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Mitigating an Energy Utility Death Spiral in the United States: Applying Lessons from Germany

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Abstract

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Eric Hopf

The purpose of this paper is to present evidence that the United States is entering a "Utility Death Spiral" - a dramatic shift away from the utility based model of electricity supply to consumers. It also explores how U.S utilities can reposition themselves to best mitigate the economic losses associated with a Death Spiral. A Utility Death Spiral is currently taking place in Germany called the "Energiewende" and it is having immediate impacts on its energy landscape. The case study of the Energiewende is presented, its impacts, and the response taken by the country's "big four" utility companies. After analyzing the German utilities, recommendations are made that inform how U.S. utilities should organize to mitigate potential impacts of a Death Spiral here in the U.S.

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1.0 Introduction

The energy landscape that the United States is currently operating in may come to see a swift and dramatic transition from conventional energy generation. Because of the rise of renewable distributed energy resources ("DER"), the economic viability of conventional energy generation systems (coal, natural gas) are deteriorating rapidly. Consumers generating their own electricity can sell their excess electricity generation back into the grid for profit and those who do not generate excess can draw supplementary electricity from renewable sources at a lower cost than from traditional energy generation sources. Cost savings and environmental consciousness are two major draws towards DER; however, a third draw is discovered when DER is paired with energy storage. Excess energy generated during off-peak hours can be stored to be used during peak hours when demand spikes. This addresses one of the major draw backs from renewable energy generation which is intermittency and unreliability. Now solar energy generated during the day can be stored and used during the night and wind energy can be used when there is no wind.

As states start to reach grid parity, which is when the cost of renewable energy generation becomes equal to, or less than the cost of conventional energy generation, there are more economic incentives for customers to move away from conventional utilities and towards DER. Currently, 20 states including Washington, DC have reached grid parity and it is estimated that by 2020, 42 states will have reached that breakthrough (Munsell, 2016). As the number of states continue to reach grid parity and the number of customers to utility companies leaving for DER increases, the demand for conventional energy generation drops significantly. This forces the utility to raises their prices of their rates to those who are still connected to their grid to be able to cover their fixed costs (Costello and Hemphill, 2014). These fixed costs include grid maintenance and maintenance of their power generating facilities. Even though volumetric energy consumption is down and fewer customers are utilizing the utility's grid system, the cost of maintaining the grid infrastructure remains the same as well as costs to maintain their PP&E (property, plant, and equipment). As rates for customers connected to the grid rise, they are increasingly incentivized to disconnect from the grid and move towards DER, typically in the form of rooftop solar. This in turn forces the utilities to again raise their rates to continue to be able to cover their fixed costs which again drives more customers towards DER. This vicious circle is what is known as the "Utility Death Spiral" (The Economics of Grid Defection, n.d., para. 9). In this article, I will be attempting to determine whether a Utility Death Spiral in the United States will threaten current utility business models and if so, what changes may need to be made.

The Utility Death Spiral is a very important issue that deserves much attention from both the energy provider as well as consumers of electricity of both conventional and renewable energy sources. Even though people are moving towards distributed energy in droves away from traditional utility companies, we still need these utility companies as they play an essential role in the industry. It is very possible that in the event of a Death Spiral, many electric utility companies may go bankrupt and no longer generate or distribute energy. Because utilities own the grid infrastructure that they transmit energy through, who will be responsible for maintaining the grid if a utility ceases to exist? Will third parties step in to maintain it? In November of 2016, the utility industry employed approximately 565,200 (Bureau of Labor Statistics, 2016). If we were to experience a Utility Death Spiral, thousands of jobs could be lost due to the collapse of these established electric utility companies. The US economy could potentially see a spike in unemployment rate and a deterioration of the grid system if we let them go under. The Death Spiral would have serious implications on lower income families and communities who may not be able to afford the initial upfront costs to purchase solar panels and the ancillary technology needed to tap into the distributed energy network (Passera, 2015). It becomes even more difficult as their rates begin to increase, lowering their amount of disposable income that otherwise could be put towards renewable energy technology (Passera, 2015).

In 2010, Germany began its very own energy transition known today as the Energiewende. This effort is focused on driving Germany towards a more dependable, affordable, environmentally comprehensive energy landscape that relies heavily on the implementation of renewable energy; mostly wind, solar, and biomass. This energy transition implemented by the German government and supported strongly by the German citizens, has brought about Germany's own, self-induced Utility Death Spiral. Since then, we have come to see major changes in the business models of some of the country's largest energy providers with varying degrees of success.

In this article, I will be conducting a case study analysis on Germany's Energiewende and the responses from many of the country's leading electric utilities. I will be looking at the actions that many of electric utilities in Germany have taken and formulate actions that U.S. electric utilities can take to mitigate potential losses incurred by a Utility Death Spiral. A Utility Death Spiral has never happened before in the United States and has only been theorized by some industry experts (Costello and Hemphill, 2014); however, if the Death Spiral in Germany is any indication of the severity of what might happen in the United States, then the US electric utilities need to form contingency plans to respond to such an event.

- Is there a trend towards Distributed Energy?
- Could a Utility Death Spiral threaten current US utility’s business model?
- What actions can be taken by US utilities to mitigate losses of a potential Utility Death Spiral?

2.0 Methods:

For this analysis, I will be taking a comprehensive look at the energy revolution taking place in Germany and the effects that it has had on the major electric utility companies operating in the country. After analyzing the effects that the Energiewende has had on the utilities that are operating business as usual, I will look at the response from each company. This information will allow me to identify which responses were the most effective at mitigating the economic damages caused by policies. I will use these responses to formulate recommendations that I believe electric utilities in the United States should consider adopting in the likelihood of a Utility Death Spiral in the country.

3.0 Findings and Discussion

3.1 Trend Towards Distributed Energy Resources

Over the past few years, the United States has started to see a very strong trend towards distributed energy generation for both residential and commercial consumers of electricity. Between 2009 and 2014, the US saw the installed solar PV capacity (MW/year) grow 1,066%, including a 1,350% increase among just residential solar (The Economics of Load Defection, 2015). During the same time, the cost of installing residential rooftop solar fell from $8.2 to $4.5 per watt. This is dramatic decline of 45% over just a 6-year span (Economics of Load Defection, 2015).

This has led to a new era of choice and empowerment in regards to how individuals produce and consume their electricity. For many years, the major barrier to rooftop solar energy generation was the initial cost of the equipment and their installation. Now that DERs are become much more affordable, it has had three major implications. 1) DERs are now more economically viable for consumers who desire to obtain their energy from renewable sources. 2) The significantly lower cost has dramatically increased the breadth of consumers that may now be able to afford DERs. 3) Has made a case for DERs to be a better economic choice over conventional energy generation due to high cost savings and quick pay back periods. This becomes a strong force behind the expansion of DERs once a state reaches grid parity. If the estimations made by Musell prove to be accurate, by 2020, 42 states in the US will have reached grid parity. This means that it will be economically preferable to implement DERs in 84% of the states in the US in just the next 3 years.

3.2 DERs Paired with Energy Storage

In-home storage units are essential for DERs to operate at maximum efficiency. This is because without energy storage facilities, all electricity generated must either be used immediately or sent back into the grid to be used elsewhere. This becomes problematic during peak hours of demand for electricity. As seen in Figure 1, peak demand typically is around 6:30 pm when individuals begin to return home for the night and start to electronics and appliances in their households. Even though a household is utilizing DERs, during this peak time they may not be able to generate the needed electricity to meet their energy demand needs. This may be because the sun is not out or there is no wind to generate the energy. This offsetting of energy demand and energy generation will force that specific household to turn to the utilities to supplement the needed energy. The utilities meet the spike in demand through the use of quick start energy generation plants, also known as Peaker Plants (St. John, 2014). These Peaker Plants typically only operate for a few hundred hours per year, with the sole purpose of meeting the peak energy demand. Due to market mechanisms, they are guaranteed revenue streams so that they may be built (Lin, Damato, 2010). This causes the price per kW to be much higher for Peaker Plants than it is at power plants that operate continuously to meet the base load electricity demand. This means that DERs not paired with in-home storage will find it very difficult to become completely independent from the utilities.

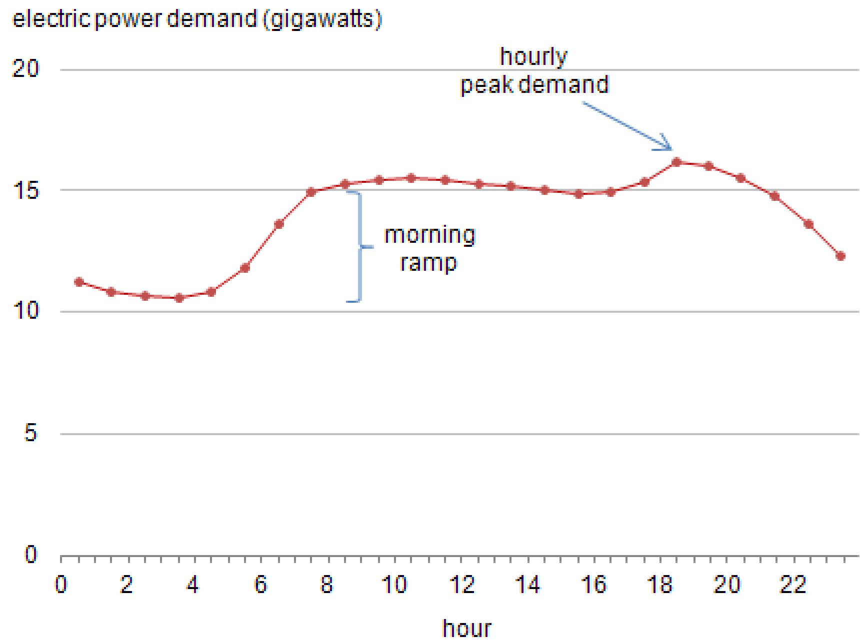

Figure 1: Electric Load Curve: New England, 10/22/2010

Source: U.S. Energy Information Administration based on data from Independent System Operator New England

While in home energy storage is essential for independence from the utility companies, it continues to be one of the largest barriers preventing DERs from overtaking conventional utilities as the preferred form of energy generation. This is because of the steep cost of purchasing and implementing an in-home battery. Currently, the most advanced in-home energy storage unit is Tesla's Power Wall 2.0. With a base price of $5,500 and a storage capacity of 13.5-kW, it is highly unaffordable for many households in the United States. Consumers could also opt for the older model of Power Wall which costs $3,500 with a 7-kW capacity (Tesla Power Wall: the complete review, 2016). This is cheaper; however, not nearly as cost effective.

While today, the cost of in-home energy storage is very high, there is much hope in the energy community that we will begin to see a rapid drop in the cost of this technology. Over the next 5 years, there is going to be an estimated 47% decrease in the total cost for lithium-ion storage technology (Labrador, 2016). With the introduction of new technology and more competition in the storage market, it is easy to see the price of storage be driven down significantly in the near future. Many companies currently working to develop cheap, affordable energy storage units predict that they can provide a unit for less than $100 per kWh which is 1/3 of the current average cost per kWh. It is predicted that both GM and Tesla could reach $100 per kWh by 2020 (Wesoff, 2016).

3.3 Germany's Energiewende

Energy systems globally are entering a period of transformation. The European Union has set forth ambitious goals to drive towards a low-carbon economy and fully integrated energy markets. G7 countries established back in 2015 that they would push to fully decarbonize their power systems, and China has recently become the largest market for renewable energy in the world. Germany is playing a very strong role in this global energy transformation by adopting what is probably the most radical and ambitious energy program of any industrialized nation in the world. They have come to call this effort, the *Energiewende*. The term "Energiewende' literally translates into "Energy Transition", and that is exactly what Germany is attempting to do. Though it had been in the planning phase throughout the 1990's and 2000's, it was implemented in 2010, just 6 months before the Fukushima nuclear reactor accident. Germany plans to use solar and wind power as the foundation of this energy transition to establish the Energiewende as a long-term energy and climate strategy with goals as soon as 2020 and as far out as 2050. I have separated the Energiewende into 2 different segments highlighting each of the targets that the Energiewende is attempting to address.

The first target, which has the staunchest support from the public is their nuclear phase-out plan which has been called for ever since the Chernobyl Nuclear Disaster in 1986. Up until March of 2011, Germany obtained 25% of their energy from the 17 nuclear reactors operating in the country (World Nuclear Association, 2016); however due to strong public opposition to this form of energy generation, the nuclear phase-out plan became a staple of the Energiewende. Since 2011, Germany has decommissioned 9 of their reactors, dropping their total production of energy from nuclear down to 16% of the country's consumption (World Nuclear Association, 2016). It is Germany's goal to have the 8 remaining nuclear reactors decommissioned and phased-out by the end of 2022 (The history behind Germany's nuclear phase-out, 2015). The plan is that while they continue to phase out nuclear energy generation in the country, they will replace that energy generation capacity with newly implemented renewable energy, which leads us to the next target of the Energiewende.

The second target of the Energiewende is its efforts to increase the total energy generation obtained from renewable sources. The long-term goal set by Germany is to obtain 80% of the electricity generation to be sourced from renewables by the year 2050. Due to how far out 2050 is, Germany has set intermediate goals to be met along the way. This includes a 35-40% share of renewable energy generation by 2025 and

55-60% by 2035 (Energiewende Goals, 2016). The majority of the renewable energy generation will come in the form of solar and wind. Between the year 2000 and 2015, Germany raised their renewable energy consumption from 6.5% to 31.6% (Energiewende: What do the new laws mean?, 2016). This has all been accomplished through the construction of several off-shore and on-shore wind farms as well as rapidly dropping cost for on-site solar energy generation for both commercial and residential properties. Initially, the Energiewende had implemented a feed-in tariff system as an incentive for consumers to produce their own electricity and sell it back into the grid for profit; however, in 2014, they replaced the feed-in tariff for a tender system. This new system of selling renewable energy operated like an auction, ensuring fair market price is paid for the energy. As you can see in figure 2, these efforts have made significant impacts in the amount of renewable energy sources installed in the country. You can clearly see an upward trend in the amount of renewable energy sources installed each year, starting in 2011, one year after the implementation of the Energiewende. In 2016, of the country's 194.1 GW power generating capacity, 101.5 GW is sourced from renewable energy sources equating to 52.3% of the total capacity.

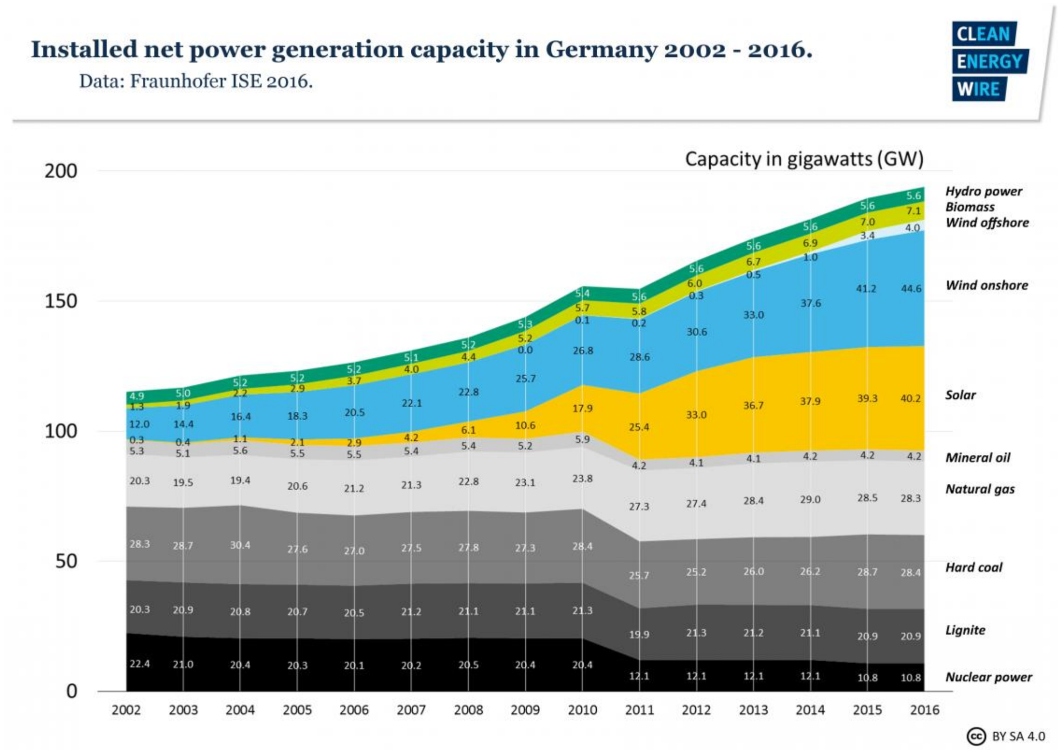

Figure 2: Installed Net Power Generation Capacity in Germany 2002-2016 Source: EIA.Gov

The third target of the Energiewende is improved energy efficiency so that they may start to lower the energy consumption of the entire country. With a short-term goal to reduce their energy consumption by 10% by 2020, relative to their 2008 levels of consumption. Their long-term goal is to reduce their consumption by 25%, also relative to their 2008 levels (Goals of the Energiewende, 2016). Germany is reaching these goals through improved energy management systems including in-home automation like smart meters and smart thermostats similar to the Nest thermostat currently in the market. In addition to this, Germany has also implemented higher standards for buildings in regards to energy efficiency and consumption. This is highly prioritized over other sectors like transportation and industry because residential homes account for approximately 40% of the total amount of energy consumed in Europe. Of this 40%, 85% is used for heating and cooling of homes (Energy efficiency made in Germany: Buildings, 2016). This is a very large portion of Germany's and all of Europe's energy consumption making it low hanging fruit for the Energiewende to focus on in order to meet their 2020 and 2050 goals.

3.4 Impacts the Energiewende on German Electric Utilities

The ambitious goals set forth by the Energiewende has had very immediate and significant impacts on the electric utilities operating in Germany. Germany's market share of electricity generation is dominated by 4 major utilities as seen in figure 3. It is important to note that Vattenfall is actually a Swedish utility company; however, has one of the largest energy profiles in Germany. Making up approximately 72% of the total market, these 4 utilities have realized major losses due to the energy transition. In 2013 alone, RWE lost $3.8 billion (Lacey, 2014). In the same year, Vattenfall saw losses of $2.3 billion for similar reasons as RWE (Lacey, 2014). In 2015, the nation's largest energy provider, E.ON reported a loss of €7 billion ($7.7 billion) which was more than double than their losses from the year before (Andresen, 2016). These major losses have been attributed to the companies cycling down many of their fossil fuel based power plants due to their unprofitability because of shrinking wholesale prices of electricity (Lacey, 2014). Because the German government is prioritizing the development and advancement of wind and solar, the wholesale price of conventional electricity generation has plummeted. As the country attempts to increase the penetration of renewable energy as well as reduced electricity demand due to energy efficiency efforts, the baseload generation from conventional energy generation quickly created of surplus of energy to be sold. This has driven down the price of the electricity from this source, making it nearly impossible to profit from. On June 16th, 2013, the wholesale price for electrcity actually fell to minus €100/MWh (European Utilities: How to lose half a trillion euros, 2013). This means that these utilities were actually having to pay consumers to take the electricity that they were generating at the time. In 2013, Germany saw the wholesale price go negative for 64 hours during the entire year (Understanding the Energiewende Imprint Background, 2015). Due to the inflexability of conventional energy generation, this makes fossil fuel energy generation riskier as renewable energy gains more traction in the country.

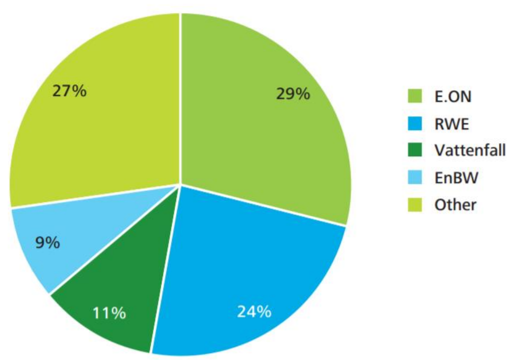

Figure 3: Germany's electric generation profile

Source: Deloitte Consulting Services

3.5 Reaction by the "Big Four" Utilities

The nuclear phase-out had by far the most significant, immediate impact on the German utility companies than anything else. All 17 nuclear power plants in the country were operated by one of the "Big Four" utility companies who also had significant equity stake in the plants that they operated, and in some cases, total ownership of the plant. The net generating capacity of all 17 plants totaled 20,339 MWe, which is lost by the four utilities. Currently, Germany has shut down 10,728 MWe generating capacity in 9 power plants (World Nuclear Association, 2016). The utilities, in attempts to recover both revenue and generating capacity in a short amount of time have increased their burning of coal. This however, is not a long term soulution for the utility companies as many of the utilities have released statements that they are commited to phasing out of coal as well. For right now, as renewable energy infrastructure is being built, these utilities have turned to the fossil fuel to fill the gap.

E.ON, which at one point in time was Germany's largest electric utility had arguably the most dramatic response to the implementation of the Energiewende. Realizing that they could no longer operate business as usual, the company decided that an major restructuring of their business model was needed. E.ON decided to split their copmany into two different companies. Since January of 2016, E.ON separated their conventional power plant operations and all of their assets associated with conventional energy generation into a newly ceated company, Uniper (E.ON, 2016). Uniper will be taking control of 42 GW of generating capcity as well as E.on's mid-stream gas (storage, transportation, ect…) (Reid, 2016). Uniper will be controlled majorily investors of E.ON. This is because for every 10 shares of E.on owned, the investors will receive 1 share of Uniper and will control approxiately 53.35% of the company (Reid, 2016). E.ON will control the remaining 46.65% of Uniper (Reid, 2016). It seems that E.ON has passed on the burden of conventional fossil fuel energy generation onto their investors. E.ON will now focus solely on renewable energy generation and grid maintenance, electricity distribution networks, and customer facing projects such as smart energy metering (Vasagar, Clark, 2015).

RWE has been hit the hardest as result of the Energiewende. Their stock price was listed at €12.40 per share, becoming the worst performing stock of 2015 on the German Stock Index (DAX), losing half of their value (Vasagar, 2015). This is because of their heavy dependence on fossil fuels for energy generation coupled with very little investment in renewable energy technology. 93% of their energy generation is sourced from fossil fuels as well as nuclear while renewable energy only accounted for 4% of their generating capacity (Michel, 2015). Conventional energy generation accounted for 22% of the company’s operating profits while renewables only accounted for 4.2% (Michel, 2015). In 2014, 45% of RWE’s conventional power plants were operating at a loss (Michel, 2015). This inability to generate profit coupled with the fact that many of the company’s power plants are over 30 years old, nearing the end of their lifespan, RWE should expect that many of their power plants are to be decomissioned in the very near future. Understanding this, RWE has decided, just like many of their competitors to dramatically shift their business to create a new “prosumer” business model. They plan on creating this new business model in similar fashion as E.ON, which is a split of the company but with one major difference. That is that E.ON's spin off contained all the conventional energy operations and assets while RWE's contains all their new renewable energy aspirations. RWE will retain majority share of the company while selling 10% of the equity to investors to raise capital to further their investment into renewable energy. Thomas Hechtfischer, director of Deutsche Schutzvereinigung fuer Wertpapierbesitz shareholder association, said "RWE sells the future, EON sells the past" (Andresen, 2016). This is much more attractive to investors than in Uniper, E.ON's spin off company. RWE plans on rapidly increasing their investment into "off" and "on" shore wind, and solar energy generation up from the low 4.2% to 20% of their portfolio by 2020; however, at the time, it had yet to be determined whether or not this will be enough to turn the company's momentum around. RWE CEO, Peter Terium stated that they may have been "possibly too late" investing in renewable energy (Vasagar, 2015). This spinoff of RWE has initially shown to be very successful. In 2016, RWE's stock rose 17% since the spinoff, becoming the second best perfomer in the DAX during that time period.

After losing an astonishing $2.3 billion in 2013 attributed to the Energiewende, Vattenfall has been looking for ways to change their business model in attempts to avoid another year like 2013 and rebound in a positive way. Completed in mid 2016, the company successfully sold of all of their assets, liabilities, and provisions associated with their lignite operations in Germany. This includes all of their lignite run power plants equaling 8,000 Mw in generating capacity, coal mines, and all costs associated with the decomissionning of the plants and the repurposing of the land (Andresen, Bauerova, Magnusson, 2016). Vattenfall was able to sell all of this to Energetický a průmyslový Holding (EPH) which is an energy company based out of the Czech Republic. In total, Vattenfall was able to sell of their assets for $1.8 billion while saving approximately $2.2 billion in liabilities that were also taken on by EPH (Andresen, Bauerova, Magnusson, 2016). By cutting ties with coal energy generation and taking all of the assets and liabilities off of their books, they have freed up a signifiacnt amount of resources to shift their focus to renewable energy technologies. This deal is also supposed to drop Vattenfall's carbon emissions to below 25 million tonnes per year from the 80 million tonnes per year that they were emitting in 2015 (Bellon, 2016). Along with Divesting entirely from coal and lignite, Vattenfall has also begun investing $3.4 billion into German cities including Berlin. They have been focusing on the development of renewable energy, district heating and decentralized energy schemes within the targeted cities. Although Vattenfall has not specifically stated which renewable energies that they will be investing in and to what extent, they have come out and stated their optomistic support for the growth of wind energy within the country. Outside of their operations in just Germany, Vattenfall has plas to grow their global wind generating capacity by 600 Mw per year as well as invest €5 billion nto renewable electricity generation over the next 5 years (Vattenfall, 2016)

EnBW, with the same realization that they could not continue to operate business as usual decided to take drastic efforts of their own. They plan on shifting their business to focus on renewable energy, grid operations, and customer facing technological development. Instead of spinning off a segment of their company, EnBW decided to undergo large scale divestment. The company has came out and stated that they plan on divesting from conventional energy generation by 80% by 2020 (Lacey, 2016). This comes in the wake of the nuclear phase-out which is forcing EnBW to shut down their plants which accounted for over half of their energy generating capacity (Andresen, 2015). In total, they plan on selling of $3.4 billion in assets, and with 6 power plants already sold by September of 2015, they are well on their way to achieving their goal (Andresen, 2015). This includes assets linked with both fossil fuel energy generation as well as nuclear energy generation. They intend to replace this loss in generating capacity with the development of renewable energy, more specifically, wind. They plan to have 40% of their installed generating capcity to be from renewables by 2020 (Andresen, 2015). The company is setting themselves up for long term future success with their aggressive investment into offshore renewable energy generation. With 336 MW of wind capacity installed between 2 facilities, they have an additional 1,700 MW of generating capacity in planning (Andresen, 2015). This places EnBW far ahead of any of their compeitors in regards to wind energy generation. Of all the responses to the Energiewende, EnBW's may have been the best of the "big four" compnaies. This is because since EnBW formulated and began implementing their proposed changes, they have seen the smallest negative impact on the company's value. This is very significant knowing that they had over half of their generating capcity invested into the soon to be gone nuclear energy. Since the implementation, EnBW saw its stock value drop 13% which when compared to E.ON's 25% drop and

RWE' 54% drop as seen in figure 4, is a very positive sign for the company (Andresen, 2015).

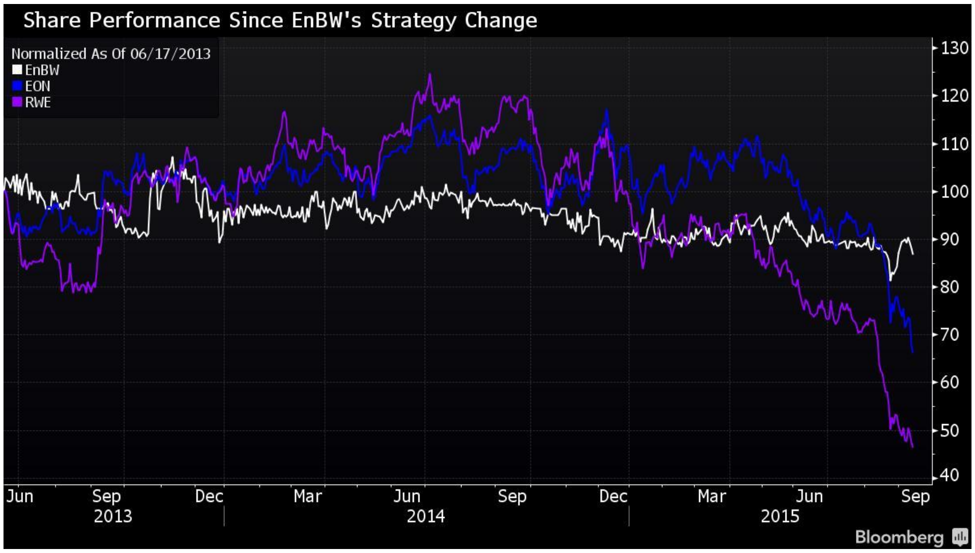

Figure 4: EnBW's Stock performance since strategy implementation

Source: Bloomberg News

4.0 Shifting United States Energy Landscape

4.1 New Direction

With the new Trump administration now in power, we are looking at a radical shift in the federal energy policy relative to the direction that the Obama administration was driving towards with the implementation of the Clean Power Plan (CPP). So far in the first days of Trump's administration, we have very little clarity in what is going to happen; however we do know the direction that we are headed towards. The only official release on the future energy landscape of the United States is the brief statement released on the White House website titled "An American First Energy Plan". In this statement, the new administration makes unsubstantiated claims that by repealing Obama's Climate action Plan would increase the wages of the American worker by over $30 billion over the next 7 years. This number is derived from another unsubstantiated claim that we will be able to raise these wages by tapping into the $50 trillion worth of shale, oil, and natural gas reserves. The administration plans on accessing these reserves by opening up federal land "that the American people own" for drilling and extraction (Whitehouse.gov, 2016). By increasing our supply of fossil fuels, the price of energy generation would expect to drop significantly for residential and commercial customers as well as generate increased profits for the working American. To support this decision to give coal a second chance, the administration said that they will embrace clean coal technologies in the form of carbon capture & storage (CCS). Lastly, the brief states that the United States will strive to achieve energy independence from the "OPEC cartel". This will be achieved by our new found love of fossil fuels and increased extraction in the years to come. From this information that the administration has provided, what is the outlook for a possible utility death spiral now looking like in the United States, and how does it affect the electric utilities?

We can expect to see federal support for renewable energy all but disappear in the coming months, including the popular 30% tax credit; however, there is reason to believe that on the state level, the support will be stronger than ever, effectively driving renewables forward. States like New York and California are going above and beyond to make renewable energy a significant part of their state's economy in the future. It is safe to conclude that the states are not just doing this because of their responsibility to protect the environment, but also it is economically the best decision. As stated earlier in the paper, more than half the states are expected to reach grid parity in the next few years, meaning it wil be cheaper to source their energy from renewable sources than from fossil fuels. Detailed below are states that are taking extraordinary steps to support renewable energy.

4.2 New York

The state of New York is pushing through with their revolutionary policy titled Reforming the Energy Vision (REV). The purpose of this action plan is to take full advantage of all the cost saving and energy security benefits brought about by renewable energy. This reform took off after superstorm Sandy hit, prompting New York State to rethink their energy systems. The goals of this initiative have 3 main objectives. The first being reducing their green house gas emissions by 80% from 1990 levels by 2050. This effort spans across power generation, transportation, industry, and buildings. The second main goal is to reduce the energy consumption from buildings relative to 2012 levels by 23%. This equates to roughly 600 trillion BTU's in energy saved from this efficiency effort. The third and most ambitious goal of NY REV is sourcing 50% of their energy from renewable energy sources by 2030 (Reforming the Energy Vision, 2016). This initiative has been so successful that between 2012 and 2015, the state saw an increase of 575% in solar (NYSERDA, 2016). Although wind energy generation plays a very small part of New York's energy economy (2.6%) (NY Department of Environmental Conservation, 2016), the state just announced that they will begin construction of the countries largest wind farm off the coast of Long Island. Renewables are not just surviving in the state, New York has made it a place where they can thrive and flourish.

4.3 California

The state of California, known for their ambitious environmental policies, has unsuprisingly set extraordinary energy policies in place for the future. The most noteable of them is their Renewables Portfolio Standards (RPS) which is to push the state's energy mix towards renewable energy. When first implemented in 2002, the goal was to have 20% of California's retail energy be sourced from renewables by year 2010. This was attainable by requiring all retail sellers of electricity to source 20% of their energy from renewable sources. This initiative has since taken off and has been built upon ever since. Currently, the initiative stands at a goal of 50% renewables by 2030 (California Renewable Energy Overview & Programs).

4.4 Massachusetts

Massachusetts has been a leader in renewable energy progression for some time now. Their aggressive approach to renewable enrgy generation, solar in particular really took off in 2008 beginning with Global Warming Solutions Act. This act set in place goals for the state to reduce their GHG emissions by 25% by 2020 and 80% by 2050. They plan on reaching this goal through channels including renewable energy installation, energy efficiencies, and even urban development to create more walkable communities (Mass.gov, 2016). Although Wind has gone relatively ignored by the state, their installed solar energy capacity is impressive as shown in figure 5 with 1,465 Mw of installed capacity to date since 2008. To date, Massachusetts is ranked 7th in regards to installed solar capacity.

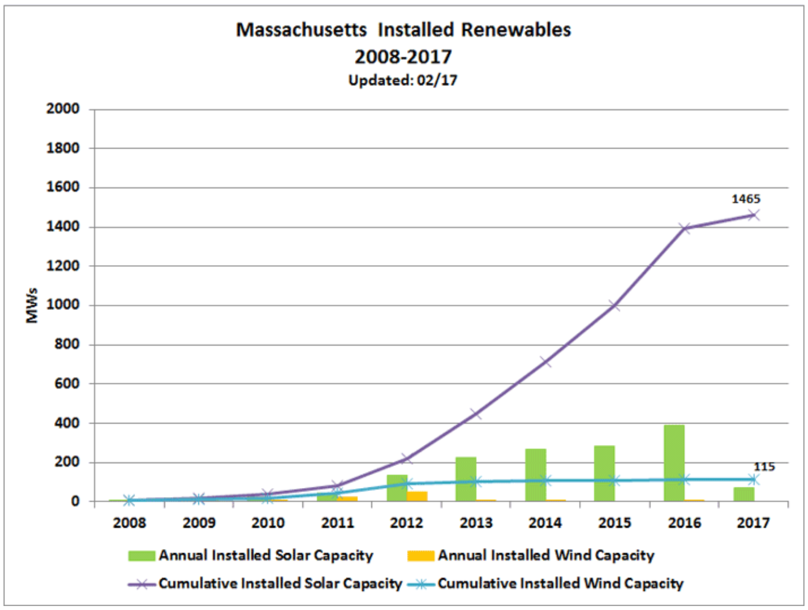

Figure 5: Massachusetts Installed Renewable

Source: Mass.gov

4.5 United States as a whole

In total, 29 states and three territories have set forth mandatory RPS legislation. The most ambitious being Hawaii aiming for a 100% renewable energy portfolio by 2045 and the smallest being South Carolina aiming for a 2% portfolio share by 2021 (State Renewable Portfolio Standards & Goals). While federal support for renewable energy is nearing the end in place for coal, many states have taken it upon themselves to establish market penetration for these energy sources. On top of the 29 states and territories, 8 states and 1 territory have set forth voluntary renewable enrgy goals meaning that compliance is not required or enforced but merely suggested. In all, only 13 states (26% of all states) and 1 territory have no plans in place to promote renewable energy generation.

4.6 New Trump Administration

With the new incoming administration prioritizing coal and other fossil fuels, one could initially believe that this is a huge hit for the growth of renewable energy. When you breakdown all the ambitions loosely layed out on the Whitehouse website, you can pick it apart and find that there are reasons to be very optimistic for the future renewable energy economy. Starting with the revival of coal as our primary source of energy, the United States has been gradually shutting down large amounts of coal generated energy capacity. In 2015, 80% of all retired energy generating capacity in the U.S. was from coal, amounting to nearly 14GW of production (EIA, 2016). Over the past several years, coal has been losing its share of generating capacity. Much of this decline has to do with increasing competition with natural gas energy generation as well as the fact that the fleet of coal plants are nearing the end of their life. Most coal power plants were built between 1950 and 1970 and those that are still in operation, surviving 2015's closures, are well beyond their 40 year life expectancy according to the National Association of Regulatory Utility Comissioners. According to the EIA, in 2013, 74% of the coal power plants in the united states were older than 30 years, making almost two thirds of the our country's plants nearing retirement. In 2015, 95 coal power plants were shut down and another 41 shut down in 2016 adding up to a total of approxiamely 18.8825 GW of generating capacity (Fitzpatrick, 2016).

President Trump, in planning his revival of coal, has not taken into account the costs that are going to be associated with having to buid new plants due to the current state of the aging plants. The average cost to build a coal power plant is more expensive now that it has ever been and is expected to become even more expensive in the future. It costs an average of $4,586/kW to construct a modern coal fired power plant with 30% carbon sequestration, an essential piece to President Trump's energy plan. A plant with 90% sequestration would cost an average of $5,072/kW (EIA, 2017). As these costs are just the projected costs of constructing these plants, actual costs that we are realizing from current plants being constructed today are much higher. The recent construction of the Kemper Power Plant in Kemper County, Mississippi is a perfect example of this. Owned by Mississippi Power, the plant which was proposed in 2009 with a budget of $2.4 billion; however after countless delays and setbacks, the plant is now $3.9 billion over budget and 2 years behind schedule pushing the completion date back to 2016. Even to this day, the plant is not fully operational. the unexpected high cost of implementing the CCS technology has had profound impats on the company as well as the taxpayers. This one plant alone threatened to bankrupt Mississippi Power. The cost to construct this one power plant was more than all of the company's assets combined. All together, the cost per kWh came out to be about $10,000. This forced the company to turn to their own customers to recover as much of the cost as possible. This resulted in an 18% rate hike for all of Mississippi Power's customers. In end, the Kemper power plant is designed to capture 65% of the carbon released from its power generation. While CCS is in fact capturing and storing carbon, at a rate of 65%, this makes the Kemper power plant equivalent to a natural gas plant (Biello, 2015).

While this cost per kWh was for a brand new plant with the addition of CCS technology is very high; retrofitting current coal powered plants has proven to be even less cost effective. The Boundary Dam power plant in Saskatchewan spent $1 billion to retrofit one of their three coal-fired boilers in 2014. This worked out to be roughly $11,000 per kWh of generating capacity, more than the Kemper power plant. This cost is also three times as much as a typical boiler. Due to the regulatory nature of the electric utilities, they are able to recoup costs incurred by raising the rates on their customers. When taking these costs and applying to the rest of the country's coal-fired power plants, this would equate to an increase of roughly $0.04 increase per kWh, an increase of 33% from the national average of $0.12 (Biello, 2015).CCS is simply not a feasible option. There have been several attempts to implement the technology; however, the success rate of the projects is a dismal 31%. With 15 CCS projects operating globaly and 7 in the planning phase, there have been 33 failed CCS projects since 2010. Even if coal is brought back, the cost associated with the CCS technology will ultimately sink the efforts.

The worst case scenario for renewable energy generation, which is also the best case scenario for coal energy generation, would be the elimination of the Mercury and Air Toxic Standards (MATS) legislation. This rule limited that amount of mercury, acid gases, and other harmful pollutants that a coal-fired power plant was allowed to emit into our atmosphere. This ruling, even though it only applies to pollutants that have a generating capacity at or above 25 megawatts, has been responsible for the closing of several coal-fired power plants over the years since 2011 when it was implemented. This ruling has placed great pressure on the utilities to comply with the standard, forcing them to weigh the costs and benefits of what it would take for their plants to meet the standard. In many cases, it was more cost effective for them to simply shut down the plants. In total, it has been estimated that the total cost incurred on the utilities is approximately $9.6 billion annually (Ross, 2012). This ruling has caused 4.7 gigawatts of generating capcity to be planned for closure from coal power plants by 2015 (Ross, 2012). This ruling, before President Trump's administration came into office, has been under intense scrutiny. Implemented by the supreme court by a result of 5-4, there is a good chance that with the new supreme court justice Gorsuch, that there is little the EPA can do to keep MATS in place. Former Justice Scalia, a strong republican ally in the supreme court criticized the ruling (and the EPA) for not taking into accounts the costs incurred on the utility companies when trying to comply with the standard. Scalia did mention that he did not believe that the EPA overstepped its bounds when implementing the ruling. If this ruling were to be overturned and the regulations put in place on the utilities were longer, there would suddenly be a large incentive to open up more coal power plants in the United States. This however is no guarantee that coal power plants will suddenly experience a strong revival. The EPA signified that the MATS would speed up the pace that coal plants would be shutting down, meaning that even without the ruling in place, coal plants will still find themselves gradually going off line but not at the rate caused by the MATS.

5.0 Recommendations

After analyzing the state of DERs in the United States, the impacts of the Energiewende and the responses taken on by each of the big four German utilities, I have established several recommendations that electric utilites in the United States should begin to think about adopting in the face of a potential Death Spiral taking place in the United States. The first recommendation, fashioned after RWE and E.ON's decision to spin of their companies into two seprate entities. Interestingly, E.ON sold majority stake of their spinoff company, Uniper to investors, passing off much of the burden onto them. While they are selling of equity in Uniper, they are growing what is left of E.ON which is focused on renewable energy generation. This is the action that I recommend. It will allow US utilities to focus more on renewable energy ventures while increasing capital from selling equity of the spinoff company focused on conventional energy generation. This has been a proven response as it has resulted in RWE becoming the second best perfoming stock on the DAX in 2016. It is important to note that RWE responded late to the Energiewende restuling in their major loss in stock value; however since their spinoff company, they have rebounded quickly.

My second recommendation comes in three parts. The first part is that the utilities should divest completely from fossil fuel energy generation. This includes all assets and liabilities associated with the process of generating electricity from nonrenewable sources. This is especially import to consider early on before a Death

Spiral begins to take place because of the devaluation of these assets once they begin to be unprofitable. While these assets including plants, resources and mines are retaining their value and in some cases may even be increasing in value due to the Trump Administration's announcement of the America First Energy Plan. The second part of this recommendation is that the capital gained from the selling off of these assets and liabilities should be quickly reinvested into DERs and consumer facing technologies. This will lower the utilities fixed costs by moving away from long term and costly power plants and towards mutliple sources of energy generation and demand response options when paired with storage. This allows for increased flexibility in the face of a shifting energy landscape, especially if a death Spiral were to occur. The third part which is to restructure their rates, moving away from fixed monthly charges which are used to cover a utility's fixed costs, and move towards more volumetric charges that will cover a utilties variable costs; which would now make up the majority of the utility's costs. To the consumer, their utility bill would drop the fixed, flat rate charge and simply add onto their volumetric charge through an increased rate. All together, this recommendation alows for the utility to be more felxible in the face of a Death Spiral. No longer locked into conventional energy generation due to their long term investments into power plants, they are able to mitigate financial losses.

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