financial instruments, so too did the emphasis it put on its financial details and stock price in its annual report, which for much of the 2000s was given first billing in annual reports, only followed by summary of its business activities and corporate strategy for the year.

Its production mix featured a relatively high amount (some 10–15%) of renewables (mostly hydro) with roughly half made up of nuclear – including nuclear in France contracted to EnBW through EDF (Fig. 4). Thus, as the need to transition to non-fossil fuel production became more and more clear over the 2000s, EnBW found itself in the relatively enviable position of having only some 30% of its production mix based on carbon. The company's strategy over the decade focused on increasing investment largely in existing areas. After divesting itself

of peripheral businesses in the early years of the new century (including telecommunications and even shoes through ownership of the Salamander brand), rhetoric around carbon featured increasingly prominently, though the large bulk of actual investment mostly went to hydro, nuclear, or modern, cleaner coal technologies. While flashily advertised, wind – in the form of land-based farms abroad or offshore farms in the North and Baltic Seas – was still a long-term plan in 2010 and even then only projected to be 15–20% of total capacity once installed years down the road (EnBW AG, 2011). This, along with continuation of most nuclear activity, comprised EnBW's plans for the future as of 2010.

As part of their mergers, both E.ON and RWE had been forced by the anti-monopoly authorities to relinquish their stakes in the East German electricity company VEAG. In their place came Vattenfall, a corporation wholly-owned by the state of Sweden. Vattenfall, founded in 1909, had, in the late 1990s, made an explicit decision to become a European player in energy markets. Thus, in 2000, it took its first steps to expand outside the Nordic market, acquiring stakes in companies both in Germany and Poland. Net sales quadrupled, number of employees increased five-fold, and quantity of electricity sold rose from 87 to 180 TWh over the period of just one year (Vattenfall AB, 2001). After first acquiring a local Hamburg electricity distributor, Vattenfall then purchased a controlling stake in the Berlin producer and supplier BEWAG including majority ownership of VEAG. With it came responsibility for a vast and dirty lignite supply chain and coal-fired power plants of the new federal states. This provoked some reflection, according to one account, in a state-owned company hailing from a country where coal was heavily frowned upon (Högselius, 2009). Yet a new generation of managers less tied to both the electricity sector and less beholden to the state, made the decision from a business perspective that the fundamentals were sound. Thus, by 2002, Swedish Vattenfall was the major player in the new provinces of the east, as well as in the cities Berlin and Hamburg. While the company had a mandate to function as a for-profit enterprise, submitting its earned income back to the state, it also had parallel mandates to be a leader in clean energy. Much like the others, it gave increasing rhetorical attention to renewable energy and the need to move away from fossil fuels, but here, too, clean energy generally meant focus on nuclear, carbon capture and storage (CCS), along with gradual build-up of wind (Fig. 2).

The first decade of the new millennium was, thus, a time of rapid expansion for the biggest four electricity suppliers in Germany. In the context of both a deregulated industry and the fundamental shift in German political economy, the companies leveraged up to expand aggressively internationally while selling off non-core activities. Shareholders in the two publicly-traded companies grew more international and executive compensation shot up. The financial fundamentals

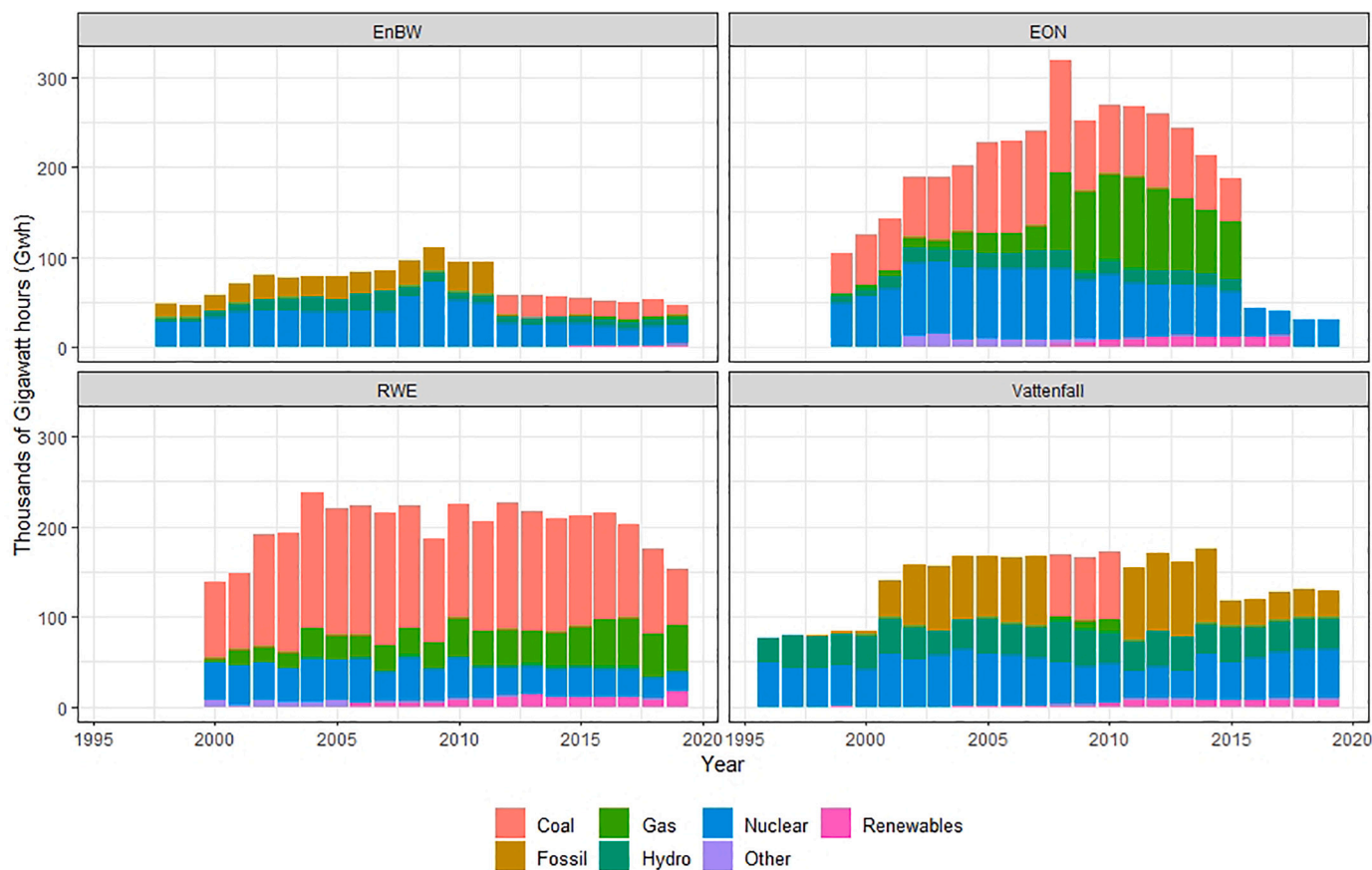


Fig. 4. Generation mix.

of the corporations in all annual reports over the 2000s moved into more prominent positions as the companies increasingly stressed the performance of their stock and their position vis-a-vis capital markets, financial ratings, and subscription to bond offerings. Increased emphasis over the decade was put on financial metrics such as debt leverage as companies were eager to pay down debt to keep capital markets happy, involving both keeping operating expenses and investments low. In conditions of high prices on electricity and steady demand, stock prices followed suit and dividends were stably awarded in the neighborhood of 50% of total profits. For some commentators, this was too good to be true and complaints of monopolistic pricing continued, including findings by government agencies that the four had, indeed, engaged in coordinated pricing strategies (Spiegel, 2007, 2009; Dohmen and Nelles, 2007). In hindsight, one might also question whether high debt level and focus on returns to shareholders might have reduced capacity to deal with future shocks. For the time being however, the four firms appeared well placed to ride out any possible bad times. Even when the global economy crashed into crisis in 2008 and 2009, moderately stable prices and inelastic demand for electricity meant that the Big 4 weathered the storm in comparatively good shape. While the companies were no doubt aware that the world was beginning to move away from fossil fuels and, in Germany, nuclear, they were confident that this could be phased in gradually.

### 3. Shock, crisis, and adaptation

The phase-out (*Ausstieg*) of nuclear continued to be a topic of political discussion in the years following the agreement of 2002. Debate began again in 2005 after a strong showing for the Christian Democrats and emerged in full force in 2009 when the Christian Democrats and liberal Free Democrats formed the government. Under arguments of

national industrial competitiveness, carbon emissions targets, and electricity prices for consumers, the government now aimed to revise the schedule of nuclear phase-out such that nuclear power stations' running times would be extended as a "bridge technology" to clean, reliable, and cheap electricity, much as the energy companies themselves argued (Bundesregierung, 2010). While the government also enacted a tax on nuclear fuel rods – a measure the utilities bitterly opposed – so, too, did it amend the Atomic Energy Law to allow nuclear stations to operate up to 14 years longer than per the 2002 agreement (Sebastian et al., 2010; RWE AG, 2011; Schreurs, 2012).<sup>1</sup> This was pithily coined the "phase out of the phase out" (*Ausstieg aus dem Ausstieg*) and would allow nuclear electricity generation into the 2030s.<sup>2</sup>

Less than a year later, however, the federal government summarily scrapped the deal that had been so recently whittled out. The Fukushima reactor meltdown, together with local political considerations, impelled the government to hastily and unilaterally rewrite the phase-out agreement and provided a policy window to pass far-reaching legislation. Nuclear drawdown would now occur on a significantly accelerated timeline. Eight nuclear plants, including one already down for repairs, were shuttered and never to come back on line. After a "stress test" and a report from a "ethics committee" made up of elder statesmen, the government proposed legislation to remove all remaining 11 nuclear plants by 2022 at the latest. The measure passed the Bundestag by a large

<sup>1</sup> The legislation was passed in somewhat unusual circumstances, bypassing the Bundesrat and eliciting protests that the law had circumvented a legally required vote. The opposition suspected a quid pro quo of longer nuclear lifetimes in return for taxes to flow into the federal budget, a deal the utilities openly acknowledged (RWE AG, 2011; Schreurs, 2012).

<sup>2</sup> The tax, on nuclear fuel rods, was eventually declared unconstitutional and refunded to the companies.

margin (Renn and Marshall, 2016).

The effects on the utilities' balance sheets were clear and immediate. Huge amounts of assets buried in nuclear power plants would have to be decommissioned, thus written down, painfully biting into profits and causing debt factors (ratios of debt to earnings or equity) to skyrocket (Fig. 5). Like concerns surrounding "transition risk", it was a sudden ruling, unexpected not in its aims but in its timing and abruptness.

In fact, the crisis was not just Fukushima. The utilities seemed to have been caught in a contingent confluence of events, what Geels and Kungl have called a "perfect storm" (Kungl and Geels, 2018). Just as a major source of revenues and buried assets were forcibly removed from their books renewables were becoming progressively competitive. So, too, did the utilities suffer from record low electricity prices driven by the economic doldrums of the Eurozone crisis. Both these factors made a difficult situation significantly worse. In their letters to shareholders the CEOs of all four companies struck a similar note: they had known that change was coming but they never imagined it would need to happen so quickly. Indeed, the confluence of events could not have been foreseen, even if they, particularly RWE, might reasonably have been accused of badly misreading the room on renewables.

Regardless, the utilities' first response was legal proceedings, complaining of unfair actions by the state and demanding to be compensated. All four utilities had recourse to this, but the difference in actions is telling. E.ON, Vattenfall, and RWE announced their plans to formally sue in court seeking reimbursement for damages due to the decision, contra what they had previously been promised, to retire nuclear plants early. The firms, so went the complaint, had been given a time line in 2002 which had then been extended in 2010 only to be cancelled some seven months later. This was simple dispossession, they argued, as the right to use their power plants as *power plants* had been summarily and unilaterally withdrawn (Kreuzfeldt, 2016). Some six years later, the German Constitutional Court in Karlsruhe found these claims to be legitimate and ordered partial reimbursement, though only a fraction of what was claimed by the utilities. Both RWE and Vattenfall were entitled to reimbursement for the amount of electricity they were promised in the previous federal agreement. E.ON was found not to have a claim. Otherwise, all three would also be evaluated for investments made in the seven months between the 2010 agreement and the 2011 decision. Fundamentally, however, the court held that the phase-out of the phase-out was not something that the utilities could claim damages from. The revised timetables were adopted by legislators with the health and safety of the population and the protection of the environment as their goal and "therefore, achieved a risk minimization of significant extent" (Oeder, 2016).

EnBW pursued reimbursement on a smaller scale for claims resulting from the immediate shut down and subsequent mothballing of reactors in 2011. These claims that were eventually denied by a regional court. The corporation declined, however, to participate in the suit to the high court due to its shareholders. The state of Baden-Württemberg had reacquired its shares in 2010. To the surprise of many, "Schwabian electricity socialism" had been reinaugurated (Kröger, 2010). By 2011 the regional government owned 45% of EnBW's shares with municipalities making up almost all the rest. Less than 1% of stock was in free circulation; some 98% was owned by organs of the state. Thus, EnBW announced it would not lodge a complaint along with the other utilities because it feared it lacked legal standing to, in essence, seek compensation from itself. No less important, if not explicitly stated, was that only months before Fukushima, a red-green coalition government had come to power in Stuttgart with the first Green party Minister-President in German history. As Der Spiegel surmised about pressing the state on the nuclear phase-out, "going to the Constitutional Court would have been to rebuff the regional government in Stuttgart, an important minority shareholder of the concern. ... this was not a problem E.ON, RWE, or Vattenfall have, which are in private hands" (Spiegel, 2012).

Of course, Vattenfall was not exactly in private hands. Yet, not only did it have no problems pressing its case against the German

*Energiewende* in German courts, it pushed even farther. Vattenfall launched an appeal and demanded arbitration through the WTO, which it had recourse to as a foreign company protected by the strictures of world trade architecture. This had the strange, and somewhat unsavory, effect of having the Swedish people seek compensation, to the tune of €4.7 billion, for Germany's attempt to move away from nuclear energy.

After a high-flying decade, the Big 4 now found themselves in a struggle for their lives. E.ON, in possession of the largest amount of nuclear plant, was the quickest to take action. While also launching cost-cutting and divestment campaigns, already in 2011 it advertised a new corporate strategy 'E.ON 2.0' and its CEO noted the need for a 'sober view' of what lie ahead. The company's balance sheet was heavy with assets whose value would almost certainly need to be written down in the years to come and the market in Europe was not expected to grow anytime soon. Thus, the company in 2013 decided to decommission a quarter of its European energy production. By 2014 the strategy had reached its culmination in the announcement that there were "two energy worlds" now, one conventional and one renewable, with concern also given to smart grids, and other local technology to improve efficiency and the grids of the future. Thus, they announced plans to spin off their conventional production facilities, what just years prior had been their most significant source of profits. The company had already, the CEO less-than-humbly noted, been praised for its "revolutionary business model" ... some see us as pioneers" (E.ON AG 2015). This was an optimistic exit on billions of euros in losses. Yet, it was a major change in course and at a time when the other three still seemed to be searching for a strategy forward.

Having divested itself of its fossil fuel production, E.ON then took another step in 2017 when, in an asset swap with RWE daughter Innogy, it agreed to divest itself of its generation plants almost completely in return for Innogy's network of infrastructure assets. E.ON would thus completely exit (following the decommissioning of its last nuclear plants by 2022) production to concentrate on infrastructure maintenance and customer-facing technologies – including smart grids, EV charging networks, and consumer technology. Again the CEO boasted that this represented "one of the most creative transactions in German history". However, the transformation of E.ON was, indeed, breathtaking. In less than a decade the company had gone from producing over 300 TWh of electricity, second most in Europe, to exiting production completely.

At Vattenfall, despite discussions about "a new normal" and "talks with our owner", there was little new in the way of strategy. Taking nuclear plants offline, some only temporarily but with their operating lifetimes slashed, cut not only into profits but also into assets as the company was forced to write-down the value of nuclear assets (called 'impairment'), leading to automatic reductions in equity on the liabilities side of the balance sheet. Like all the other utilities, Vattenfall announced cost-cutting measures, divestment of non-core assets (with changing definitions for what was regarded as "core"), and reductions in investments. In 2014 a new CEO took the helm and noted "uncertainty about where Vattenfall is headed" among its employees (Vattenfall AB, 2015). Still, however, there was no clear strategy articulated, other than a comment, made almost in passing, that the company was looking to unload its lignite operations in Germany, something that had also been reported in the press (Dohmen, 2013).

The company did finally divest its German coal operations in 2016. Yet it was not until 2017 that a clearer strategy was articulated in its annual report. In large letters on its cover the company declared itself to be committed to going 'Fossil free within one generation' (Vattenfall AB, 2018). Children graced the covers of both 2017 and 2018 reports to underline the message. This more clearly articulated strategy happened to be accompanied by return to profitability after five years in the red. The new Vattenfall would be based on decentralized, smaller-scale electricity, with significant investments in grid, infrastructure, and local solutions, with new investments in wind and, now, solar. It would also transition into a minor role in the German market, going from producing 70 TWh of electricity a year in 2014 to 22 TWh in 2017 and

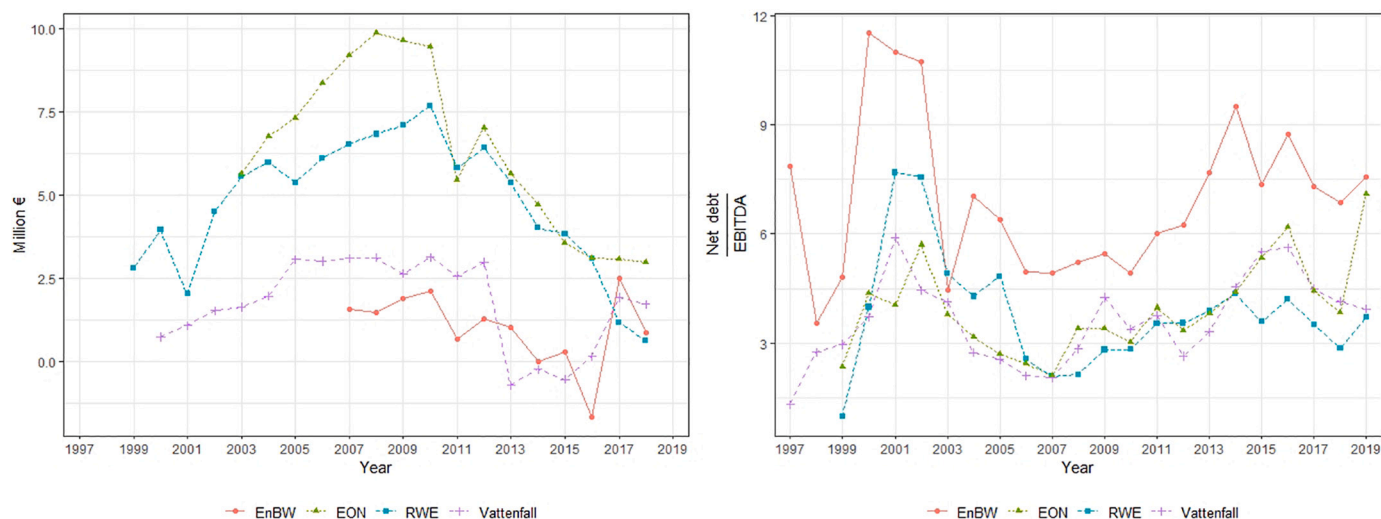


Fig. 5. EBIT (earnings before investment and taxes) on the left and debt factor on the right. Earnings decreased and debt levels rose in the aftermath of 2011.

halving its workforce.

EnBW, on the other hand, had nowhere else to retreat to. Like the others, it initially responded by announcing plans for cutting costs and increasing efficiency, divesting itself of non-core units, and capital restructuring. The following years featured much of the same. While talk continued on renewables, word frequency shows that at EnBW, as well as the others, attention given to renewable energy sources in reports to investors was somewhat stagnant after 2011 compared to the first decade of the century (Fig. 2). Indeed, the company actually opened more coal facilities, noting that these were significantly less emissions intensive than older models, though, as the report noted, “the economic outlook for conventional generation facilities in Germany has worsened considerably” (EnBW AG, 2014). However, the company seemed to founder, posting profits below or around zero from 2011 to 2016. It’s stable and local shareholding structure might have given it some reprieve, as they company suggested in its 2014 reporting, allowed them to think more long term (EnBW AG, 2015).

In 2014 and 2015 EnBW began to articulate a more coherent strategy – which they framed around two core focal points: ‘customer proximity’ and becoming the ‘engine room of the Energiewende’. Thus, it pronounced its intention to shift its attention to both local area networks and small-scale customer solutions and renewable energy. By 2020, the company aimed at renewables comprising 40% of their generation portfolio. Whereas before 2013 its wind production had been stagnant and fossil fuel generation on an upward trend, by 2019 wind power generation had increased six-fold to comprise seven percent of total production and coal use reduced by more than half. Indeed, by 2019 the company complained about German renewable energy law, not that it was too generous to renewables as had been the common refrain in the past, but that legislation made in 2017 unfairly inhibited siting and building of wind farms (EnBW A G, 2020).

RWE took longer to elucidate a clear strategy for transitioning to a post-fossil fuel future. Like the others, RWE’s immediate response was to cut costs and increase efficiency. While consecutive CEOs noted how fundamentally challenging the situation was for RWE, little new was articulated in the way of long-term strategy. RWE also seemed to have a more difficult situation on its hands because of its unique, historical shareholder structure: its shareholder municipalities were particularly reliant on dividends and in a position to make their voices heard. Decreased or absent dividend payments shot holes in already stressed rust-belt municipal budgets (Spiegel, 2014). The municipalities, now owning some 20–25% of total shares, consistently and noisily opposed behavior that would lead to decreases in dividend payments (Andresen, 2014). Both contemporary media accounts and analysis since have

suggested this might have been another issue making it difficult for RWE to change course, yet RWE does not particularly stand out when dividend-to-profit payout ratio is considered (Fig. 6). However, it was widely reported that this had led to increasingly difficult relations with the post-Fukushima CEO of RWE who had sought financing to build a new strategy for RWE (Dohmen and Hawranek, 2015).

In 2015, after years of troubling financial metrics including its first net loss in decades, RWE’s CEO announced that the company would bundle its renewable, grid, and retail segments into a new subsidiary that would remain a part of the group but trade on the stock exchange and fund itself independently on capital markets. It was essentially E.ON’s decision in reverse. Innogy emerged with an IPO and subsequent market capitalization well in excess of the rump parent company. And, as a sign of which way the wind was blowing, RWE’s CEO opted to take the job of Innogy head.

Just two years later, however, the deal was undone. If, for E.ON, this represented a continuation of its move to depart from generation (first giving up conventional generation then leaving the business altogether), for RWE it was backtracking. Having spun off its renewables to concentrate on conventional production, it was now re-acquiring its renewable production. As RWE’s CEO spoke of the deal in its 2018 annual report, this was a “new RWE” that would focus increasingly on renewables but still house significant conventional capacity. In 2019 the company announced it would be carbon neutral by 2040 and was seeking to remake its image as a “green power company”. This was perhaps the most daring but also most conventional strategy adopted by the Big 4 – a plan to transform itself into a carbon-free powerhouse while retaining its traditional capacity.

#### 4. Conclusion

Utilities are large, complex corporations with multiple overlapping interests pulling in different directions and at different speeds. As argued here, painting them all with the same broad brush overlooks how different the companies were and how different their reactions to the early 2010s conjuncture were. Through the course of a painful several years after 2011, at least three, if not four, separate strategies were worked out. E.ON, the most Americanized of the four – more highly levered, most dispersed shareholding structure, with highly-remunerated CEO and generous payer of stockholder dividends – was the one to move most swiftly and radically to define a new strategy for itself, cutting over 75 million tons of annual carbon emissions to almost nothing essentially overnight (Fig. 7). Vattenfall, too, largely exited the German electricity production market, reconsolidating itself in its





Fig. 6. Dividend payouts as a ratio of net profits. The dotted line denotes 0, below which dividends were paid in loss-making years. Shaded area shows region between 30–50%, which utilities often spoke of as optimal level of dividend payout.

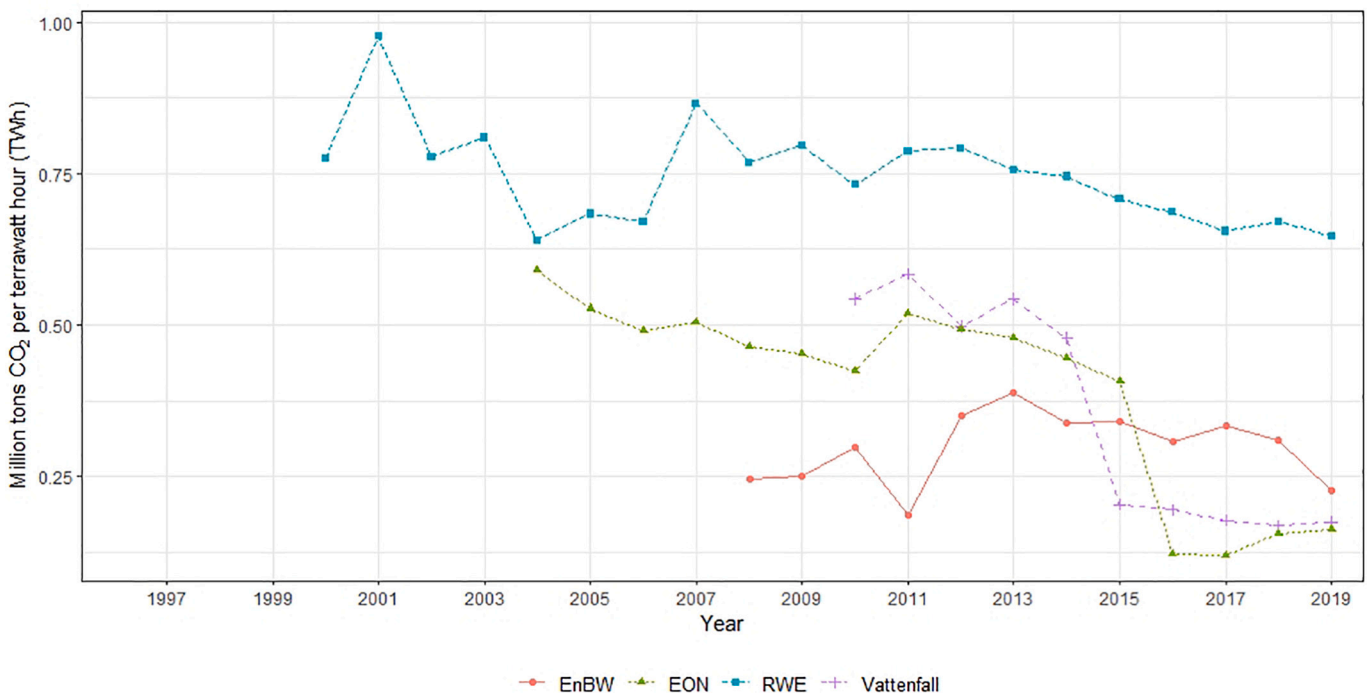


Fig. 7. Emissions intensity: direct (scope 1) CO<sub>2</sub> emissions per unit of electricity produced.

Scandinavian base and focus on hydro and nuclear generation. Although their state ownership and explicitly dual mandate might have contributed to this decision, in most respects Vattenfall played as hard and

ruthlessly as the privately owned utilities. EnBW, owned by different levels and entities of the state, lacked the same kind of mandate on renewable energy that consolidated federal state ownership provided

Vattenfall. It was lucky to have a comparatively large chunk of its energy mix in hydro and a home, local-ownership base in Germany's most prosperous province. RWE had not just legacy coal assets but a home base in an area where coal had been the foundation of the economy. It was pulled in many different directions and, perhaps, this is what made it so difficult for it to articulate a response. And what left it in what is likely the most precarious position of all the Big 4 in terms of the future.

When viewed from the perspective of transition risk, the German nuclear shut down first suggests how varied reactions are likely to be to sudden stops. Legal challenges, however, are probable as a first response, a move that both increases and prolongs uncertainty. Second, firms' history and shareholding structures play a significant role in the strategies to deal with these challenges. Firms with shareholders and historic ties to localities will find it harder to divest of old infrastructures and make them less flexible to pivot into neighboring niches. Local shareholders and voices on corporate boards do not necessarily orient firms to cleaner production, indeed the opposite is often true. Finally, in addition to 2011 producing a "perfect storm" of regulatory and economic shocks to the electricity sector, an initial shock preceded Fukushima – namely, utility deregulation and liberalization in the German political economy as a whole. The utilities meeting the challenges of 2011 were, thus, very different entities than they had been ten years prior – more leveraged, dependent on capital markets, and focused on returns to shareholders – and almost certainly less resilient to shocks. Here, too, shareholding structure had significant effects on decision-making, though as the case of Vattenfall illustrates, these effects are idiosyncratic and less pronounced than might be expected.

Importantly, however, what is good for firms is not necessarily good for society and the planet in general. E.ON and Vattenfall thus offer ambiguous examples. While both utilities reacted to the 2011 crisis by radically changing their businesses that led to drastic cuts in their emissions, they did so by divesting rather than decommissioning. The emissions simply went onto different balance sheets.<sup>3</sup> On the other hand, easing large, powerful incumbents out of the sector could have positive add-on effects by weakening lobbying coalitions that might make passing climate legislation more difficult. Weighing these factors against one another is a promising topic for future research.

Finally, while debates on climate mitigation and transformation often hinge on establishing markets for carbon and getting the prices right, the price for carbon – in existence since 2005 through the EU Emission Trading Scheme – is notable in its absence from the story here. Carbon prices were duly reported on and tracked by the companies but did nothing to make them think that transformation was urgent. Indeed, the low prices and allowances for carbon emissions that were given to the utilities, especially in the early stages, might have even added to complacency, implying that by integrating carbon prices into project accounting and strategic planning the companies were sufficiently taking climate considerations into account.<sup>4</sup> The nuclear exit was also quickly translated into prices, costs, and impairments as the state changed the bundle of rights associated with ownership of nuclear facilities (Honoré, 1961). Here, as much as with carbon markets and any other climate regulations, price is political as much as technological (Breetz et al., 2018).

<sup>3</sup> This has been a recent topic of much discussion within both activist and investing communities with numerous examples of divestment causing greater harm because smaller, less transparent, and difficult-to-monitor companies often buy polluting enterprises with the explicit goal of squeezing as much, as quickly, out of the polluting technology as possible (Raval, 2021).

<sup>4</sup> The unstable and low prices for much of the EU's carbon market scheme are well known. Initial analysis suggested that the German utilities took carbon prices into account for small-scale investments but not larger, longer term ones (Hoffmann, 2007). For general reflections and critique of carbon trading methods for bringing about deep decarbonization, see Cullenward and Victor (2020).

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- Andresen, T., 2014. RWE-Aktionäre Wollen Kapitalerhöhung in Diesem Jahr Blockieren, Welt.
- Batten, S., Sowerbutts, R., Tanaka, M., 2016. Let's Talk about the Weather: the Impact of Climate Change on Central Banks. Working Paper, 603. Bank of England, London.
- Battiston, S., Dafermos, Y., Monasterolo, I., 2021. Climate risks and financial stability. *J. Financ. Stab.* 54, 1–6.
- Bechberger, M., 2000. Das Erneuerbare-Energien-Gesetz (EEG): Eine Analyse des Politikformulierungsprozesses. [https://refubium.fu-berlin.de/bitstream/handle/fub188/20003/rep\\_00-06.pdf](https://refubium.fu-berlin.de/bitstream/handle/fub188/20003/rep_00-06.pdf).
- Berghoff, H., Rome, A., 2017. Green Capitalism?: Business and the Environment in the Twentieth Century. University of Pennsylvania Press, Philadelphia.
- Bergquist, A.-K., 2017. Business and Sustainability: New Business History Perspectives. Harvard Business School General Management Unit Working Paper, Cambridge, MA, pp. 18–34.
- Brückmann, S.O., 2004. Probleme der Deregulierung in der deutschen Elektrizitätswirtschaft: Eine industrieökonomische Analyse. Reihe, Volks- und Betriebswirtschaft, Frankfurt.
- Breetz, H., Mildenerberger, M., Stokes, L., 2018. The political logics of clean energy transitions. *Bus. Politics* 20 (4), 492–522.
- Bundesregierung, 2010. Energiekonzept: Für eine Umweltschonende, Zuverlässige und Bezahlbareenergieversorgung. White paper, Berlin.
- Carney, M., 2015. Breaking the tragedy of the horizon-climate change and financial stability. *Speech Lloyd's Lond.* 29, 220–230.
- Carney, M., 2018. A transition in thinking and action. In: Remarks at the International Climate Risk Conference for Supervisors, Vol. 6. The Netherlands Bank, Amsterdam.
- Chandler, A.D., 1992. Organizational capabilities and the economic history of the industrial enterprise. *J. Econ. Perspect.* 6 (3), 79–100.
- Christophers, B., 2022. Fossilised capital: price and profit in the energy transition. *New Political Economy* 27 (1), 146–159.
- Cullenward, D., Victor, D., 2020. Making Climate Policy Work. Polity, Medford, MA.
- Dafermos, Y., Nikolaïdi, M., 2021. How can green differentiated capital requirements affect climate risks? A dynamic macrofinancial analysis. *J. Financ. Stab.* 54, 100871.
- Deeg, R., 2010. Industry and finance in Germany since unification. *German Politics Soc.* 28 (2), 116–129.
- Dohmen, F., 2013. Abgeklemmt. *Der Spiegel* 38.
- Dohmen, F., Hawranek, D., 2015. Sisyphus in derGrube. *Der Spiegel* 21.
- Dohmen, F., Nelles, R., 2007. Pakt mit den Bossen. *Der Spiegel* 46.
- D'Orazio, P., Popoyan, L., 2019. Fostering green investments and tackling climate-related financial risks: which role for macroprudential policies? *Ecol. Econ.* 160, 25–37.
- Eising, R., 2000. Liberalisierung und Europäisierung: Die Regulative Reform der Elektrizitätsversorgung in Großbritannien, der Europäischen Gemeinschaft und der Bundesrepublik Deutschland. Springer-Verlag, Wiesbaden.
- EnBW AG, 2011. Geschäftsbericht 2010: Energie ist Vielfalt. Annual Report. EnBW Energie Baden-Württemberg AG.
- EnBW AG, 2014. Bericht 2013: Energiewende. Sicher. Machen. Annual Report. EnBW Energie Baden-Württemberg AG.
- EnBW AG, 2015. Bericht 2014: Energiewende. Sicher. Machen. Annual Report. EnBW Energie Baden-Württemberg AG.
- EnBW A G, 2020. Integrierter Geschäftsbericht 2019: Transformation. Annual Report. EnBW Energie Baden-Württemberg AG.
- E.ON AG, 2008. Geschäftsbericht 2007. Annual Report. E.ON AG.
- E.ON AG, 2010. Unternehmensbericht 2009: Die Zukunft der Energie, Wiedergedacht. Annual Report. E.ON AG.
- E.ON AG, 2011. Geschäftsbericht 2010. Annual Report. E.ON AG.
- E.ON AG, 2015. Geschäftsbericht 2014. Annual Report. E.ON AG.
- Hall, P., Soskice, D., 2001. An introduction to varieties of capitalism. In: Hall, P., Soskice, D. (Eds.), *Varieties of Capitalism. The Institutional Foundations of Comparative Advantage*. Oxford University Press, Oxford, pp. 1–68.
- Högselius, P., 2009. The internationalization of the European electricity industry: the case of vattenfall. *Util. Policy* 17 (3), 258–266.
- Hoffmann, V.H., 2007. EUETS and investment decisions: the case of the German electricity industry. *Europ. Manag. J.* 25 (6), 464–474.
- Honoré, A.M., 1961. Ownership. *Oxford essays in jurisprudence* 107, 107–147.
- Höpner, M., Krempel, L., 2004. The Politics of the German company network. *Competition Change* 8 (4), 339–356.
- Jackson, G., Höpner, M., Kurdelbusch, A., 2004. Corporate governance and employees in Germany: changing linkages, complementarities, and tensions. RIETI Discussion Paper, Tokyo, pp. 1–60.
- Jacobsson, S., Lauber, V., 2006. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy* 34 (3), 256–276.
- Jahn, D., Korolczuk, S., 2012. German exceptionalism: the end of nuclear energy in Germany! *Environ. Politics* 21 (1), 159–164.
- Jewell, J., Vinichenko, V., Nacke, L., Cherp, A., 2019. Prospects for powering past coal. *Nat. Clim. Change* 9 (8), 592–597.

- Jung, A., Schäfer, U., 1999. Wir brauchen große Firmen. *Der Spiegel* 34.
- Kröger, M., 2010. Mappus flüchtet in den Strom-Sozialismus. *Der Spiegel*.
- Kreuzfeldt, M., 2016. Atomkonzerne jammern - und klagen. *Die Tageszeitung*.
- Krichhof, A., Trischler, H., 2020. The history behind West Germany's nuclear phase-out. In: Kirchhof, A.M. (Ed.), *Pathways into and out of Nuclear Power in Western Europe*. Deutsches Museum Verlag, Berlin, pp. 124–169.
- Kungl, G., 2015. Stewards or sticklers for change?. *Incumbent energy providers and the politics of the German energy transition*. *Energy Res. Soc. Sci.* 8, 13–23.
- Kungl, G.F., Geels, W., 2018. Sequence and alignment of external pressures in industry destabilisation: understanding the downfall of incumbent utilities in the German energy transition (1998–2015). *Environ. Innov. Soc. Trans.* 26, 78–100.
- Lamoreaux, N.R., Raff, D.M., Temin, P., 2004. Against whig history. *Enterprise Soc.* 5 (3), 376–387.
- Lauber, V., Jacobsson, S., 2016. The politics and economics of constructing, contesting and restricting socio-political space for renewables-the German renewable energy act. *Environ. Innov. Soc. Trans.* 18, 147–163.
- Leaton, J., 2011. Unburnable Carbon-are the World's Financial Markets Carrying a Carbon Bubble? Carbon Tracker Initiative.
- Marx, C., 2019. Between national governance and the internationalisation of business. the case of four major west German producers of chemicals, pharmaceuticals and fibres, 1945–2000. *Bus. Hist.* 61 (5), 833–862.
- Mez, L., 2001. Der deutsche Weg zum Ausstieg aus der Atomenergie - im Konsens zu einer Quote für Atomstrom. In: Gourd, A., Noetzel, T. (Eds.), *Zukunft der Demokratie in Deutschland*. Springer-Verlag, Berlin, pp. 416–432.
- Mez, L., Piening, A., 2002. Phasing out nuclear power generation in Germany: policies, actors, issues and non-issues. *Energy Environ.* 13 (2), 161–181.
- Moore, J., Gustafson, T., 2018. Where to now?: Germany rethinks its energy transition. *German Politics Soc.* 36 (3), 1–22.
- Morris, C., Jungjohann, A., 2016. *Energy Democracy: Germany's Energiewende to Renewables*. Springer, Berlin.
- Oeder, J., 2016. Energiekonzerne haben nur geringen Anspruch auf Entschädigung für Atomausstieg. *AFP Int. Text Wire German*.
- Oei, P.-Y., Brauers, H., Herpich, P., 2020. Lessons from Germany's hard coal mining phase-out: policies and transition from 1950 to 2018. *Clim. Policy* 20 (8), 963–979.
- Radkau, J., 1983. *Aufstieg und Krise der deutschen Atomwirtschaft 1945–1975*. Reinbek, Hamburg.
- Raval, Anjali, 2021. A \$140bn asset sale: the investors cashing in on Big Oil's push to net zero. *Financial Times*.
- Renn, O., Marshall, J.P., 2016. Coal, nuclear and renewable energy policies in Germany: from the 1950s to the Energiewende. *Energy Policy* 99, 224–232.
- Rome, A., 2019. Dupont and the limits of corporate environmentalism. *Bus. Hist. Rev.* 93 (1), 75–99.
- RWE AG, 2007. *Geschäftsbericht 2006*. Annual Report. RWE AG.
- RWE AG, 2008. *Geschäftsbericht 2007*. Annual Report. RWE AG.
- RWE AG, 2011. *Geschäftsbericht 2010: Vorweg gehen, heißt Klartext reden*. Annual Report. RWE AG.
- Schreurs, M.A., 2012. The politics of phase-out. *Bull. At. Sci.* 68 (6), 30–41.
- Schweer, D., Thieme, W., 1998. *Der gläserne Riese: RWE - ein Konzern wird transparent*. Gabler, Wiesbaden.
- Sebastian, F., Gathmann, F., Medick, V., 2010. *Regierung unter Strom*. *Der Spiegel*.
- Der Spiegel, 1999. *Stromkonzerne: Töchter mit viel Schminke*. *Der Spiegel* 29.
- Der Spiegel, 1999. *Veba-Viag Fusion: Erster Schritt in die Weltliga*. *Der Spiegel*.
- Der Spiegel, 2002a. *Mit heißer Nadel*. *Der Spiegel*.
- Der Spiegel, 2002b. *RWE: Machtkampf um den Chef-Posten*. *Der Spiegel*.
- Der Spiegel, 2007. *Monopolkommission fordert harte Maßnahmen gegen Konzerne*. *Der Spiegel*.
- Der Spiegel, 2009. *Deutsche zahlen zu viel für Energie*. *Der Spiegel*.
- Der Spiegel, 2012. *EnBW verzichtet auf Klage und will trotzdem Schadensersatz*. *Der Spiegel*.
- Der Spiegel, 2014. *RWE-Krise kostet Kommunen Milliarden*. *Der Spiegel*.
- Strunz, S., 2014. The German energy transition as a regime shift. *Ecol. Econ.* 100, 150–158.
- van der Ploeg, F., Rezai, A., 2020. Stranded assets in the transition to a carbon-free economy. *Annual Rev. Resource Econ.* 12, 281–298.
- Vattenfall AB, 2001. *Annual Report 2000*. Vattenfall.
- Vattenfall AB, 2015. *Toward a more sustainable energy portfolio*. Annual and sustainability report 2014. Vattenfall AB.
- Vattenfall AB, 2018. *Fossil free within one generation*. Annual and Sustainability Report 2017. Vattenfall AB.