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Can Electricity Companies Be Too Big to Fail?

Erik R. Larsen

Department of Management, Aarhus University, Fuglesangs Allé 4, DK-8210 Aarhus V, Denmark

e-mail: erik.larsen@mgmt.au.dk

Ann van Ackere

HEC, Batiment Anthropole, Université de Lausanne, CH 1015 Dorigny, Switzerland

e-mail: ann.vanackere@unil.ch

Sebastian Osorio

Potsdam Institute for Climate Impact Research (PIK), 14473 Potsdam, Germany

e-mail: sebastian.osorio@pik-potsdam.de

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Abstract

The 2008 financial crisis has drawn attention to the concept of "too big to fail" companies, more recently relabelled "system-critical" institutions, referring to situations where the actual or near-bankruptcy of a company threatens the future of a service essential to the functioning of society. But such instances are not limited to the financial sector. We argue that if policymakers and regulators are not vigilant, a similar situation could occur in the electricity sector. So far this industry has only experienced occasional problems, but we can observe several precursory signals indicating that these problems might become more frequent. These include a tendency to globalisation in the absence of a supra-national regulator and the disruption caused by large amounts of renewable energies, resulting in companies to be stranded with loss-making thermal generators. Still, these units are essential for the electricity supply security. We discuss several cases illustrating these trends. We conclude with a discussion of how electricity regulators and policymakers should approach the “too big to fail” problem, focussing both on preventive measures that can be taken to keep such a situation from occurring and on proactive actions aimed at avoiding a crisis once a system-critical company seems at risk of collapsing.

Keywords: Electricity, "too big to fail", market concentration, energy security

1. Introduction

Over the last decade mismanagement, hubris and a general regulatory inefficiency have endangered major players in essential industries, resulting in near-catastrophic crises. Examples include the financial sector world-wide (Stiglitz, 2010), the rail industry in the UK (Shaoul, 2004), health insurance in Switzerland (Assura 2012a, 2012b) and ambulance services in Denmark (Fyns.dk, 2017). Common to all these cases has been the actual or near-bankruptcy of one or more companies, threatening the future of a service essential to the functioning of society. This raises the following question: how should a government react in a situation where it simply cannot allow a service to break down? For instance, in the Danish ambulance case, authorities could neither let the company go bankrupt (implying an interruption of the service), nor continue to tolerate substandard response times endangering patients' lives.

These events have drawn attention to moral hazard issues (Allen et al., 2015), which have long been a concern at the individual level, e.g., bonus systems rewarding high profits, without properly penalising poor performances induce traders to take excessive risks. When the downside of decisions carries little or no sanctions, actors have an incentive to focus on the upside. During and after the financial crisis there has been a significant debate concerning whether the precedent of bailing out certain financial institutions might lead to a higher level of risk-taking in the sector, due to increased reliance on government intervention should things go wrong (Allen et al., 2015). The term “too big to fail” was coined following the 2008 financial crisis, at a time when global financial stability was under threat, to characterise the key players that were critical to the stability of the system. More recently, these companies are being referred to as “system critical” by financial sector regulators.

We argue in this paper that if policymakers and regulators are not vigilant, a similar situation

could occur in the electricity sector. So far, this industry has only experienced occasional, local, problems. Examples include the challenges faced by the nuclear sector in England and Wales (Taylor, 2007), the well-known problems in California at the beginning of this century (Sweeney, 2013) and the difficulties faced by smaller distribution companies in Colombia (Larsen et al. 2004). However, we can observe several precursory signals pointing to more serious problems.

A first symptom is the increasing size of many companies. For instance, the Danish company DONG has evolved from being a regional oil company to becoming a dominant player in the national electricity market (DONG, 2017a). In other countries, despite deregulation, there has been reluctance to split up incumbent national champions, e.g., EDF still dominates the French market. More generally, since deregulation we observe a transition from local or national companies to international, if not global concerns. Companies have expanded across borders, and even continents. For instance, Vattenfall and E.ON today have subsidiaries in several European countries, while Endesa (now owned mainly by Enel) expanded rapidly across South America. This consolidation across the industry results in a situation where the failure of one or a small number of companies can create havoc, as occurred in the financial sector, where the bankruptcy of a single company had world-wide consequences. While larger companies may benefit from economies of scale, they represent a risk factor; this is particularly the case in the electricity sector, where companies often have a very low degree of diversification.

A second concern relates to who actually regulates the electricity sector. Financial services have both national regulators and international surveillance bodies, such as the Bank for International Settlements (BIS), the Financial Stability Board and the International Organization of Securities Commissions, or the European Banking Authority at the European

level. While electricity markets are under the control of regional (in the USA) or national (most European countries) regulators, there is a lack of coordination across jurisdictions. This missing element enables companies to try to game the different legislators. Where such coordination does exist (e.g., EU regulation and the Federal Energy Regulatory Commission in the USA), the focus is on market access and environmental regulation, not on companies' long-term financial health. The existence of supra-national regulatory bodies did not prevent the 2007-2008 financial crisis: early warning signs were overlooked and actions were delayed by the lengthy negotiations required to reach agreements. Still, these institutions have proven very useful in the aftermath of the financial crisis as a forum to try to agree common rules for large financial institutions.

A third concern results from technological change. Nuclear, hydro and thermal generators typically worked with a time horizon of thirty years or more. But over the last decade many of the largest players of the electricity sector have been caught off-guard by the rapid, large-scale, introduction of subsidised intermittent renewable generation technologies, i.e., wind and PV. Their profitability has suffered significantly as prices have dropped: they are stranded with significant investment which cannot be amortised under the new market conditions. This has resulted in companies mothballing recently built plants (e.g., CCGT plants (Reuter, 2015)) or decommissioning plants earlier than scheduled. The accelerated closure of thermal plants has caused concerns about the availability of generation capacity at times where the intermittent capacity is not available, leading many countries to introduce subsidies for thermal plants, often through capacity mechanisms (Höschle and Doorman, 2017).

While the failure of a critical generator or distributor endangers supply, this is only one aspect of the security of supply in the electricity sector (Larsen et al., 2017), another essential element

being transmission. But, as the transmission grid is operated as a monopoly in most countries, investment decisions and profitability of grid owners and operators are directly controlled by the regulator. In this paper we thus focus on generating companies, and to a lesser extent on distributors.

The three concerns me have discussed (company size, regulatory issues and technological change) are not the only elements affecting whether or not a company is system-critical. Resilience also plays a role. For instance, other things being equal, a plant situated in a poorly interconnected area is much more likely to become system-critical. Such risks should be taken into account by policy makers when assessing whether or not a company is "too big to fail".

The paper is organized in the following way. After a brief recall of the 2007 financial crisis we provide an overview of recent events in the electricity industry, identifying trends that point towards the emergence of "too big to fail" companies in this sector. We discuss how such companies could be identified and identify possible governmental actions. We conclude with a discussion of what can be learned from the past and what could be done to limit the risks related to system-critical companies in the electricity industry.

2. Background

What sectors are subject to the “too big to fail” syndrome? As discussed above, any sector, public or private, where a breakdown would have an immediate, large scale, detrimental impact on the provision of an essential good or service, whether at a regional, national, or global level, is concerned. We do not consider events such as the closure of a large factory resulting in regional unemployment, with possibly devastating effect on the local economy, or environmental disasters such as the Deepwater Horizon oil spill (Encyclopædia Britannica,

2017). While these problems are important and need attention, they are outside the scope of this paper as they do not lead to a long-term disruption of an essential good or service.

The issue of what happens when the collapse of a few firms in an industry can potentially take down the sector, or at least major parts of it, came to the forefront in connection with the financial crisis in 2007. While the discussion of its causes is still ongoing, there is general agreement that this led to a sudden awareness, among both policymakers and the general public, of the potential global consequences of the failure of large companies in essential industries.

The attitude and behaviour of many financial institutions in the decade preceding the 2007 crisis created concerns about the resilience of the financial system. Without going into details, there is a fair degree of agreement that the crisis resulted from a combination of factors, including weak regulation (e.g., excessive leverage enabled by insufficient capital requirements (Admati and Hellwig, 2014)), herd behaviour (e.g., housing bubbles resulting from overly optimistic price expectations (Krugman, 2009)) and what some have labelled global greed (e.g., investors getting used to high returns while becoming complacent about the risk of losses (Reavis, 2012)). This crisis has been extensively described and analysed in many publications, without reaching consensus on the exact causes and responsibilities. See, e.g., Taylor (2013), Wolf (2014), Sorkin (2009) and Paulson (2013). Neither is there consensus on the actual costs of the crisis, nor on who footed the bill, apart from some obvious victims such as evicted home owners and (small) companies that did not survive the ensuing credit crunch. While it is clear that the tax payers initially bailed out the financial institutions, the extent to which they have since recouped their losses remains disputed; so is the size of the gains or losses of the shareholders of the financial institutions. While there clearly were multiple causes

to this crisis, there is no doubt that regulatory failure was one of them.

3. Collapses, near-failures and other horror stories from the electricity sector

The events from the last decade and the experience gained from the financial sector raises the following questions: could something similar happen in the electricity sector, on what scale, what precursory signals (if any) should one look out for and, maybe most importantly, what preventive actions can regulators take to avoid getting into such a situation? Due to its physical characteristics (electricity is not a global commodity; it can only be traded over a limited distance) an instantaneous global collapse of the sector is unlikely. But significant problems at the national or regional level are possible as companies internationalise and cross-border markets are established. In this section we discuss a number of collapses or near-collapses in the electricity sector. We have chosen examples with different underlying causes to illustrate the variety of problems that can occur. For each case we provide a short vignette and discuss the causes of the problem. A table providing an overview of all the cases is given in Appendix.

Maybe the best-known example is the California crisis during the 2000-2001 period, which affected more than 35 million people. The background to this crisis consisted of the combination of increasing demand and stagnating capacity in a partially deregulated market. These events having been described in detail elsewhere (see e.g., Joskow, 2001; Borenstein, 2002; Wolak, 2003; Sweeney, 2013), we summarise the main elements relevant for this paper. During the last half of the nineties, the demand for electricity in California increased by more than 4% per year, while investments in generation capacity were limited: not a single new power plant had been built for over a decade (McNamara, 2002). This led to increasing imports, particularly from the North-Western USA. At the same time California began to deregulate the industry, following the “standard” model of deregulation, i.e., beginning with wholesale

competition (Sweeney, 2013). Unfortunately, the winter of 2000 was particular cold in the North-West of the USA, limiting its ability to export to California; this led to shortages, and eventually occasional rolling blackouts. The two main distribution companies were caught in a regulatory system that allowed wholesale prices to increase without bounds, while the retail price was regulated and fixed. This brought both companies to the brink of bankruptcy, forcing the State of California to bail them out: by August 2001 the state had spent USD 10 billion on buying electricity, which was then sold on to the distribution companies at the regulated price for a mere USD 3 billion, creating a USD 7 billion loss for California (Sweeney, 2002). While this capital injection saved the companies, the citizens of California are footing the bill to this day. Letting the two main distribution companies go bankrupt was not an option for the State, as it would have resulted in large scale disruptions of California's electricity supply. While the State might have come up with other solutions, these would have been equally, if not more costly, and possibly more disruptive.

The regulatory framework, while not the only cause, contributed significantly to the problems. First, the market design (i.e., the decoupling between the retail and wholesale markets), was a direct cause of the escalating losses. Second, the lengthy approval process for new power plants, which allowed for multiple appeals by different stakeholders (up to twelve years (Sweeney, 2013), compared to three to four years in other states), in a period of significant demand growth, created a shortage of generation capacity and an excessive reliance on imports.

A second example is Electricaribe, an electricity retailer in the north of Colombia, with 2.6 million customers and no participation in generation. The Spanish group Gas Natural Fenosa (GNF) owns eighty-three percent of the company, while the remaining is owned by public entities (Eltiempo, 2016). During the years leading up to 2015, this retailer faced financial

problems due to the non-payment of electricity by a non-negligible fraction of its customers, both private and public. The situation was exacerbated by a severe episode of El Niño in 2015 and 2016, which increased the electricity price significantly, creating liquidity problems for the company. Electricaribe became unable to obtain much needed credit, resulting in an inability to deliver the required level of service: supply became unreliable, with a high degree of interruptions. In this sector quality is commonly measured by the grouped quarterly index of discontinuity (*itad*), where lower values denote a better quality. While Electricaribe's true *itad* was 0.038, it reported a value of 0.015, just below the upper limit of 0.016 specified it in its contract with the regulator, in an attempt to hide its difficulties. But the poor service level led to several demonstrations against the company between January and May 2016. While it was obvious that the company was in serious need of re-capitalisation, its parent company, Gas Natural Fenosa, rejected any capital injection unless it received state guarantees that public institutions would pay for their consumption.

During 2016 the situation grew worse: the company being no longer able to get bank guarantees for its power purchases in the wholesale market, it was forced to settle these three weeks in advance, which put further pressure on its finances. Generators became reluctant to sign contracts with Electricaribe, forcing the company to announce to 350 of its unregulated clients that it would no longer be able to supply them in 2017. It became clear that without public bailout, the company risked becoming unable to trade electricity, endangering supply to its captive customers (Elheraldo, 2016). In November 2016 Electricaribe was taken over by the government. The Public Services Superintendence, a public entity, was forced to take out a loan to inject the USD 100 million required for the company's operations in November and December of 2016.

In this example one of the driving forces has been the inability of the company to lower the non-technical losses (i.e., people consuming electricity without paying) or, more generally, the challenge of turning around a company located in a difficult geographical area. When GNF acquired Electricaribe it was convinced it had the required experience to achieve a successful turnaround of a company with a long history of difficulties; this turned out not to be the case. Still, other companies have successfully achieved this in equally difficult circumstances in other areas of Colombia, e.g., in Bogota (Cavaliere et. al., 2007).

A third example concerns nuclear generation, which has faced problems in many countries, including England and the USA. We briefly discuss the case of a UK company, known as British Energy, created by the government during the deregulation and privatisation process of the British electricity industry in 1990. This company, which owned the eight most modern nuclear power plants in England, as well as a coal plant, was initially state-owned; it was privatised in 1996. Several difficulties became apparent after the year 2000. Electricity prices were low due to a relatively high reserve margin, affecting income (BBC, 2002). At the same time, technical problems with several reactors resulted in a lower load factor, further depressing revenues from generation (BBC, 2002). The renegotiation of a long-term contract with British Nuclear Fuels Ltd. regarding the fuel disposal also proved to be problematic (BBC, 2002). These three factors, combined with other events occurring more or less during the same time span, created major financial problems for the company, forcing it to ask for government intervention.

The final results of the negotiation between the company, the government, and its shareholders and bondholders was a settlement whereby the government injected almost three billion Euros, the existing shareholders lost most of their equity (they received about 2.5 percent of the

restructured company) and the bondholders received control of the company in exchange for relinquishing more than one billion Euro in bonds (Guardian, 2008). In 2009 the company was bought by EDF, the French state-owned nuclear operator (The Telegraph, 2008).

4. Current trends in the electricity industry

In this section we take a closer look at the trends in the electricity sector identified in the cases above: decreasing capacity adequacy, changes in market dominance, internationalisation and lower profitability of electricity companies.

One of the main concerns to surface in recent years is capacity adequacy. While the problem is wide-spread, we illustrate the point with a couple of examples from European countries. In its 2007 report the French system operator, RTE, stated that "*The security of the electricity supply in mainland France therefore appears to be reasonably assured for the next five years…"* (RTE, 2007, p. 9), indicating that there was no particular concern about capacity adequacy, given the planned new generation and trend in demand. But by 2015 the tone of the report had changed significantly: "*Interconnections make a substantial contribution to ensuring that supply and demand are balanced in France. Without interconnections, adequacy could not be guaranteed and France would experience shortfalls more or less systematically in winter.*" (RTE, 2015, p. 12). The 2016 report goes a step further, stating explicitly that France is no longer self-sufficient: even the most optimistic scenario foresees a shortfall in the absence of imports (RTE, 2016). Similar concerns have been raised by the England and Wales regulator over the last few years (OFGEM, 2015). This trend is particular worrying in Europe, which is unfamiliar with this situation: before deregulation there was excess capacity in most countries. However, technological change, i.e., the growing share of renewables, has created uncertainty for the investors and operators of thermal power plants (Larsen et. al., 2017).

A second trend raising concerns is increasing market concentration, resulting in major players being able to exercise market power. While this obviously was a non-issue during the era of regulated monopolies, it has received surprisingly little attention since, even during the process leading to the break-up of incumbent national companies. The left part of Table 1 shows the market share of the largest generator in selected European countries in 2004 and 2015, as well as the percentage change between these two years. This selection includes the countries with the most extreme (largest and smallest) values. All but two of these countries (the UK and Germany) saw a decrease in the size of their largest generator, with the most notable change being a 71% reduction in Lithuania. The share of France's largest generator, EDF, was 86% in 2015, down from 90% in 2004. This is the largest market share among generators in Europe, with the exception of some small countries who still have only one national generation company. Estonia and Greece follow closely, with market shares of respectively 80% and 71%, down from 93 and 97% respectively. At the other extreme, the country with the lowest concentration in the EU in both years is Poland, down marginally from 18.5% to 17.4%.

Table 1 Market share of the largest generator in 2004 and 2015, with percentage change, and HHI1 index for selected European countries

Country	Market share			HHI1	
	2004	2015	Change (%)	2004	2015
Poland	19	17	-6	342	303
Lithuania	79	23	-71	6,162	515
Spain	36	25	-32	1,296	600
Italy	43	27	-38	1,884	729
UK	20	29*	46	404	858
Germany	28	32	13	807	1,024
Denmark	36	33	-8	1,296	1,089
Sweden	47	41	-14	2,209	1,648
Belgium	88	49	-45	7,691	2,352

Country	Market share			HHI1	
	2004	2015	Change (%)	2004	2015
Greece	97	71	-27	9,409	4,998
Estonia	93	80	-14	8,649	6,368
France	90	86	-5	8,136	7,344

* Value from 2013. Source: Eurostat, 2017

The most common measure used to evaluate the degree of concentration in an industry is the Herfindahl–Hirschman index (HHI), defined as the sum of the square of the market shares (Church and Ware, 2000). Regulatory authorities consider a market to be highly concentrated if the HHI exceeds 2,500, and moderately concentrated if the HHI is between 1,500 and 2,500 (e.g., US Department of justice, 2010). The last two columns of Table 1 provide the square of the market share of the largest generators (HHI1) for 2004 and 2015. These numbers show that despite, the decrease in concentration, and whatever the size of their other generators, three countries remain well above the limit for highly concentrated industries, and a further two are moderately concentrated. A second generator with a market share of barely 12% would be sufficient to push Belgium into the highly concentrated category.

We posit that when electricity generation is moderately or highly concentrated, it is very likely that the largest company falls into the "too big to fail" category. More generally, we argue that even in less concentrated markets, the failure of a generator with a 30% market share would almost certainly require government intervention to prevent a disruption of supply. This raises the question of how small a generator should be to be considered non-critical. The large number of context-specific factors (e.g., share of intermittent generation, cross-border transmission capacity, etc.) precludes providing a general answer to this question. One possible guideline consists of comparing a generator's capacity to the (de-rated) reserve margin. While the break-down of a generator with a market share smaller than the reserve margin may put the electricity

system temporally under pressure, an urgent governmental intervention is unlikely to be required. Looking back at Table 1, given the current trend of decreasing capacity margins in Europe, there is little doubt that most, if not all, of these companies are too big to be allowed to fail. We elaborate on this in the next section.

Next we consider briefly the internationalisation of electricity companies. Before deregulation and privatisation started, EDF, the French incumbent electricity utility, only operated in France. Today it is one of the largest global electricity producers, active in 25 countries across the world (EDF, 2017a), with over thirty percent of its profits being generated outside France (EDF, 2017b). Similarly, the Italian utility company ENEL was active in 31 countries in 2017, mainly in Europe and South America (ENEL, 2017). Many other electric utilities have started to internationalise, with the whole industry gradually becoming more global. This affects the nature of the commitment these companies have towards their host countries. For instance, there is little doubt that EDF would be more committed and under much more political pressure in France then in, e.g., Chile. This evolution needs to be reflected in the regulation and the licences issued to companies operating outside their home country, e.g., the amount of capital required to operate as a generator or distributor.

Finally, we turn to the profitability of generators. A Mckinsey report has calculated that European utilities' profitability declined by 35 billion Euros between 2008 and 2013 (Mckinsey, 2014). As an illustration, Table 2 shows the profitability of the largest generators in the England and Wales market from 2009 to 2016. All companies have seen a severe decrease in their bottom-line, with the notable exception of SSE. This company is included for the sake of completeness, but cannot be readily compared to the others as it has a much more diversified stake in the energy industry, with significant assets in gas and the grid. Another

company performing quite well is EDF, despite its latest profits amounting to less than half the 2009 level. Together these two companies account for over 80% of the total profits. The decline in profitability observed in Table 2 should signal to regulators and policymakers that these companies deserve close attention: the collapse of any of one of them would bring the UK into serious trouble.

Table 2 Profits of the largest generators in the UK (2009-2016) in Million UKP.

Year	Centrica	E.ON	EDF	npower	Scottish Power	SSE	Total
2009	147	299	1131	145	165	424	2311
2010	226	142	683	211	352	396	2010
2011	258	293	963	168	260	466	2408
2012	291	173	875	126	94	392	1951
2013	153	-58	775	21	52	415	1358
2014	38	-77	598	-118	80	338	858
2015	73	72	602	-18	128	456	1312
2016	43	21	474	70	73	471	1152

Source Ofgem (2016a)

However, as shown in Table 3, these figures hide significant differences depending on the generation type: while nuclear and renewables are highly profitable, all companies lose money with traditional thermal generation (gas and coal). Note that the profitability of nuclear plants might be biased as this technology is highly subsidised (Ward, 2016). Symptomatic of the difficulties encountered by thermal generators is the fact that E.ON has in recent years begun to close down almost new CCGT power plants, creating concern from the British regulator that there might not be sufficient backup generation capacity for the increasing amount of intermittent renewables (OFGEM, 2015). However, it is clear that such closures of unprofitable plants are the only rational way forward to avoid endangering these companies' survival. In Germany, E.ON has taken a different, quite drastic approach. Realising that CCGT is no longer financially viable, the company has in 2016 spun off its fossil fuel assets into a separate

company, named Uniper (Guardian. 2016).

Table 3 EBIT margin of the large electricity generators in the UK in 2016, by generation type.

	Nuclear	Thermal	Renewables
Centrica	15.8%	-11.1%	14.1%.
E.ON	-	-11.0%	42.7%
EDF	22.5%	-19.4%	22.4%
RWE	-	-0.6%	28.1%
ScottishPower	-	-6.5%	36.1%

Source: Ofgem (2016b)

This pattern of economic problems repeats itself across Europe, making regulators and policymakers increasingly worried about future security of supply (Odenberger et al., 2015). More and more countries are introducing various mechanisms, among others capacity auctions, to try to ensure the long-term sustainability of thermal generation (European Commission, 2016). Lack of profitability does not only send a warning message about the state of the electricity sector, it also enhances the "too big to fail" risk. With decarbonisation of electricity markets expected to continue, markets will continue to adjust, among others by consolidating to increase market power (Blyth et al., 2016).

Our discussion so far points to serious problems in the electricity industry; while the lights have so far remained on, failure may not be that far away. Regulators have started to worry about capacity adequacy, a relatively visible problem which could be referred to as the top of the iceberg. But the other issues mentioned above have only received scant attention as yet. It

is indeed more difficult to realise the long-term consequences of a slow erosion of profitability or a gradual increase of international diversification. However, by the time the consequences of these trends become visible, the impact is likely to be abrupt and severe, given the absence of preventive or mitigating actions.

5. Identifying "Too big to fail" candidates

When should a player in the electricity market be considered as "too big to fail"? In abstract terms, this refers to companies whose sudden disappearance would endanger the security of electricity supply (SoES). Aspects to consider include the segment in which the company operates, e.g., generator versus distributor, the market design and the market resilience. Resilience has been overall associated with extreme events in literature, e.g., resilience is the ability of a national energy system to cope with supply disruptions (IEA, 2011). In a broader sense, "the effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event" (NIAC, 2009). The criticality of a player is thus highly dependent on the market resilience.

Companies who own and operate grids but are not involved in the buying and selling of electricity are generally regulated as monopolies and are as such not concerned by our discussion. Below we discuss different elements that should be taken into account when assessing whether or not a company is system-critical.

We first turn our attention to capacity adequacy; in this context only generators are of concern. As mentioned previously, the capacity margin, a key indicator of SoES (Larsen et al. 2017), is a highly visible component of capacity adequacy. Thus, a first approach to evaluating the criticality of a generator consists of a direct comparison between its share of installed capacity

and the capacity margin. To account for the very different availability factors of technologies, a comparison between the share of production and the (de-rated) capacity margin may be more appropriate. A company with a share of installed capacity or generation anywhere close to the capacity margin would be a candidate for the critical list, as its failure would endanger SoES. As discussed in the previous section (recall Table 1), there are several European countries where the market share of the largest company exceeds 50%. Another approach is to consider how the Loss of Load Probability (LOLP) would be affected if one of the main generators stopped producing. This would also give a good indication of how critical this generator is for the stable operation of the system.

Still, before jumping to conclusions, the role of a generator should be put into a wider perspective by considering the availability of substitutes. The factors outlined above that can contribute to making a generator system-critical can be enhanced or mitigated by external factors. For instance, limited grid adequacy or reliability can lead to grid congestion, transforming a small, seemingly non-essential producer into a key player. Another example relates to cross border capacity: a (small) country might be able to import significant volumes of electricity at short notice, at reasonable prices. This would require sufficient cross-border transmission capacity and neighbours with excess generation capacity. For instance, while Luxembourg can cover most of its consumption by importing from Germany (ILR, 2016), it would be impossible for, e.g., France, to cover a large percentage of its demand by imports. It should also be noted that many countries or regions have limited or no interconnections, e.g., the Greek islands of Cyprus and Crete, and the Spanish islands (Perez and Ramos, 2008).

Next we look at profitability, another essential component which needs to be monitored closely, especially for critical generators (as described above) and for all distribution companies. When

confronted with low profitability, companies can be tempted to reduce costs, among others by cutting preventive maintenance or by postponing essential investments necessary to keep installations up-to-date. This increases the likelihood of unscheduled down-times due to technical failure, a frequent cause of cascading blackouts. Such behaviour can be the start of a death-spiral, with increasingly frequent plant or grid breakdowns leading to lower revenues, further cost cutting, etc., as in the case of Electricaribe discussed above. Such events can be another signal for the regulator that a company is heading into trouble.

While low profitability can have a number of different causes, for generators one of the more common ones is an excessive capacity margin, leading to low load factors and prices. Generation capacity cycles have been documented in several countries, leading to alternating periods of over- and under-capacity (Arango and Larsen, 2011; Bunn and Larsen, 1992); company profitability will follow similar dynamics, creating uncertainty for investors, and potentially making the cycle even more pronounced. This phenomenon can be observed for instance around 2000 in Colombia: partly due to the economic crisis the country had a large reserve margin; the generators as well as the distributors lost money (Larsen et al., 2004). As we discussed in the previous section, for distribution companies non-payment, i.e., the stealing of electricity, can be a particular problem in some jurisdictions and is another signal regulators should pay attention to.

Finally, we discuss the consequences of internationalisation as a cause for concern. Both generation and distribution companies have become increasingly geographically diversified over the last decade. Internationalisation, a step towards globalisation, occurs when a company starts investing in other countries, leading to a significant share of its assets being located abroad. In electricity markets this trend is fairly recent: until about 25 years ago most countries

had national monopolies. This implies that today difficulties spread across borders, not only from a subsidiary to its parent company, but also the other way round. In the first case, a regulator in the home country of the parent company is unlikely to be aware of this risk, and even if he were, he would have limited power to intervene. In the second case, it is the regulator of the country where the subsidiary operates who might be unaware of the impending risk. In particular, he may not realise that the subsidiary is unable to make the necessary investments or perform essential maintenance due to the parent company withholding resources. One example of a parent company refusing to help out one of its subsidiaries is the case of Electricaribe discussed above. While early awareness may not enable the regulator to prevent such behaviour, it provides time to act to mitigate the consequences.

Next we briefly turn our attention to distribution companies in jurisdictions with a partially deregulated retail markets, i.e., with a significant share of captive customers. Distributors retailing to these captive customers benefit from a monopoly position, and at first sight seem to fall outside the scope of the too big to fail syndrome. Indeed, in the presence of retail competition, distribution is only a financial transaction and one would assume that another company could easily take over the customers of a failed distribution company. This reasoning only holds if the company is involved solely in distribution. But in the not uncommon case where these local monopolies own the low voltage grid, their failure can potentially create major problems as illustrated above with the Colombian and Californian examples.

6. Dealing with failing companies

Each year many companies go bankrupt; a legal process is initiated to protect the rights of the workforce, deal with the creditors and manage the assets. Ideally an investor is found to take over the company; alternatively, the assets are disposed of and the revenues used to pay off as

many of the creditors as possible. When larger companies go bankrupt, or close down their activities in a given region, the job losses are likely to make the newspaper headlines. The workforce, the suppliers and the owners (of small companies) or share-holders (of larger companies) are the main losers. Still, most of these events go unnoticed by the general public: they do not affect every-day life.

The situation is quite different when considering system-critical companies. The consequences for the population and the economy as a whole of letting these companies disappear in a disorderly fashion would be such that the state must intervene. Considering the electricity sector, no government can quietly sit by while the lights are being turned off. State-intervention can take different forms, ranging from subsidies to bridge-loans (while attempting to identifying a buyer) or, in extreme cases, nationalisation. Whatever the type of support, the government (and indirectly the population) will foot (a share of) the bill. Such actions affect the other market participants, as any form of subsidies to these ailing companies impacts the profitability of their competitors. This might in the worst case start a domino effect, bringing other companies into trouble, which in turn require state intervention.

Not intervening would be worse: with an insufficient electricity supply, planned outages at peak times might be required to avoid unscheduled, cascading blackouts throughout the country. This occurred for instance during the crisis in California, where scheduled curtailments had to be instituted (Sweeney, 2013). It is estimated that the cost of the crisis was approximately $40 billion in additional energy costs (2001–03), accounting for an estimated GDP loss of 0.7–1.5% (Royal Academy of Engineering, 2014). Overall, the economic losses from blackouts in the U.S., Europe, and other countries in the last two decades have proven to be significant.

No authority wishes to face such a situation: regular blackouts are bound to lead to political unrest, and it is most likely that the government would be kicked out of office at the next election. Furthermore, the confidence of the market will be adversely affected, putting future investments at risk not only in the electricity sector but in the economy as a whole as companies would be reluctant to invest in a location without reliable electricity. Whatever the chosen course of action, letting a system-critical company get to a stage where a governmental bail-out cannot be avoided causes significant welfare losses for the population.

7. Discussion and conclusion

How should policymakers and regulators approach the “too big to fail” problem? Two situations must be distinguished: firstly, what preventive measures can be taken to avoid the occurrence of such a situation and, secondly, if such a situation does arise, what proactive actions can be taken to prevent a crisis?

One of the underlying causes of "too big to fail" problems is moral hazard, where companies believe, rightly or wrongly, that they can undertake risky ventures with impunity, as the government will provide a safety net should things go wrong. Putting in place regulation that eliminates such convictions should be a priority. The EU took a step in this direction in 2012 for financial institutions: "*the proposal ensures that a bank's critical functions can be rescued while the costs of restructuring and resolving failing banks fall upon the bank's owners and creditors and not on taxpayers*" (European Commission, 2012, p. 1).

Still, such measures are hard to implement; it is often politically preferable for a government to be seen as the saviour of an institution (whatever the hidden long-term costs for the taxpayer)

than to hold out against the vociferous lobbying (or desperation) of large (small) shareholders and creditors. Still, in the context of electricity, the case of British Energy discussed above illustrates that measures to prevent moral hazard can be implemented: the company was saved, but the shareholders lost most of their equity. Therefore a first policy implication is that if regulators and policymakers succeed in issuing a credible threat that the standard procedure will be for shareholders to lose their stake, the moral hazard issue will be significantly reduced; companies will have strong incentives to avoiding taking unwarranted risks.

But what if a "too big to fail company" is already on the brink of bankruptcy? What can be done to limit the damage without creating a precedent that could lead to future moral hazard problems? During the height of the financial crisis many governments have opted for the "bad bank" solution: the creation of an independent entity harbouring what has been labelled toxic assets, e.g., non-performing loans and illiquid and risky securities (Boudghene and Maes, 2012). The state inherits the “bad-bank” in exchange for the injection of the necessary capital to recapitalise the bank, thus allowing the institution to survive and continue to provide its essential services. In certain cases, governments have been able to recoup part, if not all (e.g., Switzerland) of their investment (Arnal, 2014, Zaki, 2014).

Recalling Table 3, this approach offers an interesting parallel with the energy sector, with thermal plants playing the role of toxic assets. Given the continuously increasing share of subsidised intermittent renewable generation, the future of thermal plants looks all but positive and further closures are to be expected. Still, it is quite likely that sooner or later the government will need to step in to maintain this capacity to insure security of electricity supply. In this perspective, E.ON's decision to keep the economically attractive assets (renewables and the grid), while spinning of the underperforming fossil fuel plants (creation of Uniper) can be

interpreted as a pre-emptive move to protect its shareholders against future losses resulting from these plants. This raises an ethical issue though. On the one hand one could argue that it is unacceptable for E.ON shareholders not to be held responsible for the consequences of the companies' past investment decisions. On the other hand, E.ON is bound to argue on behalf of its shareholders that the financial difficulties faced by the thermal units are a direct consequence of governmental policies subsidising PV and wind energy, justifying its decision to delegate the problem to the government. This leads to a second policy implication: policy makers should intervene in time to ensure the long-term viability of thermal capacity units required to insure security of supply.

Even in the absence of an immediate default risk, regulators should monitor several indicators, among them concentration and resilience. As in other industries, regulators should keep a close eye on all merger and acquisition activities to prevent the emergence of companies able to exert significant levels of market power. Additionally, newly formed companies' size should be evaluated with respect to the de-rated reserve margin and their potential impact on the LOLP. As discussed above (Table 1) generator size is already a problem in many countries for conventional technologies (thermal, nuclear and to some degree hydro). There is no easy way to reduce this existing concentration problem in the short to medium term: forcing companies to spin off certain activities would in most countries require regulatory change, which is bound to face stiff opposition from the industry. However, regulators can and should avoid a worsening of the situation, e.g. by preventing undesirable mergers or making these conditional on certain assets being spun off.

In the longer term legislative measures could be taken to allow regulators to force companies to split or divest certain assets, or in extreme cases take over essential, but unprofitable

generation assets. Such assets could be incorporated into a strategic reserve. A major stumbling block in the latter case is the determination of a fair price.

At the same time, in a period of rapid expansion into new generation technologies, regulators should prevent the emergence of new too big to fail companies. This point is particularly relevant when considering the evolution of the wind energy sector. While a large share of PV generation is supplied by many small, often residential, "generators", there is a move towards concentration in wind, led by large generators, triggered in particular by the expansion into offshore wind parks. The largest developer of offshore wind farms is DONG, a Danish energy company, with a global market share of 16%, followed by E.ON with 9% (Energy Post, 2016). DONG expects to double its capacity between 2016 and 2020 in this rapidly expanding market (DONG Energy 2017b). While a situation where the largest firm has a 16% market share may seem an acceptable level of concentration, one should also consider the risk relating to one company playing a dominant role within one generation technology, especially if this technology is gaining in importance. Consider for instance offshore wind capacity, which is becoming the most important renewable generation technology in Denmark. Today DONG accounts for more than 50% of the total installed offshore wind capacity in Denmark (DEA, 2015), but this represent only a small share of total generation capacity as is therefore not considered problematic. But if DONG is allowed to retain such a market share of offshore wind while this technology gains in importance, the picture changes: DONG could soon become a system critical company. While today its profitability is guaranteed by generous subsidies, this will not be the case in the future, as state-support is progressively disappearing: offshore wind auction prices in Denmark have hit a record-low in 2016, down by up to 53% compared to the 2015 auction (IRENA, 2017)).

A further policy recommendation is the need for an ongoing monitoring of the situation, complemented with regular in-depth analyses of recent trends, and how the industry is expected to evolve over the next 4 to 5 years. Given the fast change pace of change characterising the electricity sector, bi-annual review could be appropriate.

Such reviews should put electricity regulators in a better position to closely monitor the resilience of system-critical companies, an essential policy measure. Drawing a parallel with the financial sector, following the crisis, regulators imposed higher levels of equity capital on large banks to increase their robustness in case of a future crisis. This measure cannot be easily transposed to the electricity sector as the industry characteristics are very different, e.g., long-term physical assets, a supply chain from generation to distribution, the importance of the mix of technologies, etc.

The actions available to regulators to improve a critical company's profitability depend on the legal framework, for instance concerning the use of capacity mechanisms, the focus of many recent interventions. Measures a regulator could take to deal with struggling thermal plants required to maintain security of supply include:

- Pay the company to keep the plant ready to operate in case of need (capacity payments);
- Limit closures or mothballing by imposing an obligation to sell the plant to an interested buyer, should one exist;
- Place the generator under direct state control (creation of a strategic reserve), with or without compensation.

In all of these cases, the challenge is to determine the right size of the compensation, so as to achieve the objective of sufficient capacity without distorting the market.

It is important to emphasise that we are not arguing that companies should not be allowed to fail in essential industries in general, and the electricity sector in particular. Rather, we posit that regulation should insure that this provision cannot be endangered by the behaviour (and subsequent failure) of one or a small number of actors.

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Appendix

Table A1 provides an overview of all the cases discussed in this paper.

Table A1. Overview of cases.

Case	Sector	Country	Main issue
California (distribution companies)	Electricity	USA	Simultaneous occurrence of increasing demand, lack of investment and inability to import in partly deregulated market
Electricaribe	Electricity	Colombia	Financial strain resulting from non-payments, compounded by climatic conditions
British Energy	Electricity	UK	Nuclear plant facing simultaneously low prices, technical difficulties and fuel disposal problems
Dong	Electricity	Denmark	A regional company becoming a dominant national player by investing in a new technology (wind)
EDF	Electricity	France	A former national monopoly retaining its quasi-monopoly status in the home-country (86% market share) while becoming a dominant player in other countries
Vattenfall	Electricity	Sweden	Rapid cross-border expansion

Case	Sector	Country	Main issue
E.ON	Electricity	Germany	Spin-off of unprofitable thermal assets to protect shareholders
Endesa	Electricity	Spain	Rapid cross-border expansion, while owned by Enel, an Italian company
Enel	Electricity	Italy	Rapid cross-border expansion
Centrica Npower Scottish Power SSE RWE	Electricity	UK	Companies not mentioned previously operating in the UK
UK railway	Rail	UK	Example of sectors facing major problems after deregulation
Banking system US /EU	Finance	USA /EU	2007/2008 financial crisis
Assura	Health Insurance	Switzerland	Bankruptcy resulting from acquired rights to unsustainably low insurance premiums
Ambulance service	Emergency services	Denmark	Example of sectors facing major problems after deregulation

References

Admati, A., & Hellwig, M. (2014). *The bankers' new clothes: What's wrong with banking and what to do about it*. Princeton University Press.

Allen, F., Carletti, E., Goldstein, I., & Leonello, A. (2015). Moral hazard and government guarantees in the banking industry. *Journal of Financial Regulation*, *1*(1), 30-50.

Arnal, S. (2014) La Suisse est le seul pays à avoir diminué pendant la crise. http://wp.unil.ch/allezsavoir/la-suisse-est-le-seul-pays-a-avoir-diminue-sa-dette-pendant-la-crise/ Accessed 18/7/2017

Arango, S., Larsen, E.R. (2011). Cycles in deregulated electricity markets: empirical evidence from two decades. Energy Policy 39, 2457–2466.

Assura (2012a) Assura SA reprend le portefeuille de Supra Assurance SA (assurance complémentaire) http://fr.assura.ch/assurance-maladie/assura-sa-reprend-le-portefeuille-de-supra-assurance-sa-assurance-complementaire-0 Accessed 28/7/2017

Assura (2012b) Communiqué de presse: Reprise des assurés de SUpra Assurances SA par Assura SA, http://fr.assura.ch/assurance/documents/communique-presse-primes-supra-fr.pdf (Accessed 28/7/2017)

BBC (2002) British energy. Generating a crisis. 6 september, http://news.bbc.co.uk/1/hi/business/2240947.stm

Blyth, W., Bunn, D., Chronopoulos, M., Munoz, J. (2016). Systematic Analysis of the Evolution of Electricity and Carbon Markets under Deep Decarbonisation. J. Energy Mark. 9, 59–94. doi:10.21314/JEM.2016.150

Borenstein, S. (2002). The trouble with electricity markets: understanding California's restructuring disaster. *Journal of economic perspectives*, *16*(1), 191-211.

Boudghene, Y., Maes, S. (2012) Relieving Banks from Toxic or Impaired Assets: The EU State Aid Policy Framework, *Journal of European Competition Law & Practice*, 3 (6), 562-577.

Bunn, D.W., Larsen, E. R. (1992). Sensitivity of reserve margin to factors influencing investment behaviour in the electricity market of England and Wales. Energy Policy 20, 420–429. https://doi.org/10.1016/0301-4215(92)90063-8

Cavaliere, C., Larsen, E. R., & Dyner, I. (2007). The privatization of EEB: From cash drain to major contributor. *Energy policy*, *35*(3), 1884-1895

Church, J., Ware, R. (2000) *Industrial Organization*. McGraw-Hill. Boston

DEA (2015) Danish experience from offshore wind development. https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_development.pdf

DONG, (2017a) Korte facts. http://www.dongenergy.com/da/investor/hovedtal/korte-facts

DONG (2017b) Wind Power. http://www.dongenergy.com/en/our-business/wind-power

EDF, (2017a) https://www.edf.fr/en/the-edf-group/world-s-largest-power-company/edf-in-the-world

EDF, (2017b) https://www.edf.fr/sites/default/files/contrib/groupe-edf/espaces-dedies/espace-finance-en/financial-information/publications/financial-results/2016-annual-results/pdf/annual-results-2016-pr-fy_20170214.pdf

El Heraldo, (2016). Decisión de Electricaribe le haría perder sus mejores clientes (Decision from Electricarible would make it lose its best clients) [WWW Document]. URL http://www.elheraldo.co/barranquilla/decision-de-electricaribe-le-haria-perder-sus-mejores-clientes-307805 (accessed 5.29.17).

El Tiempo, (2016). Las fallas que llevaron a la toma de Electricaribe (The failures that led to Electrocaribe's takeover) [WWW Document]. ElTiempo.com. URL http://www.eltiempo.com/economia/empresas/fallas-de-electricaribe-por-las-que-el-gobierno-intervino-45368 (accessed 9.18.17).

Encyclopedia Britannica, (2017) Deepwater Horizon oil spill of 2010. https://www.britannica.com/event/Deepwater-Horizon-oil-spill-of-2010

ENEL (2017) Where we are. https://www.enel.com/en/aboutus/a201608-where-we-are.html

Energy Post, (2016) Offshore wind: Europe far ahead, Siemens largest by far. August 19. http://energypost.eu/offshore-wind-grows-fits-starts/

European Commission (2012), New crisis management measures to avoid future bank bail-outs. http://europa.eu/rapid/press-release_IP-12-570_en.htm

European Commission, 2016. Report from the Commission. Interim report of the sector inquiry on capacity mechanisms.

Eurostat, (2017) Market share od the largest generators in the electricity market. http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=ten00119&plugin=1

Fyns.dk, 2017 Kortlægning afslører: Bios manglede fem abulancer hver dag. http://www.fyens.dk/indland/Kortlaegning-afsloerer-Bios-manglede-fem-ambulancer-hver-dag/artikel/3123917

Guardian, (2016) *E.ON completes split of fossil fuel and renewable operations*. January 4. https://www.theguardian.com/environment/2016/jan/04/eon-completes-split-of-fossil-fuel-and-renewable-operations

Guardian, (2008) British Energy: Background. 24 September, https://www.theguardian.com/business/2008/sep/24/britishenergygroup.edf

Höschle, H. Doorman, G. (2017) Capacity mechanisms: Results from a worldwide survey. No 7. (February), Cigre Science and Engineering

IEA, (2011). Measuring Short-term Energy Security. International Energy Agency, Paris, France. https://www.iea.org/publications/freepublications/publication/measuring-short-term-energy-security.html

ILR (2016) Chiffres clés du marché de l'électricité, https://assets.ilr.lu/_layouts/Redir/Doc.aspx?ID=ILRLU-1685561960-428

IRENA, (2017). Renewable Energy Auctions: Analysing 2016. Abu Dhabi.

Joskow, P. L. (2001). California's electricity crisis. *Oxford Review of Economic Policy*, *17*(3), 365-388.

Krugman, P. (2009). How did economists get it so wrong?. *New York Times*, *2*(9), 2009.

Larsen, E. R., Dyner, I., Bedoya, L., & Franco, C. J. (2004). Lessons from deregulation in Colombia: successes, failures and the way ahead. *Energy policy*, *32*(15), 1767-1780.

Larsen, E. R., Osorio, S., & van Ackere, A. (2017). A framework to evaluate security of supply in the electricity sector. *Renewable and Sustainable Energy Reviews*, *79*, 646-655.

McKinsey (2014) *Beyond the storm – value growth in the EU power sector*. December.

European Power and Natural Gas.

McNamara, W. (2002). *California Energy Crisis: Lessons for a Deregulating Industry*. PennWell Books.

NIAC, (2009). Critical infrastructure resilience. Finale report and recommendations.

Odenberger, M, Unger, T., Johnsson, F. (2015) *Investment requirements in th EU electricity sector up to 2050*. Working paper, VGB 388, Chalmers University of Technology.

OFGEM (2015). Electricity Security of Supply. A commentary on National Grid's Future Energy Scenarios for the next three winters. London: Ofgem.

OFGEM (2016a) *Generation profits in £ million by supplier*. https://www.ofgem.gov.uk/data-portal/all-charts

OFGEM (2016b) Large supplier: Electricity generation profitability by technology type in 2015. https://www.ofgem.gov.uk/chart/large-suppliers-electricity-generation-profitability-technology-type-2015-gb

Paulson, H. M. (2013). *On the Brink: Inside the Race to Stop the Collapse of the Global Financial System--With Original New Material on the Five Year Anniversary of the Financial Crisis*. Business Plus.

Perez Y, Ramos Real F. J. (2008) How to make a European integrated market in small and isolated electricity systems? The case of the Canary Islands, *Energy Policy* 36, 4159– 4167

Reuter, (2015) *E.ON says UK Killingholme gas plant still to close despite contract win*. http://uk.reuters.com/article/uk-e-on-britain-power-idUKKBN0TS1ES20151209

Reavis, C. (2012). The global financial crisis of 2008: the role of greed, fear, and oligarchs. *MIT Sloan Management Review*, *16*, 1-22.

Royal Academy of Engineering, (2014). Counting the cost: the economic and social costs of electricity shortfalls in the UK (A report for the Council for Science and Technology). London.

RTE, (2007) *Generation adequacy report on the electricity supply-demand balance in France*. http://www.rte-france.com/sites/default/files/2007_12_10_generation_ adequacy_ report_2007.pdf

RTE, (2015) *Generation adequacy report on the electricity supply-demand balance in France. Executive summery.* http://www.rte-france.com/sites/default/files/bp_2015 _synthese_gb_v2.pdf

RTE (2016) *Generation adequacy report on the electricity supply-demand balance in France. Executive summery. http://www.rte-france.com/sites/default/files/bp2016_synthese_va.pdf*

Shaoul, J. (2004). Railpolitik: The financial realities of operating Britain's national railways. *Public Money & Management*, *24*(1), 27-36.

Sorkin, A. R. (2009). *Too big to fail: the inside story of how Wall Street and Washington fought to save the financial system--and themselves*. Penguin.

Stiglitz, J. E. (2010). *Freefall: America, free markets, and the sinking of the world economy*. WW Norton & Company.

Sweeney, J. L. (2002). The California electricity crisis: Lessons for the future. *BRIDGE-WASHINGTON-*, *32*(2), 23-31.

Sweeney, J. L. (2013). *California Electricity Crisis*. Hoover Press.

Taylor, S. (2007). *Privatisation and Financial Collapse in the Nuclear Industry: The origins and causes of the British Energy crisis of 2002*. Routledge.

Taylor, J. B. (2013). *Getting off track: How government actions and interventions caused, prolonged, and worsened the financial crisis*. Hoover Press.

The Telegraph, (2008) *Edf buys British Energy for £12.5*. Sept. 8.

http://www.telegraph.co.uk/finance/newsbysector/energy/3071723/EdF-buys-British-Energy-for-12.5bn.html

U.S. Department of Justice (2010), Horizontal Merger Guidelines,

https://www.justice.gov/atr/horizontal-merger-guidelines-08192010

Ward, A., 2016. Subsidy for Hinkley nuclear power station quintuples to £30bn [WWW Document]. Financ. Times. URL https://www.ft.com/content/b8e24306-48e5-11e6-8d68-72e9211e86ab (accessed 9.17.17).

Wolak, F. A. (2003). Diagnosing the California electricity crisis. *The Electricity Journal*, *16*(7), 11-37.

Wolf, M. (2014). *The shifts and the shocks: What we've learned--and have still to learn--from the financial crisis*. Penguin.

Zaki, M (2014), Ce n'est pas la Suisse qui a sauvé UBS, Bilan, April 2, 2014,

http://www.bilan.ch/myret-zaki/redaction-bilan/ce-nest-pas-la-suisse-qui-sauve-ubs,

Accessed 18/7/2017