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German Energy: The People's Transition

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Abstract

After decades of polluting the earth with fossil fuels, our reckless behaviors have finally caught up with us. Among few others, Germany leads the world in unique renewable energy transitions and sustainability solutions to best suit their country and protect the environment. Through scholarly articles, past & current news sources, and various national & world databases, this paper discusses the question: how much of Germany's energy policy success rests on the back of civil society? In addition to following a strict set of national and international environmental policies and targets, Germany's strategy towards renewables and sustainability comes from their German Energiewende, a growingly popular concept that translates as "energy transition." This transition, along with "conservation & generation" and "production & innovation," will be evaluated and compared to Italy's, the Czech Republic's, and the average EU's values and responses. These will help argue that the greater compliance German civil society has demonstrated, the greater the chance the German Energiewende has of progressing on time.

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After decades of polluting the earth with fossil fuels, our reckless behaviors have finally caught up with us. Among few others, Germany leads the world in unique renewable energy transitions and sustainability solutions to best suit their country and protect the environment. Through scholarly articles, past & current news sources, and various national & world databases, this paper discusses the question: how much of Germany's energy policy success rests on the back of civil society? In addition to following a strict set of national and international environmental policies and targets, Germany's strategy towards renewables and sustainability comes from their German Energiewende, a growingly popular concept that translates as "energy transition." This transition, along with "conservation & generation" and "production & innovation," will be evaluated and compared to Italy's, the Czech Republic's, and the average EU's values and responses. These will help argue that the greater compliance German civil society has demonstrated, the greater the chance the German Energiewende has of progressing on time.

Introduction & Research Question

After centuries of developed countries dominating the developing world, we've finally uncovered a grave threat that affects everyone regardless of hierarchical status: climate change. Rising sea levels, increased frequency of extreme weather events, and global increases in temperature are all key symptoms of climate change that the entire world has experienced and will continue to experience unless something is done to halt or even reverse the damage (NASA, 2021). While some countries seem to be lacking in this effort, others are implementing ambitious policy initiatives to play their part in addressing climate change. Germany is one of those ambitious countries.

Since the late 1990s, Germany has been adding to their energy targets in order to live up to their German *Energiewende*: the German energy transition that aims to reach targets set by the German government and the EU while following their key parameters of i) low carbon emissions, ii) reliability and stability, and iii) affordable living (Strum, 2017). Throughout Germany's journey to be an environmentally-friendly and sustainable country, Germans have proven the lengths they will go through to endure financial hardships and adjustments to reach the sustainable and life-preserving goals their country has. Although this is the case for Germany, it is plainly not the case for other nations trying to achieve the same goals. Given this variation, a host of questions arise about the German *Energiewende*: What is the source of German exceptionalism? Is it technological advancement or culture? How much of Germany's energy policy success rests on the back of civil society?

To answer this question, I will be looking at three different areas: the 3-prongs of the German *Energiewende*, energy conservation, and innovation & production of renewable energy technologies. Each of these three areas will be accompanied by domestic statistics and public

polling data to best understand how German society fits into the completion of Germany's energy targets. In addition to this, public polling data will be evaluated from 2011-2019 every two years. There are obvious factors driving German energy policy, like dependency on Russian oil and gas. To control for these factors, Germany will be compared to Italy and the Czech Republic. In addition, the average EU value and response will also be shown for reference. As shown from the pulled data and polling, the greater compliance German civil society has with Germany's environmental efforts, the greater the chance the German *Energiewende* has of progressing on time.

Literature Review

As the world entered the 21st Century, developed countries started to develop renewable energy policies that would guide environmental sustainability for the next twenty years. Germany is one of the most successful European countries that aim at developing environmental sustainability (Moore & Gustafson, 2017). According to U.S. News, Germany ranks #6 in the world for Green Living and Sustainability (U.S. News, 2022). Since the *Renewable Energy Act of 1999 (EEG)*, Germany began following a strict set of goals from this institutionalized legislation based on the idea of *Energiewende* (Strum, 2017). This concept aims to outline a transition into a nuclear-free and low-carbon economy with sustainable and renewable energy sources running the country at both the local and national levels (Jacobs, 2012). More specifically, Germany has a key target of reaching 80% renewable energy sources for electricity generation by 2050 (Rooge & Johnstone, 2017). Although Germany has these established and highly sought-after goals, it didn't necessarily begin that way.

From 1982 to 1998, Chancellor Helmut Kohl established no lasting energy policy, causing the Social Democrats and the Green Party to quickly enable a nuclear phase-out after the

election in 1998 (Jacobs, 2012). However, the *Renewable Energy Act of 1999 (EEG)* then began a decades-long policy initiative that would be revised five different times in 2004, 2009, 2012, 2014, and 2016/17 (Moore & Gustafson). When the Christian Democratic Union and the Christian Social Union won the election in 2009, the nuclear plant phase-out was extended to end in 2036 as a result of only a few small nuclear plants actually being shut down (Jacobs, 2012).

This extension would most likely have stayed in place if it weren't for the Fukushima Daiichi tsunami on March 11, 2011 (Jacobs, 2012). Because of the tsunami, an earthquake ruptured causing a damaging effect on the nuclear reactors and an exogenous shock to the consensus and the institutions which preserved it (Jacobs, 2012). The entire world witnessed this event, causing a major shift in nuclear phase-out policies around the world, including but not limited to Germany, Belgium, South Korea, and Switzerland (Rogge & Johnstone, 2017). In Germany specifically, this exogenous shock accelerated German fears of the apocalypse, a sense of duty to future generations, and an interest in technological solutions (Rogge & Johnstone, 2017). Only three days after the tsunami, Chancellor Merkel required federal security checks on all nuclear plants in Germany and initiated a temporary halt of the oldest seven plants from access to the grid (Jacobs, 2012). The end of the suspension then began *Energiepaket,* a new legislative packet of seven laws and Germany's iconic nuclear phase-out plan with a "cross-party consensus": closing all nuclear power plants by 2022 (Jacobs, 2012). This ultimately suggests the response to the Fukushima disaster came from a universal aspect of German public opinion and culture, which will be shown later on.

The nuclear phase-out was added to the German *Energiewende* energy policy transition, enabling a "policy mix" formula (Rogge & Johnstone, 2017). This "policy mix" included an *increase* in renewable energy sources while implementing a *decrease* in nuclear plants for the

phase-out (Rogge & Johnstone, 2017). As described by Rogge & Johnstone, this correlation between the two pieces of the "policy mix" entails a "discontinuous change" where the new technology (renewable energy sources) replaces the old (nuclear plants) to create technological advancement (Rogge & Johnstone, 2017). This is a key concept that, since the Fukushima nuclear reactor accident, will continue in Germany's energy policy as core legislation until target completion dates (Heinrichs & Markewitz, 2017).

In terms of targets and goals for Germany's energy policy, Germany's domestic targets are known to be incredibly aggressive compared to other goals Germany has promised to follow, like the EU energy goals, the UN's Sustainable Development Goals, and from the COP21 in Paris (Rogge & Johnstone, 2017). Although they may be unattainable, Germany's goals for greenhouse gas emissions (GHG) are a reduction of 40%-45% by 2020, 55%-60% by 2030, 70% by 2040, and 80-95% by 2050, reaching the end target of the German *Energiewende* (Beermann & Tews). In terms of the nuclear phase-out, the nine nuclear reactors in Germany were to all be closed between 2015 and 2022, with three of the nine's deadlines on December 31, 2022 (Jacobs, 2012). Despite the positive change in energy sources, Germany is expected to see instability in electric power from an oversupply in the north and a shortage in the south from the nuclear plant closures, potentially threatening the consensus and causing additional regional imbalances to religion (Moore & Gustafson, 2017).

In addition to the instability of electric power, there is still an overwhelming reliance on coal as a supplier of electricity, whether being supplied domestically or from abroad (Rogge & Johnstone, 2017). Aside from the cost and time factors in the transition, there is an adjustment to energy production as well. Lignite and coal produce more energy at a faster rate compared to renewable energy, causing a slower and harder transition away from fossil fuel energy sources

(Rogge & Johnstone, 2017). Because of this, lignite, a rich natural mineral in Germany, will most likely be used past the 2050 date (Moore & Gustafson, 2018).

Aside from the restrictions and additions of energy sources, a feed-in tariff law was created in 2012 to expand renewable energy shares by providing long-term contracts and fixed rates to get small businesses started in renewable technology and energy (Jacobs, 2012). This will also increase the renewable energy shares in the transport sector, leading to a gross consumption of energy to increase to 18% in 2020 and 60% in 2050" (Jacobs, 2012). In order to increase the overall energy shares, feed-in tariff laws were put into place, causing fixed payments on renewable energy sources along with government subsidies (Jacobs, 2012). This tariff was created to make affordable options for consumers and to give small energy businesses a chance at surviving compared to the big energy companies (Jacobs, 2012). It is important to note, however, that this feed-in tariff is supposed to last a couple of decades until there has been a greater and built establishment of renewable energy sources (Strum, 2017).

The feed-in tariff and overall transition into renewable energy are major reasons why electricity prices in Germany have been on the rise for years and are now one of the most expensive in the EU (Strum, 2017). Loopholes within the feed-in tariff allow companies to save money on their energy production and transition, causing the *Energiewende* to be almost fully paid by consumers (Strum, 2017). For example, in 2017, German prices were 11% higher than the average electricity prices in the EU (Kreuz & Musgens, 2017). Other than this, higher electricity prices are also due to the need for energy infrastructure updates (Moore & Gustafson, 2018).

As mentioned earlier, there is an issue with the north and south connectivity when it comes to transporting energy across the country (Moore & Gustafson, 2018). During the

infrastructure talks, the Sudllink line, a "high-voltage interregional line," was planned and started to help fix the country's problem (Moore & Gustafson, 2018). As the project became delayed causing a three-year setback on the project, it was put aside (Moore & Gustafson, 2018). As a result, a big hole was left in a much-need transmission project, no word on how/when to restart the program, and millions of euros in debt from an unfinished project (Moore & Gustafson, 2018). From a calculation in 2018 (not including money spent on past projects), the energy infrastructure needed for Germany's vision of the *Energiewende* would cost anywhere between 35 and 50 billion euros (Moore & Gustafson, 2018).

Another issue with Germany's *Energiewende* is the energy production capabilities. Again, lignite and coal produce more electricity at a faster speed. More specifically, fossil fuel energy sources can produce around 8,000 "full load hours," which refers to the amount of electricity and amplitude of power an energy plant produces (Moore & Gustafson, 2018). With the renewable sources that Germany is looking to expand on, there are fewer carbon emissions but also a dramatic reduction in electricity production. For example, onshore wind energy reaches only around 2,000 full load hours while solar only gets to 800 full load hours (Strum, 2017). As Strum goes on, he explains that one megawatt (MW) of fossil fuel or nuclear energy is equivalent to 4 MW of wind and 10 MW of solar energy, therefore causing a big reduction in overall energy efficiency (Strum, 2017).

The idea of the German *Energiewende* is not only a concept that is being modeled around the world but is also one that has been learned from (Rogge & Johnstone, 2017). The *Renewable Energy Act of 1999* continues to be revised to match the needs and economic status of the country (Moore & Gustafson, 2018). For example, the country's economic status can be affected when there is an alarming effect on imports, including the majority of Germany's natural gas, oil,

and hard coal (Kreuz & Musgens, 2017). Since many countries like Germany have an extreme dependency on fossil fuel imports, particularly from Russia, both domestic and international issues can cause energy issues for the German *Energiewende* (Pickrell, 2022). When these shocks occur, Germany is faced with a choice concerning their *Energiewende*: forcefully regress in their progress or deal with the consequences of heightened renewable energy sources.

Nonetheless, as Germany continues to experience shocks and increased electricity prices, the German people remain and wish to fulfill the goals of their *German Energiewende*. When a random sample of Germans was asked if they were willing to implement "significant lifestyle restrictions" to reduce climate change, 86% answered "yes" (Wettengel, 2022). In addition, concern over climate change has increased by 19% in Germany since 2015 compared to a 3% decrease from prominent world leaders like the United States (Elbaum & Eckardt, 2021). When combatting climate change, most countries, specifically in the European Union, believe their government and corporations & industries should have a strong position on climate change policies and renewable energy transitions (European Commission, 2019). However, the most prominent difference between Germany and other countries attempting a similar energy & environmental transition is the way their citizens act and respond.

Over 75% of Germans believe that climate change is the toughest hardship to handle, specifically in the 21st century. (Riedel, 2021) Moreover, this concern has only grown over the last 5 years (Nijhuis, 2020). Because of this, Germans make it a priority to fight climate change and better their environmental surroundings by acting in a very individualized way, whether that means responding in a way like using public transportation, buying environmentally friendly products, or conserving electricity to achieve carbon emission goals (Riedel, 2021). Simply put:

Germans believe changing your individual behavior is more important in combating climate change than relying on technological advancements (Riedel, 2021).

Research Methodology

Throughout the results and analysis section, the German values will be compared to Italy and the Czech Republic due to their shared consumption of Russian fuel imports and industrial development. Therefore, this research will be used as a "most similar" systems comparison. This design helps explain that regardless of the similarities between the different countries, the outcomes vary (Meckstroth, 1975). More specifically, the German fuel import product share from Russia is 76.24% compared to Italy's share of 81.92% and the Czech Republic's of 75.68% (WITS, 2020). In addition to these Russian Import Share values, German results can be compared to Italy due to a similarity in technological advancements and overall economic stability. These two concepts bind the two countries together in terms of the ability to enable the generation and production of renewable energies. Germany will also be compared to the Czech Republic to establish a cultural and regional comparison, connecting these two countries at the social level of responding to climate change. All results and responses provided will be from 2010-2019 unless otherwise stated. The average EU values and responses will also be shown in all graphs and tables for general comparison.

The first section of the results will go through the progression of the *German Energiewende* with carbon emission levels, GDP, and household electricity prices for each of the three comparative countries. While carbon emission levels and GDP will be solid figures, household electricity prices will be an average of euro cents per kilowatt hour for the energy generated from the 1.000-2.500 kWh euro value and the 2.500-5.000 kWh euro value. Therefore, the household electricity prices for each year will be one value from 1.000-5.000 kWh

generation. In addition to these values, public polling from all three countries will be provided, establishing the importance of climate change and the environment for citizens in Germany, the Czech Republic, Italy, and the EU average.

Following this first *German Energiewende* section will include two specified concepts: (1) conservation & generation, and (2) innovation and production. The "conservation and generation" section will first provide the overall electricity generation values as well as specified electricity generation from fossil fuels to establish a base consumption rate in each country. The public polling section will address individual citizen conservation by asking about everyday alternatives like public transportation and the steps taken to further conserve household electricity. The goal here is to establish the decreasing fossil fuel consumption as well as the extent to which each country will go to use public transportation and conserve energy. The second "innovation & production" section will take further broken-down information from the overall electricity generation and highlight renewable energy production. This will include values and percentages from wind, solar, and biomass & waste production. The goal here is to show the variety of renewable energy each country uses which ones they use the most, and how fast they've each developed these energies into everyday life. As for public polling, individual citizen opinions will again be looked at, but this time asking about the production and installation of new appliances and equipment that complement renewable energy choices. The goal here is to establish technological advancement and financial sacrifices to implement renewable energy in the common household. Between all three of these sections, the correlation between statistical values and public polling results will explain the diversified response of Germans when protecting the environment compared to Italy, the Czech Republic, and the EU average. In each

of the following graphs, blue will represent Germany, green will represent Italy, red will represent the Czech Republic, and black will represent the EU average.

Results & Analysis

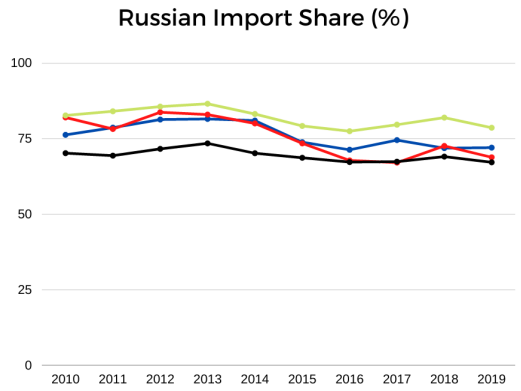


Figure 1.1 (WITS, 2020)

Within this next section, Germany's statistics and polling results will be compared to Italy, the Czech Republic, and the average EU value. As stated earlier, the controlling factor for Germany, Italy, and the Czech Republic is the Russian Import Share of Fossil Fuels. Figure 1.1 shows a 6-10% difference between the three individual countries compared to the average EU value until 2015 when the effects of the Russian financial crisis set in and fossil-fuel-dependent countries were forced to import from other countries that supplied cheaper fuels (WITS, 2020). While none of these countries hit below the EU average, all three countries reduced their dependency on Russian fossil fuel imports, causing the Czech Republic and Germany to hit closer to the EU average following the 2014 financial crisis (WITS, 2020).

The German Energiewende

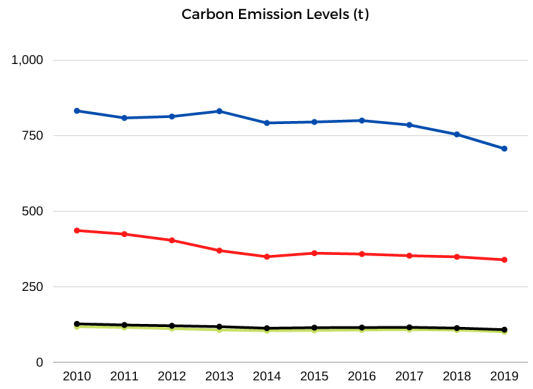


Figure 1.2 (Our World in Data, 2021)

RELATIVE CHANGE (%)
Carbon Emission Levels

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	-15.06%	-22.21%	-14.02%	-15.16%
2014-2016	1.02%	2.52%	2.33%	1.97%

Figure 1.3 (Our World in Data, 2021)

The first measurement of the German *Energiewende* is carbon emission levels which are shown in Figure 1.2. When looking at the graph, varying levels of population and electricity generation between the countries need to be addressed, highlighting the higher vs. lower carbon emission levels (Our World in Data, 2021). Because of this, it is important to look at the progression of carbon emission depletion through relative change (%) in Figure 1.3 (Our World in Data, 2021). From 2010-2019, Germany was able to match the ≈15% reduction in carbon emission levels of the EU average while the Czech Republic exceeded those standards by ≈7% and Italy fell short by slightly over 1% (Our World in Data, 2021). However, the 2014-2016 period shows the carbon emission progression during a damaging shock on energy transitions: the invasion of Crimea that eventually led to the Russian financial crisis (Our World in Data, 2021). During this time, Germany was least affected out of all options, compared to the Czech Republic and Italy which were both slightly over the EU average (Our World in Data, 2021).

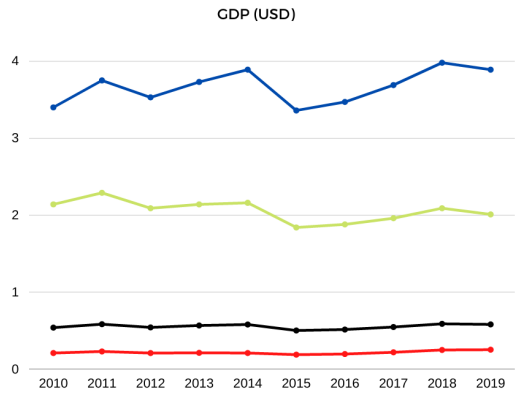


Figure 1.4 (The World Bank, 2019)

RELATIVE CHANGE (%)

GDP

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	14.41%	20.77%	-6.07%	7.76%
2014-2016	-10.80%	-6.41%	-12.96%	-11.25%

Figure 1.5 (The World Bank, 2019)

The next German *Energiewende* measurement consists of GDP in U.S. dollars. Again, the EU average, Czech Republic, Italy, and Germany all differ due to different economic, development, and population statuses, causing Figure 1.5 to be the comparative factor while Figure 1.4 is used to look at overall individual progress (The World Bank, 2019). From 2010-2019, Germany's GDP rose by ≈14.5%, almost double the EU average growth (The World Bank, 2019). Meanwhile, Italy's GDP dropped by ≈6% and the Czech Republic's grew at almost three times the rate of the EU average (The World Bank, 2019). During the shock between 2014-2016, Germany's GDP fell slightly less than the EU average while Italy just exceeded the EU average rate and the Czech Republic's diminishing rate was almost half of the EU's (The World Bank, 2019).

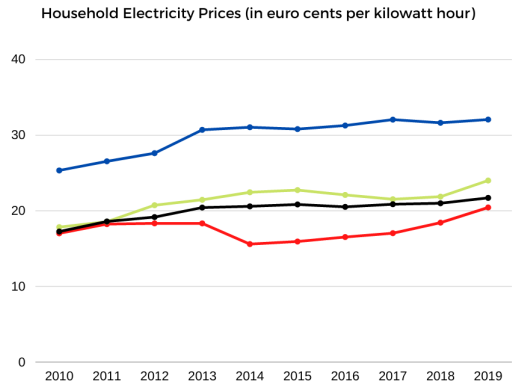


Figure 1.6

(Statista – European Union, Germany, Italy, Czechia, 2022)

RELATIVE CHANGE (%)

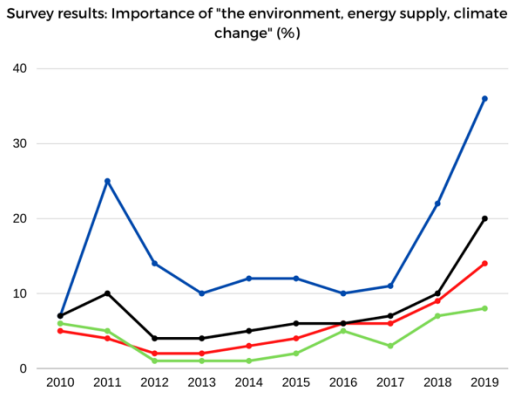
Household Electricity Prices

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	24.99%	20.08%	34.52%	25.80%
2014-2016	0.74%	6%	-1.58%	0.34%

Figure 1.7

(Statista – European Union, Germany, Italy, Czechia, 2022)

Lastly, the third German *Energiewende* measurement is household electricity prices (in euro cents per kilowatt hour). Unlike the previous measurements, the countries in both Figures 1.6 and 1.7 can be compared to one another as opposed to being looked at at the individual level (Statista – European Union, Germany, Italy, Czechia, 2022). In figure 1.6, it shows German electricity is at least 6.88-euro cents/kWh (kilowatt hour) more expensive than Italy, the EU, and the Czech Republic throughout the entire 2010-2019 time frame (Statista – European Union, Germany, Italy, Czechia, 2022). In terms of relative change between 2010-2019 (Figure 1.7), Italy's prices increased the most while both Germany and the Czech Republic fell below the average EU household electricity price (Statista – European Union, Germany, Italy, Czechia, 2022). Between 2014-2016, Germany barely increased their electricity prices, similar to the EU average (Statista – European Union, Germany, Italy, Czechia, 2022). On the other hand, the Czech Republic's prices increased by 6% and Italy's fell by nearly 2% (Statista – European Union, Germany, Italy, Czechia, 2022).



RELATIVE CHANGE (%)

Importance of "The environment, energy supply, climate change"

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	29%	9%	2%	13%
2014-2016	-2%	3%	4%	1%

Figure 1.8 (Standard Eurobarometer, 2010-2019) **Figure 1.9 (Standard Eurobarometer, 2010-2019)**

Although this is not a prong of the traditional German *Energiewende*, the general public polling of environmental importance is a large factor in how fast and thorough energy transitions occur. As shown in Figure 1.8, Germany has never fallen below any of the three comparative countries/regions except for 2010 when it was equal to the EU value of 7% (Standard Eurobarometer, 2010-2019). Within these values across Germany, Italy, the Czech Republic, and the EU average, there is a similar pattern of a large increase starting in 2017, representing the start of the global fight to achieve sustainability and environmentally friendly alternatives (Standard Eurobarometer, 2010-2019). Particularly in Germany, there is also a general spike within the EU in 2011 due to the Fukushima incident, causing worldwide attention toward energy supply (Standard Eurobarometer, 2010-2019). Figure 1.9 also compliments the fact that Germans have grown to realize the importance of "the environment, energy supply, and climate change" at two times the rate of the EU average, over three times more than the Czech Republic, and over fourteen times Italy's rate (Standard Eurobarometer, 2010-2019).

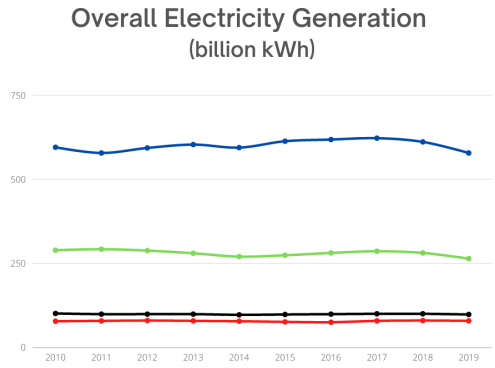


Figure 2.1 (USEIA, 2021)

As shown in Figure 2.1, the overall electricity generation (billion kWh) has remained fairly consistent with slight movement from Germany and the comparing nations (USEIA, 2021). This is being used as a reminder of additional variability between Italy, Germany, and the Czech Republic, as well as a reference of how much electricity is being generated by groups (i.e. fossil fuels, renewables, etc.) that are going to be compared.

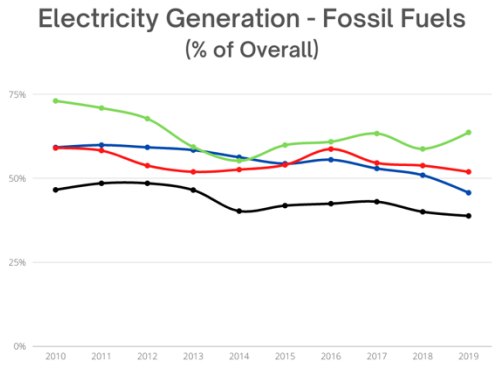


Figure 2.2 (USEIA, 2021)

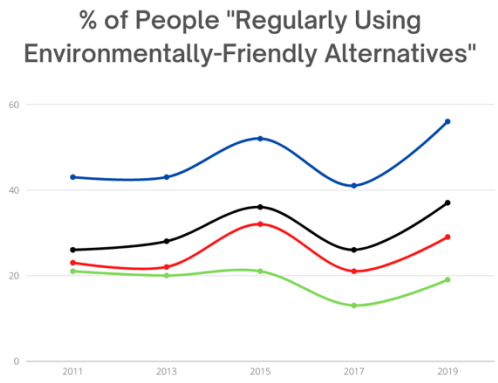
RELATIVE CHANGE (%)
Fossil Fuel Electricity Generation

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	-25.57%	-10.87%	-20.38%	-19.15%
2014-2016	2.69%	7.32%	14.76%	7.69%

Figure 2.3 (USEIA, 2021)

Figure 2.2 shows us the percentage of electricity that is generated by fossil fuels (USEIA, 2021). Unlike the EU average, Germany, Italy, and the Czech Republic all have the majority of electricity generated by fossil fuels (USEIA, 2021). In addition, we have notable movement in this category among all countries except for Germany, which remains a fairly consistent

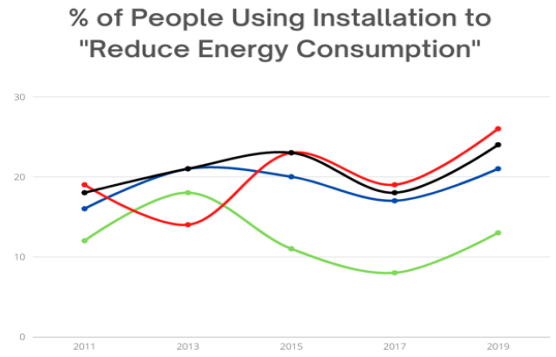
downward trend (USEIA, 2021). In Figure 2.3, the relative change is once again given, showing Germany as having by far the most progress with diminishing fossil fuels from 2010-2019 at -25.57% (USEIA, 2021). Between 2014-2016, Germany exhibited the smallest setback while the EU average and the Czech Republic had around 3 times the increase in fossil fuel generation and Italy had close to 6 times (USEIA, 2021).



RELATIVE CHANGE (%)
"Regularly Using Environmentally-Friendly Alternatives"

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2011-2019	13%	6%	-3%	11%

Figure 2.4 (Special Eurobarometer, 2011-2019) **Figure 2.5 (Special Eurobarometer, 2011-2019)**



RELATIVE CHANGE (%)
"Reduce Energy Consumption"

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2011-2019	5%	7%	1%	6%

Figure 2.6 (Special Eurobarometer, 2011-2019) **Figure 2.7 (Special Eurobarometer, 2011-2019)**

In Figure 2.4, a significant pattern is shown between all of the compared countries with an increase from 2013-2015, a decrease from 2015-2017, and then another large increase from 2017-2019 for the usage of “environmentally-friendly alternatives” (Special Eurobarometer,

2011-2019). This is most likely due to the need to save money on electricity from the Russian financial crisis (2014-2016) that increased fuel prices, a return to normalcy in 2017, and then the worldwide shift to environmental alternatives that continues to this day (Special Eurobarometer, 2011-2019). Overall, from 2011-2019, Germany had at least 15% more people using various alternatives and grew at the highest rate of 13% (Special Eurobarometer, 2011-2019). Unlike Figure 2.4, Figure 2.6 does not show a consistent pattern among the four countries at the individual level of reduction in energy consumption (Special Eurobarometer, 2011-2019). Of the four countries, Germany shows the least amount of variability but overall, the Czech Republic shows the most improvement in this area at 7%, the EU average at 6%, Germany at 5%, and Italy at 1% (Special Eurobarometer, 2011-2019). From this, we can see that reduction of energy consumption is not necessarily among one of the top options for individuals compared to using safer and more environmentally friendly alternatives (Special Eurobarometer, 2011-2019).

Innovation & Production

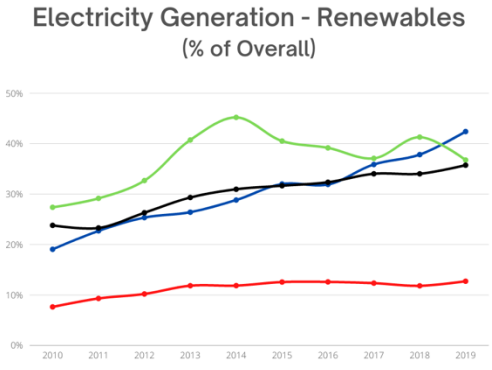


Figure 3.1 (USEIA, 2021)

RELATIVE CHANGE (%)
Renewable Electricity Generation

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	116.81%	69.49%	22.78%	45.83%
2014-2016	15.20%	2.17%	-9.83%	6.67%

Figure 3.2 (USEIA, 2021)

Figure 3.1 shows the percentage of renewable energy being generated from the overall production value and rate. Although Germany is ranked third of the countries selected in 2010, it ranked first as of 2019 and got to that point at the most consistent rate compared to the other three countries as shown in Figure 3.2 (USEIA, 2021). From 2014-2016, Germany grew 8.53%

more than the EU average, 13.03% more than the Czech Republic, and 25.03% more than Italy (USEIA, 2021). From 2010-2019, Germany grew 70.98% more than the EU average, 94.03% more than Italy, and 47.32% more than the Czech Republic (USEIA, 2021). Again, these relative changes were calculated based on the percentages of the overall electricity generation, not the whole values, making each of these percentages comparable to others (USEIA, 2021). From all these values, it is clear that Germany has far exceeded the comparing countries for generating more of its electricity from renewable sources (USEIA, 2021).

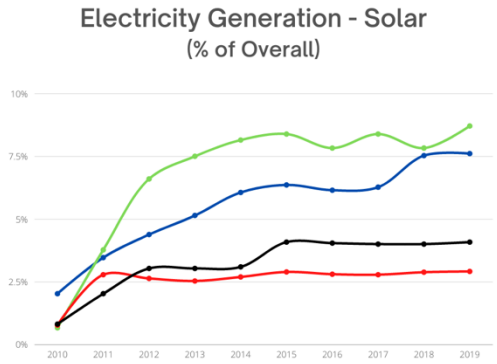


Figure 3.3 (USEIA, 2021)

RELATIVE CHANGE (%)
Solar Electricity Generation

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	226.67%	283.33%	11110.53%	387.80%
2014-2016	5.56%	0.00%	0.00%	33.33%

Figure 3.4 (USEIA, 2021)

Within renewable energies, the solar, wind, and biomass & waste sectors were pulled to look at a more broken-down version of renewable electricity generation. Figure 3.3 shows the percentage of electricity that is strictly generated from solar energy (USEIA, 2021). Compared to the Czech Republic and the EU average, it is clear that Italy and Germany have much more equipment and management for solar energy across their countries (USEIA, 2021). However, based on relative change, Germany compared from 2010-2019, the Czech Republic and Germany changed at the lowest rate of around ≈277% while the EU increased at 403.70% rate, and Italy changed at a rapid pace of 1219.70% (USEIA, 2021). From 2014-2016, Germany and the Czech Republic stuck to a relatively slow increase in solar generation while the EU prospered at 30.64% and Italy fell to -3.92% (USEIA, 2021).

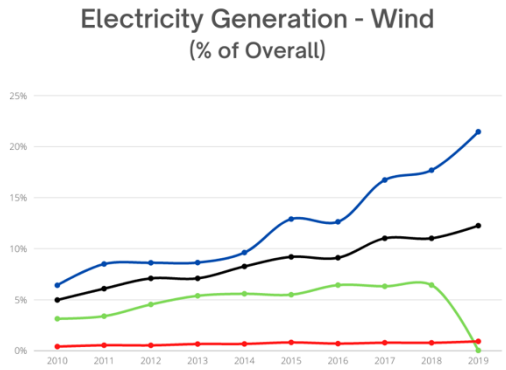


Figure 3.5 (USEIA, 2021)

RELATIVE CHANGE (%)
Wind Electricity Generation

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	226.32%	133.33%	-100%	140%
2014-2016	26.84%	0%	20%	12.50%

Figure 3.6 (USEIA, 2021)

Out of all renewable energies being used to generate electricity, wind is the primary source for Germany. Figure 3.5 shows a clear separation between each of the four countries, with both Germany and the EU average having a clear increase in wind generation throughout the graph (USEIA, 2021). When looking at the relative change from 2010-2019 (Figure 3.6), Germany exceeded a 200% growth increase while three others reached between a 125%-140% increase (USEIA, 2021). Although they couldn't reach the overachieving potential of Germany's wind growth, all countries were able to install hundreds of new wind turbines that allowed for the overall growth of renewable energy (USEIA, 2021).

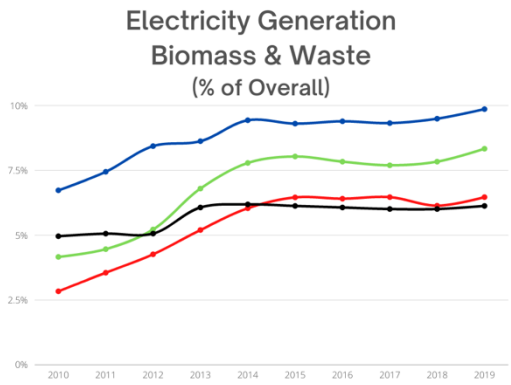


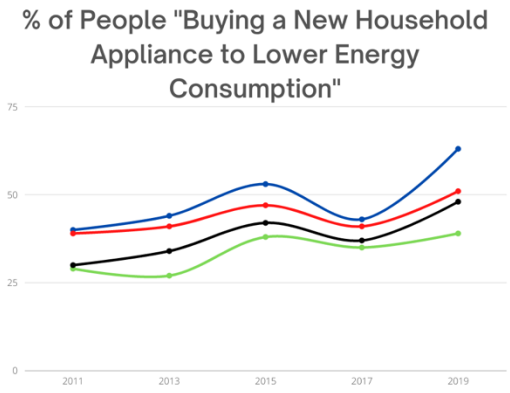
Figure 3.7 (USEIA, 2021)

RELATIVE CHANGE (%)
Biomass & Waste Electricity Generation

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2010-2019	42.50%	131.82%	83.33%	20%
2014-2016	3.57%	2.13%	4.76%	0%

Figure 3.8 (USEIA, 2021)

In addition to wind and solar energy, all four countries were able to use biomass and waste as a form of renewable energy. Again, Figure 3.7 shows Germany as the leader in this kind of renewable energy generation, having nearly 10% of overall electricity generation coming from forms of biomass & waste energy (USEIA, 2021). While it may not have started off as the preferred method, biomass & waste have grown into a more popular form of energy, especially in Europe, since 2014 (USEIA, 2021). Figure 3.8 shows a higher rate of relative growth, particularly in the Czech Republic, but also in Germany and Italy (USEIA, 2021). While Germany's biomass & waste production may not have grown as much as Italy's and the Czech Republic's rates, it still remains at a high generation rate (USEIA, 2021).



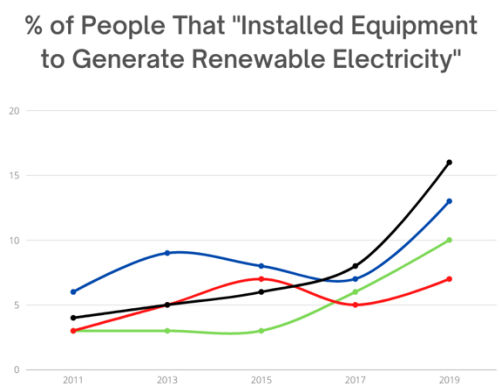
RELATIVE CHANGE (%)
"Buying a New Household Appliance to Lower Energy Consumption"

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2011-2019	23%	12%	10%	18%

Figure 3.9 (Special Eurobarometer, 2011-2019) **Figure 3.10 (Special Eurobarometer, 2011-2019)**

Other than generation rates, the Eurobarometer calculated the percentage of people in each country who "buy a new household appliance to lower energy consumption" (Special Barometer, 2011-2019). As shown in Figure 3.9, Germany leads this poll with the Czech Republic following (Special Barometer, 2011-2019). Although Italy fell below the EU average, each of the countries follows a similar fluctuation pattern with Germany showing the highest increases during these periods (Special Barometer, 2011-2019). Compared to the EU average's

relative chance from 2011-2019 in Figure 3.10, Germany exceeds this rate change by 5% while the Czech Republic and Italy both grew but fell under the EU average rate by 6% and 8% (Special Barometer, 2011-2019).



RELATIVE CHANGE (%)

"Installed Equipment to Generative Renewable Electricity"

	GEMRANY	CZECH REPUBLIC	ITALY	EU
2011-2019	7%	7%	4%	12%

Figure 3.11 (Special Eurobarometer, 2011-2019) **Figure 3.12 (Special Eurobarometer, 2011-2019)**

Another public polling question was reported in the same percentage format but asked whether people have "installed equipment to generate renewable electricity" (Special Barometer, 2011-2019). Because this was at the individual household level, this primarily refers to solar panels. When referencing back to Figure 3.3, the pattern of the percentage of solar energy being generated matches the percentage of people installing renewable energy equipment in Figure 3.11 (Special Barometer, 2011-2019). In 2015, solar energy plateaued and picked back up from 2017-2019, resembling the public polling data (Special Barometer, 2011-2019). As opposed to relative change from 2011-2019, Germany, the Czech Republic, and Italy fell below the EU average (Special Barometer, 2011-2019). However, if Germany hadn't seen that period of reduced solar energy and fewer solar panels, there could've been a more significant relative change during these eight years (Special Barometer, 2011-2019).

Conclusion

Within the German *Energiewende* analysis, I found that Germany experienced a reduction in Russian fossil fuel dependency and the country met the EU average carbon emission reduction. It was also shown that Germany contained the highest GDP out of the comparing nations and even had double the growth rate of the EU average. Germany's household electricity prices were at least 6.88-euro cents/kWh more expensive than the next highest price and the German importance of the "environment, climate change, and energy supply" was the highest among the comparable countries in addition to their doubling importance growth rate.

The "Conservation & Generation" section showed that Germany had the most relative change in their fossil fuel electricity generation reduction rate. In the public polling data, Germany held the highest relative change growth rate and overall percentage of people that used "environmentally-friendly alternatives." However, when it came down to increased installation, Germans' relative change remained average while their actual answers (%) were slightly below average. From this, we can conclude that Germans prefer to make environmentally-friendly lifestyle changes than physical equipment changes.

Lastly, the "Innovation and Production" section showed that Germany has the highest percentage of renewable electricity generation in 2019 and had the most growth in relative change. Although Germany is just short of Italy's solar generation, Germany picked up wind energy generation, allowing them to have the highest wind generation percentage and relative change. In addition to this, Germany also has the most biomass and waste generation. In terms of public polling, Germany had the highest percentage of people who "installed equipment to generate renewable technology" until the Germans shifted their priorities from solar to wind.

Other than this, Germany showed the highest percentage of people who "bought a new household appliance to lower energy consumption" as well as the highest relative change.

The German *Energiewende* is not a complete success - Germany did and is still currently experiencing high influxes of household electricity prices. It is important to note, however, that the high prices are in part tied to the tariff, which in turn is funding investment in the new technology. Yet, Germans view the environment as one of the most important issues and are willing to make lifestyle sacrifices to achieve their goals. Based on this, it is clear the success of the German *Energiewende* is in large part due to the actions and sacrifices of the German people. Compared to a country like the United States, Germany shows a true will to achieve carbon neutrality and defeat climate change as they continue to fight through shocks like the Russian financial crisis.

Currently, Germany and most of Europe are experiencing another shock as a result of the Russia-Ukraine war. In Germany's case, they've had to find other sources of fossil fuels causing electricity prices to increase to 64.44 euro cents/kWh in August of 2022 and has now decreased to 39.70 euro cents/kWh (Trading, 2022). However, Germany is finding ways to help its citizens like providing extra incentives for using renewables, budgeting for increased aid for the winter heating prices, and lowering public transport prices. For example, monthly train tickets are now only 9 euros which has not only saved Germans extra money but has reduced 1.8 million tons of CO2 as of August 2022 (Nicola, 2022).

As we continue watching the effects of the Russia-Ukraine war, we must also observe the behaviors and public opinions of Germans on the level of importance of "the environment, energy supply, and climate change" as well as their willingness to sacrifice financial stability for the greater good of climate change reversal. The Germans will also be able to answer the

question: what else can we be doing that we aren't already? During these shocks, new ideas and ways of life are created to provide relief, and if these new customs complement the German *Energiewende*, odds are they will continue to occur past the shock. This then leads to the question: can the will and ways of Germans be transferred to the United States and other world leaders? The world will continue fighting to reverse climate change and there is no doubt the German *Energiewende* will be a strong example of positive change. We've seen legislation and goals expand on these issues with little to no success. With this said, it is now simply a world matter of the power of the people.

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