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List of abbreviations

AfD	Alternative für Deutschland
BattG	Batteries Act
BMU	Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz
BMWK	Bundesministerium für Wirtschaft und Klimaschutz (Federal Ministry for Economic Affairs and Climate Action)
BMZ	Federal Ministry for Economic Cooperation and Development
BWE	German Energy Association
CDU	Christlich Demokratische Union Deutschlands
CdTe	cadmium telluride cells
CFRP	carbon-fibre reinforced polymers
CIGS	copper gallium selenide
CPV	concentrator photovoltaic cells
c-Si	crystalline silicon
CSU	Christlich-Soziale Union
EEG	Renewable Energy Act
EoL	End-of-Life
EU	European Union
e-waste	electronic waste
FDP	Freie Demokraten
GFRP	glass-fibre reinforced polymers
GHG	Greenhouse Gas Emissions
HVF	high voltage fragmentation
IKTS	Fraunhofer-Institut für Keramische Technologien und Systeme
IRENA	International Renewable Energy Agency
MAP	microwave assisted pyrolysis
NGOs	non-profit organizations
PV	Photovoltaic
R&D	Research & Development
RoHS	Restriction of Hazardous Substances Directive
SPD	Sozialdemokratische Partei Deutschlands

TA	thematic analysis
UBA	Umweltbundesamt
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WEEE	EU Directive Waste of Electrical and Electronic Equipment
WindSeeG	Wind Energy at Sea Act

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1. Introduction

The Executive Secretary of United Nations Framework Convention on Climate Change (UNFCC) Patricia Espinosa (2021) stressed in her opening speech for the United Nations Climate Change Conference COP26 that “climate change is widespread, rapid, intensifying and already impacting every region on Earth, both on land and in the oceans” (para. 45). It is regarded by many as the biggest challenge humanity faces in the 21st century and requires rapid and far-reaching action to mitigate the effects of climate change on the environment and ultimately humanity (Espinosa, 2021; Guterres, 2022; World Health Organization, 2021; UN Security Council, 2021). The central goal of the global effort to mitigate climate change is “to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels” (UNFCCC, 2022, para.2) which was established in the Paris Agreement that entered into force in 2016.

As the key driver identified behind climate change, the focus lays on reducing the Greenhouse Gas Emissions (GHG) to achieve the 1.5 °C goal (Espinosa, 2021). Thus, an important strategy is the employment of mitigation measures in several sectors such as energy industries or transportation to lessen GHG emissions, most notably the attempt to transition away from oil and gas as energy sources to renewable or ‘clean’ ones like hydro, wind and solar. A transition that has been deemed by Espinosa (2021) “beyond the scope, scale and speed of anything humanity has accomplished in the past” (para. 55). Yet, why the transition is necessary is illustrated by the fact that circa 65 percent of GHG emissions are energy-related, more accurately “energy production and use” (IRENA, 2017, p. 7).

In his inaugural address to the German parliament, the newly elected German Chancellor Olaf Scholz (2021) emphasized the need for Germany to undergo a societal, economic, and technological transformation in the coming two decades to ensure Germany’s readiness in the world of the 21st century. A central part of this transformation is focused on achieving the goal of carbon neutrality that Germany has committed to in the Paris Climate Agreement and the coalition agreement of the current German government to mitigate climate change. To achieve said goal, the new government stressed the importance of renewable energy sources, highlighting wind and solar energy as key energy sources for Germany (Scholz, 2021).

The importance of wind and solar energy for Germany is nothing new as the former energy source has been regarded as “the driving force in expanding renewables” (Federal Ministry for

Economic Affairs and Energy, 2021, para. 8). A perspective that is reflected by the fact that wind energy is the biggest renewable energy source in Germany, with solar energy following in third place. In 2021, wind and solar energy contributed 24 percent and 11 percent to Germanys energy supply, which is the result of the Renewable Energy Act (EEG) (Umweltbundesamt, 2022b). The EEG was first enacted in 2000 and has been the driver behind the development of renewable energy sources in Germany. The laws have been a pillar of the German energy transition, the German *Energiewende* and ensured renewables competitiveness by subsidizing facilities that generate renewable energy for twenty years (Umweltbundesamt, 2021).

2020 also signaled the end of the twenty-year period of guaranteed support given in the EEG (Zotz et al., 2019), which is expected to result in 'old' wind farms and solar energy plants to be shut down because they are no longer regarded as cost-effective (Wehrmann, 2021). Besides being perceived as no longer economically viable, another important aspect behind the decommissioning of wind farms and solar energy plants is their life expectancy. Although their energy sources are renewable, the technology used to convert wind and sun to energy is not. Wind turbines have a life expectancy of twenty to twenty-five years, slightly shorter than that of solar photovoltaic (PV) modules with thirty years. Consequently, more and more installations are expected to reach their end-of-life in the coming years, making the question of how to manage the waste resulting from these two renewable energy sources evermore pressing. Moreover, it is a problem that will only gain more significance with renewable energy sources as the key for the green energy transition and a sustainable future. The increase of wind farms and solar energy plants comes along with an increase in waste.

From a sustainable standpoint, recycling is the best option when it comes to waste management and is actively promoted by Germany through a number of laws and policies such as the Batteries Act (BattG) (Umweltbundesamt, 2022a). Yet, recycling can be challenging due to the materials used in the original product and the recycling technologies available that may not be (fully) developed yet, do not lead to satisfactory results or are not economical, which applies to the recycling processes of wind turbines, solar PV panels and batteries (Oteng et al., 2021; Salim et al., 2019; Xu et al., 2018; Lefeuvre et al., 2019; Lichtenegger et al., 2020).

Some scholars have begun to shift their focus towards the waste management of wind turbines and solar PV panels, mainly contributing articles and academic papers on possible recycling solutions, their performance and economic viability as well as estimations on how much waste is going to accumulate over the next two to three decades due to wind and solar energy. However, not many in research have examined the policies and regulations (or lack thereof) in regards to the waste management of wind turbines and solar PV panels. This study is thus an exploration of the rules and policies concerning the waste management of wind farms and solar energy plants in Germany. This project aims to explore how the problem of waste management is framed by different policy-relevant actors, how these different frames interact with each other and how the framing of waste management of wind turbines is similar or differs to that of solar PV panels. This thesis project therefore seeks to contribute to the existing research by offering a greater understanding of the wider policy context surrounding waste management for wind and solar energy as frames as well as interests behind them are explored.

Therefore, this is a case study on how frames shape the policy-making process, with the potential to enhance our knowledge regarding framing of sustainability issues. The identification and analysis of frames and their narratives is important because they unveil hidden assumptions in relation to a policy issue and gives transparency concerning frame sponsors and their interests (Kwan, 2009). Thus, a frame analysis enables us to understand how the issue of waste management of wind turbines, PV panels and batteries are defined and what potential implications these definitions have for policy outcomes on this issue. It helps us understand who the frame sponsors for frames in the waste management of these renewable technologies are, what policy outcomes they pursue and how they (attempt) to sway public, media and politics in their favor. Based on a qualitative study using mainly secondary and tertiary data on for example recycling, waste management, end-of-life (EoL) treatment, resource efficiency and policies of wind turbines, solar PV panels in Germany to answer the following research questions:

1. What are the frames and their frame sponsors in the discussion regarding the management of EoL wind turbines?
2. What are the frames and their frame sponsors in the discussion regarding the management of EoL PV panels and batteries?
3. What are the similarities and differences between wind turbine and PV panels plus batteries when it comes to the framing of their EoL management and the stakeholders' involvement in it?
4. How do the frames and frame sponsors influence the policy making process regarding the EoL management of wind turbines, PV panels and batteries?

2. Germany's energy transition – the *Energiewende*

Even though there is not one concurrent definition of the term *Energiewende*, it has become synonymous with Germany's long-term goal to transition its energy system away from fossil and nuclear based energy production towards renewable and sustainable energy sources. The continuous effort to transform Germany's energy production and consumption has garnered not only national but also international attention as it was the first attempt of a leading industrialized nation to conduct significant and far-reaching changes to its energy system in order to make it more sustainable (Quitzow et al., 2016).

Germany's unique effort was met with hope and skepticism as some anticipated Germany to inspire sustainable development in the global energy sector and become a role model for other developed countries (Schmid et al., 2016). In fact, Sigmar Gabriel, the German Federal Minister of Economy and Energy from 2013 to 2017, declared "motivation of others to imitate the Energiewende" (Joas et al., 2016, p.43) as a specific goal of the *Energiewende*. Whereas others have regarded the *Energiewende* as a project likely to fail, resulting in high costs for Germany's economy and population and becoming "a climate killer, an economic disaster, a burden" (Quitzow et al., 2016, p.165). Nonetheless, Germany held on to its pursuit of an energy transition with guiding principles such as the reduction of GHG emissions, the nuclear phase-out, the development of new technologies and the development of an energy supply mainly stemming from renewables (Joas et al., 2016; Rogge & Johnstone, 2017).

Set goals lend specificity to the *Energiewende* and make it measurable, for example the reduction of GHG emissions by 55 percent in 2030 in comparison to 1990 emission levels (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, 2016), the percentage of the total power generation coming from renewable being "80 percent by 2050" (Nazakat 2018, p.16) or climate neutral buildings by 2050 (Dehmer, 2013). Furthermore, the 2050 Climate Action Plan, which was adopted in 2016 presents a guideline for climate action established by the German government that not only reiterates the existing goals and principles but also expands on new ones, particularly in the transport and agricultural sector (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz, 2016; Hedberg., 2018). Thus, the specific targets in addition to the overarching principles of the *Energiwende* have been modified over the years as climate action has become a more prominent and important topic in national and international public and political debates.

The *Energiewende* is a process that requires continuous action and financial investment, which is why a stable and steady support by the public and politics is of great importance. Borden and Stonington (2014) highlighted this when they claimed that "[o]ne of the most important achievements of the *Energiewende* is its acceptance into the mainstream of German society – at individual, social and political levels" (p.378). It is remarkable that since the 2000s, German governments have maintained the path towards a cleaner energy future with "[t]he German energy policy, despite recurrent controversies, […] show[ing] [. . .] a high degree of continuity in its central aspects" (Hake et al., 2015, p.544). Although it is not necessarily a consensus of the political parties on how the energy transition is supposed to be managed, there is a general agreement and support of the *Energiewende* itself (at least of the political parties in government) (Borden & Stonington, 2014; Hake et al., 2015). This is a reflection of the broad attitude of the German public towards the *Energiewende* as "the German public remains staunchly supportive" (Cunningham, 2018, p.5).

The aforementioned high degree of support for the energy transition can be explained by looking at the history of environmental activism in Germany. One of the most important pillars of environmental activism and a driving force behind the pursuit of renewable energy sources is the anti-nuclear movement dating back to the 1970s. In the 1970s, in West Germany a strong environment movement emerged from the antiwar and social movements, concerned about the use of nuclear power and with a growing environmental awareness (Quitzow et al., 2016; Hake et al., 2015). Furthermore, Hake et al. (2015) highlight the close tie between the environment movement and an anti-nuclear standpoint by stating that "[i]n no other country was the environment movement influenced so strongly by the conflict over the civilian use of nuclear energy as in Germany" (p.534). Citizen initiatives started massive anti-nuclear protests in the 1970s, targeting nuclear power plants and later the location for the planned national disposal center for nuclear waste (Renn & Marshall, 2016; Hake et al., 2015). The protests were nationwide and sometimes escalated to violent clashes between protesters and police, most notably at the nuclear power plant sites Brokdorf and Grohnde as well as at Gorleben, the planned disposal site (Renn & Marshall, 2016; Hake et al., 2015). The anti-nuclear movement was further spurred on by the Three Mile Island accident on March 28th, 1979 (Office of Nuclear, 2022), after which they felt their stance on nuclear power as dangerous justified (Hake et al., 2015).

By now regarded as classic environmental literature such as E.F. Schumacher's "Small is Beautiful" or "Limits of Growth" written by Dennis Meadows further increased the public's interest in the environment and arising issues concerning its protection and preservation (Hake et al., 2015). Indeed, nuclear energy was not the sole focus of the environment movement as it targeted many environmental issues and formed numerous new organizations dedicated to these issues. Still, these new organizations had one commonality, their opposition to nuclear energy (Hake et al., 2015). The heightened environmental consciousness culminated in the founding of the Green Party in 1980, a political party dedicated to environmental and ecological matters. In 1983 the Greens were voted into the German parliament and thus the environment movement had its own political representative for the first time. From then on, not only pressure groups but also the Green Party tried to influence policies concerning energy and the environment (Hake et al., 2015).

These developments led the environment movement to gain in strength in the early 1980s with other prominent environmental concerns being debated. One notable example was the acid rain and the destruction of forests because of it. An environmental issue that was linked to yet another energy source, namely coal. The deep environmental damages left by coal mining certainly faced heavy criticism from the environmental movement and although most environmental organizations were against coal, they were hesitant to fight both nuclear and coal as energy sources and chose to prioritize nuclear and its phase-out (Renn & Marshall, 2016).

The search for alternative energy sources was underway with the start of the climate change debate as all the predominant energy sources, meaning uranium, coal and oil were regarded as environmentally damaging by the environment movement, leading to contemplations about how energy security could be achieved without them. The publications of these ideas in addition to the founding and election of the Greens planted the roots in German society of an energy transition (Hake et al., 2015). It is also around this time that the term *Energiewende* was first introduced by three researchers of the Institute of Applied Ecology who were activists in the environment movement (Morris, 2014). The publication of their book titled *Energiewende: Growth and Prosperity Without Petroleum and Uranium* (in German Energiewende: Wachstum und Wohlstand ohne Erdöl und Uran) is now regarded as a milestone for the environment movement and the energy transition itself (European Commission et al., 2018).

A major outside event irreversibly changing German politics was the Chernobyl nuclear disaster in 1986 (Hake et al., 2015). Before Chernobyl, all the major political parties in Germany, apart from the Green party, were in agreement when it came to nuclear energy. It was regarded as a crucial technology for Germany’s energy security by the three long established political parties that had determined German energy policy in the previous decades (Renn & Marshall, 2016).

After the Chernobyl nuclear disaster this party consensus no longer existed as the SPD stopped supporting nuclear energy (Hake et al., 2015). From then on, nuclear energy would become a recurrent controversy in the political sphere. However, the party consensus was not the only one broken up in the aftermath of Chernobyl as the majority of the population changed their position from supporting nuclear energy to supporting a nuclear phase-out (Hake et al., 2015).

Between 1986 and 1998 the government coalition of Christlich Demokratische Union Deutschlands (CDU)/Christlich-Soziale Union (CSU) and Freie Demokraten (FDP) under Chancellor Kohl held steadfast unto the use of nuclear energy, disregarding the attacks on the topic of nuclear energy by the opposition parties and the general public (Renn & Marshall, 2016). Notwithstanding, the influence of the rising interest in environmental matters in combination with the growing concern regarding the consequences of climate change did alter the certain energy and environmental policies under the Kohl administration. There are the noteworthy examples of Germany's commitment to the reduction of GHG emissions under the Kyoto Protocol, the decision to phase out hard coal and the Stromeinseisegesetz (Electricity Feed-In Act) in 1991 (Renn & Marshall, 2016). With the Electricity Feed-In Act, the Kohl administration passed the first law promoting renewables (Yao, 2018).

Yet, the adoption of the Feed-In Act is attributed to a cross party initiative, focusing on the advancement of hydropower, the biggest renewable energy source in Germany at the time (Borden & Stonington, 2014). Even though the Act focused on hydropower development, it also encompassed and benefitted the development of decentralized wind and solar power installations (Borden & Stonington, 2014). The Act implemented a new incentive structure for operators with decentralized renewable energy installations and moreover required large utilities to connect these operators to the grid, making solar and wind energy profitable in the most productive locations building the foundation for the integration of renewables in the energy market (Borden & Stonington, 2014; Cheung et al., 2019; Hake et al., 2015). However, it was not until 2000 and the enactment of the Erneuerbaren-Energien-Gesetz (Renewable Energy Law, EEG), which expanded upon the Electricity Feed-In Act, that renewable energy development and deployment took off (Cheung et al., 2019).

Despite or maybe more accurately because of the change in government after the 1998 election in which the Sozialdemokratische Partei Deutschlands (SPD) garnered the most votes and formed a government coalition with the Green Party, seizing governmental power after 16 years of a Kohl led coalition consisting of CDU/CSU and FDP, the path towards a more renewable energy system was continued (European Commission et al., 2018; Tagesschau, n.d.). The mentioned EEG was an important part of the "ecological modernization" (European Commission et al., 2018, p.6), emphasizing sustainable development and environmental compatibility in their energy policy (Renn & Marshall, 2016). Furthermore, the EEG remains a pillar of the energy transition and is regarded as the central instrument behind the achievements made thus far, specifically in the deployment of renewable energy.

Just as the Electricity Feed-In Act it was based upon, the EEG obliged grid operators to accept and feed the electricity derived from third-party renewables with the main difference in pricing (Renn & Marshall, 2016). Under the EEG, the grid operators now had to pay fixed prices which were not only decoupled from the current electricity prices but also a lot higher compared to the Electricity Feed-In Act (Renn & Marshall, 2016). Moreover, the feed-in tariffs were guaranteed over a 20-year period, allowing for investment security and making underdeveloped and consequently expensive and not necessarily effective renewable energy sources possibly profitable. Additionally, the energy technologies that already benefitted from the old feed-in tariffs under the Electricity Feed-in Act were expected to prosper even more (Ohlhorst, 2015).

The subsidies granted by the EEG to the renewable energy sources were and still are financed through the electricity consumer added as an additional charge to their electricity bills with the exception of energy-intensive industry, whose international competitiveness took priority (Cunningham, 2018). Furthermore, electricity generated by renewable sources had to be prioritized, meaning that a grid operator was lawfully obligated to always feed electricity considered renewable energy into the grid, even if electricity form other (cheaper) sources was available (Hake et al., 2015).

Besides the promotion of renewable energy, the nuclear power phase-out was another important aspect of the coalition agreement. The SPD/Green Party coalition set out to adopt a law regulating the nuclear phase out by limiting the time on operating licenses within that legislative period (Hake et al., 2015). To avoid having to pay any compensation payments to utility companies running nuclear power plants, the red-green government invited them to negotiation, resulting in a consensual agreement between government and industry in 2000 on a nuclear power phase out (Cheung et al., 2019). The agreement was enacted into law in 2002 with the amendments made to the German Atomic Energy Act (Atomgesetz) (Renn & Marshall, 2016). The operation limit was set to 32 years with every nuclear power plant being given "a so-called residual electricity volume" (Hake et al., 2015, p.539) and the possibility of transferring years from old nuclear power plants to newer ones after the old ones are shut down (Hake et al., 2015). In addition to a limited operation time, the construction of new nuclear power plants was prohibited, thus stopping large investment into the nuclear power sector (Hake et al., 2015).

Both Acts were part of continuous political and public debates and consequently constantly evaluated, especially the EEG with multiple amendments as a result. The second amendment to the EEG happened in 2004, which was made necessary because of European legal requirements and the realization that the feed-in tariffs were set too high, making the feed-in payments unnecessary high on the consumers (Nazakat, 2018). Additionally, the lower feed-in tariffs were regarded as a motivation for utility operators of renewable energy sources to be more efficient and to drive innovation and technology advancement of renewable energy technologies (Hake et al., 2015).

However, the EEG continued to provide a great boost to renewable energy technologies as their production levels remained on the rise. For example, the installed capacity of wind power "increased from 1-GW in 2000 to 3.2 GW in 2002" (Cheung et al., 2019, p.635) and production levels of onshore wind "almost quadruplet between 2000 and 2010" (Matthes, 2017, p.150). Moreover, the German wind and solar energy markets became the largest in Europe (Hake et al., 2015). The success of the EEG was actually a reason as to why it was amended in 2004. The red-green government felt embolden by the positive development of renewable energy as well as the public support for the endeavor, leading to the adoption of more ambitious targets (Cheung et al., 2019).

The path towards an energy transition with the goal of a climate-friendly energy supply was continued in the next legislative period with the grand coalition under Chancellor Merkel in power from 2005 to 2009. Its coalition agreement presented numerous ambitious targets for the development of renewable energy generation as well as touched upon other areas such as energy efficiency and the energy infrastructure. The objectives to increase energy efficiency and to modernize German power plants were set out to further foster a sustainable energy system (Hake et al., 2015). Energy efficiency is another central part of the *Energiewende* and viewed as crucial measure for achieving an environmentally friendly future as highlighted by the enactment of the Renewable Energies Heat Act in 2009 (Hake et al., 2015). Overall, the topic of climate change mitigation had developed into a prominent one in the socio-political sphere with all political parties in parliament acknowledging the need for a low-carbon energy system. However, how to accomplish said goal was where the views differed between the parties, mainly due to their differences in position regarding nuclear power.

Nuclear power was regarded by CDU/CSU and FDP as a great bridge technology in the energy transition as it is almost carbon neutral and can provide a steady energy supply, compensating for the intermittency of renewable energy sources like wind and solar, securing energy security (Dehmer, 2013). However, SPD, the Green Party and Die Linke refused the idea of nuclear power as an environmentally friendly or even clean energy source, a position that would be invigorated by the Fukushima nuclear disaster in 2011.

The coalition of CDU/CSU and FDP took over governmental power after the elections in 2010 and subsequently presented its policy package regarding the energy future in Germany with the Federal Energy Concept (Energiekonzept). It reiterated and expanded upon already existing objectives like the 2050 GHG emission reduction target and introduced new middle and long-term goals in other areas such as transport and building energy efficiency (Joas et al., 2016; Hake et al., 2015). Unsurprisingly, with political parties' pro nuclear power position in government, the energy concept also included policy changes favorable for the nuclear power industry. The Atomic Energy Act was revised, and the time of operation was extended by twelve years on average (Hake et al., 2015). This alteration meant that the government did not take back the nuclear power phase out but did push it further into the future. This decision sparked social protests and led to a revitalization of the anti-nuclear movement (Hake et al., 2015). Still, the Federal Energy Concept did strengthen Germany's goal "to become one of the first industrialized countries to base its electricity promotion, mobility, industries and households on [renewable energy]" (Cheung et al., 2019, p. 633).

Once again, it was an external event that would drastically change Germany's energy policy. After just having decided to extend the lifetime of nuclear power plants a few months prior, Chancellor Merkel announced a "nuclear moratorium" (Hake et al., 2015, p. 542) in the immediate aftermath of the Fukushima nuclear disaster on March 11th, 2011. The seven oldest nuclear power units were at first temporarily shut down in the week following the disaster but would ultimately be closed down permanently (Morris, 2014). Additionally, an ethics committee was appointed to give a recommendation on the future of nuclear power and the German energy system in general. After six weeks of deliberation, the committee presented their recommendations, including a nuclear phase-out until 2022, the installation of more renewable energy production sites and the increase of energy efficiency (Renn & Marshall, 2016). The recommendations were adopted into a legislative energy package that was enacted on June 30^{th,} 2011 and encompassed eight laws with the goal to boost the *Energiewende* (Deutscher Bundestag, 2011). The legislative package was supported by 78 percent of the

German population and showed great results for renewable energy production in the years between 2011 and 2015 as its share rose from 17 to 28 percent and over the same period nuclear's share dropped to 16 percent from 23 (Renn & Marshall, 2016).

Oftentimes, the *Energiewende* is regarded to be launched in 2011 with the decision to phase out nuclear power as it is most "commonly associated with the country's post-Fukushima national energy policies" (Quitzow et al., 2016, p.164). Even though, the *Energiewende* is closely tied to nuclear power and its phase-out, it originated from citizens and scientists in the 1970s and thus is not only an old but also not solely a "government-led phenomenon" (Quitzow et al., 2016, p.164). In fact, Nazakat, (2018) conclude that the "the support to renewables is rooted in Germany's eco-friendly culture and a long history of environmental activism with a collective desire to abandon nuclear energy" (p. 16). Paul (2018) expands upon that point of view by differentiating *Energiewende* as a movement with deep historic roots in German culture and 'Merkel's Energiewende' (p. 4), the governmental project to transform Germany's energy system to meet the international and national agreed upon greenhouse emission and energy efficiency targets and the aforementioned nuclear phase-out by 2022. It has to be noted that the so-called project of the *Energiewende* can be traced back to the 1990s and as such also did not originate in 2011. Nazakat, (2018) summed it up by pointing out that "[t]he Energiewende was dreamed up in the 1980s, became policy in 2000 and sped up after the Fukushima disaster in March 2011 (p. 16).

The latter is illustrated by the solar PV development which was so "unexpectantly positive" (Rogge & Johnstone, 2017, p. 130) and record-breaking in 2011 with an increase in output of newly installed PV of 7.5 GW (Appunn, 2014). It led to the government deciding on making adjustments to the EEG in order to keep the cost-effective with a reduction of the feed-in tariffs and a limitation on the yearly newly installed capacity as well as an absolute cap of 52 GW for solar power (Appunn, 2014). Even though solar was the first renewable energy source whose development would be limited, it would not remain the only one.

The focus on cost-effectiveness of renewable energy technologies was continued in considerations from the Grand Coalition in the following legislative period. This was the result of a growing concern of a reduction public support for the *Energiewende* as shown by the dwindling support from 2012 with 73 percent to 2014 with 65 percent (Reusswig et al., 2016). CDU/CSU and SPD presented ten central measures related to energy policy that set out to lay the groundwork for renewables as the dominant energy sources in the future. One of the measures was the overhaul of the EEG, leading to the 2014 reform of the EEG "also dubbed as

EEG 2.0” (Rogge & Johnstone, 2017, p.130). The EEG 2.0 was regarded as the “most far-reaching legislative changes since green power incentives were introduced a quarter of a century ago” (Dinkloh, 2014, para.1). The overarching goal was the gradual and planned increase of renewables. The targets set for the share of renewable energy sources of the gross German energy consumption was now set to be 40 to 45 percent by 2025, 55 to 60 percent by 2035 and 80 percent by 2050 (Bundesgerichtshof, 2014).

Importantly, the EEG 2014 emphasized the planned development of renewables which was reflected by the introduction of the so-called growth corridors for onshore and offshore wind as well as solar and biomass (Bundesgerichtshof, 2014; Dinkloh, 2014). The growth cap for renewables was a reaction to the fast expansion of energy renewable sources meant (unexpectantly) high costs due to the set feed-in tariffs and a growing need for a better management of the electricity grid to assure grid stability as well as overall supply security (Federal Ministry for Economic Affairs and Climate Action, 2023; Appunn, 2014). The “capacity of green power [. . .] expanded more than sixfold since the introduction of the […] version of the renewable energy law in 2000” (Dinkloh, 2014, para. 6). Subsequently, the amendments made in the 2014 reform of the EEG were related to the attempt to stop the increase in cost of the Energiewende with major changes to the existing funding system of renewable energy technology. The EEG 2014 laid the groundwork for a switch from the feed-in tariffs to a bidding system by 2017 with the exception of existing and small installations (maximum installed capacity of a maximum of 100 kilowatts) (Bundesgerichtshof, 2014; Appunn, 2014).

The plan was to have potential investors of new renewable capacity compete for it in a bidding process that grants the tender to those who promise the lowest electricity price for said project (Dinkloh, 2014). Additionally, the governing coalition mandated operators of renewable energy installations of a certain size and age to market their electricity directly, meaning that they can no longer sell it to their local grid operator for a guaranteed price and let them handle the selling on the market (Dinkloh 2014; Appunn, 2014). Furthermore, the introduction of a growth cap kind of acted as financial cap because reaching the annual growth cap of a renewable energy source meant that the year thereafter the guaranteed return would be decreased (Ohlhorst, 2015). Moreover, the feed-in tariffs should be continuously lowered for all installations regardless of being in line with the growth corridor or not (Appunn 2014; Dinkloh, 2014). This step was explained with techno-economic improvements that have occurred in renewable energy technologies (Rogge & Johnstone, 2017).

Furthermore, the government argued that these amendments would enhance competition and competitiveness, foster renewables' market integration and ultimately lower electricity prices. The expansion of renewable energies was supposed to be conducted "in a way that is both reliable and can be planned, and that makes them fit for the market" (Federal Ministry for Economic Affairs and Climate Action, 2023, para. 1). The fear among actors in the green power industry and advocates of renewable energy sources was that these measures will deter investors to compete for tenders and invest in renewables as installations might not be as economically viable as before. This argument is maybe backed up by the fact that "Investors out up 818 megawatts of solar facilities in the first five months of 2014, 45 percent less than in the same period last year – a year in which new construction already halved – after" (Dinkloh, 2014, para. 22) the introduction of the growth cap for solar power.

On the opposite is the example of onshore wind installations that serve as an argument for the new funding scheme as well as a need for a greater grid integration. In 2014 and 2015 the new installation capacity exceeded the governmental set growth corridor with 4.4 GW in the former and 3.6 GW in the latter year (Bundesministerium für Wirtschaft und Energie, 2017). The grid was not able to integrate the added electricity, leading to excess electricity that could not be used but still had to be paid for due to the feed-in tariffs. This example also touches upon another important aspect when it comes to the development of renewables. Another challenge identified by the Grand Coalition is the expansion of the grid and the integration of the electricity generated by renewable energy sources without endangering grid stability, energy security and the international competitiveness of Germany as an industrial site (CDU, 2017).

The coalition agreement of the Grand Coalition for their second term highlights the potential of offshore wind energy which is later reflected with the Wind Energy at Sea Act (WindSeeG). Additionally, it stresses the importance of a communicative and constructive process for onshore wind farms that incorporate concerns and considerations of local citizens and nature protection to enhance the support for wind farms amid growing protests new wind farm projects (CDU, 2017). Otherwise, the climate mitigation goals set in the coalition agreement are in line with Paris agreement and the amendments of the EEG 2017 continued the path set out by the Grand Coalition with the EEG reform in 2014. The paradigm shift in remuneration from feed-in tariffs determined by the government to tenders was finalized with the EEG 2017, meaning that now the government funds the operators who ask for the least amount to run a renewable energy installation (Federal Ministry for Economic Affairs and Climate Action, 2023). The grid expansion, specifically the restriction of development of onshore wind energy in the northern parts of Germany in order to avoid grid bottlenecks and enhance the stability of the grid was another important aspect (Federal Ministry for Economic Affairs and Climate Action, 2023). The other change for the wind industry, the WindSeeG as a part of the EEG 2017 came into force that once again aims at an expansion of offshore wind energy that is cost-effective, planned and in accordance with the existing electricity grid (Federal Ministry for Economic Affairs and Climate Action, 2023). The mechanisms to achieve this goal are among other things tenders and the integration of the approval process of offshore installations, area planning and grid connections with one another (Federal Ministry for Economic Affairs and Climate Action, 2023).

The last change in the Grand Coalition's energy policies came with the reform to the EEG that was agreed upon by the federal parliament in December of 2020 and came into force on first of January in the following year. The aspects that should be highlighted are that the EEG levy is no longer only funded by the surcharge on the electricity bill but also in part from the federal budget (Bundesministerium für Wirtschaft und Klimaschutz, 2021). Also, the remuneration for small solar power installations should be extended to 2027 even after their 20 years have run out to prevent their mass deconstruction as they would have become economically unviable (Bundesministerium für Wirtschaft und Klimaschutz, 2021).

After eight years of the Grand Coalition being in power the newly elected government of SPD, FDP and the Greens focused more heavily on climate mitigation and environmental protection compared to its predecessor. The coalition agreement lists ambitious and extensive goals and measures when it comes to environmental and nature protection, climate mitigation and energy. This can be in large part attributed to the general importance of these topics in the public and political sphere as well as the Greens being in power for the first time since 2001 to 2005. The coalition agreement included goals such as climate neutrality by 2045 instead of 2050, the nuclear phase-out, 80 percent of the gross electricity consumption generated by renewable energy sources in 2030 and the general speeding up of renewable energy expansion (Die Bundesregierung, 2023).

Some measures laid out in the coalition agreement (Die Bundesregierung, 2023) are the installations of solar panels on any new industrial buildings required by law and on any new private buildings as a rule. Onshore wind energy should be expanded to account for two percent of the land area in Germany, which varies between the states but generally is around two percent (Die Bundesregierung, 2023). Additionally, repowering should be made easier with less administrative hurdles and offshore wind energy is supposed to grow to 30 GW by 2030, 40

GW by 2035 and 70 GW by 2045, highlighting the envisioned fastness of the energy transition (Die Bundesregierung, 2023).

The so-called “Osterpaket” matches the aspirations of the new government set out in their coalition agreement. The “Osterpaket” comes into force on the first of January 2023 even though it has been approved by the federal parliament April 2022 (Polansky, 2022). The EEG and WindSeeG are just two of the several laws that had been amended as a part of the “Osterpaket”. It is the biggest amending law in centuries when it comes to energy policy (Deutscher Bundestag, 2022). Central in the “Osterpaket” is the institution of renewables as a public interest that is about securing the energy security and sovereignty (Bundesministerium für Wirtschaft und Klimaschutz, 2022b). The development of wind energy is supposed to reach a new level as the government aims to reach the new goal of being almost solely reliant on renewable energy sources for electricity by 2035 (Bundesministerium für Wirtschaft und Klimaschutz, 2022b). Achieving said goal is helped by an update of the growth corridors and an opening of explored and unexplored areas for offshore wind projects. Additionally, the administrative process is supposed to become easier and faster for solar and wind projects and overall, the whole amendments are geared towards a consequent and speedy development of renewable energy sources.

This shows that the *Energiewende* has advanced from its initial stage as a protest movement against nuclear power to a strong social and political force that is ingrained in the majority of the German population and politics, who have continued to support the path of an energy transition towards a greener and cleaner energy system over two decades. The amendments made in the policy packages supporting the *Energiewende* have come as a response towards the positive and negative developments related to the *Energiewende* and regularly updated the growth targets for renewable energy sources and expanded the support for innovation and advancement in the (green) energy sector.

2.1 The challenges surrounding the end-of-life treatment of wind turbines and PV technologies

Germany’s fast and vast expansion of onshore and offshore wind installations as well as PV installations in combination with the older wind farms and PV panels set out to lose their twenty-year long financial subsidization defined by the EEG in the coming years, the focus has shifted towards the treatment of said technologies after they have reached their end-of-life. The adoption of the Circular Economy Action Plan by the European Commission in 2020 delivered an additional push for the search after solutions for the proper handling of the growing waste volume from decommissioned wind turbines and PV panels.

Germany is expected to be one of the first countries among the countries who deploy wind and PV technology that needs to identify treatment options for wind turbines, PV panels and their batteries that are efficient, clean, economically friendly, and economically viable (Wehrmann, 2021). Based on those, it must build up a comprehensive, effective, and environmentally friendly infrastructure that deals with the waste according to the guiding principles defined in the Circular Economy Action Plan and the Sustainable Development Goals. However, there are several challenges that scientists and industry actors have to overcome when it comes to the EoL treatment of wind turbines, solar panels and batteries.

Firstly, there are uncertainties regarding the waste volumes and the potential material streams that could be obtained from the waste with estimations for decommissioned wind turbines and PV panels in the coming decades varying (Wehrmann, 2021; European Commission et al., 2013). This variation is owed to several factors including design differences, material weight, operational lifetime, economic viability, and lack of information (Volk et al., 2021; Wehrmann, 2021). Nonetheless, Volk et al. (2021) estimate that 39 percent of the installed onshore wind turbines in Germany are older than 15 years and as such nearing their EoL in the near future. They predict that the onshore wind industry in Germany will be responsible for 325,726 t to 429, 525 t of composite waste from obsolete glass-fibre reinforced polymers (GFRP) rotor blades and 76,927 t to 211,721 t from glass- and carbon-fibre reinforced polymers rotor blades (GFRP/CFRP) (Volk et al., 2021).

Additionally, Volk et al. (2021) identified 2035, 2036 and 2037 as peak years in which the composite waste volume is supposed to be particularly high with around 40,000 t/a for the GFRP and 20,000 t/a for the GFRP/CFRP material class. Notably, offshore wind installations were excluded from their study as is actually common because it is a younger technology compared to onshore wind and such not as pressing or prominent as onshore wind (Volk et al., 2021; Liu et al., 2022; Zotz et al., 2019). On the other hand, Wehrmann (2021) estimates that by 2025 the annual waste volume emerging from obsolete PV installations will be 22,000 t in Germany. However, now the PV panel waste is still regarded as negligible (Mahmoudi et al., 2021; Hocine & Mounia Samira, 2019).

The currently small amounts of waste arising from PV and offshore industry factor into the second challenge: the commercial availability and economic viability of treatment options. In the first development stages of PV and wind energy technologies the industry efforts had been centered on the technological advancement of PV panels and wind turbines to make them more efficient and cheaper in order to enhance their profitability and market competitiveness (Ramirez-Tejeda et al., 2017; Oteng et al., 2021). Consequently, the question of how to handle PV panel and wind turbine waste in a sustainable and environmentally friendly way was largely ignored by advocates and industry alike, especially after other issues arose and took precedent such as the growing public resistance against wind farms because of concerns regarding their negative impacts on environments and human health (Ramirez-Tejeda et al., 2017). As a result, the treatment options are limited and underdeveloped, something that is slowly changing but still poses a problem right now as the available disposal or recycling options are unsatisfactory.

Generally, for wind turbines the recycling or depositing process encompasses four stages, starting with the dismantling, disassembling, and cutting of the wind turbine on site to ready it for transportation. Then the wind turbine is transported to the landfill or recycling center where it is landfilled or recycled (Liu et al., 2022).

The approach most used to handle decommissioned wind turbine blades is to dispose of them in a landfill (Liu et al., 2022). Yet this option is unsatisfactory as wind turbine blades last for a really long time because the natural decay process does not set in soon, meaning that they are taking up room in the landfill for a really long time, something that is particularly troublesome considering their sizes (Cooperman et al., 2021; Liu et al., 2022). Moreover, the eventual biodegradation of organic materials of a wind turbine blade could release volatile organic compounds such as methane (Ramirez-Tejeda et al., 2017). Additionally, this practice is forbidden in some countries, among them is Germany who have forbidden the landfilling of wind turbine blades.

There are other ready-to-go approaches with established technologies available for the treatment of composite waste such as life extension that like landfilling does not involve recycling (Liu et al., 2022). Still, Volk et al. (2021) point out that extending the usage of a wind turbine does not solve the problem, only postpones it into the future. Another option is the reuse or repurposing of a wind turbine as replacement parts for other wind turbines or as something completely new such as benches or playgrounds (Cooperman et al., 2021). However, technical limits and declining revenues for older wind turbines put constraints on this treatment approach (Cooperman et al., 2021).

Other approaches that do involve recycling are incineration, cement coprocessing, pyrolysis and mechanical recycling all of which have advantages and disadvantages. For example, mechanical recycling has the advantage that new composite products can be made out of the crushed or grounded wind turbine blades (Cooperman et al., 2021). Yet, they cannot be incorporated into a new wind turbine blade as the fibers lose some of the stiffness, making them only useful for products with “less stringent design requirements, such as plastic lumber or sound-absorbing panels (Cooperman et al., 2021, p. 2).

The growing interest into the topic has also brought forth several approaches that have been tested in a laboratory setting and are still in the development stage, thus not commercially available now (Liu et al., 2022). These include fluidized as thermal recycling, high voltage fragmentation (HVF), microwave assisted pyrolysis (MAP), hydrolysis and solvolysis (Cooperman et al., 2021; Liu et al., 2022).

Comparable to the situation with wind turbines, the treatment options as well as the overall recycling capacities for PV panels are currently not suitable. The disposal on a landfill is unacceptable for PV panels because of its hazardous waste as they consist of lead and cadmium among other things. Thus, disposing of them without treatment on a landfill could lead to harmful chemicals being released into the environment, contaminating it and potentially the drinking water, which is why this is not an option when it comes to the EoL treatment of obsolete PV panels (European Commission et al., 2013; Chowdhury et al., 2020). Generally, there are physical, thermal and chemical recycling processes presently available to the PV industry (Chowdhury et al., 2020). Furthermore, the recycling technologies presently available are “delamination, material separation and metal purification” (Tao & Yu, 2015, p.112) that are established. Other methods have been explored and tested in research projects such as vacuum blasting, attrition and flotation as material separation technologies (Tao & Yu, 2015).

A driver behind the research on PV panel waste recycling was the EU Directive Waste of Electrical and Electronic Equipment (WEEE) adopted in 2012 that made the EU a pioneer in PV electronic waste regulation (Chowdhury et al., 2020) as it was the first legal act in the world that asked for the establishment of a PV-specific collection system and set out recycling and recovery targets (Chowdhury et al., 2020). Germany was the second country within the EU to ratify the directive, meaning that Germany planned to enact the regulations set out in the WEEE. Under the new directive PV panels were categorized as electronic waste (e-waste) and included new and stricter guidelines for producers and importers of PV panels. The directive outlined how PV panels should be collected, recycled and recovered (Oteng et al., 2021).

From 2012 onward, the producers and importers of PV panels that sell them on the EU market are responsible for their EoL treatment and have to collect, recycle and recover PV waste. The producer responsibility was included, aiming to build a functioning and effective recycling system that is able to properly manage the growing waste volumes of PV waste and to further the development of recycling technologies that limit the negative environmental impacts of PV waste (Chowdhury et al., 2020). Another important aspect of the EU strategy to achieve an environmentally friendly EoL stage for PV panels is the prohibition of waste exports, ensuring that the PV waste has to be properly handled in the EU (Chowdhury et al., 2020). The product consent scheme was implemented as a control mechanism that obligates manufacturers and importers of PV panels to provide data for their PV panels, including material composition etc. (Chowdhury et al., 2020).

The materials used in PV panels are of particularly interest for the EU as the updated Restriction of Hazardous Substances (RoHS) Directive, which entered into force in 2011, restricts the hazardous metal contents in PV panels (Directorate-General for Environment, 2023a; Mahmoudi et al., 2021). The directive aims to persuade manufacturers to develop PV panel technology that incorporates less lead and cadmium to make them more environmentally friendly (Mahmoudi et al., 2021). Another EU legislative act followed a similar strategy as the WEEE and RoHS Directives, with the main difference that it is specifically for batteries. The problem of the improper disposal of batteries that wrongly end up in landfills or are incinerated, resulting in potential harm for the environment and human health is hoped to be stopped with the adoption of the Batteries Directive in 2006 (European Commission, 2019; European Commission, 2020; European Commission, 2022).

The goal is also the minimalization of hazardous components in batteries as well as the establishment of an effective management system through measures introduced under this directive. One of the measures is the implementation of several targets such as a collection target for portable batteries of 65 percent per year and a target for the material recovery from batteries through recycling (European Commission, 2020). Similar to PV panels, the obligation to take back, collect, recycle and dispose of the batteries falls on the retailers and manufactures who brought the batteries onto the EU market (Umweltbundesamt, 2022a). However, it is important to note that the current system does not include specific targets or measures for industrial or automotive batteries, thus making the current system not suitable for industrial batteries (European Commission, 2019). The directive is also lacking when it comes to material recovery as of now it only considers lead and cadmium and disregards other valuable components such as cobalt and lithium in their efficiency targets (European Commission, 2019).

As a result, the European Commission has called for a modernization of the current legislation on batteries in the EU to address these identified shortfalls and make it more in line with the principles of a circular economy (European Commission, 2020).

The Circular Economy Action Plan focuses on "how products are designed […], encourages sustainable consumption, and aims to ensure that the waste is prevented and the resources used are kept in the EU economy for as long as possible" (Directorate-General for Environment, 2023b, para.2). Herewith, the developers of wind turbines and PV panels received a set of factors to consider while comping up with new designs for wind turbines and PV panels. As mentioned previously, the earlier stages of technology development did not take into account the EoL treatment of these technologies, let alone how to ensure an efficient and sustainable recycling of wind turbines and PV panels. Thus, the third challenge regarding these technologies is their design.

Wind turbines are made from several components such as wind blades, steel tower, generator and concrete foundations (Sakellariou, 2018). Most of these components can be recycled fairly easily due to already existing processes that are established and commercially mature (Cooperman et al., 2021). The notable exception are the blades that are challenging to recycle because of the thermoset composites used in their construction. The high tensile strength fibers glass or carbon are combined with polymer resin creating GFRP and CFRP that are composite materials and make up 80 to 90 percent of the total blade mass (Cooperman et al., 2021). Besides the difficulties attached to recycling composite materials, the differences between GFRP and CRFP require different recycling processes, meaning that development of recycling processes specific to GFRP and CFRP are needed. Another aspect concerning wind blades that further complicates the recycling is their size. It makes them difficult to handle, which is why they are mostly cut into smaller pieces on site before they are ready for further transport.

However, wind turbine blades are not the only renewable energy technology that is challenging to recycle due to its design. PV panels consist of multiple solar cells which are protected by glass as well as a plate that has a translucent and waterproof layer usually made from plastics (Wehrmann, 2021). An aluminium or sometimes another metal frame encases the plate (Wehrmann, 2021). 90 percent of the module's weight is made up by glass, plastic and metal with other materials only appearing in small amounts like copper and silver (Wehrmann, 2021). The biggest difference in component materials is because of the cell technology used in the PV panel (Wehrmann, 2021). Currently, various technologies are available that can be grouped into two generations.

The first generation of PV panels are crystalline silicon (c-Si) cells that are either monocrystalline or polycrystalline (Farrell et al., 2020). They differ in "the silicon substrate that makes up the wafer" (Farrell et al., 2020, p. 4) but have the same manufacturing process and had an 85 percent share of the solar cells installed worldwide in 2017 (Wehrmann, 2021). Farrell et al. (2020) estimate their market share around 80 to 90 percent over the last 40 years and as such has been the dominant technology. Even though their design enables them to have a high efficiency and production at a low cost, it also makes maintaining and reusing c-Si PV modules tough while limiting recycling options (Farrell et al., 2020).

The second generation of PV technologies are thin film technologies that compared to c-Si cells are made out of more complex and toxic components but could need fewer material volumes (Wehrmann, 2021). The thin film technologies are cadmium telluride cells (CdTe), amorphous silicon and copper indium gallium selenide (CIGS) (European Commission et al., 2013). The third generation of PV panels is still under development with new technologies emerging such as concentrator photovoltaic cells (CPV) and organic solar cells (European Commission et al., 2013; Chowdhury et al., 2020). As a result of the different technological generations and their diverse modules, the recycling of PV panels cannot be regarded as one fits all due to the varying material compositions of the PV panels.

All in all, an effective infrastructure with product specific recycling facilities must be build up that are able to handle the growing waste volumes that is expected to arise in the coming years and decades from aged renewable energy technologies. Additionally, markets for recycled materials have to be identified so recycling is economical and truly sustainable by using secondary materials in a productive way (Liu et al., 2022). Recycling has the potential to reduce environmental impacts with material recovery as it (partially) offsets the demand for virgin materials (Cooperman et al., 2021). This is of particularly importance regarding PV panels and batteries due to the growing concerns surrounding rare materials, like the environmental impacts of current mining practices and the risk of supply bottlenecks in the future because of the ever-growing demand (Wehrmann, 2021). EU directives act as guidelines for the future of waste treatment with the overarching focus on creating a circular economy. They put pressure on and simultaneously incentivise the industries to develop a sustainable EoL stage for wind turbines, PV panels and batteries. Consequently, the recovery and recycling of conventional resources and rare metals used in wind turbines, PV panels and batteries, are crucial in achieving a circular economy and sustainable development.

3. Frames and framing theory

Although the framing concept has its roots in social psychology with Bartlett's work (1932*) Remembering: A study in experimental and social psychology and as such started in the field of social psychology*, it continued to appear and develop within numerous research fields (van Gorp & Vercruysse, 2012; Patterson et al., 2021). These include besides psychology, language studies, political science, and sociology with the latter being regarded as the second broad foundation of framing (Patterson et al., 2021; Borah, 2011). However, the various research fields have their own conceptualization that do not (totally) match with one another, resulting in a lack of consistency when it comes to the definition and application of what frames and framing are (Vliegenthart & van Zoonen, 2011).

In social sciences, Gregory Bateson is credited for the introduction of frames as a concept with his essay *A theory of play and fantasy: A report on theoretical aspects of the project for study of the role paradoxes of abstraction in communication* (Vliegenthart & van Zoonen, 2011). However, the scholar who the sociological concept of framing is widely attributed to is Goffman, specifically his book *Frame analysis: An essay on the organization of experience* from 1974 (Borah, 2011; Kwan, 2009). He builds upon Bateson original concept and expands it in the following definition:

> I assume that definitions of a situation are built up in accordance with principles of organization which govern events - at least social ones - and our subjective involvement in them; frame is the word I use to refer to such of these basic elements as I am able to identify. That is my definition of frame. (Goffman, 1974, pp.10-11).

In other words, Goffman argues that the world is overwhelming to social actors who cannot fully understand it and struggle with interpretating the world around them (Scheufele & Tweksbury, 2007). According to Goffman, everyday social experiences can be made sense of by social actors with the help of frames that can be regarded as cognitive shortcuts that enable social actors to define and organize these social experiences and situations (Kwan, 2009). Thus, individuals apply "schemata of interpretation" (Goffman, 1974, p.21), meaning frames which help people to process and interpret information in a meaningful way (Scheufele & Tweksbury, 2007; Borah, 2011). These "primary frameworks" (Goffman, 1974, p. 24) are the result of communication processes that lead social actors to adopt frames unconsciously amid them. It is important to note that even though frames are adopted in communication, going by Goffman's definition they are "not property of a communication, but rather describ[e] an individual's perception of a situation; the frame reveals what an individual sees as relevant to understanding a situation" (Druckman, 2001, p. 228). Therein, the focus lies on what individual social actors are thinking.

Another prominent definition of frames and framing emerged following Goffman's work with a different focus that no longer is solely about the individual and its cognitive understanding of the world (Druckman, 2001). "Frames in communication" (Druckman, 2001, p. 227) focus on the construction of communication while highlighting the speaker and the choices they made regarding words, presentation styles and phrases when delivering information (Druckman, 2001). Instead of revealing information about an individual, frames in communication give insight into the speaker (Druckman, 2001). Consequently, the major difference is the attention to speech instead of thought.

However, there are aspects that both definitions have in common like the interest in variations concerning social actors' sense-making of the same situation, whether it be in thought or communication (Druckman, 2001). Namely, the difference in salience or emphasis individuals or speakers attach to an event or issue of concern (Druckman, 2001).

Another notable definition is offered by Gamson and Modigliani (1989), who view frames as "a central organizing idea" (p. 3) of an interpretative package that are used to "mak[e] sense of relevant events, suggesting what is at issue" (Gamson & Modigliani, 1989, p. 3). Gamson and Modigliani (1989) combine in their understanding of frames and the framing process these two definitions of frames by arguing that there are "media frames" (Gamson & Modigliani, 1989, p. 3) which are utilized by journalist to make sense of and report on the world. Additionally, these media frames are possibly passed on to the people reading their reports, potentially influencing them in their understanding of the topic(s) featured in their reports (Gamson & Modigliani, 1989, p. 3).

In order to communicate the frames, journalists use specific framing devices that are identified by Gamson & Modigliani (1989) as exemplars, metaphors, depictions, visual images and catchphrases who propose the way in which an issue should be thought about as well as reasoning devices which are consequences and roots that allude to justifications for actions that should be taken regarding said issue (Gamson & Modigliani, 1989). The reasoning and framing devices make up the interpretative package, communicating in an effective and efficient manner the positions and frame at hand.

However, Gamson and Modigliani (1989) point out that not every package is equally successful and make out three determinants for a package success or failure, including media practices, sponsor activities and cultural resonances. The more familiar the targeted audience of a frame is with the symbols used to communicate it, the more likely it is that the frame resonates with its audience, appearing common and instinctive. Furthermore, frames have sponsor like social movement organizations and political parties attempting to promote the frames best suited for them and their interests through advertising, pamphlets, speeches, and the like. Yet, journalists do not passively accept the frames pushed by sponsors on a given issue as working practices and norms of journalists influence how they report by using for example the balance norm that is aimed at providing thorough and balanced reporting (Gamson & Modigliani, 1989).

Gamson & Modigliani's understanding of frames and how they come about differs significantly in one aspect from Goffman's, namely in the intentionality of frames. While Goffman believes in the unintentional utilization of frames in a process that individuals are not consciously aware of, Gamson and Modigliani (1989) do regard frames as interpretative packages that are intentionally as well as unintentionally used by sponsors, journalists and audiences in a process that happens consciously and unconsciously.

The shift away from frames as an unintentional result of interactions between different social actors, be it individual or collective, to frames as tools intentionally or unintentionally used in the communication process to influence the receiver at the end of it is exemplified by Entman's (1993) famous definition of framing:

> To frame is to *select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation* for the item described (p.52, emphasis in original).

As such, Entman (1993) regards selection and salience as an integral part of framing that leads to some aspects of reality highlighted by frames while others are consequently excluded. He understands framing as an exertion of power over the human consciousness in the form of communication, traceable in news reports, utterances and speeches (Entman, 1993). Hence, frames have the four following functions which are to define problems, make moral judgements, diagnose causes, and suggest remedies (Entman, 1993). It is important to note that despite the frame functions, one should not confuse frames with positions on policy issues (Gamson & Modigliani, 1989). As their name already suggests, frames provide the bigger frame of an issue that could be used by sponsors with opposing positions on a policy issue.

In the communication process, Entman (1993) makes out (at least) four positions of frames, including the culture, the communicator, the receiver and the text. Here, culture is understood as the set of frames that are most common in people's thinking and the discourse (Entman, 1993). Communicators like journalists or politicians choose what they say based on frames and framing judgements that can be conscious or unconscious (Entman, 1993). The suggested frames are visible in the text, which contains or leaves out specific stock phrases, metaphors, stereotypes, etc., evoking certain frames and can be made more salient through repetition or their placement (Entman, 1993). However, the frames in the text do not necessarily guide the receiver's thinking of an issue and the conclusions drawn by the receiver can be different than intended by the communicator (Entman, 1993). Just because a frame is present in a text does not mean that it has to have an effect on the receiver as they are several factors mediating the influence of a frame, namely the applicability of a frame to the belief system of the individual, prior knowledge the individual had on the issue, the presence of counter-frames, the deliberation in a group, etc. (Entman, 1993, Chong & Druckman, 2007).

Nonetheless, how an issue is framed has the huge potential to shape how people view and evaluate it plus how they would prefer to follow up on it, impacting political communication significantly. Entman (1993) concludes that "the frame in a news text is really the imprint of power – it registers the identity of actors or interests that competed to dominate the text" (p. 55).

As illustrated above, the understanding of frames and framing has changed and evolved over the years with no single fixed definition. The way frames and framing are defined is mainly influenced by the research field and its underlying assumptions regarding thought, communication, and reality.

Here, I follow the definition of frames according to Gamson and Modigliani (1989) as "central organizing ideas" (p. 3) that offer an explanation or interpretation of an event or issue that help people make sense of them. The frames are not always intentionally used or adapted by frame sponsor and people receiving the frames alike. This is because frames build upon and evoke cultural values, belief systems, etc. which we all consciously or unconsciously reference. Additionally, these are also among the reasons influencing how well a frame is received and if it dominates or even makes it into mainstream and political debates. As such, frame sponsor attempt to utilize frames in a way that sways public opinion in their favor and aim to offer the main interpretation of an event of issue.

The way in which they seek to accomplish this is of special interest for me. I am not just interested in the frames applied in the discourse surrounding EoL management for renewable energy sources, specifically PV panels, batteries, and wind turbines but more so in the arguments and justifications used by frame sponsors within and behind their frames. It gives insight into the reasons for the usage and promotion of a certain frame of its sponsor as well as underlying cultural values and belief systems. Generally, not only the understanding of a certain event or issue along with the reasons behind it are articulated within a frame.

3.1 Framing the German *Energiewende*

Whether it be about education, employment or climate change, frames have a substantial impact on how something is perceived by the public (Busch & Judick, 2021). Hence, various actors such as political parties, social movements, civil organizations, cooperations, and think tanks partake in framing. They play a key role in the framing process as sponsors to first achieve interpretative power and secondly retain it (Busch & Judick, 2021). Something that is of particular interest when it comes to debates pertaining to climate change as it has far-reaching effects on all of society. Consequently, climate policy can widely impact how we live by enacting rules and regulations in regard to for example the mobility and construction sectors. Different actors gain advantages or disadvantages from certain climate policies, making it understandable that they have an interest in framing a topic in their favor so that people adopt their frame and ultimately enter public and political debate to affect policy decisions (Schlichting & Schmidt).

In Germany, the existence of climate change is accepted by the majority of people and almost all major political parties as illustrated by the overall approval of the *Energiewende*. However, the best way to achieve the *Energiewende* and therefore climate change mitigation is contested. The disagreement on how to best pursue the goal of climate neutrality was the main reason why support for the *Energiewende* within the German population declined in recent years. Instead of disapproving the *Energiewende* itself, it was the dissatisfaction with the progress made in regard to it that lowered approval. Yet, the backing of the project from the German population is indispensable due to the high cost and far-reaching transformations associated with the energy transition. Without the unwavering support from the majority of the people in Germany, the development of renewable energy sources would have likely not been as successful as it has. One of the main reasons attributed to the success by industry actors was the continuous political support for renewable energy sources stemming from constant and strong public support that attracted and reassured investors to give money to renewable projects.

Thus, there is the importance to retain the majority support from the German population for the *Energiewende* as well as establishing a satisfactory roadmap for the process of achieving the goals set by it. The latter leaves a lot of room for stakeholders to influence the public opinion and the policy process. Of course, the centrality of renewable energy sources has been pointed out throughout the past two decades and remain incredibly important for the *Energiewende*. Yet, rising opposition against wind farms and the newly opened debate in Germany surrounding nuclear power are good examples showing that there is still a lot of opportunities for frame sponsors to influence public perception and policies in a certain direction. As solar and wind energy are regarded as the two pillars of the energy transition in Germany, it is of particular interest to uncover the interests, motivations and reasonings of sponsors behind frames regarding EoL management of PV panels, batteries and wind turbines as it can give insight into how the policy making and therefore the development of wind and solar energy (might be affected) going forward.

4. Research Design

4.1 Methodology

The strategy that is used as a starting point and guide throughout the research for this thesis is induction as it is best suited for the acquisition of knowledge needed to answer my research questions. For one, inductive logic of inquiry is concerned with social phenomena as well as the individuals, more specifically the distribution, patterns, and correlation of their characteristics (Blaikie & Priest, 2019). These are examined by the researcher through observing and comparing collected data, making (limited) generalizations based upon the data (Danermark et al., 2002). Hence, all findings are closely linked with the data (Braun & Clarke, 2006) as it is not really a theory that defines the research process but rather the data itself. In other words, by using induction, one moves from the empirical materials towards theory development and not the other way around (Blaikie & Priest, 2019). However, this does not mean that the research is purely data-driven as there are other things informing our collection, analysis and discussion of data such as background knowledge comprised of previous research, traditions and theories within one's discipline (Blaikie & Priest, 2019).

Still, it allows for a certain freedom when observing a premise/phenomenon as there are no constraints enacted by a pre-defined theory that one has to adhere to. In this case, there are no pre-defined frames about the EoL management of wind turbines or PV panels, meaning that I can examine the data without looking for pre-existing frames that might negatively influence my analysis as I try to make the frames 'fit' the collected data instead of the other way around. By using an inductive approach, I can collect and measure the data in a way that enables me to construct frames that truly stem from the data and not prior done research.

Secondly, because it is data that is the basis of theory development, inductive logic is best suited for 'What' research questions that aim to describe and explore what is happening and in what way(s) (Blaikie & Priest, 2019), like the research questions regarding the frames used to describe end-of-life management of renewable energy sources in this thesis. Furthermore, questions that go beyond description and exploration and are focused on assessing impacts and evaluating can also be answered with the help of induction (Blaikie & Priest, 2019). In other words, 'why' certain observations could be made or 'why' these specific consequences that always build upon a previous 'what' question, in this case 'why' these frames and 'why' do they differ or are similar with one another regarding different energy sources.

Yet, an inductive research strategy has limitations as it cannot be used for the production of universal laws (Blaikie & Priest, 2019). As induction takes an observed phenomenon and utilizes the garnered knowledge from the collected data to make generalizations there is always the possibility of making an observation that contradicts the general assumption (Danermark et al., 2002). Hence, an inductive research strategy can never provide final conclusions or certainty about a phenomenon. Rather, it can offer plausible conclusions derived from the findings of the research that are consistent enough to generalize them (Blaikie & Priest, 2019).

Adding to my reasoning for using an inductive research strategy, I will further elaborate on my underlying assumptions regarding theory, epistemology, and ontology as they are of particular importance regarding the understanding and completeness of the thematic analysis, which is the method used for my thesis.

Firstly, my definition of frames and framing is based on a social constructivist approach. Social constructivism presumes that reality is mentally constructed by individuals who are all situated within a specific context, namely social groups and periods of time (Pujante, 2017). Consequently, everyone has its own reality which is grounded in and influenced by its surroundings, experiences and social relationships and interactions (Young & Collin, 2004; Beck & Kosnik, 2006; Myburgh & Tammaro, 2013). Furthermore, constructivism regards not only human beings as contextual and situated but also learning (Zembylas, 2005). Hence, there is a close link between experience and knowledge as constructivists deem the latter something that is actively constructed rather than discovered or found (Myburgh & Tammaro, 2013). Human beings have experiences that we try to make sense of by either using existing models and concepts or by inventing new ones. This constructed sense-making of our experiences is communicated to others via language which acts as a mediator (Myburgh & Tammaro, 2013; Pujante, 2017).

When the mental construction – the knowledge – is articulated by an individual to others in their social group it is either met with approval or disapproval. In the case of it being approved, the knowledge is adopted by others and potentially society as a whole which serves as a validation of it (Myburgh & Tammaro, 2013). The validated knowledge is then “maintained by social institutions” (Myburgh, Tammaro, 2013, p. 217) until other or new ideas and experiences emerge that either invalidates the existing knowledge or offers an alternative description or explanation that finds greater popularity in society to become dominant (Beck & Kosnik, 2006).

Not all constructions are accepted equally by society and individuals, meaning that even though constructivists do not speak about true or correct constructions, there are criteria that measure the acceptability of a construct, for example by the potential consequences of a construction on certain individuals or social groups (Morales-López, 2017).

Important to point out is the understanding of reality, knowledge and knowledge production put forth by social constructionism and adopted by me throughout my research. For one, reality is ultimately individual or subjective. There is not one universal reality that we experience and live in together (Guachalla, 2018). However, our realities are heavily context bound and rooted in social groups whose boundaries we seldom leave.

Secondly, knowledge cannot be regarded as something absolute or fixed as it is always under scrutiny and reassessment (Beck & Kosnik, 2006; Pujante, 2017) given its constructed nature. Yet, this does not mean that 'anything goes' and all constructions are equal.

Hence, the importance of another concept that can act in qualitative research as quality control: reflexivity (Dodgson, 2019). Reflexivity regards the understanding of how researchers potentially influence their own research due to their own experiences and characteristics being crucial to the knowledge generation process (Berger, 2015). In other words, reflexivity is about the researcher recognizing and reflecting on their role in the creation of knowledge to continuously and critically self-evaluate one's own positionality while conducting research and its possible effects on the research, meaning its process as well as the outcome (Berger, 2015). The researcher's positionality is influenced by their gender, age and beliefs among other things (Berger, 2015).

Consequently, it means to not only focus on the researched but also onto oneself as "one's own situatedness" (Berger, 2015, p. 220) can impact research questions, data collection, interpretation and results (Dodgson, 2019). Thus, reflexivity challenges the view that knowledge is objective because it looks at knowledge production and the researcher generating it as connected with one another (Berger, 2015). Therefore, reflexivity is utilized to enhance the ethics and rigor of research as it monitors the "involvement and detachment of the researcher and the researched" (Berger, 2015, p. 221). This is achieved by articulating decisions made during the research process and the rationale behind them along with using first-person language (Berger, 2015). Lastly, reflexivity is important throughout the entirety of the research process (Dodgson, 2019).

4.2 Method

4.2.1 Data collection

The collected data for the analysis is made up of a collection of official government documents such as white papers or parliamentary inquiries as well as speeches, position papers, newspaper articles and comments on various websites. At first, the data was collected through Google search engine and later through the public online archive of the German Federal Government, Federal Ministry of Economic Affairs and Climate Action (BMWK), Federal Ministry for Economic Cooperation and Development (BMZ) and Umweltbundesamt (UBA). When it was possible, the data was downloaded as PDF and otherwise copied and pasted into Microsoft Word. The search was filtered by using a combination of keywords, namely ‘Abfall’, ‘Waste’, ‘Recycling’, ‘End-of-life’, ‘EoL’, ‘Windräder’, ‘Wind turbines’, ‘Batteries’, ‘Photovoltaic’, ‘PV panels’.

Only data that was openly accessible and free of charge was considered. Moreover, data that were the exact same just replicated on different websites such as descriptions of research projects on the various website of participants were excluded to avoid doubling. The same applies to articles that were published on information portals for wind or solar industry that were simply a copy of companies press releases. In those cases, only the original source was considered. Newspaper articles were included under the condition that they either contained an interview or quoted statements from stakeholders. In my thesis stakeholders are producers, importers, dealers, system operators, municipalities, governments, political parties, waste treatment companies, industry associations, lobby companies, non-profit organizations (NGOs), research institutes and environmental agencies and associations. Moreover, data sources for EoL battery management were only included if they had a connection to PV panels of solar energy as for the purpose of this thesis batteries are only considered as a part of PV systems - an admittedly special and significant one, but a part nonetheless.

Additionally, only sources stemming from year 2014 onwards were included as 2014 introduced significant regulatory changes to the development and expansion of renewable energy sources with the updated EEG. It signaled a slight attitude shift towards renewable energies and their expansion. This might prove interesting to see whether this shift might be noticeable or considered in the framing of EoL management of wind turbines, PV panels and batteries. Plus, this time frame allows for the tracking of changes in frame usage and/or their sponsors as well as a consideration of diverse data sources.

Thus, the data considered for this thesis are made up of 68 sources in total, including 32 pertaining to wind turbines and 36 about PV panels and batteries. The different types of data are shown in Table 1. Types of data sources on page 32.

Table 1: Types of data sources

Type of data source	Amount
Articles	18
Briefings	1
Blog posts	3
Newspaper articles	10
Position papers	2
Press releases	9
Reports	10
Websites	14
White papers	1

4.2.2 Method of analysis

The method I use for the analysis in this thesis is thematic analysis (TA). TA is a very popular method within qualitative research that is used for "identifying, analysing and reporting patterns (themes) within the data. It minimally organizes and describes your data set in (rich) detail" (Braun & Clarke, 2006, p. 79) and helps inform us what is considered important by the authors of texts, how they perceive and experience things and what underlying attitudes within the data can be perceived (Herzog et al., 2019). In other words, it helps me identify what frames are used and by whom, as well as the possible reasons why those frames and not others. Additionally, it can be used for all sample sizes from small to large and all types of qualitative data (Braun & Clarke, 2006).

Because of its accessibility and flexibility, TA is a widely used method that has risen in popularity ever since Clarke and Braun published their article *Using thematic analysis in psychology* in 2006, which "has become the standard point of reference for TA" (Wiltshire & Ronkainen, 2021, p.160). Yet, it is important to highlight that TA is not one single 'school' (Braun & Clarke, 2022) but really a number of differing approaches that can all be considered TA (Braun & Clarke, 2019). These approaches share certain characteristics that identify them as TA such as theoretical flexibility or the development of themes and codes but vastly differ in other ways (Braun & Clarke, 2022).

The differences are mainly due to divergent and at times contrasting research values and conceptualizations as a result of varying theoretical, epistemological and ontological assumptions on part of the researcher themselves (Braun & Clarke, 2022). Therefore, Clarke and Braun (2017) argue that it is not a methodology. Rather, it allows researchers to build their own framework with TA as a part that adds and not informs the research. Hence, Braun and Clarke (2006; 2019) stress the importance of clearly outlining the theory and philosophical approach used by the researcher that is underpinning the TA. This is not to say that TA can be regarded as atheoretical or 'anything goes'. Not every theoretical framework or research question matches TA, which is why the researcher must be very clear on why and how they conduct TA. A benefit is that it improves the research as it forces the researcher to really think about their philosophical assumptions and decisions as well as reasons for TA in this specific approach. Plus, it allows others to follow the research process and decisions more easily, allowing for a deeper understanding of the researcher's stance as well as the research itself (Braun & Clarke, 2019).

As a result of my theoretical, epistemological and ontological assumptions, I will conduct TA in the following way that is based upon but not according to Braun and Clarke's reflexive TA. This is mainly due to the fact that they have elected a constructionist approach for TA whereas mine is a social constructivist one as explained previously. At first, this might not seem like the biggest difference as I stay within the qualitative paradigm but becomes noticeable in the last stages of the analysis when it moves beyond collection and observation and goes more into analyzing and explaining the collected data because my focus lies upon the individual (and social) instead of almost purely social.

The next, obvious difference between Braun and Clarke and me is (the name of) what we are searching for. In the case of Braun and Clarke (2022) it is themes that "are patterns of meaning anchored by a shared idea or concept (central organizing concept)" (p. 9), whose definition matches that of Gamson and Modigliani's frame definition. Thus, it is not necessarily what we are looking for differs, but again the role and agency of the frame speaker that makes the difference.

Aside from these differences that mostly impacts the last stage as the analysis or what Braun and Clarke (2006) have dubbed "producing the report" (p. 93), a lot of the other aspects are similar which is why I chose to keep most of Clarke and Braun's (2017) proposed procedures as they are including the six phases of a TA.

I will start the analysis with the first phase of TA that is about the familiarization with the collected data (Braun & Clarke, 2006). At this stage, reading and re-reading the data is of immense importance as it helps searching for things that stand out such as patterns, metaphors or things that are more subtly hidden, for example meanings (Braun & Clarke, 2006). Everything that seems of interest or initial coding ideas should be written down as notes. The note-making should be kept up throughout the entire analysis as it aids the researcher to deeply engage with the data and (re)trace thought processes and decisions (Braun & Clarke, 2019). Additionally, this functions to heighten the transparency and reflexivity of the analysis and in turn the quality of the research as it offers others the possibility to follow the researcher's thoughts and can function as an illustration on how they reached certain conclusions (Herzog et al., 2019; Braun & Clarke, 2006).

Once the data is familiar (enough), meaning I have reached "an initial idea about what is in the data and what is interesting about [it]" (Clarke & Braun, 2006, p. 88), I will move on to the generation of initial codes. Here, codes are defined as "the smallest units of analysis that capture interesting features of the data (potentially) relevant to the research question" (Clarke & Braun, 2017, p. 297). What is of interest or relevance can be the semantic as well as latent content of the data (Braun & Clarke, 2006). In general, they function as building blocks that constitute in my case frames. I will code the data manually as it allows for a more in-depth and flexible analysis of the collected data with the unfortunate disadvantage of being very time consuming. Yet, the deep understanding of the data takes precedence over the sample size, resulting in a smaller sample size compared to research using automated coding.

In this phase of the analysis, it is more about organizing the data into preliminary groups in order to be able to start thinking about which codes may combine to a frame (Braun & Clarke, 2006). The frame is (often) broader than the codes and as such can envelope several of them. Braun and Clarke (2006) point out that it is not a point of concern when not all codes fit the initial frames or frame map as TA is not a linear process. Throughout the entirety of the analysis, one goes back and forth between the collected data and one's own observations etc.

Having formed the initial frames, it is time to review and refine the frames as a next phase of TA (Braun & Clarke, 2019). This is done by first looking at the codes to ensure that they match the data (extracts) they are based upon as well as the frames in which they function as building blocks to be certain that they fit it (Braun & Clarke, 2019). Then, the focus is widened from codes and individual frames to the frames overall to look at their relation to one another and ascertain that they reflect the data set (Braun & Clarke, 2006).

After the frames are refined and substantiated, the next phase is about defining and naming the frames before they are showcased in the report (Braun & Clarke, 2006). In the report I will not only present the frames themselves but also explain them by going into underlying assumptions they might entail and the potential reasons why end-of-life management of renewable energy sources is framed in these certain ways and not others.

4.2.3 Research quality

Given the methodology this thesis adheres to, it is problematic to use criteria such as validity, generalizability, and replicability to judge the quality of this research. Although, these criteria are well-known, well used and widely accepted research criteria, they stem from a positivist paradigm and as such are not fitting for qualitative research. The rejection of 'objective' facts as well as the existence of one reality are in stark contrast with the principles of positivism. The notion that good research has to be valid, objective, replicable, reliable and generalizable may apply to quantitative research that is numbers-based but does not for qualitative research (Tracy, 2010). Hence the need for a different conceptualization of good research in qualitative studies.

Tracy (2010) devised a model that is suitable for qualitative research and presents eight markers that are able to indicate excellent qualitative research. Tracy (2010) presents her criteria – the eight "Big-Tent" – as "*universal* hallmarks for high quality qualitative methods across paradigms" (p.837, emphasis in original). The idea of universal criteria for qualitative research might seem problematic or even wrong after the rejection of previously mentioned criteria. Still, Tracy (2010) stresses the fact that these universal criteria she presents are not a return to positivist criteria but rather flexible and adaptable criteria that match the complexity of qualitative research. Furthermore, the requirement of criteria for research, even qualitative research is there as they serve as a basis for exchange and dialogue of researchers within and between scientific communities (Tracy, 2010). It also enables qualitative researchers to present their research in a matter that is desirable for others who may follow a more positivistic approach. Hence, the possibility to become noticed by people who otherwise would have disregarded or misunderstood the research (Tracy, 2010). Moreover, criteria allow us to "communicate value for our work to a variety of audiences" (Tracy, 2010, p. 838).

Therefore, in the following I will shortly explain on the eight "Big Tent" criteria introduced by Tracy and elaborate on how they apply to my research. The following table (Table 2) is based on Tracy (2010) Table 1. Eight "Big-Tent" Criteria for Excellent Qualitative Research (p.840).

Table 2: The "Big-Tent" Criteria applied to my thesis

Quality of Research	**In my thesis**
The topic of the research is	
Relevant	The EoL management of wind turbines and PV panels as well as (their) batteries is of great importance as it can currently be regarded as a weakness when it comes to sustainability. The life-cycle assessment of technologies/products in all of their life stages needs to be considered in order to improve.
Timely	Waste volumes are expected to increase due to the first generation of installed renewable technologies reaching or nearing their EoL plus subsidization through the EEG ending for most of them (in the near future).
Significant	There needs to be a solution for a sustainable EoL management for renewable energy sources, especially with the increasing importance and development of renewable energy sources in the future. Therefore, it is important to understand how this issue is framed and by whom to realize how the policy process might be influenced and by whom.
Interesting	Currently, there is little known about how EoL management of wind turbines, PV panels and batteries is framed in Germany, by whom and why. Additionally, it allows insight into the interaction between discourse and policy process when it comes to this topic.
The study uses sufficient, abundant, appropriate, and complex	
Theoretical constructs	Frames and framing are two concepts that help capture and reflect the discussion in a meaningful way.
Data and time in the field	I have chosen to solely focus on secondary data that was collected and analyzed over the course of a little over a year, starting in November 2021 and ending in December 2022. Throughout that year, I have returned multiple times to search the data to be considerate of new developments and to capture as much of the discourse surrounding EoL management of these two energy sources as possible.
Sample(s)	I have a relatively small sample size due to my chosen method of analysis in TA and how I conducted it. Manual coding takes up more time than automated coding but offers more flexibility and allows for a more in-depth analysis that I was aiming for.
Context(s)	Germany is a good context to study the framing of EoL management of PV panels, wind turbines and batteries as it is not only a country with ambitious sustainability goals but was also one of the first countries to deploy wind and solar energy installations on a large scale. Furthermore, it has a long history of societal engagement and mobilization when it comes to environmental issues and policies meant to increase the development of sustainable energy. Consequently, one of the first countries having to deal with this issue.
Data collection and analysis processes	In chapter four I provide a detailed account of how I have conducted my data collection as well as analysis process. Plus, the analysis and discussion offer insights into the frame development.
The study is characterized by	
Self-reflexivity of the researcher	Self-reflexivity plays a big role throughout the entire research but becomes specifically noticeable in the methodology where my assumptions on reality and knowledge production that led to my definition of frames and framing as well as use of TA is based upon are explained. Furthermore, my perceptions, assumptions, considerations play a vital role in the discussion.
Transparency about the methods and challenges	I try to be as transparent as possible especially when it comes to the coding and analysis process by giving a detailed explanation of how I conduct the TA and the sources my data is based on. Additionally, the limitations and constraints are explained at the end of this chapter, given an honest account of what this research can and cannot do.

Quality of Research	In my thesis
Showing rather than telling	By explaining the German *Energiewende* I tried to give the reader a good insight and understanding into German energy and sustainability politics. Moreover, it gives an awareness of the strong role of grassroots movements and other organizations in it. Plus, I give examples of data extracts to illustrate the frames.
Triangulation or crystallization	Crystallization can be found in my data sources as I take my secondary data from multiple websites that are governmental, non-governmental, company websites, magazines and newspaper articles. However, aside from multiple sources there is not really a crystallization in terms of method and theoretical framework.
Multivocality	My research does not include research participants in the form of interviews or surveys, meaning that the multivocality is only given in the sense that I try to include as many different stakeholders as possible and take their local significance into account.
Member reflections	Does not really apply for my thesis as I do not have active participants.
The research influences, affects, or moves particular readers or a variety of audiences through	
Aesthetic, evocative representation	I hope to have written in a way that is interesting, compelling, and easy to understand for my target audience. I wish to have presented the created frames in a convincing way.
Naturalistic generalizations	Not sure how this applies to my research as it is explained by Tracy to be about experience.
Transferable findings	Not sure how this applies to my research as it is explained by Tracy to be about experience.
The research provides a significant contribution	
Conceptually/theoretically	At its most basic, my research contributes conceptually by applying frames and framing to EoL management of PV panels and wind turbines.
Practically	I argue that the knowledge produced through my research is useful as it gives insight into an under researched topic that is of importance by illuminating the frames, framing practices and frame sponsors participating in the public discourse as well as the potential connections between frames, framing and the policy process. It can motivate people to act by giving them political awareness.
Morally	Aims to further strengthen the position of sustainability issues.
Methodologically	I do not feel as if I used my methodology in a particular creative or new way. However, I think I utilized the methodology in an insightful way.
Heuristically	I hope that I give interesting suggestions for further research in my discussion and conclusion.
The research considers	
Procedural ethics	Of course, I follow procedural ethics as I pledge to deliver accurate, honest, and authentic findings in my research.
Culturally specific ethics	I am aware of my cultural background and the ethical values that accompany it.
Relational ethics	I think this applies more to field work in foreign communities, for example. Additionally, I do not have research members that actively participate.
Exiting ethics	Not sure if this applies to my research but I try to avoid presenting frames and their sponsors negatively in the sense of victim blaming.
This study	
Achieves research goals	In my opinion I answer the set-out research questions in the introduction, specifically in the conclusion.
Fit of methods/procedures	As I argue throughout the entirety of Chapter four, I use the methods and procedures best suited for answering my research questions.
Research is meaningfully connected throughout	Yes, I think that I do so throughout the entirety of my thesis.

In summary, I think that my chosen theoretical and methodological approach are best suited to answer my research questions. My focus was more on an in-depth analysis rather than a complete one. Especially, considering that I argue completeness is difficult if not impossible to achieve and moreover not a goal I set out to accomplish. However, I did strive for quality research and believe that I managed to produce it according to the criteria introduced by Tracy as illustrated above (see Table 2.).

Still, I have to acknowledge the weaknesses and limitations of my research. On the one hand, the constraints set by the scope of a master thesis did not allow me to consider all frames that I found in my analysis. The frames I chose to further examine were the ones that were either the most prevalent frames in the discussion or stood out to me because they were only used for one energy technology and not the other. Still, more frames than the six I introduce in the analysis are noticeable when it comes to the framing of EoL management of the two renewable energy sources. On the other hand, the discussion regarding the wind turbine, PV panel and battery waste is continuously added to, meaning that by the time I ended my search for data sources, new ones have probably already come to be. Thus, I cannot claim completeness as these new data sources could potentially introduce new frames or frame sponsors.

Additionally, there is the possibility that there is data that I did not consider as it did not show up with the search terms I used. In my opinion the search terms I used are in line with my research questions and as such are plentiful for my research. Even though, I cannot rule out that the inclusion of other search terms would result in new data sources.

On the topic of data sources, I have chosen to only focus on secondary data sources as I believe that they allow me to garner a comprehensive and detailed overview over frames and their sponsor without the need for primary data. Yet, I recognize the addition of primary data could bring about new and interesting information, especially in regard to the stakeholders who do not really make an appearance in the discussion.

5. Analysis

5.1 Capacity frame

The analysis found that the most often used frame when it comes to the EoL management of wind turbines is the capacity frame. The stakeholders using the capacity frame define the EoL management as the capacity to treat the old wind turbines and the waste stemming from them. It is about the (German) waste treatment structures, including the processing concepts, the number of waste treatment plants and companies as well as the expertise concerning waste arising from EoL wind turbines. Hence, on the one hand it is referring to capacity in the sense of structures in place, the quantity of the waste disposal infrastructure. On the other hand, it pertains to the capacity, or in other words the ability to handle materials and volume arising from wind turbine dismantlement and disposal.

> Most components of wind energy power plants have sufficient capacities and clear processes available to them for recycling whereas rotor blades do not (Umweltbundesamt, 2022c, para. 2 translated by author).

The German Federal Environment Agency as well as other various stakeholders point towards the currently available and most importantly established waste management capacities whilst discussing the EoL treatment of wind turbines. Just as done in the quote above, most often the components are split by stakeholders into two categories: the ones that are recyclable and the ones that are non-recyclable. Thereby lies specific focus on the components that are perceived to be non-recyclable, namely the rotor blades and the composite materials they are made from. Actors from the waste treatment industry, the political party AfD and other stakeholders claim that there is a distinct lack of knowledge and consequently companies that are able to properly dispose of rotor blades.

> 6. As far as the Federal Government is aware, are there enough incinerators for the parts that cannot be separated now and in the near future, and if not, how is this problem to be solved? (FDP in Bareiß, 2018, p. 3 translated by author).

As a result, the current capacity is found to be insufficient by some stakeholders and even at the risk of becoming overwhelmed by the waste volumes that are estimated to enter the waste treatment infrastructure in the coming years. The description of a wave or flood of waste is commonly used, indicating a force (of nature) that is threatening to befall the waste treatment industry (Fraunhofer, 2020; Hagedorn, 2020; Pinna & Sans, 2021). It is to drive home the argument that Germany is currently and, in the future, not equipped to deal with not recyclable and even already recyclable waste as inadequate processing concepts and too few treatment facilities exist. The Umweltbundesamt (2019) calls future ‘bottlenecks’ a likely possibility when it comes to the recycling capacity of wind turbines, leading to stakeholders including but not limited to AfD, FDP as political parties, waste treatment companies like Remondis and the wind industry, questioning what to do with the wind turbines after they reached their EoL.

The response to that question and at times criticism differs between stakeholders who pick up the capacity frame to counter the arguments leveled at them. For one, the German government that consisted of CDU/CSU and SPD defended the current waste treatment structures as sufficient and attested no problem when it came to the recycling of all components including GFRP rotor blades (Wenzel, 2017). The government maintains that there is a long history of established processing methods that enable the complete or almost complete recyclability of wind turbines and the German Wind Energy Association (BWE) is of the opinion that existing structures - albeit limited in the case of GFRP rotor blades - are enough to cope with the growing waste streams resulting from old wind turbines (German Energy Solutions Initiative, 2022c; Deutscher Bundestag, 2020; Nestler, 2021; en:former, 2020; EnBW, 2021; Wallasch et al., 2018).

> ‘We do not share the view that there could be bottlenecks in the recycling of the rotor blades, since there is only one plant in Germany so far,’ explains BWE Managing Director Wolfram Axthelm: ‘The plant has sufficiently high, approved capacities, which are currently still available and unused’ (Axthelm in Nestler, 2021, para. 19 translated by author).

An exception to that are rotor blades made from CFRP that presently have no established recycling methods where the focus is shifted towards research projects that are in the process of finding solutions and eventually supposed to lead to the development of capacities that are able to accommodate the influx in composite waste (Wenzel, 2017; SRU, 2022).

Just as with wind turbines, the capacity frame can also be found in the debate surrounding the EoL treatment of PV installations. Although some concerns are raised by the AfD (in Landtag Nordrhein-Westfalen, 2019) and Deutsche Umwelthilfe (2021), the argumentation of insufficient capacities is not nearly used as often by stakeholders comparatively to EoL management of wind turbines. Rather, it is reasoned that current waste volumes are manageable with the processing structures in place and even though capacities must be expanded, there is still (enough) time between now and significant waste streams emerging from EoL PV installations that the needed infrastructure can be developed in time (Fraunhofer ISE, 2022; German Energy Solutions Initiative, 2022a; Axians eWaste, 2022).

5.2 Economic frame

The economic frame is about the financial implications and costs of the EoL management of wind turbines to the wind industry, the government or other stakeholders.

> The disposal of a rotor blade is cost-intensive (Kannheiser in Kroll & Szombathy, 2022, para. 7 translated by author).

Mr. Kannheiser works for eurecum, a company that specializes in waste disposal, amongst others the dismantlement and disposal of wind turbines. He frames the disposal and therefore the management of old wind turbines as expensive, a cost that must be covered by the operators of said wind turbines. Furthermore, FDP members (Bareiß, 2018) mirrored Kannheiser's statement by declaring that the EoL wind turbines are requiring time-consuming and expensive dismantling and disposal processes. Additionally, Kannheimer explains that their costumers do not ask for the most sustainable but the cheapest option when it comes to disposing wind turbines (Kroll & Szombathy, 2022). Hence, monetary cost greatly affects how a wind turbine is disposed of, meaning which processing options are considered the cheapest option. Even though, Eva Phillip, working for the energy supplier Vattenfall as the Chair of Wind Sustainability, clarifies:

> At the moment, recycling blades is more expensive than burning them. Of course, we hope that these technologies will become cheaper as technology advances (in Kaufmann, 2021, para. 14 translated by author).

This apparent prioritization of economic over environmental considerations is criticized by the Umweltbundesamt (2020) who argue that the protection of people and environment trumps higher cost of a treatment method compared to other.

Still, the focus on financial implications of EoL wind turbine management continues in the statements from other policy actors exemplified by the AfD and FDP. These two political parties inquired in an oral or written question directed at the Federal government and Federal state government after the cost of disposal for wind turbines as well as the expense of renaturation where the wind installations used to be and moreover who has to finance all this (Deutscher Bundestag, 2020; Feicht, 2020; Deutscher Bundestag, 2021; Feicht, 2021; Wenzel, 2017). In response, the Federal and state governments indicated towards the legal obligation operators of wind turbines have regarding the EoL management of their wind turbines. Particularly their obligation to fund the dismantling, disposal and renaturation processes from reserves they were legally required to set aside specifically for this purpose as part of the permission process for the wind turbine installation (Deutscher Bundestag, 2020; Deutscher Bundestag, 2021; Wenzel, 2017).

In turn, the Umweltbundesamt (2020) puts into question the adequacy of these reserves and warns that a ´funding gap` is a likely possibility when it comes to the management of EoL wind turbines. According to the Umweltbundesamt (2019) the estimated cost of disposal on which the financial reserves from operators are based on do not match the actual cost of disposal, leaving a funding gap that needs to be accounted for. Yet, the Federal government disagrees with this assessment and claims that there is not a funding gap as the legal requirements are sufficient and operators are able to cover the cost (Feicht, 2020). However, the AfD members take the likely or non-existent funding gap as given and call forced insolvency on the part of operators as a way to escape their obligation to cover the cost a problem (Feicht, 2020). Moreover, they wonder whether the cost would then befall the ´public purse´ (Feicht, 2020). Again, the German government deflects assuring that there is no funding gap, and the case of forced insolvency is not a problem as proper legislation is in place (Deutscher Bundestag, 2021). Nonetheless, other stakeholders, including representative of wind industry actors voice similar concerns and fear that the EoL management obligations turn out to be more extensive than anticipated by operators and monitoring authorities alike, leading to higher costs that the wind industry should not be expected to solely bear or simply accept (Henkel & Böhme, 2020).

On the other, the EoL management of wind turbines is also regarded as a possible revenue stream not only for companies who conduct the dismantlement and disposal but also companies that discover the recycling of wind turbines as a new business model. As Hagedorn, a recycling company specializing in the dismantlement of wind installations, put it:

> Sustainable demolition: a win-win solution for everyone involved (Hagedorn, 2020, para. 3 translated by author).

The win-win situation Hagedorn (2020) is talking about refers recycling as a processing route that benefits the environment and the operators because recycling can be more lucrative than simple disposal due to the income generated by selling the recycled materials. Other stakeholders agree with the view that secondary materials can have a positive market value, making them profitable (Umweltbundesamt, 2022d, Deutscher Bundestag, 2020). The German government and wind industry actors are hopeful that the increasing demand for processing routes will trigger a market reaction that will make EoL management a profitable business model whilst creating new markets for secondary materials that allow for cheaper manufacturing of new wind turbines (Hagedorn, 2020; Bareiß, 2018; Fraunhofer IWES, 2022; SRU, 2022; en:former, 2020).

For stakeholders concerned with the EoL management of PV systems and batteries the economic frame is also noticeable in the discussion (Kreibe et al., 2020). There is the International Renewable Energy Agency (IRENA) that calls financing of the processing structures as the most important aspect of the EU WEEE Directive (Weckend et al., 2016). The cost of collection and recycling of PV modules is also prevalent in the argumentation of the non-profit association Deutsche Umwelthilfe that finds:

> The costs and effort of the collection processes are often not attractive for owners of used photovoltaic modules (Deutsche Umwelthilfe, 2021, p. 12 translated by author).

They regard the current system as cost-intensive and point towards a recycling market that is underdeveloped and not financially viable (Deutsche Umwelthilfe, 2021; Dold, 2022). Akin to the waste management of wind turbines, the cost stemming from the disposal of PV panels is criticized as once again the possibility of insolvency of a manufacturer is brought up that would leave society having to cover the costs for these PV panels where the manufacturer responsibility no longer applies (Hörstmann-Jungemann, 2016). Still, the opportunities of resulting from the management of EoL PV panels as revenue streams, economic opportunities and future markets probably outweigh the concerns regarding its cost (Dold, 2022; Hörstman-Jungemann, 2016; European Environment Agency, 2021; EU Publications Office, 2022s). In particular the European Commission focuses on the development of economic feasible second-life-batteries, the establishment of PV EoL industries and the recovery of resources from EoL PV systems and batteries (EU Publications Office, 2022c; EU Publications Office, 2022b).

5.3 Cross-sectoral collaboration

The analysis showed that the cross-sectoral collaboration frame was used by a lot of wind and waste treatment actors as well as other stakeholders, including research institutes and the government. It regards EoL wind turbine management as part of cross-sectoral collaboration.

> I'm just suggesting that it would be better to look for solutions together (Wilms in Zepelin & Dunkel, para. 23, 2017 translated by author).

Wilms regards the management of wind turbine waste as a collaborative effort because even though waste treatment companies are towards the end or the end of a product’s life, every single phase is connected with one another. The product goes through several phases beginning with design and development to production to consumer to waste management and in the optimal scenario back to manufacturer, meaning multiple stakeholders are involved. Hence the need for communication and collaboration between the different stakeholders as their activities affect the actions of others. This pertains to political actors as well because they set out the rules and regulations for these processes to take place. So, Hirst asks for more collaboration between the stakeholders as according to him the responsibility to effectively deal with wind turbine waste does not solely lie upon the waste management industry (Zepelin & Dunkel, 2017).

The inclusion in the design considerations of new wind turbines could help inform developers about their recyclability and possible challenges resulting from the design and materials used for the construction of wind turbines. The thought is that a design geared towards not only performance, but recyclability as well could result in higher quality recycling and in turn easier and more economical processes that could benefit everyone involved (tagesschau, 2021a; Donner, 2021; Weißhaupt, 2020). The industry association WindEurope elaborates:

> The wind industry will continue engaging with the cement industry and recycling technology providers to ensure commercially viable and environmentally sound recycling and recovery options become available across Europe (WindEurope, 2020, p. 8).

In particular in the development and design stage is collaboration with waste disposal companies important as the continuous technological advancement leads to the use of quickly changing material compositions that basically make the development of high-quality recycling methods difficult as the waste treatment industry is basically playing catch-up and has to come of up numerous concepts that often are not economical (Donner, 2021)

Plus, the wind industry actors are eager to point out that the wind industry is not the only source of composite waste that is regarded as the most challenging component of a wind turbine to efficiently dispose (Deutscher Bundestag, 2020). In fact, WindEurope (2020) spotlights that only a small percentage of the total composite materials waste in Europe is because of the wind industry. It is noted that aviation, automotive and boat building industry use composite materials much more than the wind industry (tagesschau, 2021a; Morgenstern, 2021; WindEurope, 2020). Moreover, the usage of composite materials is not only expected to go up with the growth of the wind industry but also the rise of e-mobility as lightweight materials are worked with to balance out the weight of batteries to ensure the high performance of cars and so on (Zepelin & Dunkel, 2017; Morgenstern, 2021). Thus, a joining of forces could result in faster development of higher quality management specifically of rotor blades because more resources in the form of funding and expertise could be provided.

Furthermore, a combining of waste streams could have the added benefit of causing a bigger reaction from the market as the treatment of composite material waste appears more economically interesting for companies in the face of large(r) waste volumes (WindEurope, 2020; en:former 2020).

Cross-sectoral collaboration also frames some of the conversation surrounding EoL PV panels and battery management as it is used most often to promote research and innovation on the topic.

> The originality of the project relates to the cross-sectorial approach associating together different sectors like […] the PV industry (innovative PV cells) and the industry of recycling […] with a common aim: make use of recycled waste materials (EU Publications Office, 2022b, para. 1).

Once again, a collaborative approach is pushed as the best way to further the development of waste management resulting from EoL PV panels and batteries and the establishment of processing structures (Deutsche Umwelthilfe, 2021). Without a collaborate effort, the acceptance of waste management systems cannot be guaranteed and lead to unsatisfactory implementation (Weckend et al., 2016). The required reconsideration of the product life management and the ensuing implications for design and development of innovative PV panel and batterie technologies are also mentioned by stakeholders (EU Publications Office, 2018; Deutsche Umwelthilfe, 2021).

5.4 Environmental and public health protection frame

Using the frame of environmental and public health protection, stakeholders push the notion that EoL management of PV panels and batteries is a way of protecting the environment and people. Depending on the stakeholder, the management of waste from PV installations is framed either as beneficial to the environment or an absolute necessity to ensure the safety of people and nature.

> Opponents of solar energy keep coming up with fairy tales about the modules being hazardous waste, but that clearly belongs in the realm of legend (Meyer, 2018, para. 2 translated by author).

A central point of the frame is the description of PV modules as hazardous and as illustrated by the quote from Meyer (2018) on the blog from IBC SOLAR, a company that provides the planning and project management for PV systems whether this is classification is true or not. However, Meyer (2018) goes even further and claims that the categorization of solar panels as hazardous is done by opponents of solar energy to damage its image as a potential threat to the environment and public health that the description of hazardous waste potentially invokes.

Although other stakeholders do not word their opinion on PV waste as hazardous waste, it still features discussions of this classification. Most stakeholders such as research institutes, non-profit associations and waste treatment companies make the differentiation between PV panels as a whole which are regarded as not hazardous and their individual substances, some of which are classified as dangerous (Deutsche Umwelthilfe, 2021; Sonderabfallwissen, 2020; Fraunhofer UMSICHT, 2023). The explanation given by several stakeholders such as the the PV industry actor Solar Frontier (2015) and the website Sonderabfallwissen is that there are substances contained in solar systems that are dangerous:

> First and foremost, solar systems are not hazardous waste. Depending on the type of solar cells, however, individual components (e.g., cadmium or lead) can be classified as dangerous (Sonderabfallwissen, 2020, para. 5 translated by the author).

Thus, the presence of dangerous substances could lead to environmental damage in the case of PV systems not being professionally handled (Knowledge Centre for Biodiversity, 2022; tagesschau, 2021b). Improper disposal could result in the release of pollutants that are toxic. Hence, some stakeholders invoke the environment and public health protection frame to stress the need for the proper handling of EoL PV installations so no harmful pollutants are released in to the environment to protect people and nature. They aim to ensure the proper management of PV installations now and in the future, highlighting the necessity of efficient and available processing structures so that no potential harm befalls the environment or people.

Another aspect pertaining to the environment and public health frame is the conservation of resources by recovering valuable resources through the proper management of PV and battery waste. With high quality processing structures that can effectively recycle materials contained within PV systems and batteries, the demand of virgin materials could lessen. In particular the preserving of rare earth minerals as a result of recycling and in turn the growth of secondary materials that act as substitutes or replacements of virgin rare earth minerals could potentially result in great environmental and health benefits (Veolia, 2021; Hörstmann-Jungemann, 2016).

> When recycling processes themselves are efficient, recycling not only reduces waste and waste-related emissions but also offers the potential for reducing the energy use and emissions related to virgin-material production (Weckend et al., 2016, p. 19).

Besides, IRENA and the research institute Fraunhofer IKTS (2021) call attention to the extraction and production processes of virgin rare minerals that have negative impacts on the environment because they are energy-intensive and tend to use chemicals that can be harmful to nature and people (Weckend et al., 2016). A lot of times the safety of workers is disregarded and bring about human rights violations (Fraunhofer IKTS, 2021). Consequently, the stakeholders using the environmental and public health frame do so to highlight the necessity along with the benefits of proper waste management for PV panels and batteries.

Similarly, to how Meyer (2018) was strongly against the description of PV panels as hazardous waste, the Bundesministerium für Wirtschaft und Klimaschutz (2022a) called the claim that wind turbines end up in hazardous waste landfills a prejudice that is not true. The main difference between these two examples is that in the case of the latter the designation of wind turbines as hazardous waste is not what is called a prejudice but their disposal in landfills. Comparable to PV installations, the stakeholders framing EoL wind turbines, and their treatment are more focused on the processing structures than the wind turbines itself. Here, the stakeholders are also in favor of the existence of proper EoL wind turbine management including the dismantlement and disposal processes to avoid noise or environmental pollution at the hands of oil residues or shredded rotor blades in consequence of wrong and even illegal management (Umweltbundesamt, 2022d; Bareiß, 2018; Feicht, 2020).

The environment and public health protection frame includes the opportunity of resource conservation given that high quality management is done to recover the resources contained within the wind turbine waste (German Energy Solutions Initiative, 2020a). Wilms, working for a waste management company asserts that the wind industry is too wasteful when it comes to raw materials (Zepelin & Dunkel, 2017), In contrast, other stakeholders, which can be positioned within the wind and energy industry, regard higher quality management of the waste stream generated by wind turbines as the potential to become even more sustainable or green (WindEurope, 2020; en:former, 2020; Radtke, 2022).

Yet, the focus only lies upon the environmental benefit of using secondary materials instead of including the extraction and production of virgin materials. The environment and public health protection framing was done in a way that described composite materials as a problem (Feicht,

2021) and generally utilized the frame to pose wind turbines and PV panels as a threat to the environment and people's safety. However, members of the AfD were not the only political actors that questioned the safety of wind turbines as the FDP was also concerned and questioning the safety of people and environment when it comes to old wind turbines. Still, most other stakeholders do not regard them as such a danger to the environment and people as in particular the AfD might want to make them out to be.

5.5 Ecological modernization frame

Possibly the most prevalent frame in the discussion surrounding EoL PV system and batterie management is the ecological modernization frame. The concept of Ecological Modernization places technological development at the center of climate change mitigation. Therefore, stakeholders invoking this frame regard the EoL management of these technologies as an opportunity for ecological modernization.

> End-of-life PV panel management for holds the potential to develop new pathways for industry growth and offers employment opportunities to different stakeholders (Weckend et al., 2016, p.87).

The argument of stakeholders from industry, society and politics alike is that the management of EoL PV panels and batteries offer chances for economic growth which not only benefits society but also environment. The high-quality management of these high-tech waste streams call for technological advancement in the areas of treatment methods and secondary material use for new products (EU Publications Office, 2018; German Energy Solutions Initiative, 2022b; Fraunhofer CSP, 2023). Additionally, the whole processing infrastructure needs to be expanded to accommodate coming waste volumes arising from EoL PV systems. The expectation is that this generates the development of new business models and the creation of new markets that are beneficial for the economy as it stimulates economic growth and advantageous for the environment with better resource management (EU Publications Office, 2021; Weckend et al., 2016).

> There is an opportunity right now to make photovoltaic modules a real part of the circular economy and to make Germany a pioneer in the high-quality collection, repair, reuse and recycling of solar systems (Deutsche Umwelthilfe, 2021, p. 12 translated by author).

The Deutsche Umwelthilfe, a non-profit association for the protection of environment and consumers, highlights another aspect of the ecological modernization frame: the idea of being a pioneer. Framing EoL management as efforts to pioneer a more sustainable economy, namely a circular economy is offering the first mover advantage to industry actors who took part in those efforts (German Energy Solutions Initiative, 2019; Wörrle, 2019). With the increasing commitment towards a more sustainable future, the demand for green technologies, methods and businesses rises accordingly. Being a pioneer in this area allows stakeholders the acquiring of knowledge and expertise that they can use to act as a supplier for green solutions and become a leader in their respective field, securing an advantageous position over competitors and ensuring economic profitability (German Energy Solutions Initiative, 2022b; Weckend et al., 2016; EU Publications Office, 2018; Axians eWaste, 2022).

The ecological modernization frame is also commonly used by political actors as it not only can potentially further acceptance of political decisions but also can generate active support from societal an industry actors. Policies and legislation that are in place to achieve more sustainability and climate change mitigation are often connected to high (upfront) costs that necessitate the spending of money on the part of government, industry and public to fund R&D of sustainable technologies and businesses, exemplified by the *Energiewende*. Thus, the framing of the EoL management as an economic opportunity that creates new jobs and revenue streams gives reason and reassurance to invest in R&D for recycling and treatment techniques (German Energy Solutions Initiative, 2020b; German Energy Solutions Initiative, 2021a; German Energy Solutions Initiative, 2022d).

However, using the ecological modernization frame to gather support and acceptance from society among others, is not only done by political actors but also industry actors. Something that is not as noticeable with stakeholders from the PV and battery industry but definitely apparent when it comes to the EoL management of wind turbines. The notion that wind industry already has a high ecological standard that is only being improved by better EoL management is very prominently featured and a lot of industry actors highlight their commitment towards 100 % percent recyclability of wind turbines and the efforts they are already undertaken to achieve said goal (en:former 2020; Umweltbundesamt, 2019; WindEurope, 2020; German Energy Solutions Initiative, 2022c; Vattenfall, 2021).

It is done as a way to uphold and further the green image of the industry whilst ensuring (continued) societal and political support for wind energy (Donner, 2021; Hagedorn, 2020; German Energy Solutions Initiative, 2022c). In general, industry efforts towards more sustainability in their business practices can result in higher legitimation and acceptance from society, strengthening their image and business.

5.6 Energy security frame

Another central frame for the EoL management of PV panels and batteries is the energy security frame which defines it as a potential increase in energy security. Energy security is about the secure and affordable supply of energy. The aim of energy security is to protect and built up a resilient critical energy infrastructure.

> Concerted efforts are underway in Germany to recycle more and become less dependent on photovoltaic (PV) imports (German Energy Solutions Initiative, 2022a, para. 2).

The efforts the German Energy Solutions Initiative are speaking of are mainly undertaken by the Federal government in conjunction with research institutes and start-up companies to reduce Germany's import dependency, specifically regarding rare earth minerals. Thus, it is not surprising that they are also the main frame sponsor for energy security. The German government pushes for more innovation in the field of EoL management of batteries and PV installations, using the energy security frame to support research and development (R&D) in this area (German Energy Solutions Initiative, 2022d; German Energy Solutions Initiative, 2021b). Research institutes and niche companies pick up and invoke the framing for their research projects to gain political and financial support and industry interest.

The idea behind framing EoL management of PV panels and batteries to heighten energy security is that with an efficient management, namely high-quality recycling more secondary materials become available to the market. Consequently, the manufacturers could use the recycled rare earth minerals instead of virgin rare earth minerals, leading to a lessening of the demand for imported minerals. Additionally, the processing of EoL PV panels and batteries would be conducted domestically, keeping the resources within Germany, and making them accessible to domestic manufacturers who can utilize the secondary materials for their products.

According to the frame sponsors, this would lead to more 'domestic' rare earths minerals, technologies, and expertise, opening a new supply chain for materials and technologies (Karlsruhe Institute of Technology, 2022). This would strengthen energy security as the diversification of supply chains for energy sources as well as owning energy reserves and resources are key aspects of ensuring energy security.

The thinking is that the demand for rare earth minerals is only expected to increase concurrent with the energy transition towards a clean energy supply as renewable energy technologies utilize more rare earth minerals than energy technologies that are considered non-renewable like coal or gas. Plus, only a few countries own rare earth minerals allowing them to use their position as suppliers to exert political or economic pressure on import dependent countries. Gaining a new and domestic supply of rare earth minerals and technologies could make Germany less susceptible to blackmail.

The energy security frame does not appear to be used by stakeholders participating in the discussion surrounding EoL management of wind turbines.

6. Discussion

One of the most actively engaged political actors among the parliamentary parties in the conversation surrounding EoL wind turbines and PV panels seemed to be members of the political party AfD, closely followed by the FDP. These stakeholders mostly used three frames when talking about the treatment of old wind turbines and PV panels: the environment and public health protection frame, the capacity frame and the economic frame. The environment and public health protection frame is used the least among the three by AfD and FDP members to discuss EoL management of wind power plants and PV installations. Noticeably for both political parties is the focus on wind turbines over PV panels or batteries.

A possible reason is an often-referenced report from the German Environment Agency that was about the development of guidelines for the dismantlement, disposal of EoL wind turbines. The study was referenced for a lot of questions and positions the members of these two political parties had on the EoL wind turbines. Among other things the study predicted capacity issues when it came to disposal of wind turbines in terms of knowledge as well as treatment routes. Hence, a strong utilization of the capacity frame by both AfD and FDP when it came to questions and statements pertaining to EoL management of wind turbines.

However, the German government as well as wind industry actors disagreed with these findings and declared that there are no imminent capacity challenges. The stakeholders from the waste management industry appear to be split on how they perceive the situation regarding EoL wind turbines as well as PV panels. Some regard the current system for sufficient and able to handle the waste from wind turbines, PV panels and batteries whereas others find it to be inadequate. Yet, the stakeholders all think there is room for improvement whilst either stressing the already great recyclability and system in place or criticizing the non-recyclability and the perceived lack of available treatment routes.

The other framing used even more prominently by the AfD is the economic one. In fact, the AfD members are the one stakeholder who felt as if they really pushed economic framing of EoL management of wind power plants. I think this is a major difference in how solar systems and wind power plants and their EoL management is framed when it comes to economics. While the framing is similar for both energy technologies regarding the questioning how much the cost of disposal is or expected to be and who must pay for it as well as the resulting implications for government, industry actors and the public. It is done more in this vein by stakeholders concerned with EoL wind turbines in comparison to EoL PV panels and batteries.

For the latter the perceived business opportunities and economic benefits were spotlighted, specifically in regard to high quality management of solar systems. The economic and environmental considerations were linked in such a way that the argument for recycling and recyclability of PV panels and batteries was seen as a change for economic growth and sustainability. It was presented closely connected with one another to highlight the management of EoL solar systems as a chance to improve economy and environmental protection at the same time. Simply put, the ecological modernization frame was used more often by stakeholders including policymakers, researchers and industry actors for PV panels and batteries compared to wind turbines. However, that is not to say the frame of ecological modernization is not present in the conversation of EoL wind turbines and their management. Just that the 'purely' economic frame is seemingly utilized more often by stakeholders.

A possible reason as to why there is this difference in frame usage by stakeholders between wind and PV EoL management could be the German government and their framing or more accurately their involvement in the discussion concerning the dismantlement and disposal of wind power plants and solar systems. In the case of the wind turbines, the German government seemingly takes on a more reactive than proactive position when it came to talking about the expected increase in EoL wind turbines and how their disposal was supposed to be carried out. Actually, a lot of my data for the German government as a stakeholder in the conversation about EoL wind turbines is based on the answers given by them to parliamentary questions from members of the AfD and FDP.

On the other hand, for PV panels and battery there was more data besides parliamentary questions such as articles on new technological innovations or research projects. Therefore, it makes sense that for EoL wind turbines the German government adopted the frames used by FDP and AfD in their questioning to provide information. Answering questions that used an economic frame by utilizing the economic frame as well appears logical. Concerns regarding an expected funding gap that requires the government to step in to ensure the proper dismantling and disposal of wind turbines can be easily deflected by the German government stating it is of the opinion that the financial reserves set aside by the wind power plant operators as part of the legal permit process for construction of wind turbines are enough to cover the entire expenses. This example illustrates how the German government takes the framing used by AfD and FDP to void their arguments or concerns and strengthen their position on cost and financial security of the EoL management from wind turbines.

Still, it makes everyone focus on this one specific and potentially negative aspect of EoL management whereas a proactive approach might not only void the concerns but also counters the perceived problems by spotlighting other aspects of old wind turbines and their possible treatment routes by using for example the ecological modernization frame. The same applies for the capacity frame that was used by FDP and AfD to frame their questions directed at the German government. Admittedly, the German government kind of flipped it on its head, at least from how it was utilized by the members of the AfD and FDP and instead of highlighting the negative aspects (non-recyclability and limited treatment routes) they chose to pronounce what is currently recyclable and assured that even though rotor blades are certainly a challenge they are not a problem. Again, it dissuaded concerns by pointing out what is already available and possible regarding EoL wind turbine treatment.

Yet, it was also a chance to expand more on what is done in the wind and waste management industries and undergoing research efforts that might possibly even be funded by the government or other policymakers. Arguably, the answer to a parliamentary question might not necessarily be the place to do so, which is all the more reason why I am bewildered that the German government has not taken the opportunity to publish a white paper or something similar.

Different stakeholders sharing frames is not uncommon or problematic. Quite the opposite, it is to be expected with frames being often embedded in a society's culture and frame sponsors trying to garner support from the public, media and other frame recipients for their position or opinion by invoking a frame that make people connect to and understand their argument, statements, and sentiments.

However, it is strange to me that the German government has not utilized political position and platform to be more involved in the discussion surrounding EoL management of wind turbines and steer it towards a seemingly more favorable direction. Maybe this is where a bias on my part is the reason why this stood out to me so much and I am wondering why the German government left so much room for other stakeholders to possibly take over the discussion. As this was a challenge or problem – depending on who is talking about the EoL management of wind turbines – that was expected to occur by the end of the subsidization period for wind turbines of the first generation which was 2020, I thought there would be more about it coming from the German government themselves.

Particularly due to their being so much on the *Energiewende*, the EEG and wind energy that made me (falsely) assume that if there is a lot about the role of wind energy and the future of wind energy from the German government, there must also be quite a lot about the EoL on wind energy. However, the lack of engagement regarding the disposal of wind turbines could also be attributed to prioritization on the part of the German government.

Another central aspect of the EoL stage of wind power plants that is not really about the disposal of wind turbines but still closely connected to it is the discussion of Repowering. Repowering is about replacing old wind turbines for either technical or economic reasons with new and higher performance wind turbines. Now with a significant amount of wind power plants expected to be dismantled from 2020 onwards because they fall out of the EEG subsidization, leaving questions for operators and policymakers on how to replace the loss of wind energy and whether Repowering is an option for a given site. Thus, the focus might have been on Repowering and the process can be done as smoothly as possible to make a step toward the goal of a clean energy supply despite the dismantlement of some wind power plants.

The perceived prioritization of the development of renewable energy sources to mitigate climate change and become more sustainable might have led to another aspect of sustainability be overlooked, namely resource management. Or in other words the wind turbines and PV systems are climate friendly but that does not mean they are automatically environmentally friendly, especially when it comes to their production and unfortunately also their disposal.

Another explanation for the comparatively small participation might be the current legislation when it comes to wind turbine and PV panel and battery disposal as the German government has stated that it is satisfactory. Although numerous stakeholders thought it could do with improving and asked for more legally binding guidelines when it comes to the EoL management of these energy technologies, it is true that Germany is conform with EU regulations and with their landfill ban for wind turbines even ahead of most other member states. Meaning Germany could actually be considered a leader or example concerning EoL treatment of wind turbines, PV panels and batteries. So, looking at it from this perspective it could explain why the German government has not been as involved in the discussion as they could and have argued that the status quo is more than good enough for the moment. Consequently, the absence of change in regulations or legislations concerning EoL management of wind turbines, PV panels and batteries should not be surprising.

Something that might also minorly play into it is the avoidance of criticism or more accurately avoidance of having to acknowledge it regarding the execution of the *Energiewende*. A comparison that was made twice in the context of wind turbines and one time also included PV panels was the comparison of wind power with nuclear power. It was argued that just like with nuclear power the policymakers invested into an energy source without pausing and thinking about the resulting waste that eventually has to be adequately dealt with. Basically, the German government jumped head-first into the renewable energy technologies and *Energiewende* which could become a big problem later on.

Now both times it was admitted that this is quite a drastic comparison as the waste from nuclear power is radioactive which is life-threatening and waste stemming from wind energy is not. Still, it had (probably the intended) effect on me as a reader. One of the things that immediately popped into my head were snippets of the news that covered the protest that accompanied the transport of waste from nuclear power plants in which people chained themselves onto the train tracks to halt the transports and ultimately stop them altogether along with the stop of nuclear power. In fact, the open question of where the final storage for this radioactive waste should be was a major reason why there was and is such a strong opposition against nuclear power in Germany. Thus, making this comparison could result in a strong reaction from people who share this cultural understanding, conveying the urgency for (political) action to find solutions and the criticism on the perceived thoughtlessness of German policymakers.

Now, I do not think this comparison was made to make wind turbines and PV panels out be these giant sources of potentially dangerous waste and more about illustrating the assumed need of political support for dealing with the disposal of wind turbines and PV panels in the form of regulations, funding and more foresightedness. Still, the German government might think it is better not to broach this issue to avoid discussions they rather not have such as the state and progress of the *Energiewende* and the role and future of the 'green' energy source nuclear power as classified by the EU.

Whatever the reasons may be for the participation or lack thereof by the Government in the conversation surrounding EoL management of wind turbines and to some extent of PV systems remains interesting and noteworthy to me. In contrast, in my opinion the involvement of the AfD in the conversation surrounding EoL wind power plants and PV systems concerning their disposal and their framing of it is not surprising and in actuality in alignment with their political identity. AfD is the first and only political party in the German Bundestag that questions climate change as a resulting from human activities. Furthermore, the AfD is against the EEG and the expansion of renewable energy sources due to the assumed high cost of the *Energiewende* and the destruction of nature and instead support coal and nuclear power as energy sources.

As interesting as it is to see who speaks about something and in what way, it is equally as interesting to think about who does not participate in the discussion of EoL management of wind turbines, PV panels and batteries and possible reasons why. Staying with political parties, the probably loudest silence was on the part of the Green party, especially before they became part of the German Federal government towards the end of 2021. For a political party whose flagship is environmental protection and sustainability, the lack of participating in the discussion surrounding the EoL management of these renewable energy technologies does strike me as odd.

The Greens initially non-existent and later small involvement could be explained by their desire to highlight the positive aspects of these energy sources on the environment instead of the ones that could be taken as (additional) negative impacts. Especially during a period in which renewables have faced bigger scrutiny and even opposition, displayed in the changes made to the EEG in 2015. The updated EEG set limits to the development of renewable energy sources for the first time in the history of the *Energiewende* by implementing expansion corridors as a response to the rising public resistance towards renewable installations and an overall dissatisfaction setting in with the progress of the energy transition as a whole. The reasoning of the Green party might have been that it is smarter to keep quiet about the potentially negative impacts of wind and solar energy on the environment to avoid giving further fuel to the fire.

Still, this did not stop other stakeholders' involvement in the debate, concretely associations and organizations that are active in climate action and environmental protection. They acknowledged the challenges attached to the dismantling, collection, recycling and disposal of solar systems and wind power plants whilst proposing measures on how to tackle said challenges in an environmentally friendly and efficient way, so they do not end up becoming the problem that other stakeholders make them out to be. Oftentimes arguing that although the economic implications of waste treatment methods should not be disregarded, their impact on environment and people should take precedence.

Invoking the frame of environmental and public health protection is done by them to point out the perceived flaws of the current EoL management to improve the ecological standard of wind and solar energy. These stakeholders aim to garner public and political support in order to receive the financial and legislative backing that is assumed to be needed to make the EoL management of the wind turbines and PV systems circular and thus sustainable. Admittedly, the environmental and public health protection frame is used by some stakeholders to make out wind power plants and solar installations as something harmful and even potentially dangerous to people and environment to criticizes the strong governmental support for renewables. Still, this is a minority and most stakeholders focus on the EoL management instead of using it as a way to question renewable energy sources and their true greenness.

In fact, this might be the very reason why a political actor like the Greens should partake in the conversation surrounding EoL management of wind power plants and solar systems. Convincing other stakeholders and the public that the noted weakness is no reason to not support them as a big part of a more sustainable (energy) future. On the contrary, the argumentation regarding the EoL management of these renewable energy sources could be that the already green technology has the opportunity to become even greener with higher quality management of PV panels, batteries and wind turbines.

This strategy was seemingly chosen by the wind and waste treatment industry like the German and European associations for wind energy or energy suppliers, all of whom stressing the as of now high ecological standard within the wind industry along with their desire and commitment to further increase the environmental friendliness of the industry. They actively call for support from political actors and other stakeholders to make their goals become achievable. Maybe the wind industry cannot allow themselves to remain quiet in this discussion because the public and political support is central for its acceptance and development. Yet, I argue that the Green party should not either as this topic is very closely linked to their political identity as an environmentalist political party. Hence, it could be interesting to conduct further research and potentially ask Members of the Green party about their position on EoL treatment of renewable energy technologies.

Generally, it stands out how actively and strongly the stakeholders within the wind industry participated in the conversation surrounding the EoL wind turbines and their management even compared to their counterparts in the PV and battery sector. My explanation for the discrepancy between the respective engagement of solar and wind industry is threefold, Firstly, the solar sector is not nearly as much criticized for its technologies possible negative impacts on the environment and people compared to wind power plants (e.g., wind turbines as cause for killed birds, noise pollution). As such, the recyclability of wind turbines or more accurately the current non-recyclability of CFRP rotor blades might be a welcome target for opponents of wind power plants. Thus, the wind industry must react more pronounced to counter the criticism leveled at them by opponents and sway public opinion in their favor.

Secondly, the existence of dangerous substances contained in PV panels and batteries made policymakers include PV panels in in the EU Directive WEEE and subsequently in its German transposition in the form of a revised Electrical and Electronic Equipment Act. Moreover, batteries have their own law in the Battery Act that regulates just as the Electrical and Electronic Equipment Act the collection for PV panels the collection and disposal of them. The harm that could result from the improper disposal of PV panels and batteries is seemingly more worrying to policymakers than dismantlement and disposal of wind turbines and the potential impacts on safety of people and environment when it is not done legitimately. Currently, there are only a few legally binding guidelines concerning the dismantling and disposal of wind turbines, one of which is the landfill ban. However, at the moment the landfill ban only applies to Germany and three EU member countries without a harmonized European legislation in place compared to PV panels. Thus, leaving a lot of room for possible loopholes and interpretation on behalf of the operators and waste treatment companies.

Thirdly, the perceived importance of the EoL management regarding wind turbines in comparison to EoL management of PV systems. In my opinion, how pressing the topic is perceived as by the different stakeholders involved plays a key role in the participation of and the framing itself. In the case of PV panels there is already a well or adequately functioning processing system in place, depending on the stakeholder that is currently and in the near future able to handle the expected waste volumes stemming from PV installations. In contrast, the not quite as regulated system for wind turbines, does not function well enough when it comes to the rotor blades according to many stakeholders with the notable exception of the German government. Particularly the expected rise of composite material waste, often described as 'wave' by various stakeholders that was predicted to appear in 2020 was of special concern.

Actually, the wave of waste did not emerge in 2020 and the years after it due to the extension of subsidization period for wind power plants who would have reached the end of the 20-year subsidization period set in the EEG by 2020. Yet, the point remains that the waste volumes stemming from EoL wind turbines are anticipated to starkly rise now in the very near future, making it seemingly more urgent than PV panel waste. For PV panels the argument could be that everyone involved is assured that there is still enough time between now and the time that EoL PV panels are estimated to significantly increase to develop and scale up the existing treatment system to make it more environmentally friendly and increase its capacity to handle the incoming waste stream, whereas this is questioned by some stakeholders in the case of wind turbines. Hence, the predicted time frames for the EoL management of wind turbines and EoL management of PV installations seemingly makes the former become more prominent in some stakeholder's minds.

Of course, this does not mean that there is no (significant) discussion surrounding the EoL treatment of PV installations or that stakeholders simply put it off as a future problem. The focus of wind industry actors just appears to be more on the extended manufacturer responsibility of PV panel disposal and its implications for the industry. They ask for stricter controls of the EoL PV panel management process from supervising authorities so the companies who fulfill their obligations of a proper and legal disposal are not at a disadvantage to those market actors who do not. The point made by these stakeholders is that the improper disposal of PV panels can not only be harmful to the environment and public health but also to the image of the industry.

More importantly, the perceived lack of control gives those companies who follow the law a competitive disadvantage to those companies that do not simply because the former has costs that the latter avoid with illegal disposals of PV panels. Still, just as with the EoL treatment of wind turbines, the focus lies heavily on the need for more or already undergoing research efforts and ensuing innovation. In actuality, the frame of ecological modernization is very prevalent in the articles and descriptions about EoL PV and battery treatment from policymakers and research institutes. Although the framing of old wind turbine management as a way for ecological modernization is also noticeable, it is mainly pushed by actors from the wind and waste treatment industry not as much by policymakers or research institutes. Comparatively to PV panels and battery there is a surprisingly small number of research projects conducted or funded by the policymakers for the development of recycling processes for composite materials. Most of the research efforts came from the wind industry itself and unlike PV panels and battery recycling in a lot of private-public partnerships.

Granted, the German Environment Agency conducted two studies on behalf of the German government that were about the state of affairs regarding the technological treatment methods, the economics and regulations of the dismantlement and disposal of EoL wind power plants. This was done to provide a detailed and knowledgeable and up to date overview over the management situation of EoL wind turbines at the moment and in the future. Furthermore, the study aimed to offer guidance for all stakeholders including wind operators, waste treatment companies and policymakers on good practice, challenges accompanying the treatment processes of EoL wind turbines and possible solutions. Yet, it does strike me as curious that the German government outright disagreed with one of the central findings of the study, namely the expectation of the emergence of funding gaps for the disposal of EoL wind turbines. Nevertheless, the wind industry seems to be the primary driver behind R&D into the recyclability of wind turbines whereas for PV systems it does appear to be a more collaborative between policymakers and industry actors.

This might be also the reason why the framing of old wind turbine management as cross-sectoral collaboration is done by stakeholders who are part of either the waste treatment or wind industry more than their counterparts in the PV and battery industry. Although the cross-sectoral collaboration frame is certainly part of the discussion surrounding EoL management of PV and batteries, it is more about showcasing the already undertaken efforts and the opportunities arising from the results. Or in other words, more about improving what is already there and what more can be accomplished. For stakeholders using the cross-sectoral frames for EoL wind turbines it is more focused on their desire for political support for their efforts in circularity in the form of public-partnerships and funding of R&D. However, most stakeholders in both the discussions regarding EoL PV systems and wind power plants argue for more cross-sectoral collaboration to between industry sector to really accomplish a circular economy. Still, the somewhat noticeable difference in political support for R&D concerning EoL treatment of PV systems compared to wind turbines makes me think.

One of the things that stood out to me during the search and data collection process was the amount of research projects and studies conducted on batteries that were focused on or attached to some form of e-mobility. The focus on battery recycling for the mobility sector might explain the interest of German policymakers in battery and subsequently PV system recycling. I think it is no secret that Germany is known for their cars and that the car industry is a very big and important of the German economy. Thus, the car industry and its lobby hold a lot of power, making them very influential when it comes to decision pertaining to topics connected to mobility and even climate change.

Therefore, it actually does not come as a surprise that a lot of research efforts are about tied to the mobility sector and about improving the performance and recyclability of batteries. As e-mobility becomes more significant as the assumed future of mobility, the automobile industry as well as policymakers have an interest in becoming leaders in e-mobility and maintain their economic standing and image for quality technology nationally and internationally. A possible reason why the ecological modernization frame is more prominently used in the debate about EoL PV and batteries than wind turbines. It is used by policymakers to frame their management as another opportunity for Germany's economy to grow creating a new market and acquire new expertise while simultaneously keep being a leader in the global automobile industry now and in the future.

Notably, the mobility sector is not only using batteries like PV systems but also composite materials that constitute the majority of the rotor blades from wind turbines. Something that is pointed out by wind and waste management alike. Even the German Energy Solutions Initiative mentions the presence of composite materials in the automobile, boat building and aviation industry. Yet, this does not seem to hold the same meaning as the usage and recyclability of batteries do. Maybe the apparent difference in perceived importance by policymakers and researchers can be explained by the resources used to build batteries and in turn the ability to recover them through high quality recycling, specifically the rare earth minerals. Hence, composite materials do not have quite the same scarceness attached to them as rare earth minerals do. Thus, composite materials might not drive innovation the same as rare earth minerals do because their scarcity is only going to increase with growing demand that is expected to occur due to the energy transition and their use in renewable energy technologies and infrastructure.

Furthermore, the frame that is the biggest difference between the discussion of EoL management of PV systems and wind turbines probably plays a key role in the regarded importance of rare earth minerals and in turn batteries: the energy security frame. A framed that on the one hand has not been used by any stakeholder so far for wind turbine EoL management but is featured quite apparently pushed by policymakers and research institutes when it came to PV systems and batteries. Again, the growing demand for rare earth minerals and the supply monopoly of a few countries over these minerals make it understandably that the German government and other stakeholders take an increased interest in the recovery and recycling of the rare earth minerals contained in batteries and PV systems.

The continuous access to rare earth minerals is central not only to the expansion of solar energy but also other technologies and products exemplified by the mobility sector. Ensuring that the supply of rare earth minerals is able to meet the demand is important for the industry, economy and society as disruptions to the supply could create bottlenecks and hinder the economical and sustainable development. These disruptions could be the result of a country putting economic or political pressure on Germany to hike up the price or to sway policymakers to change their position on a given issue.

A very recent example for the latter is Russia’s war in Ukraine and the ramifications of Germany’s political support for Ukraine on the country’s gas supply. For the longest time did Germany supply its Gas from Russia which drastically stopped with Russia’s war of aggression on Ukraine leading Germany to desperately search for new suppliers to better their quite precarious energy security when it comes to gas and ensure the gas supply throughout the winter and beyond.

Another recent example that severely disrupted global supply chains is the Covid-19 pandemic and the measures taken as a response. Even though it was not about economic or political leverage leading to supply issues and disruptions it showcases that sometimes unexpected circumstances can also become challenges or even threats to energy security. Admittedly these two examples are extreme ones but arguably because of their extremeness and recentness worth mentioning as it illustrates how fast things can evolve and have huge ramifications on something we have previously taken for granted. Thus, energy security has certainly moved up on the political agenda of the German government and other stakeholders when considering the current status quo, including the EoL treatment of PV panels and batteries. Consequently, the framing is now used more frequently in the discussion regarding EoL PV panels and batteries and it remains to be seen whether it is also picked up by stakeholders regarding the EoL management of wind turbines.

7. Conclusion

All in all, the EoL management of PV panels plus batteries and wind turbines is quite similar in terms of frames used and frame sponsors involved. So, what are the frames and their frame sponsors in the discussion regarding the management of EoL wind turbines? In short, several frame sponsors and frames can be detected. Specifically, German political parties, policymakers, industry actors from the wind plus the wase management industry, researchers and NGOs frame the discussion around EoL wind turbines by using either of these five frames, namely cross-sectoral collaboration, economic, environment and public health, ecological modernization and capacity.

What are the frames and their frame sponsors in the discussion regarding the management of EoL PV panels and batteries? Answering my second research questions leads to similar results. The environment and public health frame, ecological modernization frame, cross-sectoral collaboration frame, capacity frame, economic frame and energy security frame are utilized throughout the conversation about PV and batteries regarding their EoL treatment by stakeholders such as the national and international policymakers, research institutes, actors within the solar and waste treatment industries and NGOs.

Thus, what are the similarities and differences between wind turbine and PV panels plus batteries when it comes to the framing of their EoL management and the stakeholders' involvement in it? The answer to the third research question is that the only difference in framing between EoL wind turbines and EoL solar systems is the energy security frame that is only used by frame sponsors regarding PV panels and batteries EoL treatment and does not appear in the conversation surrounding EoL wind turbines. Hence, the other five frames displayed/ featured in this thesis are framing both the management of old wind turbines and solar systems. Still, there are noticeable differences regarding the statements, arguments and opinions that are framed by either of the five frames: capacity, economic, cross-sectoral collaboration, environment and public health protection and ecological modernization.

Depending on the energy technology various aspects can be highlighted by a given frame that might apply to EoL wind turbines but not to EoL PV panels and batteries or at least not to the same extent and vice versa. Consequently, frames do deviate for the management of EoL solar systems and EoL wind power plants although it is not the frames themselves and more their content and usage.

These variations can be attributed to the stakeholders who are involved in the discussions regarding the EoL management of PV panels, batteries and wind turbines as frame sponsors that utilize frames to illustrate and argue their position or point on the matter with the goal to garner or grow support in the public and other stakeholders. Hence, some stakeholders adopt a frame to spotlight a perceived issue or problem of the EoL treatment of solar systems or wind turbines whilst others choose the same frame to dissuade or counter arguments of another stakeholder. Of course, not all framing is done to counteract another stakeholder but primarily about directing the conversation in their favor and gaining public, industry and/or political support.

Therefore, the frames for capacity, economic and cross-collaboration are more prominent for wind turbines because numerous stakeholders from the wind industry, waste treatment industry, political parties and researchers are focused on the perceived challenges associated with wind turbine waste, composite material waste that is expected to increase significantly and what to do about it immediately. The current capacities and knowledge are in the foreground with several actors pointing towards recyclability, treatment routes and financial implications of EoL wind turbines. Besides, future actions and requirements to improve EoL management of wind turbines are presented and argued for.

However, the immediate and near future seems to be prioritised instead of all the research and market possibilities. For PV panels and batteries, it appears to be almost the opposite compared to wind turbines. Even though the waste treatment infrastructure is discussed by quite a few stakeholders, it is used more as a starting point for the future, which can be achieved through desirable developments that are supposed to heighten the sustainability, profitability, and resilience of the solar sector, explaining the utilization of the ecological modernization and environment and public safety frame. Again, as pointed out previously these two frames can also be found for EoL management of wind turbines but not as pronounced.

The immediacy of increased waste volumes from EoL wind turbines and the perceived (lack of) engagement as well as on the part of the policymakers are probably the two biggest reasons for the frames used as well as the way they are applied by stakeholders when it comes to EoL wind turbine management. In the case of PV panels and batteries, it is the perceived remoteness of significant waste volumes arising from EoL solar systems, their material components (rare earth minerals) and the involvement of policymakers that are the biggest influences on the framing of EoL battery and PV panel management.

Generally, the dismantlement and disposal of wind turbines and solar systems are closely embedded in the *Energiewende* and at times appear to be swallowed by it. The prioritization of the development of renewable energy sources before their EoL management on the part of policymakers and other stakeholders is noticeable in the discussion surrounding the EoL treatment of PV panels, batteries and wind turbines. As a result, performance and expansion of these renewable energy sources still takes precedence over their recyclability with stakeholders only starting to rethink their design considerations towards more sustainability.

An often-referenced goal by industry actors is circularity which is in alignment with the EU and their Circular economy action plan. Aside from the goal of circularity, the green image of the solar and wind energy is a strong motivator for the wind and solar industry to improve the sustainability of wind turbines and PV systems with a higher quality management of EoL products.

Yet, to achieve these industry as well as political goals of more sustainability and circularity in the energy industry and economy, various stakeholders ask for more political support in the form of funding and legally binding regulations that policymakers are only partially inclined to give. The status quo, at least concerning current legislation pertaining to the disposal of EoL wind turbines, PV panels and batteries, is regarded by the German government as completely sufficient, meaning there have been no changes or additions to the regulations that are at the moment in place despite growing importance of the topic.

Consequently, the answer to my fourth research question – how do the frames and frame sponsors influence the policy making process regarding the EoL management of wind turbines, PV panels and batteries? – is the conclusion that so far the governmental actors have held onto the status quo and in turn the non-governmental actors have not (yet) managed to influence the policy making process in a noticeable way when it comes to the implementation of new policies, regulations and legislation.

In my thesis I took a thorough look at the frames and the frame sponsors participating in discussion regarding the EoL management of wind turbines, PV panels and batteries in Germany. I was able to identify six frames that were prominently in either one or both conversations concerning these energy technologies and attempted to them as well as their frame sponsors engagement. Through spotlighting the framing of the EoL treatment of wind power plants and solar systems I not only manage to expand the knowledge on this topic but also gave small insights into how the *Energiewende* affects the framing and actions of stakeholders, specifically the German government. The results of my analysis illustrate and explain the similarities and differences in framing and frame sponsors between these two renewable energy sources and their EoL management and can be used to look into and compare other energy sources and their EoL treatment in Germany.

7.1 Limitations of my thesis

Yet, I must acknowledge the limitations of my research, beginning with the scope. As a result of my inductive and qualitative approach paired with manual coding meant that I could not include every available data source and frame that I found throughout my search and analysis. Therefore, I had to implement criteria that reduced the number of sources to a manageable size without threatening the integrity and research quality of my thesis. Still, I had to make informed choices based on what I wanted to further explore and in turn focus on. One of these choices included the restraint regarding the search terms I worked with to collect my data. Using only these search terms meant that other possible sources that have their spotlight on something other than waste or EoL management and recycling are not included. Thus, the possibility that there could be other stakeholders and other frames from the ones I have included in my thesis does exist.

Additionally, I could only include the most prominent frames for EoL management of wind turbines and EoL solar system in my thesis due to the scope of a master thesis. As a result, there are frames that appear in the discussion surrounding EoL wind turbines and EoL PV panels and batteries which I could not include. Generally, there will be always frames that I could not consider in my thesis as the potential sources on this topic is growing with the continuous publications of new articles and so on. Thus, completeness can never be truly achieved as even the most up to date research can already be slightly outdated by the time it is finished and gets published. Nevertheless, it is important to point out that this is not a complete representation of all the frames and frame sponsor involved in the conversation about EoL treatment of these renewable energy technologies.

Furthermore, my choice to not have any primary data for my research meant that there are some (in my opinion) prominent stakeholders that are not considered as they have no contribution to the discussion. Even though absence or more accurately silence also allows for insights it might be interesting or useful to include primary data like interviews to gain further knowledge on what they have to say about the topic of EoL management of renewable energy sources. This also includes public opinion which is not considered in this thesis but plays an important role when it comes to the acceptance of renewable energy technologies and the *Energiewende* as a whole.

7.2 Further research prospects

Hence, it could be beneficial to look further into the topic by expanding the scope of my thesis by the inclusion of other search terms, data and frames for the EoL management of PV panels, batteries and wind turbines. Furthermore, it might be interesting to continue to follow the framing of EoL wind turbines, PV panels and batteries to examine whether or not there are significant changes to it going forwards under the current government coalition consisting of SPD, FDP and the Greens when they have more time in power than the one year that I could include. Particularly, because the Green party was one of the prominent stakeholders that was surprisingly absent from the discussion on EoL treatment of wind power plants and solar systems. Therefore, it might be possible to capture the framing of the Green party without having to conduct interviews with members of the Greens. Even though, I still think it would be an interesting research prospect to build upon my research and specifically approach the stakeholders that were not included due to their silence on the issue.

Also, the exploration of other stakeholders that were not included because I chose to focus on others e.g. the public offers great research prospects. It would be compelling to explore the framing effects on the public regarding the EoL management of wind power plants and solar systems or even solely conduct a study on their attitude or frames towards the topic as the public voice or voices is missing in my thesis.

Furthermore, it might be useful for further research to widen the scope and take a closer look at the EU than I have done in my thesis as German legislation and policies are deeply linked with rules and regulations from the EU. Thus, a more detailed EU context might deliver new insights regarding the involvement and framing of policymakers concerning EoL wind turbines and PV systems that I did not reach because I foremost focused on Germany.

Moreover, the expansion towards other renewable and non-renewable energy sources would allow for a more comprehensive knowledge on how energy sources are framed in general, renewables in particular and the differences and similarities between the two. Additionally, further research on the framing of batteries related to their use, for example for solar systems compared to e-mobility could shed light on how different industries potentially result in different or similar framings.

8. References

Appunn, K. (2014, October 7). Comparing old and new: Changes to Germany's Renewable Energy Act. *Clean Energy Wire*. https://www.cleanenergywire.org/factsheets/comparing-old-and-new-changes-germanys-renewable-energy-act

Axians eWaste. (2022, March 31). Die richtige Entsorgung von ausgedienten Solaranlagen [The correct disposal of disused solar systems]. *Axians eWaste*. https://www.axians-ewaste.com/blog_entry/entsorgung-von-solaranlagen/

Bareiß,T. (2018). *Kontrolle und Entsorgung von Windkrafträdern: Kleine Anfrage der Abgeordneten Oliver Luksic, Karlheinz Busen, Frank Sitta, u. a. der Fraktion FDP* [Inspection and disposal of wind turbines: Small question from MPs Oliver Luksic, Karlheinz Busen, Frank Sitta, and others the FDP parliamentary group]. Retrieved from https://www.bmwk.de/Redaktion/DE/Parlamentarische-Anfragen/2018/19-3619.html

Beck, C., & Kosnik, C. (2006). *Innovations in Teacher Education : A Social Constructivist Approach*. State University of New York Press.

Berger, R. (2015), Now I see it, now I don't: researcher's position and reflexivity in qualitative research. *Qualitative Research, 15*(2), 219–234. https://doi.org/10.1177/1468794112468475

Blaikie, N., & Priest, J. (2019). *Designing Social Research*. (3rd ed.). Polity Press.

Borah, P. (2011). Conceptual Issues in Framing Theory: A Systematic Examination of a Decade's Literature. *Journal of Communication, 61*(2), 246–263. https://doi.org/10.1111/j.1460-2466.2011.01539.x

Borden, E., & Stonington, J. (2014). Germany's Energiewende. In W. W. Clark (Ed.), *Global Sustainable Communities Handbook: Green Design Technologies and Economics* (pp. 369-386). Elsevier Inc. https://doi.org/10.1016/B978-0-12-397914-8.00015-1

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative research in sport, exercise and health, 11*(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806

Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative psychology (Washington, D.C.), 9*(1), 3-26. https://doi.org/10.1037/qup0000196

Bundesgerichtshof. (2014, July 21). *Gesetz zur grundlegenden Reform des Erneuerbare-Energien-Gesetzes und zur Änderung weiterer Bestimmungen des Energiewirtschaftsrechts* [Law on the fundamental reform of the Renewable Energy Sources Act and on changing other provisions of the energy industry]. Bundesgerichtshof. https://www.bundesgerichtshof.de/DE/Bibliothek/GesMat/WP18/E/EEG-Reform.html

Bundesministerium für Wirtschaft und Energie. (2017, August 11). *EEG 17 – Fragen und Antworten*. Bundesministerium für Wirtschaft und Klimaschutz. https://www.bmwk.de/Redaktion/DE/Downloads/E/eeg-2017-fragen-und-antworten.pdf?__blob=publicationFile&v=20

Bundesministerium für Wirtschaft und Klimaschutz. (2021, January, 01). *Gesetz zur Änderung des Erneuerbare-Energien-Gesetzes und weiterer energierechtlicher Vorschriften: Gesetzesnetwurf der Bundesregierung* [Law to amend the Renewable Energy Sources Act and other energy regulations: Draft law by the federal government]. Bundesministerium für Wirtschaft und Klimaschutz. https://www.bmwk.de/Redaktion/DE/Artikel/Service/gesetz-zur-aenderung-des-eeg-und-weiterer-energierechtlicher-vorschriften.html

Bundesministerium für Wirtschaft und Klimaschutz. (2022a). *Faktencheck: Vorurteile gegenüber der Windenergie* [Fact check: prejudices against wind energy]. Bundesministerium für Wirtschaft und Klimaschutz. https://www.bmwk.de/Redaktion/DE/FAQ/Windenergie/faq-windenergie.html

Bundesministerium für Wirtschaft und Klimaschutz. (2022b, April 06). *Überblickspapier Osterpaket*. [Easter package overview paper]. Bundesministerium für Wirtschaft und Klimaschutz. https://www.bmwk.de/Redaktion/DE/Downloads/Energie/0406_ueberblickspapier_osterpaket.html

Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz. (2016). *Climate Action Plan 2050: Principles and goals of the German government's climate policy* [Brochure].

https://www.bmuv.de/publikation?tx_bmubpublications_publications%5Bpublication%5D=395&cHash=f466358edeae98c23d7c3c5ff4350ccc

Busch, T., & Judick, L. (2021). Climate change—that is not real! A comparative analysis of climate-sceptic think tanks in the USA and Germany. *Climatic change*, *164*(1-2). https://doi.org/10.1007/s10584-021-02962-z

CDU. (2023). *Koalitionsvertrag von CDU, CSU und SPD.* [Coalition agreement between the CDU, CSU and SPD]. Christlich Demokratische Union Deutschlands. https://archiv.cdu.de/koalitionsvertrag-2018

Cheung, G., Davies, P. J., & Bassen, A. (2019). In the transition of energy systems: What lessons can be learnt from the German achievement? *Energy Policy*, *132*, 633–646. https://doi.org/10.1016/j.enpol.2019.05.056

Chong, D., & Druckman, J. N. (2007). A theory of framing and opinion formation in competitive elite environments. *Journal of Communication*, *57*(1), 99–118. https://doi.org/10.1111/j.1460-2466.2006.00331.x

Chowdhury, M. S., Rahman, K. S., Chowdhury, T., Nuthammachot, N., Techato, K., Akhtaruzzaman, M., Tiong, S. K., Sopian, K., & Amin, N. (2020). An overview of solar photovoltaic panels' end-of-life material recycling. *Energy Strategy Reviews*, *27,* 100431 https://doi.org/10.1016/j.esr.2019.100431

Clarke, V., & Braun, V. (2017). Thematic analysis. *The journal of positive psychology*, *12*(3), 297-298. https://doi.org/10.1080/17439760.2016.1262613

Cooperman, A., Eberle, A., & Lantz, E. (2021). Wind turbine blade material in the United States: Quantities, costs, and end-of-life options. *Resources, Conservation and Recycling*, *168*, 105439. https://doi.org/10.1016/j.resconrec.2021.105439

Cunningham, T. (2018). ENERGIEWENDE: FROM GERMANY'S PAST TO EUROPE'S FUTURE? In T. Cunningham, A. Hedberg, S. Nazakat, & L. Yao (Eds), *ASSESSING THE ENERGIEWENDE: AN INTERNATIONAL EXPERT REVIEW* (pp. 5–9). Konrad Adenauer Stiftung. http://www.jstor.org/stable/resrep17543.4

Danermark, B., Ekström, M., & Jakobsen, L. (2002). *Explaining Society: An Introduction to Critical Realism in the Social Sciences*. Routledge.

Dehmer, D. (2013). The German Energiewende: The First Year. *Electricity Journal*, *26*(1), 71-78. https://doi.org/ 10.1016/j.tej.2012.12.001

Deutscher Bundestag. (2011). *Die Beschlüsse des Bundestages am 30. Juni und 1. Juli* [The enactments of the German parliament from 30. June and 1. July]. Deutscher Bundestag. https://www.bundestag.de/webarchiv/textarchiv/2011/34915890_kw26_angenommen_abgelehnt-205788

Deutscher Bundestag. (2020). *Windenergieanlagen: Rückbau, Recycling und Ökobilanzierung* [Wind turbines: dismantling, recycling and life cycle assessment]. Retrieved from https://www.bundestag.de/resource/blob/706672/83a3afbadfcc0134c053a14f1be859ab/WD-8-028-20-pdf-data.pdf

Deutscher Bundestag. (2021). *Förderung von Recycling-Lösungen und Recycling-Firmen zur Eindämmung des anfallenden Sondermülls durch ausgediente Windkraftrotorblätter: Kleine Anfrage der Abgeordneten Enrico Komning, Steffen Kotré, Tino Chrupalla, Leif-Erik Holm, Dr. Heiko Heßenkemper, Hansjörg Müller, Marc Bernhard, Andreas Bleck, Karsten Hilse, Dr. Rainer Kraft, Dr. Heiko Wildberg und der Fraktion der AfD* [Promote recycling solutions and recycling companies to curb the accumulating hazardous waste from worn-out wind turbine rotor blades: Small question from MPs Enrico Komning, Steffen Kotré, Tino Chrupalla, Leif-Erik Holm, Dr. Heiko Heßenkemper, Hansjörg Müller, Marc Bernhard, Andreas Bleck, Karsten Hilse, Dr. Rainer Kraft, Dr. Heiko Wildberg and the AfD]. Retrieved from https://www.bundestag.de/presse/hib/822882-822882

Deutscher Bundestag. (2022). *„Osterpaket" zum Ausbau erneuerbarer Energien beraten* [„Easter package" for the development of renewable energies deliberated]. Deutscher Bundestag. https://www.bundestag.de/dokumente/textarchiv/2022/kw19-de-erneuerbare-energien-891870

Deutsche Umwelthilfe. (2021, March 10). *Kreislaufwirtschaft in der Solarbranche stärken* [Strengthening circularity in photovoltaics]. Deutsche Umwelthilfe. https://www.duh.de/projekte/pv-recycling/

Die Bundesregierung, (2023). *Koalitionsvertrag zwischen SPD, Bündnis 90/Die Grünen und FDP*. [Coalition agreement between SPD, Bündnis 90/Die Grünen and FDP]. Presse- und Informationsamt der Bundesregierung. https://www.bundesregierung.de/breg-de/service/gesetzesvorhaben/koalitionsvertrag-2021-1990800
Dinkloh, P. (2014). EEG 2.0 – A new legal framework for the German energy transition. *Clean Energy Wire*. https://www.cleanenergywire.org/dossiers/eeg-20-new-legal-framework-german-energy-transition-0
Directorate-General for Environment. (2023a). *Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)*. European Union. https://environment.ec.europa.eu/topics/waste-and-recycling/rohs-directive_en
Directorate-General for Environment. (2023b). *Circular economy action plan*. European Union. https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en
Dodgson, J. E. (2019). Reflexivity in Qualitative Research. *Journal of Human Lactation*, *35*(2), 220-222. https://doi.org/10.1177/0890334419830990
Dold, P. (2022, March 18). *Photovoltaics World Recycling Day: Recycled silicon for new solar cells*. Strom-Forschung. https://www.strom-forschung.de/news/2022/world-recycling-day-recycled-silicon-for-new-solar-cells
Donner, S. (2021, September 27). Aus der Puste [Out of breath]. *fluter*. https://www.fluter.de/recycling-wie-viel-muell-machen-windraeder
Druckman, J. N. (2001). The Implications of Framing Effects for Citizen Competence. *Political behavior, 23*(3), 225-256. https://doi.org/10.1023/A:1015006907312
EnBW. (2021, November 04). *Wie werden eigentlich Windkraftanlagen recycelt?* [How are wind turbines actually recycelt?]. EnBW. https://www.enbw.com/unternehmen/eco-journal/wie-werden-windkraftanlagen-recycelt.html
en:former. (2020, April 28). Ausrangiert: Wie entsorgt man 42.000 Rotorblätter? [Discarded: How do you dispose of 42,000 rotor blades?]. *en:former*. https://www.en-former.com/ausrangiert-wie-entsorgt-man-42-000-rotorblaetter/
Entman, R. M. (1993). Framing: Toward Clarification of a Fractured Paradigm. *Journal of Communication*, 43(4), 51-58. https://doi-org.ezproxy.uis.no/10.1111/j.1460-2466.1993.tb01304.x
Espinosa, P. (2021, October 31). *Remarks by UNFCCC Executive Secretary Patricia Espinosa to open COP26*. UNFCCC. https://unfccc.int/news/remarks-by-unfccc-executive-secretary-patricia-espinosa-to-open-cop26
EU Publications Office. (2018, October 16). *Recycling of photovoltaic waste boosts circular economy*. European Union. https://cordis.europa.eu/article/id/240250-recycling-of-photovoltaic-waste-boosts-circular-economy
EU Publications Office. (2021, April 14). *Circular economy innovations for industrial and urban waste management*. European Union. https://cordis.europa.eu/article/id/411500-circular-economy-innovations-for-industrial-and-urban-waste-management
EU Publications Office. (2022a, February 09). *Demonstrating circular economy business models in the solar power sector*. European Union. https://cordis.europa.eu/article/id/435688-demonstrating-circular-economy-business-models-in-the-solar-power-sector
EU Publications Office. (2022b, August 09). *Implementation of a CirculAr economy Based on Recycled, reused and recovered Indium, Silicon and Silver materials for photovoltaic and other applications: Fact Sheet*. European Union. https://cordis.europa.eu/project/id/641972
EU Publications Office. (2022c, December 02). *PHOtovoltaic waste management- advanced Technologies for recovery and recycling of secondary RAw Materials from end-of-life-modules: Fact Sheet*. European Union. https://cordis.europa.eu/project/id/958223
European Commission. (2019, April 09). REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the implementation and the impact on the environment and the functioning of the internal market of Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC. Retrieved from https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52019DC0166

European Commission. (2020, December 10). *Green Deal: Sustainable batteries for a circular and climate neutral economy* [Press release]. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2312

European Commission. (2022, December 09). *Green Deal: EU agrees new law on more sustainable and circular batteries to support EU's energy transition and competitive industry* [Press release]. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_7588

European Commission, Directorate-General for Environment, & BIO Intelligence Service. (2013). *STUDY ON PHOTOVOLTAIC PANELS SUPPLEMENTING THE IMPACT ASSESSMENT FOR A RECAST OF THE WEEE DIRECTIVE*. European Union. https://op.europa.eu/en/publication-detail/-/publication/944769fa-6545-41c1-8d1f-de5f2061c3c0

European Commission, Directorate-General for Research and Innovation, Velte, D., Kuittinen, H. (2018). *Mission-oriented R&I policies: in-depth case studies: Energiewende (Germany): case study report*. European Union. https://data.europa.eu/doi/10.2777/835267

European Environment Agency. (2021). *Emerging waste streams: Opportunities and challenges of the clean-energy transition from a circular economy perspective.* European Union. https://www.eea.europa.eu/publications/emerging-waste-streams-opportunities-and

Farrell, C. C., Osman, A. I., Doherty, R., Saad, M., Zhang, X., Murphy, A., Harrison, J., Vennard, A. S. M., Kumaravel, V., Al-Muhtaseb, A. H., & Rooney, D. W. (2020). Technical challenges and opportunities in realising a circular economy for waste photovoltaic modules. *Renewable & sustainable energy reviews*, *128*, 109911. https://doi.org/10.1016/j.rser.2020.109911

Federal Ministry for Economic Affairs and Energy. (2021) *Renewable Energy*. Federal Ministry for Economic affairs and Energy. https://www.bmwk.de/Redaktion/EN/Dossier/renewable-energy.html

Federal Ministry for Economic Affairs and Climate Action. (2023). *The next phase of the energy transition: The 2017 Renewable Energy Sources Act*. Federal Ministry for Ecnomic Affairs and Climate Action. https://www.bmwk.de/Redaktion/EN/Artikel/Energy/res-2017.html

Feicht, A. (2020). *Rückbau und Entsorgung von Windrädern: Kleine Anfrage der Abgeordneten Leif-Erik Holm, Tino Chrupalla, Dr. Heiko Heßenkemper, weiterer Abgeordneter und der Fraktion der AfD* [Dismantling and disposal of wind turbines: small question from MPs Leif-Erik Holm, Tino Chrupalla, Dr. Heiko Hessenkemper, another member of parliament and the AfD parliamentary grou]. Retrieved from https://www.bmwk.de/Redaktion/DE/Parlamentarische-Anfragen/2020/19-16796.pdf?__blob=publicationFile&v=2

Feicht, A. (2021). *Rückbaukosten von Windkraftanlagen: Schriftliche Frage an die Bundesregierung im Monat August 2021 Frage Nr. 543* [Dismantling costs of wind turbines: Written question to the federal government in August 2021, question no. 543]. Retrieved from https://www.ingrid-nestle.de/wp-content/uploads/2021/09/21-09-07-Rueckbaukoste-von-Windkraftanlagen.pdf

Fraunhofer. (2020, March 02). *Intelligently recovering and recycling balsa wood* [Press release]. https://www.fraunhofer.de/en/press/research-news/2020/march/intelligently-recovering-and-recycling-balsa-wood.html

Fraunhofer CSP. (2023). *PERC Solar Cells from 100 Percent Recycled Silicon*. Fraunhofer CSP. https://www.csp.fraunhofer.de/en/areas-of-research/pv-recycling-crystallization.html

Fraunhofer IKTS. (2021, February 02). *Green battery technology: Fraunhofer IKTS opens new site in Freiberg* [Press release]. https://www.ikts.fraunhofer.de/en/press_media/press_releases/2021_2_2_p_green_battery_technology_fraunhofer_ikts_opens_new_site_in_freiberg.html

Fraunhofer ISE. (2022, February 07). *PERC Solar Cells from 100 Percent Recycled Silicon* [Press release]. https://www.ise.fraunhofer.de/en/press-media/press-releases/2022/solar-cells-from-recycled-silicon.html

Fraunhofer IWES. (2022, April 06). *Fraunhofer IWES entwickelt konkrete Konzepte fürs Rotorblatt-Recycling* [Fraunhofer IWES develops concrete concepts for rotor blade recycling][Press release]. https://www.iwes.fraunhofer.de/de/presse/nachhaltig-wirtschaften-und-entsorgen--fraunhofer-iwes-entwickel.html

Fraunhofer UMSICHT. (2023). *Ökobilanz: Was beim Recycling ausgedienter Solarzellen zu beachten ist* [Life Cycle Assessment: What to consider when recycling used solar cells]. Fraunhofer

UMSICHT. https://www.umsicht.fraunhofer.de/de/projekte/entsorgung-photovoltaik-backsheets.html
Gamson, W. A., & Modigliani, A. (1989). Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach. *The American journal of sociology*, *95*(1), 1-37. https://doi.org/10.1086/229213
German Energy Solutions Initiative. (2019, October 17). German know-how leads to more sustainable redox-flow battery storage systems. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2019/20191017-re3dox.html
German Energy Solutions Initiative. (2020a, March 23). New life for old wind turbines *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2020/20200323-new-life.html
German Energy Solutions Initiative. (2020b, September 14). Old batteries transformed into new. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220914-old-batteries-into-new.html
German Energy Solutions Initiative. (2021a, February 09). State-of-the-art facility for green battery technology. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2021/20210209-green-battery-technology.html
German Energy Solutions Initiative. (2021b, May 05). Building the foundation for more sustainable electric batteries. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2021/20210505-electric-batteries-foundation.html
German Energy Solutions Initiative. (2022a, February 16). Large-scale recycling of silicon from old solar panels. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220216-large-scale-recycling-old-solar.html
German Energy Solutions Initiative. (2022b, July 13). Breakthrough for photovoltaic system recycling. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220713-pv-recycling.html
German Energy Solutions Initiative. (2022c, August 10). German North Sea windfarm has world's first recyclable blades. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220810-recyclable-wind-turbines-blades.html
German Energy Solutions Initiative. (2022d, September 21). Reactivating graphite and critical metals from batteries. *Federal Ministry for Economic Affair and Climate Action*. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220921-reactivating-critical-metals.html
Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.
Guachalla, A. (2018). Perception and experience of urban areas for cultural tourism: A social constructivist approach in Covent Garden. *Tourism and Hospitality Research*, *18*(3), 297-308. https://doi.org/10.1177/1467358416646820
Guterres, A. (2022, November 07). *To Reach Climate Goals Humanity Must Cooperate or Perish, Secretary-General Warns, Calling for Solidarity Pact among All Nations, at Implementation Summit Opening* [Press release]. https://press.un.org/en/2022/sgsm21573.doc.htm
Hagedorn. (2020, December, 17). *Windräder verdienen eine grüne Entsorgung* [Wind turbines deserve a green disposal][Press release]. https://www.unternehmensgruppe-hagedorn.de/aktuelles/news/windraeder-verdienen-eine-gruene-entsorgung
Hake, J. F., Fischer, W., Venghaus, S., & Weckenbrock, C. (2015). The German Energiewende – History and status quo. *Energy*, *92*, 532-546. https://doi.org/ 10.1016/j.energy.2015.04.027
Hedberg, A. (2018). GERMANY'S ENERGY TRANSITION: FROM A VISION TO A STRATEGY. In T. Cunningham, A. Hedberg, S. Nazakat, & L. Yao (Eds), *ASSESSING THE ENERGIEWENDE: AN INTERNATIONAL EXPERT REVIEW* (pp.10-15). Konrad Adenauer Stiftung. http://www.jstor.org/stable/resrep17543.5
Henkel, J., & Böhme, M. (2019, November 27). *Abriss und Recycling alter Windräder als Herausforderung für die Branche* [Demolition and recycling of old wind turbines as a

challenge for the industry]. TaylorWessing. https://www.taylorwessing.com/de/insights-and-events/insights/2019/11/abriss-und-recycling-alter-windrder-als-herausforderung-fr-die-branche

Hocine, L., & Mounia Samira, K. (2019). Optimal PV panel's end-life assessment based on the supervision of their own aging evolution and waste management forecasting. *Solar Energy, 191*, 227-234. https://doi.org/10.1016/j.solener.2019.08.058

Hörstmann-Jungemann, P. (2016, March 01). *Entsorgung von Altmodulen* [Disposal of old modules]. Solarenergie Förderverin Deutschland E.V. https://www.sfv.de/artikel/entsorgung_von_altmodulen

IRENA. (2017). *Turning to Renewables: Climate-Safe Energy Solutions*. International Renewable Energy Agency. Retrieved from https://irena.org/publications/2017/Nov/Turning-to-renewables-Climate-safe-energy-solutions

Joas, F., Pahle, M., Flachsland, C., & Joas, A. (2016) Which goals are driving the Energiewende? Making sense of the German Energy Transformation. *Energy Policy, 95*, 42-51. https://doi.org/10.1016/j.enpol.2016.04.003

Karlsruhe Institute of Technology. (2022, September 01). *Recycling Materials: Turning Old Batteries into New Ones* [Press release]. https://www.kit.edu/kit/english/pi_2022_077_recycling-materials-turning-old-batteries-into-new-ones.php

Kaufmann, D. (2021, November 17). Wie nachhaltig können Windmühlenflügel sein? [How sustainable wind turbine blades be?]. *DW*. https://www.dw.com/de/wie-nachhaltig-k%C3%B6nnen-windm%C3%BChlenfl%C3%BCgel-sein/a-59815935

Knowledge Centre for Biodiversity. (2022, November 14*). Solar photovoltaic, wind, hydropower and other renewable energy sources*. European Union. https://knowledge4policy.ec.europa.eu/biodiversity/solar-photovoltaic-wind-hydropower-other-renewable-energy-sources_en

Kreibe, S., Berkmüller, R., Förster, A., Peche, R., Reinelt, B., Krupp, M., Röder, S., & Schleifenbaum, M. (2020, October). *ILESA – Smart steering of waste streams containing precious and minor metals: pooling, temporary storage, recovery rate*. Retrieved from https://www.umweltbundesamt.de/en/publikationen/ilesa-smart-steering-of-waste-streams-containing

Kroll, J. & Szombathy, M. (2022, June 01). Interview: „Wir sehen GFK als Rohstoff und wollen daraus wieder was machen“ [Interview: “We see GFRP as a raw material and want to make something out of it again”]. *EU-Recycling*. https://eu-recycling.com/Archive/35693

Kwan, S. (2009). Framing the Fat Body: Contested Meanings between Government, Activists, and Industry. *Sociological inquiry*, *79*(1), 25-50. https://doi.org/ 10.1111/j.1475-g682X.2008.00271.x

Landtag Nordrhein-Westfalen. (2019). *Müll der Zukunft – Was geschieht mit alten Photovoltaik-Anlagen?: Antwort der Landesregierung auf die Kleine Anfrage 297 vom 5. September 2019 des Abgeordneten Dr. Christian Blex AfD* [Garbage of the future – What happens to old photovoltaic systems?: The state government's response to the small question 297 of September 5, 2019 by MP Dr. Christian Blex AfD]. Retrieved from https://afd-fraktion.nrw/2019/09/05/muell-der-zukunft-was-geschieht-mit-alten-photovoltaik-anlagen/

Lefeuvre, A., Garnier, S., Jacquemin, L., Pillain, B., & Sonnemann, G. (2019). Anticipating in-use stocks of carbon fibre reinforced polymers and related waste generated by the wind power sector until 2050. *Resources, conservation and recycling*, *141*, 30-39. https://doi.org/10.1016/j.resconrec.2018.10.008

Lichtenegger, G., Rentizelas, A. A., Trivyza, N., & Siegl, S. (2020). Offshore and onshore wind turbine blade waste material forecast at a regional level in Europe until 2050. *Waste Management*, *106,* 120–131. https://doi.org/10.1016/j.wasman.2020.03.018

Liu, P. Meng, F., & Barlow, C.Y. (2022). Wind turbine blade end-of-life options: An economic comparison. *Resources, Conservation and Recycling*, *180*, 106202. https://doi.org/10.1016/j.resconrec.2022.106202

Mahmoudi, S., Huda, N., & Behnia, M. (2021). Critical assessment of renewable energy waste generation in OECD countries: Decommissioned PV panels. *Resources, Conservation and Recycling*, *164,* 105145. https://doi.org/10.1016/j.resconrec.2020.105145

Matthes, F.C. (2017). Energy transition in Germany: a case study on a policy-driven structural change of the energy system. *Evolutionary and Institutional Economics Review*, *14*(1), 141–169. https://doi.org/10.1007/s40844-016-0066-x

Meyer, I. (2018, April 16). Recycling: Die Module müssen vom Dach – und nun? [Recycling: The modules have to be removed from the roof – now what?]. *IBC Solar Blog*. https://www.ibc-blog.de/2018/04/recycling-die-module-muessen-vom-dach-und-nun/

Morales-López, E. (2017). Epilogue. In E. Morales-López & A. Floyd (Eds.), *Developing New Identities in Social Conflicts : Constructivist Perspectives* (pp. 273-284). John Benjamins Publishing Company. http://ebookcentral.proquest.com/lib/uisbib/detail.action?docID=4983485

Morgenstern, T. (2021, August 03). Windkraft aus nachhaltig erbauten Anlagen [Wind power from sustainably built plants]. *nD*. https://www.nd-aktuell.de/artikel/1155200.recycling-bei-windraedern-windkraft-aus-nachhaltig-erbauten-anlagen.html

Morris, C. (2014). Germany's Energiewende: Community-Driven Since the 1970s. In W. W. Clark, *Global Sustainable Communities Handbook: Green Design Technologies and Economics* (pp. 105–113). Elsevier Inc. https://doi.org/10.1016/B978-0-12-397914-8.00007-2

Myburgh, S., & Tammaro, A. M., (2013). *Exploring Education for Digital Librarians: Meaning, Modes and Models.* Chandos Publishing.

Nazakat, S. (2018). GERMANY'S ENERGY TRANSFORMATION: IT'S NOT EASY BEING GREEN. In T. Cunningham, A. Hedberg, S. Nazakat, & L. Yao (Eds), *ASSESSING THE ENERGIEWENDE: AN INTERNATIONAL EXPERT REVIEW* (pp.16-17). Konrad Adenauer Stiftung. http://www.jstor.org/stable/resrep17543.6

Nestler, R. (2021, April 05). Recycling alter Windkraftanlagen: Wie die Mühlen zermahlen werden [Recycling old wind turbines: How the mills are ground]. *TAGESSPIEGEL*. https://www.tagesspiegel.de/wissen/wie-die-muhlen-zermahlen-werden-5743318.html

Office of Nuclear. (2022, May 4). *5 Facts to Know About Three Miles Island*. Office of Nuclear. https://www.energy.gov/ne/articles/5-facts-know-about-three-mile-island

Ohlhorst, D. (2015). Germany's energy transition policy between national targets and decentralized responsibilities. *Journal of Integrative Environmental Sciences*, *12*(4), 303–322. https://doi.org/10.1080/1943815X.2015.1125373

Oteng, D., Zuo, J, & Sharifi, E. (2021). A scientometric review of trends in solar photovoltaic waste management research. *Solar energy*, *224*, 545-562. https://doi.org/10.1016/j.solener.2021.06.036

Patterson, J., Wyborn, C., Westman, L., Brisbois, M. C., Milkoreit, M., & Jayaram, D. (2021). The political effects of emergency frames in sustainability. *Nature Sustainability*, 4(10), 841–850. https://doi.org/10.1038/s41893-021-00749-9

Paul, F. C. (2018). Deep entanglements: History, space and (energy) struggle in the German Energiewende.*Geoforum*, *91*, 1–9. https://doi.org/10.1016/j.geoforum.2018.02.017

Pinna, M., & Sans, S. (2021, June 25). Windkraft in der Diskussion: Rotorblätter müssen nachhaltiger werden [Wind power under discussion: Rotor blades must become more sustainable]. *euronews*. https://de.euronews.com/my-europe/2021/06/25/windkraft-in-der-diskussion-rotorblatter-mussen-nachhaltiger-werden

Polansky, M. (2022, April 6). Habeck präsentiert sein „Osterpaket" [Habeck presents his „Easter package"]. ARD-aktuell/tagesschau.de. https://www.tagesschau.de/inland/energiewende-habeck-osterpaket-101.html

Pujante, D. (2017). The discursive construction of reality in the context of rhetoric: Constructivist rhetoric. In E. Morales-López & A. Floyd (Eds.), *Developing New Identities in Social Conflicts : Constructivist Perspectives* (pp. 41-66). John Benjamins Publishing Company. http://ebookcentral.proquest.com/lib/uisbib/detail.action?docID=4983485

Quitzow, L., Canzler, W., Grundmann, P., Leibenath, M., Moss, T., & Rave, T. (2016). The German Energiewende – What's happening? Introducing the special issue. *Utilities policy*, *41*, 163-171. https://doi.org/ 10.1016/j.jup.2016.03.002

Radtke, K. (2022, July 13). Kreislaufwirtschaft bringt enorme Vorteile für Offshore-Sektor [Circular economy brings huge benefits to offshore sector]. *Windmesse*. https://w3.windmesse.de/windenergie/news/41412-offshore-sektor-branche-grossbritannien-schottland-kreislaufwirtschaft-investtion-ausschreibung-scotwind-recycling-rohstoff-material

Ramirez-Tejeda, K., Turcotte, D. A., & Pike, S. (2017). Unsustainable wind turbine blade disposal practices in the united states: A case for policy intervention and technological innovation. *New Solutions*, *26*(4), 581–598. https://doi.org/10.1177/1048291116676098

Renn, O., & Marshall, J. P. (2016). Coal, nuclear and renewable energy policies in Germany: From the 1950s to the "Energiewende." *Energy Policy*, *99*, 224–232. https://doi.org/10.1016/j.enpol.2016.05.004

Reusswig, F., Braun, F., Heger, I., Ludewig, T., Eichenauer, E., & Lass, W. (2016). Against the wind: Local opposition to the German Energiewende. *Utilities Policy*, *41*, 214–227. https://doi.org/10.1016/ j.jup.2016.02.006

Rogge, K.S., & Johnstone, P. (2017). Exploring the role of phase-out policies for low-carbon energy transitions: The case of the German Energiewende. *Energy Research and Social Science*, *33*, 128-137. https://doi.org/10.1016/j.erss.2017.10.004

Sakellariou, N. (2018). Current and potential decommissioning scenarios for end-of-life composite wind blades. *Energy systems (Berlin. Periodical)*, *9*(4), 981-1023. https://doi.org/10.1007/s12667-017-0245-9

Salim, H. K., Stewart, R. A., Sahin, O., & Dudley, M. (2019). End-of-life management of solar photovoltaic and battery energy storage systems: A stakeholder survey in Australia. *Resources, Conservation and Recycling*, *150*, 104444. https://doi.org/10.1016/j.resconrec.2019.104444

Scheufele, D. A., & Tewksbury, D. (2007). Framing, Agenda Setting, and Priming: The Evolution of Three Media Effects Models. *Journal of Communication*, *57*(1), 9-20. https://doi.org/https://doi.org/10.1111/j.0021-9916.2007.00326.x

Schlichting, I., & Schmidt, A. (2012). Strategische Deutungen des Klimawandels [Strategic interpretation of climate change]. *Frames und ihre Sponsoren*, *25*(2), 29-41. https://doi.org/doi:10.1515/fjsb-2012-0205

Schmidt, E., Knopf, B., & Pechan, A. (2016). Putting an energy system transformation into practice: The case of the German Energiewende. *Energy Research and Social Science*, *11*, 263-275. https://doi.org/ 10.1016/j.erss.2015.11.002

Scholz, O. (2021, December 15*). Regierungserklärung von Bundeskanzler Olaf Scholz* [Government declaration by Olaf Scholz][Speech transcript]. Presse- und Informationsamt der Bundesregierung. https://www.bundesregierung.de/breg-de/service/bulletin/regierungserklaerung-von-bundeskanzler-olaf-scholz-1992008

Solar Frontier, Trina Solar, SunPower, JinkoSolar, Conergy, aleao solar, & PV Cycle. (2015, September 03). *Branchenführer sprechen sich gegen Trittbrettfahrer bei der PV-Abfallentsorgung aus* [Press release]. https://www.solar-frontier.eu/aktuelles/pressemitteilungen/2015/detail/branchenfuehrer-sprechen-sich-gegen-trittbrettfahrer-bei-der-pv-abfallentsorgung-aus/

Sonderabfallwissen. (2020, July 01). *Wohin mit ausgedienten Solarmodulen?* [What to do with disused solar modules]. Sonderabfallwissen. https://www.sonderabfall-wissen.de/wissen/wohin-mit-ausgedienten-solarmodulen/

SRU. (2022). *Klimaschutz braucht Rückenwind: Für einen konsequenten Ausbau der Windenergie an Land* [Climate protection needs tailwind: Towards a reliable expansion of onshore wind energy in Germany]. Retrieved from https://www.umweltrat.de/SharedDocs/Downloads/DE/04_Stellungnahmen/2020_2024/2022_02_stellungnahme_windenergie.html

tagesschau. (n.d.). *DEUTSCHLAND BUNDESTAGSWAHL 1998* [German federal election 1998] ARD-aktuell/tagesschau.de. https://www.tagesschau.de/wahl/archiv/1998-09-27-BT-DE/index.shtml

tagesschau. (2021a, July 27). *Vom Rotorblatt zum Autotürgriff* [From the rotor blade to the car door handle]. ARD-aktuell/tagesschau.de. https://www.tagesschau.de/wirtschaft/technologie/windrad-rotorblaetter-recycling-101.html

tagesschau. (2021b, September 26). *Wie umweltschädlich sind Solarzellen?*[How harmful are solar cells to the environment?]. ARD-aktuell/tagesschau.de. https://www.tagesschau.de/wissen/technologie/photovoltaik-recycling-101.html

Tao, J., & Yu, S. (2015). Review on feasible recycling pathways and technologies of solar photovoltaic modules. *Solar Energy Materials and Solar Cells*, *141*, 108–124. https://doi.org/10.1016/j.solmat.2015.05.005
Umweltbundesamt. (2019, November 01). Zu geringe Recyclingkapazitäten für Rückbau von Windenergieanlagen: UBA-Studie betrachtet Umweltaspekte des Recyclings alter Windenergieanlagen [Insufficient recycling capacity for dismantling wind turbines: UBA study considers environmental aspects of recycling old wind turbines]. *Umweltbundesamt.* https://www.umweltbundesamt.de/presse/pressemitteilungen/zu-geringe-recyclingkapazitaeten-fuer-rueckbau-von
Umweltbundesamt. (2020, July 20). Windenergieanlagen: Rückbau, Recycling, Repowering [Dismantling, Recycling, Repowering]. *Umweltbundesamt*. https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/windenergieanlagen-rueckbau-recycling-repowering
Umweltbundesamt. (2021, September 10). Erneuerbare-Energien-Gesetz [Renewable-Energy-Act]. *Umweltbundesamt*. https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-gesetz
Umweltbundesamt. (2022a, February 16). Batterien und Altbatterien [Batteries and waste batteries]. *Umweltbundesamt*. https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/batterien-altbatterien#berichtspflichten-gemass-ss14-und-ss-15-batteriegesetz-battg
Umweltbundesamt. (2022b, December 15). Erneuerbare Energien in Zahlen [Renewable energy in numbers]. *Umweltbundesamt*. https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#uberblick
Umweltbundesamt. (2022c, September 12). Rotorblattverwertung von A bis Z [Rotor blade recycling from A to Z]. *Umweltbundesamt*. https://www.umweltbundesamt.de/presse/pressemitteilungen/rotorblattverwertung-von-a-bis-z
Umweltbundesamt. (2022d, September 26). Rotorblattaufbereitung und Recycling von Faserverbundwerkstoffen [Rotor blade processing and recycling of fiber composite materials]. *Umweltbundesamt*. https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/windenergieanlagen/rotorblattaufbereitung-recycling-von
UNFCCC. (2022). *The Paris Agreement*. United Nations Framework Convention on Climate Change. https://unfccc.int/this-site/terms-of-use
UN Security Council. (2021, February 23). *Climate Change 'Biggest Threat Modern Humans Have Ever Faced', World-Renowned Naturalist Tells Security Council, Calls for Greater Global Cooperation* [Press release]. https://press.un.org/en/2021/sc14445.doc.htm
Van Gorp, B., & Vercruysse, T. (2012). Frames and counter-frames giving meaning to dementia: A framing analysis of media content. *Social Science and Medicine*, *74*(8), 1274–1281. https://doi.org/10.1016/j.socscimed.2011.12.045
Vattenfall. (2022, February 09). *Vattenfall verzichtet auf Deponierung von Rotorblättern* [Vattenfall refrains from landfilling rotor blades][Press release]. https://group.vattenfall.com/de/newsroom/pressemitteilungen/2021/verzicht-deponierung-rotorblaetter
VEOLIA. (2021, June 10). *VEOLIA testet mit Partnern vollständiges Photovoltaik-Recycling im industriellen Maßstab* [VEOLIA tests with partners the complete photovoltaic recycling on an industrial scale] [Press release]. https://newsroom.veolia.de/pressreleases/veolia-testet-mit-partnern-vollstaendiges-photovoltaik-recycling-im-industriellen-massstab-3098711
Vliegenthart, R., & van Zoonen, L. (2011). Power to the frame: Bringing sociology back to frame analysis. In *European Journal of Communication*, *26*(2), 101–115. https://doi.org/10.1177/0267323111404838
Volk, R., Stallkamp, C., Herbst, M., & Schultmann, F. (2021). Regional rotor blade waste quantification in Germany until 2040. *Resources, Conservation and Recycling*, *172*, 105667. https://doi.org/10.1016/j.resconrec.2021.105667
Wallasch, A. K., Lüers, S., Rehfeldt, K., Vogelsang, K. & Jachmann, H. (2018). *Vorbereitung und Begleitung bei der Erstellung eines Erfahrungsberichts gemäß § 97 Erneuerbare-Energien-Gesetz: Teilvorhaben II e): Wind an Land* [Preparation and support in the creation of a

progress report in accordance with § 97 of the Renewable Energy Sources Act: Sub-project II e): Onshore wind]. Retrieved from https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/bmwi_de/deutsche-windguard-vorbereitung-begleitung-erfahrungsbericht-eeg.pdf?__blob=publicationFile&v=7

Weckend, S., Wade, A., & Heath, G. (2016, June). *END-OF-LIFE MANAGEMENT: Solar Photovoltaic Panels*. Retrieved from https://www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels

Wehrmann, B. (2021, February 8). Resources and recycling needs for Germany’s wind turbines. *Clean Energy Wire*. https://www.cleanenergywire.org/factsheets/resources-and-recycling-needs-germanys-wind-turbines

Weißhaupt, P. (2020, February 03). Faserverbundwerkstoffe und ihr Potenzial für Klima- und Ressourcenschonung [Fiber composite materials and their potential for climate and resource conservation]. *Umweltbundesamt*. https://www.umweltbundesamt.de/faserverbundwerkstoffe-zukunftsmaterial-offener#faserverbundwerkstoffe-und-ihr-potenzial-fur-klima-und-ressourcenschonung

Wenzel, S. (2017). *Antwort auf die mündliche Anfrage: Wie entsorgt man ein Windrad?* [Answer to the oral question: How do you dispose of a windmill?]. Retrieved from https://www.umwelt.niedersachsen.de/startseite/aktuelles/pressemitteilungen/antwort-auf-die-muendliche-anfrage-wie-entsorgt-man-ein-windrad-154746.htmlg

WindEurope. (2020). *How to build a circular economy for wind turbine blades through policy and partnerships*. WindEurope. https://windeurope.org/policy/position-papers/how-to-build-a-circular-economy-for-wind-turbine-blades-through-policy-and-partnerships/

Wörrle, J. T. (2019, May 05). Solarmodule: So sauber ist die Entsorgung wirklich [Solar modules: So clean is the disposal really]. *DHS*. https://www.deutsche-handwerks-zeitung.de/solarmodule-so-sauber-ist-die-entsorgung-wirklich-135269/

World Health Organization. (2021, October 30). *Climate change and health. World Health Organization*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

Xu, Y., Li, J., Tan, Q., Peters, A. L., & Yang, C. (2018). Global status of recycling waste solar panels: A review. *Waste Management*, *75*, 450-458. https://doi.org/10.1016/j.wasman.2018.036

Yao, L. (2018). THINKING ABOUT THE GERMAN ENERGIEWENDE: AN OUTSIDE VIEW ON THE CHALLENGES AND OPPORTUNITIES AHEAD. In T. Cunningham, A. Hedberg, S. Nazakat, & L. Yao (Eds), *ASSESSING THE ENERGIEWENDE: AN INTERNATIONAL EXPERT REVIEW* (pp. 18–20). Konrad Adenauer Stiftung. http://www.jstor.org/stable/resrep17543.7

Young, R. A., & Collin, A. (2004). Introduction: Constructivism and social constructionism in the career field. *Journal of vocational behavior*, *64*(3), 373-388. https://doi.org/10.1016/j.jvb.2003.12.005

Zembylas, M. (2005). Three Perspectives on Linking the Cognitive and the Emotional in Science Learning: Conceptual Change, Socio-Constructivism And Poststructuralism. *Studies in science education*, *41*(1), 91-115. https://doi.org/10.1080/03057260508560215

Zepelin, J. von, & Dunkel, M. (2017, March 01). Wohin mit dem Windradmüll? [What to do with the wind turbine waste?]. *Capital*. https://www.capital.de/wirtschaft-politik/energiewende-windraeder-abfall-recycling-rohstoffe-remondis-8570

Zotz, F., Kling, M., . Langner F., Hohrath P., Born, H. & Feil, A. (2019, October). *Entwicklung eines Konzepts und Maßnahmen für einen ressourcensichernden Rückbau von Windenergieanlagen Abschlussbericht* [Development of a concept and measures for a resource-securing dismantling of wind turbines Final report]. Retrieved from https://www.umweltbundesamt.de/publikationen/entwicklung-eines-konzepts-massnahmen-fuer-einen